
Conor Michael Harte
Department of Management & Enterprise, Munster Technological University, Cork, Ireland, conor.m.harte@mycit.ie

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Cluster Evolution: A Longitudinal Analysis and New Method for Cluster Life Cycle Stage Identification

By
Conor M. Harte, BA Accounting and Finance

Doctor of Philosophy
Faculty of Business and Humanities
Supervisors: Dr John Hobbs, Dr Breda Kenny

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ABSTRACT


Conor Harte

National governments and policy makers alike need data and expertise as they seek to develop accurate and relevant cluster policies and initiatives. It is argued that clusters also have life cycles similar to the way industries, products, and technologies have a life cycle, including a variety of stages (Ingstrup and Damgaard, 2013; Jia et al., 2015; Fornahl and Hassink, 2017; Ferrari et al., 2020). This research addresses three objectives:

1. Analyse the longitudinal development of a cluster to record, measure and analyse its evolution over a three-year period;
2. Create a new methodology to support cluster life cycle stage identification;
3. Support policy makers in developing and implementing tailor-made policy initiatives relevant to the cluster’s current stage along its respective cluster life cycle.

For the very first time, V-LINC methodology is applied in a longitudinal capacity, to record, visualise, and analyse the BioWin cluster and its ecosystem. A conceptual model, based on three pillars (Economic Impact, Cluster Organisation and V-LINC) encompassing twelve carefully selected variables, is created to identify the stage a cluster is positioned in the cluster life cycle. The outputs of a longitudinal V-LINC analysis measures the effectiveness of cluster policies/initiatives and if they are relevant to the cluster’s identified life cycle stage. This can help to further develop clusters and support its members’ internationalisation.

The key findings of the research contribute to the understanding of how clusters at different stages of the cluster life cycle operate and what supports they require. It is also vital to comprehend what policy initiatives are required at each stage of the life cycle, as a ‘one-size-fits-all’ policy implementation does not work. This research has practical implications for policy makers and managers of cluster organisations to name but a few. There are also implications for researchers focused on clusters, cluster life cycles, longitudinal cluster analyses and cluster policy with the empirically tested model of cluster life cycle stage identification contributing to the cluster literature.

Keywords: V-LINC, Cluster, Cluster Organisation, Ecosystem, BioWin, Mapping, Cluster Life Cycle
DECLARATION OF ORIGINALITY

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

I declare that the thesis embodies the results of my own work. Following normal academic conventions, I have made due acknowledgement of the work of others. The research has fully complied with the Institute’s Code of Good Practice in Research.

Signed:

Conor Harte.

Date: 31/08/2022

Signed:

Dr John Hobbs.

Date: 31/08/2022
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Chapter 1

1 INTRODUCTION

1.1 Research Background

The cluster phenomenon has emerged as one of the main pillars of modern economies, not only in Europe but also throughout the world. Industrial clusters have undergone a long conceptual evolution, which began in the late nineteenth century with Alfred Marshall and lasted for over a century. Clustering has empirically demonstrated an ability to boost the economic performance of regions, especially in relation to cluster firms' productivity and innovation capacity as well as enhancing firms' overall success. Clusters have been defined in many different ways by a myriad of authors (Enright, 1996; Porter, 1998b; van den Berg et al., 2001; Ketels, 2013; Manning, 2013; Huh and Lee, 2019; Bergman and Feser, 2020; Sedlmayr et al., 2021). There are also numerous themes that remain constant throughout and Moynihan (2018, p. 4) alludes to this point, noting most agree that “clusters are formed by geographically proximate, interlinked nodes which create commonalities and complementarities.”

Porter’s work in his ‘Competitive Diamond of Local Industrial Clustering’ highlights determinants of competitive advantage for nations. Several of these determinants affect how firms compete, such as the availability of resources and skills required to gain a competitive advantage, the information that shapes the investment and innovation landscape and how they are perceived, employee and manager aims and objectives when competing, and the pressure on firms to invest and innovate. Globally, governments and regions have committed to promoting and supporting industry clusters as a means to create jobs and competitiveness. Byrne (2016, p. 1) argues “cluster theory is based on the premise that collaborative regional ecosystem can contribute to enhancing innovation, growth and competitiveness of regions and their member companies which are part of clusters.” Naumanen (2019, p. 5) when comparing clusters with other non-clustered locations found that clusters display:
“13.5% higher average wage
+0.7% higher annual wage growth rate
+0.5% higher annual employment growth rate
143% more global frontier firms
77% more high-growth firms
141% more rapidly growing start-up.”

More than 3000 clusters exist in the EU (EC, 2021) with members employing over 50 million people. They account for almost every fourth job in Europe (61.8 million jobs or 23.4% of total employment) and about half of the jobs in exporting industries (50.3%) (EC, 2021). Clusters drive growth in Europe through their higher number of innovative and high-growth firms, presenting better performance on key social and competitive indicators. Economic and geographical scholars have long tried to explain why certain industries thrive, expand and succeed in certain locations, while others do not. In recent decades, cluster initiatives (see section 4.3) have become “a central part of industrial, regional and innovation policy-making across the developed world” (Sölvell et al., 2003, p. 15). Globalisation has led to regions and firms having to adapt the way in which they operate, with advances in communication, technology, skills and transportation constantly evolving.

Clusters, once viewed as static, pre-defined, isolated and successful entities (Bresnahan et al., 2001; Martin and Sunley, 2003, Sair and Slilem, 2022), have continuously evolved since the late 19th century and are argued to pass through stages of a ‘cluster life cycle’ (Brenner, 2004; Bergman, 2007; Klepper, 2007; Sölvell, 2008; Menzel and Fornahl, 2010; Ingstrup and Damgaard, 2013; Jia et al., 2015; Fornahl and Hassink, 2017; Denney et al., 2020; Ferrari et al. 2020; De Sousa Ostapenko et al., 2021). Similar to that of industries, products and technology, industry clusters have a life involving stages and subsequently the cluster life cycle concept is placed at the core of this body of work. De Sousa Ostapenko et al. (2021, p. 21) note clusters’ and industries’ life cycles “are not the same; different clusters belonging to the same industry can follow very different growth paths.” Clusters can grow or decline independently of the industry's development based
on the homogeneity or heterogeneity in competencies and cluster-specific technological or institutional lock-ins (Trippl et al., 2015; De Sousa Ostapenko et al., 2021).

Empirical studies and results have shown clusters to enhance companies’ innovation and performance (Porter, 1998; Doloreux and Lord-Tarte, 2013; Trippl et al., 2015; Conz et al., 2017; Desmarchelier and Zhang, 2018; Felzensztein et al., 2018), subsequently; the effect of cluster agglomeration is not constant. Positive agglomeration effects, which exist during the early stages of the cluster life cycle, are replaced by congestion effects, which negatively constrain firms as the cluster matures (Menzel and Fornahl, 2010; Martin and Sunley, 2011; Dyba et al., 2020). It is argued that clustered companies outperform non-clustered companies at the beginning of the life cycle and “have worse performance at its end” (Menzel and Fornahl, 2010, p. 206). In reference to the work of Trippl et al. (2015) and Porter (1998a), De Sousa Ostapenko et al. (2021, p. 21) note as clusters are not a static phenomenon; their structure and configuration change, “they continually evolve, maintaining vibrancy as competitive locations for centuries or losing their competitive edge due to both external and internal forces.”

Economists and scholars alike have long sought to answer certain questions such as ‘why do firms co-locate in geographic locations; why are clusters important and why do regions want strong clusters?’ Firstly, there is a need amongst producers to locate as closely as possible to resources required for production and being close to such resources reduces costs and time while strengthening the overall efficiency of the production process. Secondly, Marshall (1920, p. 269) defined the ‘patronage of a court’ that produces the “demand for goods of especially high quality.” The geographical proximity of firms, according to Pavan (2020)) is a phenomenon driven by particular factors. Industrial districts are a result of a lengthy process, which requires the connecting, and amalgamating of firms. Advantages of this process are realised once this agglomeration of firms persists over a prolonged period of time.

Cluster theory has achieved a universal level of acceptance, and Duranton (2011, p. 3) acknowledges this adding cluster building and cluster development are now “widely
viewed as key pillars of local development policies.” The importance of cluster policies is a recurring theme throughout this thesis and the need for developing and implementing tailor-made, timely, specific and relevant policies for clusters is crucial. However, to date there is a distinct lack of methods and/or rubrics that can assist in the identification of cluster life cycle stages for clusters under investigation. Policy makers and cluster organisations alike can benefit from such a tool or model if they are prevented from falling into the mistake (that authors and scholars once believed) that cluster policies can simply be developed and implemented using a one-size-fits-all approach. The data required to complete such a model can be gathered via a longitudinal analysis of a cluster. Longitudinal studies in the current literature are, as already alluded to, few and far between and this is due to the complexities and limitations associated with such studies. For example, the author experienced difficulties such as the cost and time consuming nature of longitudinal cluster studies, to name but a few. These limitations and more are discussed in greater detail later in the thesis.

The work of vom Hofe and Chen (2006) places a spotlight on issues of cluster theory concerning measurement, identification and comparison of clusters, rendering it problematic. Clusters are becoming more important economically for regions (implemented as economic development tools) with links to Smart Specialisation Strategy (S3) plans. There is a need to ensure clusters are measured accordingly and this in turn will allow clusters to be measured and analysed by each individual and organisation alike in the same way, thus providing more accurate and comparable data and results. There is little in the literature linking cluster life cycles, longitudinal studies and specifically, cluster life cycle stage identification models. Given the need to combine such methods and tools for growth in the blue economy, this needs to be addressed.

### 1.2 Definitions

Given the breadth of definitions, and their importance in framing the scope of this research, and in any subsequent application of findings, Table 1.1 provides key definitions pertinent to this research and that will be applied throughout. For the purposes of this research, the following definitions are used;
Cluster | A geographically proximate group of firms in related and supporting industries, economic actors and institutions linked in some way, which benefit from their mutual proximity and connections (Byrne, 2016).

Cluster Organisation | These are legal entities that support the strengthening of collaboration, networking and learning in innovation clusters and act as innovation support providers by providing or channelling specialised and customised business support services to stimulate innovation activities, especially in SMEs (ECCP 2020).

Cluster Initiative | An initiative or programme to facilitate clustering (ECCP, 2021).

Cluster Management | The organisation and coordination of the activities of a cluster in accordance with a certain strategy, to achieve clearly defined objectives (Schretlen et al., 2011).

Cluster Governance | Appointing cluster managers and evaluating their performance, setting the vision and strategy of the cluster and approving action plans (Schretlen et al., 2011).

Cluster Life Cycle | The metaphor of the life cycle carries obvious biological connotations of the progression of an entity or cluster in this instance, through the various stages of its ‘life,’ from birth to death (Martin and Sunley, 2011).

Smart Specialisation Strategy | Combines industrial, educational and innovation policies to suggest that countries or regions identify and select a limited number of priority areas for knowledge-based investments, focusing on their strengths and comparative advantages (OECD, 2021).

Table 1.1: Definitions of Terms Used in the Thesis  
Source: Author and references within

1.3 Research Rationale, Aims and Objectives

The rationale for undertaking this thesis arose from an interest in supporting the development of cluster policy by providing vital information and knowledge from an established cluster in Belgium where the author resides. There is a wide-ranging body of literature examining clusters; despite this, there are a number of gaps, which remain; these gaps are addressed in this research. This body of work seeks to contribute to the literature in two ways;

**Firstly**, this research aims to implement a new methodology for a longitudinal cluster analysis by elaborating on established cluster analysis methods i.e. V-LINC, integrating techniques external to the field of economic geography, while showcasing the prospect to visualise cluster ecosystems. In doing so, this is the first longitudinal V-LINC analysis undertaken and the research aims to fill in some of the gaps in the existing literature,
particularly in the field of longitudinal studies pertaining to cluster life cycles. The objective of this study is to map, measure, analyse and assess the evolution of the BioWin cluster over a three-year period, with the learnings and results having implications for policy makers.

**Secondly**, the author identified a real lack of frameworks and conceptual models within the current literature that can be used to identify the life cycle stage of a particular cluster under investigation. If one considers longitudinal analysis and cluster evolution, there is a need to investigate the concept of cluster life cycles in combination with a need for clusters, cluster organisations and policy makers to understand at what particular stage of the life cycle their cluster is at. A key aim is to build a method for cluster life cycle stage identification. This new method is applied to the BioWin cluster (active in the field of life sciences) ultimately informing the organisation at what stage of the cluster life cycle their cluster is currently at. The new methodology is designed to be replicable in any cluster in any region or sector across the globe, allowing cluster life cycle stages to be identified. This in turn can assist policy makers in developing well-timed, tailor-made policy initiatives that are relevant to the cluster and suitable to the stage of the cluster life cycle it is positioned. This is vital as a generic one-size-fits-all policy implementation process is not an effective method (Pavan, 2020).

Having discussed the research contributions in detail, the following objectives are used to achieve the aforementioned aims:

1. **Analyse the longitudinal development of a cluster to record, measure and analyse its evolution over a three-year period;**

2. **Create a new methodology to support cluster life cycle stage identification;**

3. **Support policy makers in developing and implementing tailor-made policy initiatives relevant to the clusters current stage along its respective cluster life cycle.**

These objectives and how they are realised are discussed throughout the body of work with section 9.9 providing more in-depth details of how they are achieved.
1.4 Method

The absence of a consistent, comparable and universal method for cluster analysis is evident in the study performed by the Harvard Competitive Institute in 2003, of more than 800 clusters from 52 countries worldwide. It employed no less than 48 different methodologies to perform a comprehensive analysis, which is a noteworthy weakness in Porterian cluster analysis. Authors such as Feser and Bergman (2000), Cortright (2006), vom Hofe and Chen (2006), Hobbs (2010) and Byrne (2016) note the lack of a clear and concise method for measuring and analysing clusters.

This research applies V-LINC (Visualisation of Linkages In Networks and Clusters), a hybrid methodology for cluster analysis, to evaluate The BioWin Health Cluster longitudinally between 2018 and 2020. V-LINC derived from the work of Hobbs (2010) entailing the ‘Four i Linkage Scale’ methodology, and further developed by Byrne (2016), is implemented and used to record, measure and analyse the linkages and relationships that firms in a particular cluster engage in to enable further comprehension of the cluster ecosystem. V-LINC is originally comprised of three elements: firstly, a method to collect linkage data from firms; secondly, a software tool (Byrne, 2016) to visualise cluster ecosystems, and thirdly, analysis to assist the development of tailor-made policy initiatives. The research seeks to build on these elements that were originally implemented in a V-LINC research of 12 months, and apply it longitudinally, tracking the evolution of the linkages gathered year after year. The creation of an improved more replicable data collection method (during a period of more than 12 months) is sought which can be applied to various clusters and regions.

The data from V-LINC analyses of the BioWin cluster is assessed annually and after taking into account the regional context, policy initiatives are developed for each cluster to build on existing strengths and address weaknesses identified in the analysis. The firms that participated in this research were carefully selected through the assistance of BioWin, the cluster organisation. The results of the V-LINC analyses, their visualisations and

---

1 V-LINC is a hybrid methodology as it combines existing methods with new techniques used in cluster analysis
policy initiatives are presented in the individual cluster and firm reports from Year 1 (2018) to Year 3 (2020). The research compares the clusters results each year in relation to three cluster determinants: 1) the value chain, 2) knowledge linkages, and 3) economic policy and support. The research also investigates how dependent clusters are on local linkages, and the relative importance of global networks (Bathelt et al., 2004; Owen-Smith and Powell, 2004; Wolfe and Gertler, 2004; Denney et al., 2020). This study seeks to add a vital, seamlessly replicable component to the cluster theory literature, which can be used to record, measure, analyse and classify/identify clusters and their respective cluster life cycle stages. This will subsequently be used to enable policy recommendation development that could ensure optimal growth in any given cluster in any given sector or country.

1.5 Structure of the Thesis

The thesis is made up of nine chapters. Following this introductory chapter, the thesis is structured as follows:

Chapter 2 provides an introduction and overview of the Wallonia region, followed by an in-depth look at the BioWin cluster under investigation. A brief look at the regions own S3 is complemented by an outline of the BioWin cluster, its history and how it functions. The chapter is supported by information attained from a structured interview with the Managing Director of BioWin, Dr Sylvie Ponchaut. The chapter concludes with a brief summary of the COVID-19 global pandemic that occurred during the time of this research, including the role BioWin and its members played in combatting the highly infectious disease that saw numerous industries and sectors come to a near standstill.

To accurately discuss, measure and analyse industry clusters, one must first comprehend cluster theory, including its intricacies and shortcomings. Chapter 3 aims to simplify the concept of clustering by outlining the theory on industry clusters and its origins regarding geographic proximity and agglomeration literature. The wealth of cluster definitions available and commonly adopted in academic discourse are examined, with key cluster
characteristics outlined. The chapter ends with a summary of the advantages and shortcomings of clustering.

Chapter 4 investigates cluster organisations, cluster initiatives and cluster managers. Although separate entities, they each play a pivotal and leading role in enhancing competitiveness, yet are commonly incorrectly used in an interchangeable manner. This chapter seeks to create distinct, clear and concise definitions and understandings, while clarifying the differences between these key concepts, as well as examining the roles they play in economic and regional development. To finish, the chapter summarises the different key roles cluster organisations, cluster initiatives, and cluster management independently play in industry clusters.

While researchers once believed that clusters were a static entity and path dependent tools, it has been proposed that similar to industries and products, for example, clusters too pass through different stages of a life cycle. Accordingly, Chapter 5 examines the concept of cluster life cycles, which is at the heart of this overall research, providing definitions to facilitate understanding of why clusters emerge, grow, mature and potentially decline and or reinvent themselves. The various stages of cluster life cycles and policy initiatives are assessed and discussed in detail.

Chapter 6 introduces the philosophy of research, its framework, paradigms and approaches. Then the numerous and varying cluster analysis methodologies from the literature before presenting and investigating in detail, the V-LINC methodology developed by Byrne (2016). The steps involved when applying the V-LINC methodology are described. The chapter ends with the introduction of a conceptual model for identifying cluster life cycle stages and the pillars and variables upon which it is built.

Chapter 7 provides a detailed look at the methodological approach taken by the author for this research study. It examines V-LINC as the base method in combination with the authors’ new additional steps required when implementing V-LINC in a longitudinal
research. Due to the effects of the COVID-19 global pandemic, the V-LINC data collection and interview process required adaptation and in light of the author's needs to adapt to new protocols across Belgium, face-to-face and online interviewing techniques are collectively reviewed. The chapter concludes with a summary of the V-LINC methodology.

The V-LINC reports for the BioWin cluster are presented in Chapter 8. The V-LINC report for Year 1 (2018), its results and visualisations are presented in full and discussed, followed by a review of the policy initiatives developed in relation to the 2018 results. This is proceeded by the Year 2 results from the V-LINC data analysis and comparison of Year 1 to Year 2 data. It should be noted that the Year 2 report focuses solely on the comparative and new element of the research incorporating the 'Retained', 'New' and 'Lost' linkages between 2018 and 2019 and the policy recommendations garnered. The Year 3 comparative results then follow the same process as the Year 2 results and are subsequently presented alongside the policy recommendations for 2020. The chapter concludes with the categorisation of the cluster life cycle, showcasing the data used in the cluster life cycle stage identification for the BioWin cluster.

Chapter 9 evaluates the overall findings of the longitudinal research, in which the empirical, theoretical and methodological contributions of the study are presented. It begins with a summary of the policy implications typically found at each of the four stages of the cluster life cycle followed by the policy implications for the relevant stage the BioWin cluster is positioned at the time of the research. Under the empirical contribution heading, a summary of the evolution of the V-LINC analysis results for the three years combined is displayed alongside a data review of the same period of time. Theoretical and practical contributions are presented; limitations are identified as are areas for future research. The main conclusions are drawn in this chapter, highlighting the relationship between the aim, objectives and research questions and how they are realised.
In the following chapter, the reader is provided with a holistic view and deeper understanding of the cluster (BioWin) and region (Wallonia), in order to put the research in context with whom and where it was conducted and why.
Chapter 2

2 CLUSTER AND REGION

2.1 Introduction

This thesis aims to support the development of cluster policy by fast-tracking knowledge from an established cluster in Belgium. For this reason, a region and cluster, which are experienced and have well-developed connections with industry is required. From a practical perspective, with the author based in Belgium for the duration of their studies, and the Wallonia region having its own cluster programme since 2006, managed by Service Public de Wallonie (SPW), it was an ideal environment to undertake such a study. Thus, one of the Walloon clusters, the BioWin Health Cluster was a good strategic partner for this study. In this context the author, BioWin, SPW and Munster Technological University (MTU) saw mutual benefit from collaboration and learning from each other’s insights, experience and expertise. The primary purpose of this study is to fill in some of the gaps in the existing literature, particularly in longitudinal studies of cluster life cycles and finding a reliable method for identifying cluster life cycle stages. The research involves a three-year study mapping, measuring, analysing, and assessing the evolution of the BioWin cluster and the linkages their members engage in annually, while taking the key learnings and findings that could have implications for policymakers.

In this chapter, an overview of the Wallonia region is provided, followed by an in-depth look at the BioWin Cluster. An introduction to the Service Public de Wallonie (SPW) and Wallonia as a European Creative District (ECD) is found in section 2.2.1, alongside clusters and S3 within the Wallonia region itself in section 2.2.2. The first part that introduces and discusses the Wallonia region ends with section 2.2.3, providing an insight
to the role foreign investment and the Agence Wallonne a l’Exportation’ (AWEX) play within Wallonia. This is then followed by a section introducing the BioWin cluster (section 2.3), its history and how it operates. This particular section and chapter is supported with information from a structured interview in April 2021 with Dr Sylvie Ponchaut, Managing Director (MD) of BioWin. Dr Ponchaut was appointed as MD of BioWin in 2014 and was able to provide an inside account into how both the cluster and the Wallonia region have developed to date. The chapter finishes with the conclusion in section 2.4.

2.2 The Wallonia Region

The region of Wallonia is a former powerhouse of heavy industry during the industrial revolution due to its coal and iron deposits. It has reinvented itself focusing more on high value sectors, namely aeronautics and aerospace, life sciences, transport and logistics, agri-industry, fine mechanics and nanotechnologies, green chemistry and sustainable materials (Wallonia, 2020). In 1970, the region of Wallonia was legally created, and since 2008, the two Ministries, The Ministry of the Walloon Region (MRW) and The Walloon Ministry of Equipment and Transport (MET), amalgamated, and thus the Service Public de Wallonie (SPW) was born (SPW, 2020).

Wallonia is a hotspot for numerous innovative biopharma and biotechnology companies and the biopharmaceutical industry in Wallonia has proven to be a major catalyst for growth in the region. The pharmaceutical sector provides more than 54% of all jobs within Belgium and is the main industrial activity in the region (AWEX, 2020). Of the twenty five thousand direct jobs associated with the industry, two thirds of them are located in the Wallonia region. Belgium represents 16% of the total European turnover in the biotech industry (AWEX, 2020). For three consecutive years (2017-2020), Belgium has positioned itself as the ‘European biotech leader’, with the country’s firms representing 24% of the total stock market value of all European biotech firms. Despite the global COVID-19 pandemic arriving during 2020, the overall value of Belgian biotech firms grew in value from 27 billion euro to 42 billion euro (a 56% increase on the previous year) (Flanders, 2021). Belgium’s biotech success across Europe is driven by major
players, for example, UCB, Argenx and Galapagos. Argenx raised 780 million euro, which was the largest increase in capital for a publicly traded biotech firm in Europe (Flanders, 2021). The average market value of smaller firms within Belgium increased from 171 million euro to 259 million euro (Flanders, 2021).

The Wallonia region presents itself as a major exporting region, having sold goods to the value of ca. 50 billion euro in 2019 (an 11.2% increase compared with that of 2018) with pharmaceutical and chemical industries responsible for 35% of this total in 2020. The bio-pharmaceutical sector is constantly expanding and was one of the only sectors to negate the job losses and closure effect that the COVID-19 health crisis had globally (AWEX, 2021).

2.2.1 The Service Public de Wallonie (SPW) and European Creative District (ECD)

The SPW is the Public Service of Wallonia; it is the government administration of the Walloon Region, located in Namur, in the south of Belgium. Structurally, the SPW consists of eight Directorate-Generals (DGs). These DGs are responsible for managing public, industry, associations and local authorities’ needs and expectations. They include:

- The General Secretary of the SPW
- The SPW Budget Logistics and ICT
- SPW Mobility and Infrastructures
- SPW Agriculture, Natural Resources and Environment
- SPW Territory, Housing, Heritage and Energy
- SPW Interior and Social Action
- SPW Economy, Employment and Research
- SPW Taxation (SPW, 2021).

SPW was formed in 2008, and supports the Walloon Government in realising the policy created and established (Wallonia, 2020). Optimising the quality, effectiveness and efficiency of the services provided to the public is essential in order to respond and adapt to the constant changes in market trends and new needs of society. SPW is the first interface between regional institutions, individuals, businesses and associations.
The Walloon parliament and government, combined with the SPW and the public interest bodies, are responsible for the policy and strategy implementation processes within the region. As a government agency, the SPW mobilises roughly 10,000 people spread out across Namur, the Wallonia region and Brussels (Wallonia, 2020). Wallonia is located at the heart of Europe, with the region attracting multi-national corporations such as Google, Microsoft, GSK and Baxter etc. to locate and develop their business activities (Wallonia, 2020). These large multinational players are vital to the region in providing expertise and knowledge to other industry sectors as well as attracting a talented and skilled workforce to the region.

Out of forty European candidate regions, Wallonia was selected as a “European Creative District” (ECD) in 2013, demonstrating the regions competency and potentially providing an explanation for why multi-national corporations have chosen the region as a location for their activities (AWEX, 2020). The ECD title was promoted through the implementation of the ‘Creative Wallonia’ programme over a three-year period from the beginning of 2013 to the end of 2015. SPW and other government agencies built the programme on four pillars: creative skills, improved support for businesses, enhanced financial support and accommodating clusters and networking activities (Interreg, 2020). The success of the Creative Wallonia programme now sees it placed as one of the vital axes of the Walloon Smart Specialisation Strategy (S3) and receive recognition internationally from the European Commission (Interreg, 2020). It is important at this point to take an in-depth look at the S3 origin and implementation across the region.

2.2.2 Clusters, Smart Specialisation Strategy and the Wallonia Region

Cluster policies have increasingly shaped part of the global political toolbox (Sölvell, 2008). In 2006, a cohort of Walloon competitiveness clusters\(^2\) were created and initiated by the Minister of the Economy through the Marshall Plan\(^3\). Six competitiveness clusters

\(^2\) A competitiveness cluster is a formation of companies and actors (research centres and university departments) encompassing a promising economic field (http://clusters.wallonie.be)

\(^3\) The term ‘Marshall Plan’ was used by a former head of Wallonian government, Elio di Rupo referring to the immense aid given to Europe by the United States post World War II (Economy: Innovation clusters form heart of grand revival plan, 2012)
or ‘pôles de compétitivité’ were developed and located in Wallonia, in sectors of strategic importance. Five were created in 2006 with the sixth pole being formed in 2009 (Figure 2.1). The six Poles implemented industrial projects by bringing large firms, SMEs and research and training providers together, with an aim of creating and bolstering activity as well as stimulating employment in unchartered domains. Furthermore, they sought to develop industry’s internationalisation capabilities and have endeavoured to renovate the economic fabric of Wallonia (Wallonia Clusters, 2020). Figure 2.1 is included as an empirical example and visual aid to display the timeline of cluster policy development in the Wallonia region, as well as when the region launched the concept of a ‘business cluster’ first in 2001, before adding the ‘competitiveness cluster’ concept in 2006. What started as a bottom-up approach in 2001, developed into a hybrid approach incorporating top-down and bottom-up approaches to the development of cluster policies in Wallonia.

Figure 2.1: The Timeline of Development of Clustering Policies in Wallonia
Source: Author based on EC (2020)

In terms of jobs, new products and innovative service creation, the poles have become a vital cog in the wheel of large-scale industrial policy within the region through supporting the winning of industrial contracts and increased visibility across international markets (Wallonia Clusters, 2020). This aligns with the work of Sedlmayr et al. (2021) in which they suggest internationalisation is more than simply tapping into new markets and recognising new market opportunities. Internationalisation, for SMEs also means
complementing value chains i.e. innovative capacities in SMEs can increase if research partners are found in tandem with the initiation of new product development.

In 2015, the Walloon government officially developed a specialisation strategy for Wallonia titled ‘Towards a regional policy of sustainable industrial innovation’ (Wallonie Economie, 2015). The approach taken by the Walloon government was grounded in the policy of ‘Competitiveness Poles’ and clusters and the success of previous legislatures. The aims and objectives of the new strategy involved “stimulation of innovation in the broad sense, including ICT, and emphasis on industrial development; involvement of SMEs with potential in industrial and innovation dynamics and support for the creative economy; development of the circular economy and Internationalisation of industrial and innovation players” (Wallonie Economie, 2015). In this policy, SMEs target foreign markets in order to grow and develop, while ensuring they connect with the right people as well as being visible to potential global customers and investors.

The clustering policy of Wallonia focused on two areas: ‘Business Clusters’ and ‘Competitive Clusters’. The competitive clusters’ mission is to stimulate the growth of innovative collaborative projects stemming from intercompany synergy, and connections to universities, research and innovation centres (Wallonia Clusters, 2020). Thus, six sectors were prioritised and chosen by the Walloon government and were represented by the following cluster organisations; BioWin, GreenWin, Logistics in Wallonia, MecaTech, Skywin and Wagralim (Wallonia Clusters, 2020). Business clusters are financed to develop economic action (be it industrial, technological or commercial), whilst, competitive clusters are mostly implemented to achieve investment, increase R&D/training projects and drive internationalisation (Wallonia Clusters, 2020). Taking a more detailed look at the two cluster forms:

**Business clusters** encourage economic development for SMEs, connect them, and integrate them into existing and future ecosystems, promoting innovation and creativity while fostering sustainable growth that responds to environmental and societal challenges. Martin and Sunley (2011, p. 1303) note that a business cluster is a “composite system or population of entities, in this case of firms.” In the Wallonia region, business clusters are financed to develop economic activities and promote innovative partnerships,
whether of an industrial, commercial or technological nature (Wallonia Clusters, 2020). The Wallonia Clusters (2020) define business clusters as an association that has been formed primarily at the initiative of companies active in the Walloon Region, but also has the scope to invite academic institutions, research centres, training centres, etc. Business clusters can be characterised by

- “the mobilization of a representative critical mass covering one or several fields of activity;
- a co-operation framework encompassing related activities,
- the voluntary development between the companies of a complementarity relationship, vertical or horizontal, profit or non-profit;
- the promotion of a common vision of development” (Wallonia Clusters, 2020, p. 3).

**Competitive clusters** are focused on the strategic development of support for their members aspiring to improve and as such, the Walloon clustering policy plays a vital role in the Wallonia’s S3. According to the Wallonia Clusters (2020, p. 2) In Wallonia, a competitive cluster can be defined as a group of firms, training centres, and public or private research units that are “committed to a partnership-based approach with the aim of generating synergies in relation to common projects.” Within the Wallonia region, the competitive clusters are mainly supported for the realization of investment, R&D or development projects, training in line with the competitive positioning strategy that they themselves have defined (Wallonia Clusters, 2020). The key elements of competitive clusters incorporate partnerships; firm common projects and international visibility are these elements bring together the three main components of firms, training, research and innovation.

It is important to note that the partnership elements of a competitive cluster can allow firms to grow, align the required competencies to launch ambitious projects and enhance innovation capacities by relying on the competencies of their partners. This in turn can improve the workforce’s skills and expertise. The partnerships also play a role in improving each stakeholder’s visibility as well as the cluster’s visibility at a European and international level. For competitiveness and international visibility, the partnership
must reach critical mass around a market and related technology and scientific fields (Wallonia Clusters, 2020). The National Reform Programme (2018, p. 133) notes the Mecatech and BioWin Clusters have joined with other regional stakeholders to launch the ‘Medtech’ Wallonia initiative, which aims to support start-ups and businesses working in medical technologies. This initiative is “part of more global cooperation with the other Belgian regions based around a Medtech Accelerator.”

The National Reform Programme (2018) details how the European Commission selected Wallonia as a test region for industrial transition and that they provide the region with support for developing its S3 strategy in order to meet such industrial transformation challenges. The Walloon government S3 implementation is used to ensure that the regional efforts continually adhere to the driving forces of its clustering policy. The National Reform Programme (2018, p. 133) described how S3 was designed as “an evolving process, and its implementation will therefore be continued and improved.” Interest and development of an S3 policy is obligatory for EU members to be eligible for the receipt of European Structural Funds. Wallonia has welcomed the S3 policy with open arms and is reaping the benefits of integrating same with local policies (Keller et al., 2018). The Wallonia region is a living example of a region implementing S3 policies and the region supports Pavan’s (2020) argument that S3 is one of the most important tools in defining and implementing regional innovation pathways successfully.

2.2.3 Foreign Investment in the Wallonia Region and AWEX

Foreign companies invested €15.5 billion in Wallonia between 2000 and 2019, creating nearly 37,000 jobs directly in the pharmaceutical sector, the majority of which have come from the U.S (Wallonia, 2019). As a primary contact point for foreign companies and or potential foreign investors considering the Wallonia region as a base, the ‘Agence Wallonne a l’Exportation’ (AWEX) is a key part of the region’s growth and success in relation to the attraction of foreign investment. Lambrecht and Pirnay (2005, pp. 97–98) note that since 1998, AWEX co-ordinates internationalisation and “plays a vital role acting as the main contact point for all foreign companies interested in locating in the Wallonia region or bolstering their already existing activities.” AWEX supports all
Walloon companies targeting overseas markets and seeking to increase their exports (AWEX, 2020). In Belgium, the legal responsibility for financial support to SMEs has been transferred from the national level to its three regions; the Flemish, Brussels and Walloon. AWEX see the value in the creation of clusters regionally and have since worked strategically to harvest better outcomes for the entire ecosystem, by working with clusters at a regional level to support their shared agendas.

The Walloon clusters, through support from SPW and AWEX bring together members, e.g. manufacturers, research/training centres and universities, who are active in particular fields and who wish to collaborate (AWEX, 2020). Business-to-Business partnerships are formed within these clusters to develop synergies, with such connections combined with an objective of carrying out research and development and pilot investment for training projects (AWEX, 2020). Among many attractive pull factors to the region, Wallonia has supportive regional and federal initiatives, which allow companies the opportunity to reduce training and recruitment costs. Attracting a skilled workforce is an ongoing process, but retaining them is even more imperative. To support such recruitment and retention, Wallonia offers a series of housing aids calculated based on the workers family and income situation (WESPW, 2020). Such pull factors are taken into consideration when firms are deciding to locate in the Wallonia region or perhaps when investigating expansion of existing activities.

Having examined the Wallonia region, the next section introduces the BioWin cluster, its origins, mission, services provided, and roles and responsibilities to understand the cluster organisation and how it operates.

2.3 The BioWin Cluster

2.3.1 Introduction

BioWin, since its inception in 2006 has gained international recognition as a key player in the area of health biotechnology and medical technologies from its base in the southern region of Belgium. Through bringing together the plethora of health science actors in Wallonia, BioWin has created an ecosystem that promotes innovation and excellence,
while allowing the region to develop unique and highly specialised capacities in the areas of biotech and medtech (biowin, 2020). BioWin’s experience make it an ideal partner with which to conduct research. The cluster is made up of 10 large Biopharma companies (Baxter, IBA, IRE Elit, GSK Vaccines, Kaneka Eurogentec, Janssen Pharmaceutica, Alten, UCB, XPE Pharma and Science and Zoetis), 5 universities (Université Catholique de Louvain, Université Libre de Bruxelles, Université de Liege, Université de Mons and Université de Namur) and over two hundred highly specialised and innovative SMEs. A diverse community within a small country but whom is world renowned for its contribution to bio health and technology.

However, since 2005, a worrying trend (Figure 2.2) has appeared as bio-pharmaceutical exports have steadily declined from when Belgium had a market share of 14% to a low of 6.6% in 2018. A slight recovery to 7.3% of world export share was recorded in 2019. In Figure 2.2, the vertical blue bars refer to the Export Value in US$ while the green line represents Belgium’s share of world exports. It is increasingly evident just how integral a role the sector plays for both the regional economy and country as a whole with pharmaceuticals accounting for 35% of Wallonia’s total exports (biowin, 2020). Two regional biopharma clusters make up the biopharma sector in Belgium – BioWin in the southern region of Wallonia and Flandersbio in the north of Belgium. To re-establish itself as one of the worlds’ leading exporter of bio-pharmaceuticals, clusters like BioWin must continue to support their members to enhance their internationalisation and grow their export levels.
The BioWin cluster is committed to ensuring the development of research excellence, job creation and bolstering the economic attractiveness of the Wallonia region. The cluster has continuously supported the international visibility of the biotech, medical technologies (medtech) and pharma Walloon ecosystem, while systematically aligning the actors of health innovation in the region (biowin, 2020a). A steady growth in employment levels combined with value added growth of the region’s firms has been evident since BioWin’s creation in 2006. It is vital to understand the biopharma sector to ascertain if the worrying trend in pharmaceutical exports mentioned above can be halted by establishing policy supports and initiatives to support industry further through clustering.

Figure 2.2: Belgian Biopharmaceutical Exports by Year
Source: Harvard Business School (2021)


2.3.2 Origin of the BioWin Cluster

In 2006, an initiative undertaken by the government and the former Minister of Economics to create a Health Cluster of Wallonia was strongly supported by large companies, which included the then CEO of GSK, Jean Stéphenne and the CEO of Ion Beam Applications, Yves Jongen. Günther and Meissner (2017, p. 5) support this approach and highlight the role of ‘champions’ in a cluster when they noted that “if large and financially strong players are involved in a cluster, the existence of a professional cluster management is more or less self-evident because it is often driven and established by these companies.” The local government in 2005/06, asked the current large companies to prepare all paperwork to launch what they, at the time called the ‘BioWin Clustering Activity’. The working group involved GSK and UCB, as these two large firms are crucial for the pharmaceutical ecosystem, combined with a number of professors from an array of universities who were also involved in the reflection process. The BioWin health cluster was launched as one of the six competitiveness clusters located in the region. BioWin’s legal status is a ‘not for profit’ organisation and has been since its foundation.

Cluster governance is defined by Schretlen et al. (2011, p. 3) as the intended collective actions of cluster stakeholders to advance the cluster and develop a sustainable competitive advantage. Cluster governance thus “represents the interests of cluster stakeholders (e.g. universities and research institutes, large and small companies, government, supporting structures etc.), while cluster managers strive to serve the needs of cluster stakeholders.” The Walloon government imposed rules for the six clusters in Wallonia regarding how they are to be governed. In the past, BioWin was obliged to have a large company representative as president of the board. However, other stipulations from government state that the president must be elected from industry and the cluster board must have fair representation from the ecosystem membership.

The BioWin cluster is governed by a board of directors, which consists of 16 individuals drawn from member representatives of large companies (5), SME representatives (5), university/academic representatives (5) and non-university research centre
representatives (1) (biowin, 2020b). The board is chaired by a President, who is supported by two Vice-Presidents, each of which is elected from the large firms, SME and university/academic representatives elected to the board in the first instance.

The overall BioWin governance is aligned with Schretlen et al.’s (2011, p. 25) beliefs that “inclusiveness in cluster governance implies equal participation, equal treatment and equal rights of cluster members.” In other words, all stakeholders including SMEs and start-ups have the right to partake in the governance processes of the cluster and influence the decisions that affect their respective entities. The role cluster organisations play in enhancing cluster inclusiveness involves the regular provision of courses, workshops and events for their members and these equal opportunities lead to members feeling part of the cluster and engaging in collaborative work within the cluster.

SMEs play an important role across Europe, they represent 99% of all enterprises, account for more than half of European GDP and provide 100 million jobs in the private sector alone (EC, 2020). However, many (Jaegersberg et al., 2007; Estimè, 2008; Wong, 2009) still perceive that SMEs are poorly represented and integrated in clusters. In 2016, BioWin members amended the details of the original documentation drafted during the foundation of the cluster to allow a representative from a small company to be the president of the board. This amendment was granted, to give smaller firms more of a voice but the government maintained their stance on the need for industry (large or small firms) to be president of the BioWin board. SMEs have a real voice at a decision-making level within the cluster with 5 seats on the board.

The governing board of BioWin is supported by 11 employees who work directly for the cluster organisation, to implement their strategy and day-to-day running of events, projects and initiatives. Their roles range from the Managing Director, Director of Research and Innovation to European Projects Manager, Manager of Membership Development and International Affairs Representative. The staff, through the Managing Director update on activities, finances and strategy whilst proposing different items to the
governing board who then meet to discuss and decide what actions are to be taken. The next section looks more in depth at the mission and vision of the BioWin cluster.

2.3.3 BioWin’s Mission and Vision

As a cluster organisation, BioWin encourages collaboration between cluster actors and promotes inter-firm networking through events and trade missions. This is achieved by creating a cluster identity, fabricating the cluster’s strategy and overall vision as well as business development objectives and encouraging innovation projects and attracting research and innovation investment (Ketels et al., 2012). BioWin’s mission is twofold; to enhance innovation to ensure the public health sector is equipped with the correct knowledge and tools to combat future challenges and grow jobs through raising the competitiveness of Wallonia’s health sector players and community. BioWin’s vision to 2025 is for Wallonia to be recognised internationally for its world-class academic, clinical and industrial research environment in the field of Life Sciences. A major focus point is the competitiveness of the Walloon pharmaceutical industry to be strengthened, and the region to be one of the world’s largest hubs in research, development and industrial production of vaccines and biologics. The development of an efficient and competitive healthcare innovation ecosystem created by unifying the hospital and business worlds is also sought after (biowin, 2020c).

BioWin has a number of aims and objectives which include; improving cross-border collaboration in research and innovation, further enhancing Wallonia’s competency in medical imaging and building new connections with actors that may further develop BioWin and the regional healthcare ecosystem (biowin, 2020h). Over the past fifteen years, the cluster has grown which has seen its employment evolve. The employment of BioWin members companies has grown from 7,920 in 2005 to 16,424 employees in 2018 (biowin, 2020e).

BioWin’s focus is on supporting its members in the development of the local cluster ecosystem, by developing the local conditions necessary to drive competitiveness before focusing on export markets. External to the region, BioWin performs a vital role in creating new contacts from countries bordering Belgium and beyond.
2.3.4 BioWin’s Cluster Services and Membership Fees

BioWin offers a number of services to their members:

- Guidance for companies in relation to funding available to them to help enhance collaborative, innovative biotech and medtech projects. This includes providing support in building international projects (biowin, 2020i).
- Extensive support to members looking to submit applications for EU funding by sourcing the best partners to collaborate with (locally and internationally), formalise and critique/analyse the application at each stage and highlight what sources of funding are best suited to the member’s project while further developing their strong connection with the relevant organisations (biowin, 2020j). BioWin seeks to enhance member firms’ visibility regionally and internationally and through the organisation of specific theme-based events targeted at growing firms networks.
- Communication resources to enhance members’ ability to connect internationally, these include: brochures, press conferences, presentation opportunities at international trade missions/events and electronic communication through the BioWin website and newsletters etc. (biowin, 2020k).
- Connects members with potential collaborators, via global networking events and collaboration with AWEX and Wallonia Brussels International (WBI).
- BioWin also hosts events that focus on different areas e.g. R&D, strategic or business partnerships and collaborations (biowin, 2021).

It is important to note that BioWin benefits from creating new global connections and linkages for members as they retain a success fee if investment in a Walloon company is made. This remains an attractive incentive for BioWin, especially as members have raised substantial funds between 2005 and 2020. BioWin's 2020 report, for example, highlights that the cluster members from 2005-2020, have raised nearly 3 billion euro from investment funds which is a marked improvement on the original 33 million euro raised by member firms in 2005 (BioWin Report, 2020, p. 15).
**BioWin Membership**

Of the 242 members of the BioWin cluster in 2021, 220 were categorised under the heading ‘basic members’ with the remaining 22 classed as ‘premium’ members. Membership fees contribute significant finance to the cluster on an annual basis. Figure 2.3 displays the BioWin membership fees for 2021, with both ‘basic’ and ‘premium’ options shown. Under the title ‘basic’ membership, firms are entitled to all the services provided by BioWin, while being a ‘premium member’ offers firms extra (non-specified) communication services not found under the basic membership package. Premium membership also guarantees greater visibility for the firms through BioWin’s communication channels i.e. website, e-newsletters, blog etc. BioWin initiated the premium membership option in 2019.

In the latter part of Figure 2.3, an ‘associate’ member refers to firms who are not active in the field of BioWin’s four strategic areas, but still pay a fee to be part of the BioWin cluster. The associate members incorporate complementary skills not available inside the BioWin team but are still crucial for the growth of the other cluster members. The associate members are selected carefully on the basis of their reputation and records of accomplishment. These members work closely with BioWin, the cluster organisation, on specific topics.
2.3.5 BioWin and Smart Specialisation Strategy (S3)

The concept of a Smart Specialisation Strategy (S3) was introduced by the European Commission to support the strategic economic development of all European regions by assessing the assets and characteristics a region has and its economic potential. Strengthening the regions innovation system and ultimately enhancing the regions entire economy is the principal role of having a S3 (BAK, 2021). While governments and regions all across Europe are required to have S3 cluster policy strategies, clusters such as BioWin have also decided to implement their own S3 strategy.
BioWin’s own S3 incorporates six key technological areas in which their members are active: bio-pharmacy, cell therapy, medical devices, bio manufacturing, data science and radiation applications in healthcare (Wallonia, 2020). The S3 strategy for the cluster allows it to dovetail and synergise with the greater Walloon region RIS3 strategy. BioWin collaborates with numerous other clusters across Europe namely in France, Germany and Switzerland as well as clusters internationally based in Canada and the USA who follow similar strategies (biowin, 2020p). This ensures BioWin stays up to date with current best practices, technological advances and innovation in these particular areas that align to their members’ markets and expertise.

2.3.6 BioWin Strategy, International Collaboration and Recognition

In 2019, BioWin published its strategy for the period 2020-2023. During this three-year period, BioWin aims to implement two projects: 1. Enhance the bio manufacturing industry’s overall development in Wallonia and 2. Endeavour to place Wallonia as a world leader in the area of health innovation (biowin, 2020m). Focusing on the latter, BioWin have an international strategy positioned around; thematic missions with other bio-regions or health clusters and attendance at global trade fairs partnered with AWEX (biowin, 2020n). These missions/fairs involve the accompaniment of local firms to global events with an aim of enhancing their international export activity prospects, through collective stands or grouped/team presentations and focus on the strategic markets as identified by the cluster members in Europe, Israel, North America and Asia. (biowin, 2020o).

BioWin participates in a number of European and International Projects. Under the COSME ‘Clusters Go International’ programme (2018-2020) BioWin are part of project ‘Magia’, which focuses on medical technology. This project was specifically aimed at supporting the medtech sector in enhancing cross border collaboration especially for SMEs and business network organisations. This was to bolster the competitiveness of SMEs in global markets and to ensure greater visibility for the European medtech industry (ECCP, 2020). There were four main industrial clusters: Bio industry Silvano Fumero -

4 For more information on RIS3 strategies visit www.ec.europa.eu
Italy, BioWin - Belgium, Lyon biopole - France and Norgenta Nordeutsche - Germany (biowin, 2020q). The Wallonia region awarded BioWin its support through the medium of the DGO6 as a partner of the COSME programme.

In addition to the ‘Magia’ project, BioWin was involved in an Interreg project (2016-2020) called ‘Nanocardio’ in an associated partner capacity. The project had a life span of four years with a total budget of €1.6 million, its strategy created by the Interreg V Program aimed to improve and support cross-border collaboration in research and innovation, a priority focus of the European Union. BioWin was involved in the project alongside a number of other associations from Belgium and France, while the University of Mons (based in the Wallonia region) is the project leader (biowin, 2020r). European cooperation projects provide BioWin with the platform to attain vital knowledge and expertise that can be transferred to their members and support those members seeking to establish cross-border collaborative relationships. Academia and industry collaborating is a vital part of the clustering process and these European projects can be an attractive space for actors within the cluster to collaborate.

BioWin engaged as a partner in the following projects: S3martMed, CE4BIG, and MAGIA2Market. BioWin is also developing bilateral cooperation agreements with the following European clusters, including: FlandersBio - Flanders, Medicen - Ile-de-France, Lyonbiopole - Auvergne-Rhones-Alpes, bioPmed - Piemonte, Life Science Nord - Hamburg, Biocat - Catalonia, BioM - Bavaria (biowin, 2020s). BioWin offers its member’s unrivalled access to international networks including CEBR (Council of European Bio Regions), European Respiratory Cluster Antwerp (eu.reca) as BioWin sits on the board of both organisations. The CEBR is a European association bringing together over forty clusters in the area of health and is responsible for providing a real space to exchange good practices and launching new initiatives (biowin, 2020t).

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5 For more information on Interreg Europe visit https://interreg.eu/about-interreg/
6 For more information on these projects, see https://biowin.org/fr/projets-fr/
The cluster is also involved with Rad4Med (The Belgian Network for Radiation Applications in Healthcare) and EDCA (European Diagnostic Clusters Alliance). In order to streamline, organise and support these collaborations, BioWin has developed a European department to aid its members in creating strategic partnerships with European partners availing of the opportunities and proposals offered by the European Commission (biowin, 2020u). The support this department provides is focussed specifically on key funding programmes; Horizon 20207 (which will be replaced by the forthcoming Horizon Europe 2021-2027 programme), Innovative Medicines Initiative and Eurostars, as well as European structural funding (biowin, 2020v).

BioWin is a member of the European Cluster Collaboration Platform (ECCP). The ECCP aims to enhance and further develop clusters at a European level by promoting and amplifying international cooperation and collaboration between clusters while contributing to the European and international policy discussion on inter-cluster cooperation (ECCP 2020c). By having BioWin showcased as participating with the ECCP strengthens members ability to participate in EU programs and projects (biowin, 2020w).


As part of the ECEI labelling process a benchmarking analysis and certification audit are carried out. Benchmarking8 involves an assessment of the following areas of a cluster:

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7 “Horizon 2020 programme is running from 2014 to 2020 with a €80 billion budget. It provides research and innovation funding for multi-national collaboration projects as well as for individual researchers and supports SMEs with a special funding instrument” (ec.europa.eu, 2020)

8 “Benchmarking is an efficient and effective way to identify the potential of a cluster and to develop strategic recommendations for its professionalisation within a relatively short timeframe. Benchmarking involves a comparative analysis of structures, processes, products and services. It compares a cluster entity to peers in the same field of activity and/or to best practices from entities in other areas. The
• Cluster structure
• Management, strategy
• Financing
• Services provided
• Contacts and interactions with the environment
• Results of operation and the cluster’s reputation” (ESCA, 2021).

The Gold, Silver and Bronze labels are used as a validation tool for cluster organisations. It points to their value and ability while aiming to encourage motivation and competition in order to contribute to the clusters overall growth. BioWin is the first competitiveness cluster in Belgium accredited with the Silver quality label. The Walloon government is supportive of initiatives that aim to develop a real culture of evaluation by recognised independent bodies and in turn finance the costs associated with the labelling assessment.

To achieve the Silver Label, a four-step audit is conducted involving:

1. The cluster organisation undergo a second Bronze Label benchmarking process 1.5-2 years after its previous benchmarking.

2. Completing, in detail, an ESCA form regarding three areas of quality indicators of the ECEI in which the cluster organisation has improved. Thus, the cluster organisation is expected to portray how these improvements contributed to the clusters’ overall development.

3. An auditor carries out an on-site visit to validate the areas of improvement. The auditor will assess if the cluster organisation meets the minimum requirements of the Silver Label ECEI. Accreditation cannot be awarded if a cluster organisation does not meet even one of the requirements.

4. A report detailing the results and containing customised recommendations for improvement is developed by the auditor (ESCA, 2021).

objective of benchmarking is to identify concrete potentials for improvement in certain areas and to learn from better performing peers or other entities in order to improve one’s own structures, processes, products and services” (Sedlmayr et al., 2021, p. 167).
The COVID-19 pandemic has impacted the BioWin cluster and cluster members. Members have experienced difficult times financially, structurally and in an organisational capacity due to unknown element and for example a number of clinical trials were cancelled, which led to investors withdrawing their funding. Hospitals prioritised COVID-19 related issues and therefore, the development of new and different pathologies/new cancer drugs also had to be postponed. Thus, such research was unable to be completed, and with results rendered unusable, in some instances, investors withdrew their funding.

2.4 Conclusion

This chapter examined the Wallonia region and the BioWin cluster’s development. Having reviewed the cluster, it is apparent that BioWin is a worthy subject for this research in regards to tracing its longitudinal development and assessing its growth as a cluster organisation. The next chapter will analyse the cluster literature to discover how clusters have developed organically, or through policy towards the animation of cluster organisations i.e. to assess how such organisations can be sustained in either or both forms over the longer term.
Chapter 3

3 CLUSTER THEORY

3.1 Introduction

To understand clusters and clustering as a whole, it is vital to investigate their origins in economic geography. Chapter 3 begins by introducing the cluster concept, the origins of cluster theory and the researchers and academics who outlined cluster theory and have added to the literature (section 3.2). Then, cluster definitions are examined (section 3.3), the advantages of clustering are presented (section 3.4) before reviewing the shortcomings of the theory (section 3.5). Types of Industrial Districts and Clusters are then discussed in section 3.6 before section 3.7 provides a conclusion to the cluster theory chapter.

Clusters as a concept are by no means a new phenomenon. Marshall (1920) outlined links between companies in industrial districts across England throughout the 1890s. Evgeny et al. (2016, p. 180) note the “cluster approach has been used in practice since the beginning of the 20th century.” The foundations of cluster literature in use today are derived from the work of Marshall, 1920; Porter, 1990, 1998; Swann, 1992; Saxenian, 1994; Delgado et al., 2016. The aforementioned studies all contain similarities, notably, the majority of cluster definitions identified that regional and industry performance and success relies on interconnected economic activity. Such interconnections involve the creation of new jobs and formation of new businesses as part of the process (Feldman and Audretsch, 1999; Porter, 2003; Feser et al., 2008; Glaeser and Kerr, 2009; Delgado et al., 2010; Neffke et al., 2011; Sedlmayr et al., 2021).

Lyon and Atherton (2000) believe that industrial clusters can be characterised by three distinguishing factors, regardless of discrepancies in size, structure or sector;
commonality, connectivity and concentration. A cluster’s characteristics are said to be responsible for a firm’s interconnectedness with other stakeholders (Porter, 1990; Bititci et al., 2004). The collaboration that occurs between firms and other stakeholders is viewed as a catalyst for synergy creation and benefits of collocation and thus the cluster cannot be formed without it (Porter, 1990; Schmitz, 1995; Raco, 1999; Lyon and Atherton, 2000; Lechner and Dowling, 2003; Coughlan et al., 2003; Segil, 2004; JICA, 2004; Cohen and Roussel, 2005; Brown et al., 2007; Niu, et al., 2008; Parung and Bititci, 2008; Gourgiotis et al., 2021).

Clusters are important, and there are many reasons for a region to support and build strong clusters. They play an integral role across a wide range of policy areas and fields, namely; innovation, industrial and regional development, science and SME support. Pavan (2020, p. 33) regarding the recent cluster attraction, adds “in recent years the literature on regional innovation systems has grown at a higher pace than that on clusters, leading to greater interest from the academic world.” To comprehend clusters is to view them as local, national or even international agglomeration of actors at diverse levels (Aziz and Norhashim, 2008). According to the European Panorama of Clusters and Industrial Change (Naumanen, 2019) and EC (2021), European clusters account for 61.8 million jobs or 23.4% of total employment. Clusters drive growth in Europe through their higher number of innovative and high-growth firms, displaying better performance on key social and competitive indicators. They find a 13.5% higher average wage and 77% more high-growth firms in specialised clusters than in other non-clustered locations.

EC (2021, p. 6) argue various types of firms, research and knowledge institutions, science and technology parks, financial services providers, non-profits, and public authorities are integrated in clusters and “they create vital networks at regional, cross-regional, national and EU level. And their importance is growing, there are over 3,000 clusters in the EU, employing over 50 million people and accounting for almost one in four jobs in Europe.” Günther and Meissner (2017, p. 1) suggest “there is broad consensus that economic development and societal welfare align with the effectiveness and efficiency of countries’ science, technology, and innovation infrastructure.” A broad range of actors with different ambitions, missions, and aims pursues Science, technology, and innovation excellence.
3.2 Cluster Origins

The agglomeration of related economic operations or companies is a principal feature of clusters and their economic geography (Marshall, 1920; Porter, 1990; Krugman, 1991; Ellison and Glaeser, 1997; Delgado et al., 2016; Sedlmayr et al., 2021). The World Bank (2009, p. 126) believe clusters are a means of “stimulating economic development at the local, regional, and global level. They play an important role in the modern economy and its search for competitiveness.” In an EC report (2016, p. 14) it is suggested that “clusters are the result of a cumulative process, where the success of one company paves the way for others to follow. Such processes take a long time, and are inherently unpredictable. Cluster evolution is a natural process, but it is not automatically a successful one.”

The cluster concept has become a subject of intense research studies and economic analysis starting with the study conducted by Michael E. Porter (1990); the competitive advantage of nations (Boja, 2011). Porter’s (1990) work discusses how important it is to analyse and identify industry clusters as a conduit to implement regional policies. Clusters are regarded by many as an important tool in economic development (Porter, 1998; Martin and Sunley, 2003; Asheim et al. 2006; EC, 2016; Sedlmayr et al., 2021) with the creation and implementation of clusters viewed as a priority amongst regional policy programmes and seen as a pathway to encourage growth and job creation within a region (Klofsten et al., 2015). The speed at which academic research on clusters has grown is largely attributed to cluster strategies\(^9\) and policies being increasingly considered as avenues in which firms can enhance their international competitiveness (Giuliani et al., 2005).

Access to specialised skills and inputs are cheaper and obtained more easily when firms are active within clusters as the circulation of public information and knowledge is more tangible and readily available (World Bank, 2009). Van Egeraat and Doyle (2018, p. 108) explain that for many of the above reasons “the cluster concept has become very

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\(^9\) Key components of a cluster strategy must include: “Insights from previous analysis and work, such as a cluster mapping, the analysis of potentials and the defined goals need to be well integrated in the strategy. Definition of the cluster’s range of outputs and services • Organisational structure • Implementation strategy (steps) • Monitoring & evaluation (M&E) • Action plan.” (Sedlmayr et al., 2021, p. 94)
influential in both academic and industrial policy circles.” Günther and Meissner (2017, p. 4), in line with the work of Maskell (2001a, b), Malmberg and Maskell (2002) and Bathelt and Taylor (2002), suggest “important features to characterize clusters are the vertical and horizontal integration and interaction of cluster participants.” The vertical and horizontal interaction is a key aspect of a cluster, especially for clusters striving to enhance innovation, competitiveness and overall ability of the cluster and region.

Due to the influential nature on how firms compete, cooperate and organise, clusters are regarded as productivity and competitiveness enhancers for the firms within a cluster compared to non-members (Porter, 1990: Poudre and St. John, 1996; Baptista and Swann, 1998; Delgado et al., 2016). Boja (2011, p. 34) believes “the cluster is an economic phenomenon that is placed in a competitive context in which many businesses simultaneously compete and collaborate to gain different economic advantages.” Van Egeraat and Doyle (2018, p. 108) note that “according to Porter, the competitive advantage of an industry derives from the ‘national diamond’, i.e. the four determinants of competitive advantage which are created within the nation state: factor conditions; demand conditions; related and supporting industries; firm strategy, structure and rivalry.”

Porter identifies two other influences, namely chance events and government. They suggest that the concept in Porter’s model is operational in nature involving clustering not cluster i.e. the pathway to cluster development. The vital role that interaction plays among cluster actors means that effective interaction is responsible for cluster competitiveness and advantage in an industry. Van Egeraat and Doyle (2018, pp. 108-109) conclude that “underlying the operation of the national diamond and the phenomenon of clustering are the exchange and flow of information about needs, techniques and technology. Geographical concentration can greatly facilitate the flows of this information, so central to the capability to innovate and to upgrade competitive advantage.”
Academic research on industry clusters is only 30 years old, since the introduction of the cluster concept (Porter, 1990), yet the idea has been implemented in regional economic development and policies across the world. Growth, development and evolution of clusters have been overlooked, primarily due to shortcomings of data (Porter, 1998; Swann, 1998; Bathelt and Boggs, 2003; Klepper, 2010). Günther and Meissner (2017, p. 2) discuss how in “Europe and in many other countries, in the late 1990s and early 2000s, governments engaged in large scale initiatives for innovation in the economy, including funding and planning support for industrial and innovative clusters.” Fornahl and Hassink (2017, p. 3) suggest “clusters are not closed entities, but are embedded in an ecosystem of actors, linkages, rules, etc.” The fact that clusters seem to have loose boundaries seems to intensify this difficulty in measuring and analysing cluster success and benchmarking metrics against others.

Byrne (2016, p. 1) indicates cluster theory is based on the premise that a collaborative regional ecosystem can “contribute to enhancing innovation, growth and competitiveness of regions and their member companies which are part of clusters.” Within an agglomeration of a sector/industry, different actors have the ability to support one another and facilitate the birth of new ideas, created in planned and unplanned environments. Thus, clusters and innovation, go hand-in-hand playing a vital role in these locations (Ketels et al., 2012). In other words, the innovation processes between firms is where clusters perform an integral role (Furman et al., 2002). Delgado et al. (2016, p. 35) highlight “an understanding of cluster emergence and relatedness could have wide-ranging implications for forward-looking regional strategy.”

It is argued that in the majority of cases that clusters are not created, but rather emerge as a result of different opportunities provided by different locations for specific firms to grow, succeed and financially invest (EC, 2016, 2018). Sedlmayr et al. (2021, p. 6), in reference to the work of Bergman and Feser (2020), share similar views, adding “clusters can arise on their own where suppliers and supplementary service providers relocate or establish businesses in places where there are already enough partners with complementary competencies.” In order to understand ‘how’ and ‘why’ clusters exist,
one must view the cluster as an agglomeration of different types of actors (Sölvell et al., 2009).

Among the vast amount of clustering literature and its’ practical applications, is a common understanding that clusters are categorised by regional proximity, specialisation and networking (Skokan, 2005). In the past three decades, a comprehensive literature has reframed the multitude of agglomeration drivers. These include specialised institutions, local demand conditions, regional business’ organisational design and social networks (Porter, 1990, 1998; Saxenian, 1994; Storper, 1995; Markusen, 1996; Sorenson and Audia, 2000; Delgado et al., 2016; Sedlmayr et al., 2021). It is intuitive that inputs, outputs, knowledge and skills, play an integral role in connecting a blend of firms within a cluster.

For regional competitiveness to flourish, one must gain an understanding of a regions’ own cluster strengths and weaknesses when compared to other regions. Delgado et al. (2016, p. 33) assert that in order to “make this comparison, a set of regionally comparable cluster definitions that marks the industry boundaries of each cluster is necessary.” Günther and Meissner (2017, p. 3) note “the establishment and organization of clusters are frequently assumed an effective and efficient mechanism to enhance industries’ and thereby regions’ and nations’ competitiveness.” The nature of the relationship between cluster actors can involve both co-operation and competition (Johannisson et al., 2007).

Having reviewed the work of Marshall (1890), Krugman (1991) and Malmberg et al. (1996), one can surmise that: the majority of national economic/industrial areas are found in a limited number of regions; companies involved in particular sectors often locate in common areas; as companies in an economic agglomeration, over time, can endure, and survive longer than isolated companies. While discussing the origin of clusters and their geographic boundaries, one must also consider the varying definitions of clusters and clustering, proposed by academics as cluster literature has developed and this is discussed in the following section.
3.3 Definitions of Clustering

The available literature defining clusters and the concept of clustering is vast. Byrne (2016, p. 18) states “organisations and academics have developed numerous definitions of clusters and there is much debate over its definition.” One of the most used and cited definition of an industry cluster was developed by Michael Porter, the man responsible for developing cluster theory and strategy. Porter (2000a, p. 16) suggests “a cluster is a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and externalities.” The theory behind this definition is twofold: firstly, cluster characteristics can bolster the innovation and growth of a region and secondly, enhance the region’s competitiveness as well as the clustered firms.

Byrne (2016, p. 18) argues Porter’s definition has “not been wholly accepted as a standard cluster definition by academics, researchers, policy makers and economic geographers.” Consequently, it is one of a myriad of cluster definitions in the literature. Martin and Sunley (2003, p. 16), reveal that cluster concept and theory “has acquired such a variety of uses, connotations and meanings that it has, in many respects, become a chaotic concept.” In order to gain a more holistic view of clusters, the author lists various definitions uncovered during a thorough review of the literature since Porter (1990) introduced the concept. It is important to note that the definitions presented are but a sample of the numerous cluster definitions existing in academic discourse. The author considers that the definitions in Figure 3.1 disregard the notion and concept that like products, technologies and industries, clusters too pass through stages of a life cycle and should be addressed.
Porter (1998a, p. 199): “A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities.”

Roelandt and den Hertog (1999, p. 9): “Clusters can be characterised as networks of producers of strongly interdependent firms (including specialised suppliers) linked each other in a value-adding production chain.”

Crouch et al. (2001, p. 163): “The more general concept of ‘cluster’ suggests something looser: a tendency for firms in similar types of business to locate close together, though without having a particularly important presence in an area.”

Isaksen and Hague (2001, p. 13): “A concentration of interdependent firms within the same or adjacent industrial sectors in a small geographic area.”

Ketels et al. (2006, p. 9): “A cluster refers to a group companies and other institutions in related industries that are co-located in a specific geographic region.”

Hobbs (2010, p. 64): “Clusters are drivers of innovation made up of mutually beneficial localised groupings of specialised and interconnected firms, organisations and institutions, which both compete and co-operate. Cluster participants’ production processes overlap, and members are therefore closely linked through the complementary exchange of goods, services or knowledge.”

Viederyte (2013, p. 624): “Groups of companies and institutions co-located in a specific geographic region and linked by interdependencies in providing a related group of products and/or services.”

Byrne (2016, p. 2): “A geographically proximate group of firms in related and supporting industries, economic actors and institutions linked in some way, which benefit from their mutual proximity and connections.”

Huh and Lee (2019, p. 5): “An industry cluster is defined as an aggregation in which the scientific technology system, the business support system, the business support platform, the local innovation infrastructure and other factors pertaining to the CCIs of concern are organically interconnected.”

Bergman and Feser (2020, p. 4): “Clusters are defined very generally as a group of business enterprises and non-business organizations for whom membership within the group is an important element of each member firm’s individual competitiveness.”

Figure 3. 1: Industry Clusters: A Selection of Definitions from the Literature

Source: Author

It is imperative to acknowledge the inimitable debate that exists over clustering and its definition and that there is no exclusively used and wholly accepted definition in use
today. Thus, upon reviewing the selection of cluster definitions (Figure 3.1), Byrne (2016), identifies three characteristics of the cluster concept that feature in most definitions. These include:

1. Clusters consist of firms in related and supporting industries, economic actors and institutions.
2. The firms and actors in a cluster must be geographically proximate or concentrated.
3. These co-located firms must be connected or linked in some way, which results in a superior performance of the firms.

Laur et al. (2012) recommend viewing clusters as ‘matchmakers’ incorporating and integrating different actors. Günther and Meissner (2017, p. 3), based on the work of Johannisson and Lindholm Dahlstrand (2009), Moss (2009) and Carayannis and Borowik (2010), add “clusters are voluntary assemblies in an association style, which bring together actors with different backgrounds and ambitions but overarching similar visions and needs.” However, taking into account the plethora of cluster definitions, this research will use the definition proposed by Byrne (2016, p. 20); a cluster is “a geographically proximate group of firms in related and supporting industries, economic actors and institutions linked in some way, which benefit from their mutual proximity and connections.” Having reviewed a sample of cluster definitions, it is appropriate to outline the advantages associated with clusters, their regions and related actors in the next section.

3.4 Advantages of Clustering

Clusters are said to have a plethora of advantages for industry, policy makers and the higher education sectors locally, regionally and nationally. Gonzalez-Torres et al. (2020) note that industrial clusters and global value chains have gained the interest of both business leaders and scholars in different disciplines. To be part of a cluster can provide an array of potential benefits and advantages for firms (Gonzalez-Torres, 2020; EC, 2021).

Firstly, and perhaps the most recognisable and deliberated advantages of clustering concern:

1. Better wages
2. Innovation enhancement

3. Larger pools available of human resources and

4. Reduced financial and transport costs.

The initiation and implementation of clusters and the support they provide, target the generation of positive externalities for the members, which include advantageous access to shared infrastructure and human resources as well as a welcomed reduction in transport and production costs (Makarov et al. 2016). Clusters have received worldwide recognition, with some of the main drivers for the attractiveness of clusters related to higher wages, reduced financial and transport costs, increased innovation and access to skilled workforce (Porter, 1990; Krugman, 1991; Baptista and Swann, 1998; Porter, 1998; Sölvell et al., 2003; Morosini, 2004; Fromhold-Eisebith et al., 2021; EC, 2021).

Boja (2011) highlights that within a cluster, research and innovation is more prominent than in an agglomeration of firms affording clustered firms an edge over non-clustered rival firms. Marshall (1890) and Krugman (1991) both observed distinct positive effects and results that support the above hypothesis, that companies within a cluster benefit from a reduction in financial and transport costs. Waite and Williams (2009, p. 501) note that collaboration between firms in the same field or sector can combine complementary resources and create collective efficiencies “in the form of reduced transaction costs, accelerated innovation through more rapid problem solving and greater market access, particularly in overseas markets.” Another crucial advantage is that industry clusters can facilitate internationalisation i.e. entry into foreign markets, which is a common aim of SMEs (Schmitz, 1995; Merrilees et al., 1998; Boja, 2011).

Some further advantages associated with clusters, discussed by Boja (2011), include:

1. Easier access to local markets for products, services and other resources

2. An enlarged market due to concentration of firms, which in turn broadens customer reach

3. More specialisation in products and services
4. An increase in competition that augments motivation
5. Enhanced cooperation between cluster members
6. Increased confidence amongst firms as a result of proximity and stimulates communication.

Byrne (2016, p. 7) reiterates the benefits of increased collaboration, between the triple helix players in a region or nation to encourage an ecosystem to work together harmoniously. He discusses how clusters are accepted as “an analytical concept and key policy tool by policy makers and governments all over the world, who utilise the theory to achieve the aims, goals and growth targets for industry sectors of importance at a regional or national level.” Giuliani et al., (2005) suggest that one of the advantages of clusters is that they provide a broad network of specialised inputs and provide access through their concentration to a skilled workforce that allows companies to develop their core business, which facilitates the assimilation of competencies and resources. This is supported by Gonzalez-Torres et al. (2020, p. 2) who believe a cluster or industrial district “requires geographic proximity and sectorial concentration of organisations in order to seek complementarities that allow them to generate competitive advantages.”

Klofsten et al. (2015, p. 65) highlight the studies that “have demonstrated the additional benefit of clusters to society in general through their value enhancement for the involved actors and the economy.” These enhancements include knowledge accumulation, collaboration leading to synergy creation, and improved information flows (Porter, 1998; Johannisson and Lindholm Dahlstrand, 2009; Sölvell, 2009; Smith et al, 2013). Byrne (2016, p. 44) argues “the formation of local institutional supports for industry clusters is a key element that contributes to the growth of a cluster.” Delgado et al. (2016, p. 1) discuss the cumulative need for useful data tools to “measure the cluster composition of regions and support regional policy development as well as business strategy.” It is believed that local industries, due to their dispersed geographic nature across regions, focus mainly on serving their regions public/population (Delgado et al., 2016). Local regions can benefit advantageously by having the industry’s focus solely on their own area, potentially through bringing employment opportunities to the local catchment area and not elsewhere.
The advantages of clusters cannot be ignored or denied, and EC (2021) state clusters have a positive impact on economies. The European Panorama of Clusters and Industrial Change (ECCP, 2020) and SME barometer (EC, 2020) provide evidence that companies within industrial groupings are more innovative than operating alone, create more and better jobs, conduct more market research, register more international patents and export more than other companies. In short, EC (2021, p. 10) argues “productivity in clusters is 25% higher than the average productivity. Cluster members are more likely to be planning to grow turnover than non-members, are more likely to have adopted advanced technologies and have a higher propensity to digital and sustainable innovation.”

Schmitz (1999, p. 141) summarises various advantages associated with clusters, incorporating his earlier work; Schmitz (1995b). He argues that clustering can “facilitate a deep division of labour and specialisation as well as cooperation between enterprises (often coexisting with fierce local rivalry).” Essentially, clusters provide efficiency gains that small businesses cannot normally achieve on their own. As a result of local external economies and joint action, these gains are captured in the concept of collective efficiency.

3.4.1 Factors that Drive Cluster Advantages

While advantages of clusters have been discussed, it is important to review how these advantages are realised. According to Adkins (2021, p. 60) “localised industries can become industrial districts over time, each developing a number of advantages and characteristics.” Hobbs (2010) states agglomeration advantages, discussed in literature, can be assembled under three headings: 1. Marshallian externalities 2. Porter’s market conditions 3. Co-operation built on trust

1. Marshallian externalities;

(i) Labour market pooling i.e. firms in clusters may have better access to workers and at lower recruiting and training costs (Marshall, 1890; Porter, 1998a) with such pooling argued to also lower search and transaction costs for recruitment and allows more effective matching of jobs to people (Porter, 1998a). Bresnahan et al. (2001, p 847) note
that established companies look unfavourably at the spillovers that they create by training people who would then use these competencies outside the firm. Their research highlighted other sources of training, apart from universities and large firms. “In Northern Virginia, the development of sophisticated technical capabilities in ICT, and particularly in communication technologies, has stemmed from existing bases of competencies provided by years of contract research for the government and the defence department in the area.”

(ii) **Privileged access to large local supplier markets** i.e. successful clusters offer privileged access to large local supplier markets, offering a wide variety of highly specialized intermediate products and services. “The cluster represents a spatial form that can be an inherently more efficient means of assembling inputs, if competitive local suppliers are available” (Porter, 2000b, p 259). Clusters bring greater depth and specialisation to suppliers by exposing them to opportunities and niches available in the market, as well as lowering entry risks due to the large number of local customers.

(iii) **Knowledge spillovers** i.e. learning and knowledge transfer represent the lifeblood, and skilled labour represents the gene pool of clusters (Hobbs, 2010, p. 40). “Privileged access to tacit knowledge in geographic proximity through formal transmittal processes as well as informal channels such as knowledge leakages, are made possible by casual inter-firm interactions, workers changing jobs, etc” (Lublinski, 2002, p 28).

2. Porter’s market conditions;

(i) **Inter-firm rivalry** i.e. Inter-firm rivalry within a locality can be highly motivating and therefore may have a positive effect on productivity and the innovative performance of firms. Rivalry with locally based competitors has particularly strong incentive effects because of the ease of constant comparison and because “local rivals have similar general circumstances (for example, labour costs and local market access), so that competition must take place on other things” (Porter, 1998a, p. 219).

(ii) **Sophisticated and demanding buyers** i.e. “Sophisticated and demanding buyers pressure local firms to meet high standards in terms of product quality, features, and service” (Porter, 1990, p. 89). Firms gain competitive advantage if domestic buyers provide detail of advanced needs and wants.
(iii) Complementarities i.e. the way participants complement each other in the activities they perform. Porter believes that the most obvious form of complementarity is amongst products.

3. Co-operation Built on Trust;

An important factor which governs the degree to which actors (firms or non-firms) co-operate with one another is trust. Schmitz (1999, p 142) maintains that “for a deep division of labour and co-operation between firms to be efficient at reasonable cost, trust is essential.” Rosenfeld (2002, p 9) highlights the important role of industry leaders. He believes “behind every successful cluster is a group of innovative firms led by people who value learning, are committed to their community and, therefore, are willing to work toward a collective vision for their industry.” These benchmark companies often play a key role in building and sustaining cluster organisations.

Clustering advantages contribute to achieving and sustaining competitive success with the interplay of advantage in many determinants creating self-reinforcing benefits, which are difficult for foreign rivals to replicate. A cluster cannot be defined solely based on geographical proximity without also taking into account agglomeration advantages, which are brought about by inter-firm links and regular face-to-face contact, leading to heightened cooperation and mutual trust between firms. These advantages and characteristics, and the description of how they are realised are shown in Table 3.1.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
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<tbody>
<tr>
<td>Hereditary Skills</td>
<td>Particular skills are passed down through generations; reinforcing characteristics of concentrated trade.</td>
</tr>
<tr>
<td>Growth of Subsidiary Trades</td>
<td>Range of suppliers develop to support the core industry.</td>
</tr>
<tr>
<td>Use of Specialist Machinery</td>
<td>High division of labour and specialisation resulting from significant volumes of similar production.</td>
</tr>
<tr>
<td>Local Market for Skills</td>
<td>Localised industries provide a local job market, with relative ease of seeking jobs, and employers seeking workers.</td>
</tr>
<tr>
<td>Industrial Leadership</td>
<td>Derived from the industrial atmosphere and described as “the power of doing now what others will presently be doing, or at all events trying to do” (Marshall, 1919, p.27)</td>
</tr>
<tr>
<td>Innovation</td>
<td>Sharing of good ideas facilitated by strong local social networks.</td>
</tr>
<tr>
<td>Competitive and Cooperative</td>
<td>Firms within districts co-operate vertically, or through associations, but remain competitive.</td>
</tr>
<tr>
<td>Unique Cultural Identity</td>
<td>Workers are committed to the district, rather than firm, with local identity and bonds strong.</td>
</tr>
</tbody>
</table>

Table 3.1: Advantages and Characteristics of Marshall’s Industrial Districts

Source: Author, based on the academic thesis of Adkins (2021)

In relation to Table 3.1, by connecting formal and informal relationships, rules, customs, and norms, these characteristics contribute to developing the atmosphere of the district, which is essential to the growth of districts and firms. In the Marshallian industrial district, a unique cultural identity plays a key role in reducing transaction costs and fostering relationships through its relative sociocultural homogeneity, referred to as the ‘communitarian factor’ (Adkins, 2021). As uncertainty is reduced, confidence grows resulting in greater competitive advantage and flexibility.

While examples of advantages of clusters and how they are realised have been provided, the next section focuses on the shortcomings of clusters and cluster literature.

### 3.5 Shortcomings of Clusters

Østergaard and Park (2015) in relation to the previous section of cluster advantages, argue that negatives are also associated with the positive factors. The accumulation of labour and human resources raises wages due to the increased competition and demand for specific skill sets. Firms can lose valuable knowledge and expertise to competitors as employees can change jobs more easily within clusters. Additionally, localised
knowledge spillovers can also negatively influence firms' performance because of the loss of information.

Without trust, Schmitz (1999, p. 141) argues “clustering in itself, that is the sectoral and geographical concentration of enterprises, brings few benefits.” Waite and Williams (2009, p. 509) note that a lack of trust between members “ultimately will lead to a general level of non-performance in the cluster,” thus limiting the potential benefits, impact and advantages clustering can provide. Trust and the integral role it plays in clusters is a characteristic of successful clustering that is by no means innate to each clustered firm or actor. Although the presence of a cluster could facilitate collaboration and increased inter-firm connectivity effectively, it does by no means occur automatically (Pyke, 2000). Trust is a two-way street, takes time and requires commitment from all parties involved in order to promote collaboration successfully. Trust is not guaranteed to be present among each actor and thus limits the sharing of knowledge, expertise and resources if not developed. Openness and honesty (Karlsson et al., 2007) combined with constant communication must be maintained in order to ensure trust can exist, grow and flourish (Kim and Park, 2015; Rosli et al., 2018).

Boja (2011, p. 34) posits that “although there are globally recognized cluster examples such as Hollywood or Bollywood in film industry, wine industry in California, information technology in Silicon Valley and Boston, economic research must provide models that can be applied to a lower regional level so that economy policy makers can identify or help start clusters initiatives.” Therefore, without implementing an adequate development model, or structured approach the concept and advantages of clustering is but theoretical. A further limitation relates to when trying to measure and analyse clusters, the requirement of a more transparent methodology is greatly needed (Punj et al. 1983; Feser and Bergman, 2000; Cortright, 2006; vom Hofe and Chen, 2006; Hobbs, 2010; Byrne, 2016). The Harvard Competitiveness Institute employed roughly 48 contrasting methodologies to reveal more than 800 clusters spanning across 52 different countries (Crawley and Hill, 2008) highlighting the lack of transparency.
Although a plethora of cluster analysis and case studies involving clustering exists, a
generic model that can clarify why some clusters are successful and why others are not is
still somewhat lacking. Dridi and Hewings (2002, p. 1) in relation to the research of Feser
(1998), argue that missing from cluster analyses are “transparent methods that could be
used to identify and analyse industry clusters and this has led to difficulties in the
empirical application of an attractive conceptualization.” Martin and Sunley (2003, p. 10),
regarding clusters and the lack of generic descriptions/definitions, suggest it results in
“conceptual and empirical confusion,” and as such clusters continue to be subject to
ambiguity and doubt.

The lack of a universal definition of a cluster within the literature and an associated
methodology to analyse, understand and measure key performance indicators creates
confusion and a lack of understanding among researchers, scholars and the general public.
Consequently, these shortcomings limit the impact of clustering, with Delgado et al.
(2016, p. 2) reiterating the “lack of a comprehensive methodology to define and compare
alternative sets of cluster definition.” Having reviewed some of the shortcomings of
clustering, the following section investigates the types of industrial districts and clusters
that exist.

3.6 Types of Industrial Districts and Clusters

Like industry clusters, the origin of industrial districts can be traced back to economist,
Alfred Marshall. A Marshallian industrial district (including the Italianate variant linked
to the Third Italy), a hub-and-spoke industrial district, a state-anchored district, and a
satellite platform industrial district may all be categorised as part of Markusen's (1996)
typology. Typically, Marshallian districts are characterised by many small, locally owned
businesses that trade extensively with one another and do not engage in cross-regional
cooperation. The Italianate variant is similar, but typically involves greater co-ordination
between members and business associations. A hub-and-spoke district is similar to a state-
anchored district, in that there is a central anchor entity and smaller, related firms linked
at the perimeter. Anchor entities in hub-and-spoke districts are private firms, while those
in state-anchored districts are state-owned entities and form the fundamental differences
between them. Large, externally owned firms dominate satellite platform districts, with little intra-district trade or commitment to regional suppliers (Markusen, 1996).

Markusen (1996) introduced and uses the term ‘sticky places’, for city regions which demonstrated resilience in advanced industrial countries. Rather than having small firms play a big role, Markusen’s sticky places owe their success to investment by the state or by large multinational corporations. She examines situations in which these actors provide the glue that encourages smaller firms to stay and expand, and attracts newcomers to a region. Markusen’s three types of industrial districts are characterised by circumstances and relationships that make them 'sticky': as their flag bearer companies and institutions resist globalization and refuse to relocate to lower cost locations, they maintain levels of employment, incomes, and living standards. Indeed Markusen (1996) discovered that one extensively researched formulation is the ‘new industrial district’ (NID), which is based on the concept of the successful expansion of mature industries in the Emilio-Romagna region of Italy (Storper, 1989; Best, 1990).

Markusen (1996, p. 294) notes that contrary to the emphasis on small firms in the NID concept, the alternative models demonstrate the “continued power of the state and/or MNCs to shape and anchor industrial districts, providing the glue that makes it difficult for smaller firms to leave, encouraging them to stay and expand, and attracting newcomers into the region.” Markusen believes each type performs rather differently to one another in relation to “income distribution, permissiveness toward labour organisation, short-to-medium-term cyclicality, and longer-term vulnerability to secular change” (Markusen, 1996, p. 294). Markusen (1996, p. 300) is convinced that all of the features of industrial districts are included under the notion of agglomeration. Thus, she proposes that the stickiness of a place resides “not in the individual locational calculus of firms or workers, but in the external economies available to each firm from its spatial conjunction with other firms and suppliers of services.”

Markusen (1996, p. 294) suggests “NIDs owe their stickiness to the role of small, innovative firms, embedded within a regionally cooperative system of industrial
governance which enables them to adapt and flourish despite globalising tendencies.” Markusen (1996, p. 294) argues that there are at least three other types of industrial district, or ‘sticky places,’ applicable in advanced industrialised countries. She states, “stickiness connotes both ability to attract as well as to keep, like fly tape, and thus it applies to both new and established regions” and proposes the following types of industrial district: hub and spoke, satellite platform and state anchored districts, basing their existence on analysis of metropolitan regions in Brazil, South Korea, Japan and the United States. New types of regions differ significantly from NIDs and have been able to weather elevated capital mobility due to their structures. Table 3.2, based on the work of Marshall (1920), Markusen (1996) and Belussi and Caldari (2009), summarises some key features of the aforementioned types of industrial districts.
<table>
<thead>
<tr>
<th>Business Structure</th>
<th>Marshallian Industrial Districts</th>
<th>Italianate Industrial Districts</th>
<th>Hub and Spoke Districts</th>
<th>Satellite Platform</th>
<th>State-Anchored Industrial Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Structure</strong></td>
<td>Locally owned, small businesses dominate the business structure</td>
<td>Locally self-contained production systems with a high level of vertical disintegration</td>
<td>Business structure dominated by one large hub firm surrounded by suppliers</td>
<td>Business structure dominated by large, externally owned and headquartered firms</td>
<td>Business structure dominated by one or a few large government institutions or universities</td>
</tr>
<tr>
<td><strong>Co-operation</strong></td>
<td>A low degree of cooperation or linkage with firms outside of the district</td>
<td>Cooperation among competitor firms to share risk, stabilise market &amp; share innovation</td>
<td>Low cooperation among competitor firms to share risk, stabilise market &amp; share innovation</td>
<td>Low cooperation among platform firms to share risk, stabilise market &amp; share innovation</td>
<td>Low degree of cooperation among local private-sector firms to share risk &amp; innovation</td>
</tr>
<tr>
<td><strong>Scale Economies</strong></td>
<td>Scale economies relatively low</td>
<td>Scale economies relatively low</td>
<td>Scale economies relatively high and low rates of turnover of local business</td>
<td>Scale economies moderate to high</td>
<td>Scale economies relatively high in public-sector activities; low local business turnover</td>
</tr>
<tr>
<td><strong>Labour Market</strong></td>
<td>A highly flexible labour market within the district</td>
<td>Cooperation among competitor firms to share risk, stabilise market &amp; share innovation</td>
<td>Substantial intradistrict trade among hub firms and suppliers</td>
<td>Minimal intradistrict trade among buyers and suppliers</td>
<td>Substantial intradistrict trade among anchor institutions and suppliers</td>
</tr>
<tr>
<td><strong>Patient Capital</strong></td>
<td>Existence of “patient capital” within district</td>
<td>Disproportionate shares of workers engaged in innovation</td>
<td>Little ‘patient capital’</td>
<td>No ‘patient capital’ within district</td>
<td>No specialised sources of finance, patient capital, technical expertise, business services</td>
</tr>
<tr>
<td><strong>Competition And Commitment</strong></td>
<td>Vigorous competition among firms</td>
<td>Cooperation among competitor firms to share risk, stabilise market &amp; share innovation</td>
<td>Low cooperation among competitor firms to share risk, stabilise market &amp; share innovation</td>
<td>Low cooperation among platform firms to share risk, stabilise market &amp; share innovation</td>
<td>High degrees of cooperation, linkages with external firms</td>
</tr>
<tr>
<td><strong>Workers Commitment</strong></td>
<td>Workers committed to district, rather than to firms</td>
<td>Strong union and trade associations that provide leadership and shared services</td>
<td>Workers committed to hub firms first, then to district, then to service firms</td>
<td>No trade associations that provide leadership and shared services</td>
<td>Workers committed to large institutions first, then to district, then to small firms</td>
</tr>
</tbody>
</table>

Table 3.2: A Summary of Certain Key Features of Each Industrial District
Source: Author, based on the academic thesis of Hobbs (2010)
According to Markusen (1996), firms within the Italian case placed a higher emphasis on territorial organisation (Bartolini, 2021) and conscious networking than they did within Marshallian industrial districts. Collective strategic planning, shared infrastructure (marketing, training, and technical support) provided by trade associations, and increased personnel exchange are all examples of shared infrastructure.

3.7 Conclusion

This chapter began by introducing the origins of cluster theory, how it developed, who developed it and how it has evolved in the literature over time. Section 3.3 explored and collated a number of cluster definitions from the early 1990s to 2021, highlighting the similar and differing views of numerous scholars and researchers when defining clusters and the concept of clustering. There is an abundance of articles and academic debates around the topic of cluster definition and the need for an appropriate definition that is universally used and accepted. Asheim et al. (2006, p. 15) allude to such debates by noting clusters vary considerably in “type, size, origin, structure, organization, dynamics and developmental trajectory. It seems most unlikely that different clusters can all be explained in the same way. We may well need different types of theory and explanation for different clusters.”

Following on from the definitions of clusters section is a summary of the advantages associated with clustering. These advantages are not limited to one firm or sector, rather an entire region and its members, particularly in terms of the bolstering of their entrepreneurial and innovative characteristics, competitiveness and potential. Clusters have demonstrated the ability to improve the economic performance of firms and regions as well as unlocking sources of regional advantages in terms of competitiveness. Section 3.4.1 examined factors that drive the realisation of clustering advantages and how the benefits of clusters are achieved. Local and national authorities and regional development agencies, globally, have invested time and effort in promoting the formation of clusters emphasising their potential economic advantages. A gap in these efforts is having an agreed, generic, ‘one size fits all’ (Njos and Jakobsen, 2016) definition for clusters and thus, shortcomings and limitations within the cluster theory literature are a constant
feature, and are discussed and examined in section 3.5, before section 3.6 introduced and explained the types of industrial districts that are in existence.

In the next chapter, some key terms including a *cluster organisation* e.g. an impartial facilitating membership based organisation that connects industry, academia and government; a *cluster initiative*, e.g. an initiative or programme to facilitate clustering (EC, 2016) and a *cluster manager* e.g. an impartial facilitator who coordinates members and implements the strategic vision of a cluster organisation (Schretlen et al., 2011), are introduced and discussed in detail. Each component has a role to play in driving competitiveness and are frequently and erroneously used interchangeably.
Chapter 4

4 CLUSTER ORGANISATIONS, CLUSTER INITIATIVES AND CLUSTER MANAGEMENT

4.1 Introduction

A cluster, cluster organisation and cluster initiative, although each separate entities, play a different role in driving competitiveness, yet, are commonly used interchangeably, which is incorrect. This chapter seeks to create separate, clear and concise definitions and understandings, while clarifying the differences between these key concepts, as well as examining the roles they play in economic and regional development. It is an opportune time to introduce and discuss the concept of clusters and how they differ from networks/associations. Chapter 3 discusses cluster theory and that clusters often get used interchangeably with business networks and associations, which is also incorrect. Business networks/associations are defined by Besser and Miller (2011, p. 113) as “formal arrangements between independent businesses for the purpose of enhancing business success.” These networks are typically based on contractual arrangements (joint ventures, alliances, and supply chains) and stand-alone networks are formal, membership organisations (industry associations and regional business associations).

Business networks and associations have the ability to bring people together from a networking perspective but do not focus on the research and innovation and internationalisation element that clustering has brought to the fore, and this is a crucial difference. This provides the rationale for this chapter, while outlining what the key factors and terms are that make clusters stand apart from other entities. In contrast to these networks/associations, clusters as defined by Hobbs (2010, p. 64) are “drivers of innovation made up of mutually beneficial localised groupings of specialised and interconnected firms, organisations and institutions, which both compete and co-operate.
Cluster participants’ production processes overlap, and members are therefore closely linked through the complementary exchange of goods, services or knowledge.” The distinct differences between clusters and networks/associations mentioned, involve members mutually benefitting while competing and co-operating together on a regular basis, all with a collective aim and objective to enhance the competitiveness, innovativeness and success of their own firms as well as the overall cluster.

After this introduction, the chapter reviews cluster organisations (section 4.2) with their roles, responsibilities and functions further investigated in tandem with a brief look at three pillars of activity in successful cluster organisations and the approaches used to develop a cluster organisation. Next, in section 4.3, cluster initiatives, are introduced, described and analysed in detail: including definitions, the role of trust, the various types of cluster initiatives and exploring the features of successful and competitive clusters and initiatives.

Finally, there is an extensive review of cluster management (section 4.4), outlining the concept of cluster excellence alongside the roles and responsibilities of cluster managers. The differences between cluster management and cluster governance is reviewed, before discussing the uncertainties surrounding clusters and the role of adaptive management. To conclude, the chapter summarises key roles, and responsibilities of cluster organisations, cluster initiatives, and cluster management and their differences.

4.2 Cluster Organisations

The concept of clusters has been discussed in previous chapters without the theory of a ‘cluster in the wild’, which was introduced in the work of Michael Porter and Christian Ketels. This concept identifies how certain clusters do not require cluster organisations and work alone. Examples of such clusters include Silicon Valley in the U.S and Medtech in Galway, Ireland to name but a few. However, not all clusters operate in the wild. Some require connectors and bridges to be able to build the capacity to strengthen networks and collaborations. Typically, cluster organisations are developed by government and are

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either built bottom-up or top-down. Not all clusters require a cluster organisation but in the EU, it is common practice and these organisations are used to develop clusters.

Increased collaboration has been achieved within several strong cluster programmes, through utilising new forms of organisations functioning as intermediaries equipped with skills to implement the intended tasks and strategies of the cluster (Glaser, 2013). In the cluster literature these organisations have been referred to as ‘cluster organisations’ (Ketels et al., 2012; Ketels, 2015) and ‘Institutions for Collaboration’ (Ketels, 2003; Waxell and Malmberg, 2007; Gutiérrez-Martínez et al., 2015). For the purpose of this research, the term *cluster organisation* will be solely used and investigated. Cluster organisations, are the bodies that are responsible for a) connecting the triple helix of academia, industry and government, through events and other collaborative means which in turn can enhance a cluster/regions competitiveness, b) successfully creating an optimum environment for these connections to grow, develop and flourish, and if done well, this can c) help ensure the overall future success of their cluster. In short, cluster organisations begin the process of sharing a project/challenge that cannot be solved alone, as Calamel et al. (2012, p. 58) note that collaborative projects are “people coming together to solve a problem.” Viederyte (2013, p. 625) notes “most cluster organisations were founded within the last 15 years.”

Regions within these last 15 years have aimed to become more competitive and enhance their innovative capacities. As these regional aims and objectives grow so too does the need to become more organised as policy makers and clusters alike are not leaving such important factors to chance. As such, the European Cluster Collaborative Platform (ECCP\(^\text{10}\)) was born. Cluster programmes have been initiated and implemented in numerous regions worldwide, none more so than across Europe. Clustering has become so important to Europe that the commission has invested in the ECCP. Their role is to provide European clusters a platform to connect to other European clusters and beyond, while boosting their visibility and highlight their impact in industries and global markets. They provide special services and matchmaking events to support internationalisation.

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\(^{10}\) For more information on the European Cluster Collaborative Platform, visit [www.clusterorganization.eu](http://www.clusterorganization.eu)
The vast number of European cluster organisations tells its own story across all industry sectors. According to the ECCP (2020b), more than 3600 European cluster organisations exist. Clustering is used as an economic development tool and the Figure 4.1 identifies ‘why clusters matter’ as well as how productivity is bolstered by clusters, with many points already alluded to in the introductory chapter.

Figure 4.1: Why Clusters Matter
Source: ECCP (2020)

Figure 4.1 displays only a number of the positive impact clusters can have on regions and economies alike, focusing on the number of jobs clusters have created as well as the increase in productivity associated with clustering.

Ketels et al. (2006, p. 9) maintain cluster organisations “operate in widely different settings. Not only do they act in different social and political contexts, but they also address different industry sectors, each with its own idiosyncratic problems and limitations.” This highlights the need for specificity when creating and applying cluster organisations to certain regions. For cluster development to succeed, it is vital that actors within the cluster benefit individually on the basis of a common goal (Sedlmayr et al., 2021). Cluster organisations through their work on behalf of members from the fields of science and business – must significantly contribute to the two following outcomes:
(1) increased competitiveness and innovation capacity of the individual cluster actors through the synergetic interplay of different core competences

(2) The overall development of the cluster in size, memberships, services, and growth accelerator (Sedlmayr et al., 2021, p. 25). It is the individual programmes, events, collaboration opportunities and matchmaking initiatives etc., which can increase competitiveness for individual cluster members and collectively for the cluster as a whole.

Cluster organisations were, at first, almost entirely associated with advanced economies, from as early as the mid-1990s, but have since been adopted in developing economies (circa 2000). There are now hundreds of cluster organisations implemented across these transitioning economies highlighting the value and importance attributed to clustering and the impact it can have on economies at both a regional and national level (Ketels et al., 2006). Ketels et al. (2012, p. iii) undertake a comprehensive study of cluster organisations, exploring “what they were doing, how they were organized and governed, how they were financed, and not least some measure of good or bad performance.” Across 50 different countries worldwide, 356 cluster organisations were analysed. Van Egeraat and Doyle (2018, p. 113) indicate that this “2012 survey revealed that most cluster programmes supported both the establishment of new cluster management organisations as well as the further development of already existing mature cluster management organisations.”

Ryzhkova and Prosvirkin (2015, p. 4) believe cluster organisations have the ability to “facilitate the improvement of values of competitiveness factors and the increase of general competitiveness of enterprise.” Cluster organisations, based on compelling evidence, can be viewed as tools for cluster policies, can implement change and can create an economic impact if their overall cluster is strong (Ketels and Protsiv, 2013). Sölvell and Williams (2013, p. 10) believe cluster organisations around the world “come in many shapes and forms. They differ in the way they are organized and governed (some have explicit members whereas others work with different sets of firms and organizations depending on the project), the way they are financed (various combinations of public and private funding), and what activities and services they provide.” Cluster organisations discover methods to demonstrate excellence towards their members, policy makers and
the wider community (Schretlen et al., 2011). Developing strong networks and combining them with the creation of a devoted organisation i.e. a cluster organisation, for the cluster has the possibility to improve its overall success (Wolfe, 2009).

Ketels et al. (2012, p. 37) argue that “one way to view cluster organizations is that their fundamental task is to facilitate collaboration.” Sölvell and Williams (2013, p. 38), apart from collaboration facilitation, believe “cluster organisations can facilitate rejuvenation of traditional sectors, but also help in building emerging sectors in a region. The need for increased cluster dynamics is as important in emerging industries as in mature industries. Firms in all clusters can, if they innovate and upgrade their competitive advantages, compete in international markets.” For that reason, cluster organisations are by no means limited to having regional impact. They contribute to the growth of the overall clusters’ reputation and how the region is viewed both locally and internationally by enhancing the cluster’s visibility. Thus, they provide additional intangible support to the cluster members based on reputation enhancement (Humphrey and Schmitz 2002). The perception of a cluster and cluster organisation being the one entity is often misunderstood. For example, in Silicon Valley a cluster is present without a cluster organisation existing (Porter, 1990; 1998b). The following sub-section outlines a number of cluster organisation definitions.

**4.2.1 Definition of Cluster Organisations**

Within the literature, numerous definitions of cluster organisations exist. Byrne (2016, p. 2) suggests a cluster organisation is a “body which facilitates the workings of the cluster.” Coletti (2010, p. 679) defines cluster organisations as “intermediate bodies employing people in charge of animating clusters.” Glaser (2013, pp. 5-6) asserts that cluster organisations are composed of different governance bodies, that on the one hand “develop strategic plans for a defined geographic area in a specific sector and, that, on the other hand, through a variety of tasks (e.g. networking events, place marketing, aid in accessing venture capital or other research subsidies), try to improve the area’s competitiveness.” ECCP (2020a, p. 1) defines a cluster organisation as “the legal entities that support the strengthening of collaboration, networking and learning in innovation clusters and act as
innovation support providers by providing or channelling specialised and customised business support services to stimulate innovation activities, especially in SMEs. They are usually the actors that facilitate strategic partnering across clusters.” Van Egeraat and Doyle (2018, p. 113) argue that “European cluster policy has evolved considerably over time: from 1990 to 2000 the focus was on understanding clusters; over the next ten years cluster identification and data development were the focus; whereas between 2010 and 2015 professionalising the management of clusters was the target.”

Coletti (2010, p. 681) defines cluster organisations as “the organised actions carried out to launch, develop and manage clusters with the involvement of involving private industry, public authorities and/or academic institutions.” This example of a cluster organisation is directed by a board of governors, and financed by public funding, private funding and membership fees (Sölvell et al., 2003). Consequently, concerning cluster management, it is vital to take an in-depth look at the cluster organisations’ roles and responsibilities.

4.2.2 The Role and Functions of Cluster Organisations

When one considers the roles and functions of cluster organisations, in simple terms, cluster organisations essentially ‘manage’ the day-to-day running of the cluster (Glaser, 2013). Their roles and functions vary, while Byrne (2016, p. 45) referring to Ketels et al. (2012), highlights that “cluster organisations foster collaboration between cluster participants and facilitate networking through events and programs.” Cluster organisations’ roles and functions include, and are by no means limited to:

1. Facilitating networking at events
2. Building a cluster identity
3. Developing a strategy and vision for the cluster
4. Promoting the cluster and its members internationally i.e. enhancing internationalisation
5. Bringing together all cluster actors including the triple helix of academia, industry and government
6. Improving and strengthening the clusters’ competitiveness through initiatives and programs.

One of the main tasks of a cluster organisation is to provide services from which their members can benefit (Coletti, 2010). Cluster organisations also play a role in business development objectives, which include export promotion, enhancement of R&D development and initiating innovation projects (Byrne, 2016). Similarly, Schretlen et al. (2011), in relation to the six roles and functions mentioned above suggest that the cluster organisation promotes the cluster via activities involving common brand development, representing the cluster at conferences nationally and internationally. Such events and conferences are vital for communicating with the media and can be combined with networking workshops.

Byrne (2016, p. 45) suggests that, “cluster organisations are not only local; they tap into networks with other clusters globally, closing the gap to global markets and value chains. Cluster organisations are typically small and nimble organisations with half employing three or fewer employees.” Among the responsibilities and services provided by cluster organisations, is the ability to promote internationalisation and remove barriers for a cluster and its host region (OECD, 2009; EC, 2011). Clusters and cluster organisations play a vital role in preparing firms for international markets. For example, to improve the internationalisation of a cluster, cluster organisations can initiate and organise trade missions across the globe for member firms targeting particular markets to attend, while also representing the cluster at certain conferences and trade fairs. Here, they can connect firms to one another at these events or connect with fellow cluster organisations abroad. Byrne (2016, p. 252) argues “a cluster organisation requires a strategic plan and should aim to provide services including business development, facilitating research and innovation, and aiding internationalisation.” In the same breath, and along the same theme of internationalisation, Byrne (2016, p. 216) believes “clusters play a vital role in preparing firms for international markets through interactions with demanding and sophisticated local customers, support from associations such as cluster organisations, and gaining objective knowledge from firms in the cluster with experiential knowledge of exporting through networks.”
Cluster organisations can play a pivotal role in strengthening the regions research and innovation ability whilst also improving firms capabilities in relation to internationalisation. Glaser (2013, p. 12), using France as an example, highlight the roles and responsibilities of cluster organisations, stating they “have to enhance new partnerships between local actors, build strategic collaborative research and development projects, and promote an overall environment conducive for cluster members in general and for innovation in particular.” Glaser (2013, p. 15), proceeds to discuss the importance of “how cluster organisations organise, articulate and manage a collaboration enhancement process between local actors.”

Cluster organisations have the potential and capacity to bring together all the different actors identified within a cluster. They can connect small firms with large firms, industry with education and academia with business (Ketels et al., 2012). This is achieved by creating an optimal environment to do business in and by providing the venue to meet, where prevalent issues can be considered and acted on collectively (Ketels et al., 2012). A cluster organisation can help the different actors enter dialogue by tearing down barriers to communication and thus, “get the traffic moving along the paths and over the bridges into the commons.” (Ketels et al., 2012, p. 4). In short, cluster organisations are responsible for connecting the triple helix ecosystem, building trust amongst its members, and enhancing a region or nations competitiveness.

Ketels et al. (2012, p. 5) when discussing Sölvell and Williams’ (2013) three pillars of cluster activities, (Figure 4.2 on page 89) believe different emphases are placed on the three pillars depending on the cluster organisation. Certain activities are focused on building and developing the fundamentals of the cluster commons with others geared towards collaboration enhancement between firms and organisations with all “the three areas being interconnected.” In short, cluster organisations “play a crucial role in boosting collaboration and networking among companies as well as in building bridges across different ecosystems, enabling innovation among SMEs” (Sedlmayr et al., 2021, p. 6). In

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11 Sölvell and Williams (2013, p. 7) state “these are actors that are prepared to invest time and money into building more dynamic and innovative clusters. They do this by constructing a commons where actors meet and exchange ideas, and by initiating cooperative projects across actor boundaries.” They propose that one can view the commons as a ‘white space’ in between the actors.
the next sub-section, the ‘three pillars of activity’ in relation to cluster organisations is examined.

4.2.3 Cluster Organisations and the Three Pillars of Activity

Sölvell and Williams (2013, pp. 10-11) theorise that cluster organisations “rest on three pillars of activities.” The first pillar involves the identity and attractiveness of the cluster and the cluster organisation’s role is to build the ‘cluster commons’ i.e. create an identity whilst establishing trust and lines of networking.

The second pillar relates more to research and innovation projects, where the cluster organisation is responsible for facilitating innovative enhancements, be it via purpose built incubators or upgrading human resources. Ketels et al. (2012, p. 6) refer to this as ‘bridging innovation gaps’ and how “bridging to public organizations can lead to improved regulation and redirection of public investments. Bridging to research can involve incubator services and commercialization of research results and bridging to education can improve HR supply and upgrading inside the cluster.” The third pillar of cluster organisation activities comprises of member firms’ business evolution. Internationalisation is deemed an exemplary objective as well as joint trade missions and other commercial operations that aid SMEs who are not established enough to perform these activities alone.

Byrne (2016, p. 174) highlights potential issues for SMEs, noting “that they do not have the time or resources to apply for R&D projects. A cluster organisation could help members submit or provide proposal writing services, like other European cluster organisations.” Should problems arise, Viederyte (2013, p. 624) believes cluster issues need to be “handled within the cluster organizations based on transparency, communication and on the presence of leading individuals within the cluster organisation.”
Having reviewed the three pillars of activity in cluster organisations, the following subsection discusses the methods to develop a cluster organisation.

### 4.2.4 Approach to Developing a Cluster Organisation

The World Bank (2009) describes a four-step approach to developing and setting up a cluster organisation. Stage one, as Figure 4.3 depicts, involves cluster mapping and stakeholder engagement. Stage two involves the application of ten cluster tools\(^\text{12}\) to pinpoint gaps in the competitive position of the cluster whilst promoting inter-firm collaboration and use of common strategies. Next, stage three concerns the partnership formation of cluster members with organisations in the public sector in order to accelerate policy reform in the development of infrastructure, research and innovation and training. Lastly, in the fourth and final stage, the foundation for the creation of policy reforms stems from business links developed through clustering (World Bank, 2009). The World Bank (2009, p. 116) states that cluster organisations fundamentally, become “a tool for

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12 The 10 tools are “(1) cluster mapping; (2) product and market segmentation; (3) SWOT (strengths, weaknesses, opportunities, and threats); (4) Gap analysis (comparing actual performance with potential performance); (5) Porter’s five forces analysis; (6) value chain analysis; (7) market trends analysis; (8) competitive positioning analysis; (9) old and new institutions for collaboration; and (10) monitoring and evaluation” (World Bank, 2009, p. 127).
government in pursuing policy reform because together they (cluster initiatives and policy reform) may create positive externalities by informing government of the policy implications and possible business responses.”

To deliver a functioning cluster and with it a cluster organisation, international best practice in cluster development indicates that a 24-month funded period is required, e.g. as is the case in the Catalonia Cluster Development Strategy (Figure 4.4), and model used by Business Upper Austria. After the 24-months, the cluster is expected to fund itself through a combination of a smaller proportion of public funding, increased private funding and competitively won European and national funding.
Barriers to Collaboration within Cluster Organisations

Jaegersberg and Ure (2011) are of the opinion that if clusters are to realise their objective, not just in theory, but in a practical manner, i.e. creating wealth within the region and improving collaboration between members, that there is a need for an enhanced understanding of the barriers to knowledge sharing and alignment between stakeholders, as well as identifying barriers to collaboration in relation to SMEs as the driver of growth and job creation.

Byrne (2016, p. 46) discusses how there are barriers that hinder a cluster’s potential, including collaboration, knowledge sharing and interaction. By bringing different actors together, cluster organisations aim to overcome these obstacles and in turn increase the cluster’s competitiveness. They “connect actors, along the value chain and across related sectors, and between industry, academia and government. Not only can they connect the actors locally, but they can facilitate connections with firms and organisations outside the cluster and region - globally and with similar clusters worldwide.” Ketels et al. (2012) posit that in an ‘ideal’ cluster, actors will all collaborate perfectly. However, this is rarely
(if ever) the case and barriers to collaboration exist throughout all clusters, across all industry sectors. Ketels et al., (2012, p. 38) suggest that in a dream cluster “government is fully tuned to the needs of firms. Researchers are in constant dialogue with business. Educational institutions communicate with firms about how best to supply the cluster with the skills and competences it needs. Capital providers interact with firms and supply the capital needed.”

In reality, however, there are many kinds of barriers to interaction and these barriers create gaps that limit collaboration, which then inhibits innovation. Ketels et al., (2012, p. 38) believe one of the most important roles of a cluster organisation is to “bridge these gaps, to improve interaction and enhance the performance of the cluster. In addition to the gaps within the cluster, they must also work on bridging two external gaps: between the cluster and other clusters (sometimes called ‘cross-clustering’), and between the cluster and global markets (both attracting talent and investment from outside, and reaching out to global buyers, suppliers and partners).”

The main barriers to collaboration within cluster organisations, found in the literature, include and are by no means limited to the contents of Table 4.1. Overcoming such barriers is a key role of cluster organisations and cluster managers.

<table>
<thead>
<tr>
<th>The Main Barriers to Collaboration Within Cluster Organisations</th>
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<tbody>
<tr>
<td>• Lack of trust and mutual commitment</td>
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<tr>
<td>• No clear goal setting</td>
</tr>
<tr>
<td>• Poor structure within the organisation</td>
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<tr>
<td>• Lack of quality in leadership roles</td>
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<tr>
<td>• No roadmap for development in the organisation.</td>
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<td>• A shortage of information</td>
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<tr>
<td>• Financial costs</td>
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<td>• Having a low number of contacts</td>
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<tr>
<td>• Differing opinions on goals, culture and methods of operating</td>
</tr>
</tbody>
</table>

Table 4.1: Barriers to Collaboration within Cluster Organisations
Source: Author
Jaegersberg and Ure (2017, p. 225) argue that despite implementing factors such as the exchange of strategic knowledge alignment, skills, expertise and information between players i.e. positive externalities, “there was often little evidence of any coherent strategy for connecting them up, either to support knowledge transfer, or collaboration in the creation of shared value.” Moreover, the infrastructure surrounding communication and collaboration is vital to influence skill, knowledge and resource distribution in clusters and this infrastructure is progressively seen as a key element and catalyst for value creation in successful clusters as well as a tool to overcome the aforementioned barriers (Morosini, 2004; Sölvell and Williams, 2013). Thus, the lack of a clear infrastructure to accommodate a cluster’s needs can act as a barrier to collaboration.

Without common goal setting, structure and quality leadership in combination with a clear vision and strategy, barriers to collaboration will continue to exist within cluster organisations. These barriers can prevent clusters from growing, thriving and potentially cause confusion amongst other organisations, firms and their staff alike. For example, Byrne (2016, pp. 252-253) firmly believes that “existing organisations, which call themselves cluster organisations, require a behavioural and mind-set change from their staff and a shared value plan with cluster members to transition from a trade/industry association to cluster organisation. This is achievable over the medium to long term and requires a strategic roadmap of developmental stages – where progress can be measured.” Therefore, the cluster organisation can 'facilitate' collaboration by adopting a different mind-set, involving the preparation and implementation of a clear and transparent plan, which allows barriers to collaboration to be eliminated and gaps to be narrowed.

Having reviewed cluster organisations and their associated characteristics, functions, roles and responsibilities, the author introduces and explains the term cluster initiatives in the next section, in order to avoid misunderstanding between the terms.

4.3 Cluster Initiatives

Cluster initiatives, in essence, are programmes, events, digital collaboration tools and concepts created to bolster the innovation and competitiveness of a region through bringing cluster members together to collaborate (Coletti and Di Maria, 2015). In other
words, a cluster initiative can be an initiative or programme run by the cluster or one that is supported by government and/or private members for the cluster organisation. It can take the form of support for skills and training, a research and innovation programme, global export support or networking for SMEs to name but a few. EC (2016, p. 15) theorise “cluster initiatives are one of the main channels through which cluster policy can engage with a cluster.”

Clusters and cluster initiatives are two separate entities. Clusters refer to an economic phenomenon of concentrated economic activities, for example, Silicon Valley (EC, 2016). On the other hand, cluster initiatives describe intentional efforts to develop, enhance and amplify a cluster, a region and its “economic stronghold” (EC, 2016, p. 15). Cluster initiatives can strengthen a clusters connections and in doing so, improve the overall level of performance of the cluster. If a cluster is deemed a ‘strong’ cluster, increased economic impact is said to be generated from cluster initiatives (Ketels and Protsiv, 2013).

According to Coletti and Di Maria (2015, p. 330), a cluster initiative (CI) involves:

1. Different member firms and organisations (three main types of actors: private, public and academic)
2. Often a cluster organisation (CO) with an office, cluster facilitator/manager, website etc.
3. Governance of the initiative (e.g., constellation of CO board)
4. Financing of the initiative (international/national/regional/local public funding, member fees, consulting, etc.).

Fornahl and Hassink (2017, p. 225), support the findings of Ketels et al. (2012) when they suggest “cluster initiatives are formal associations of cluster actors (firms, universities, research institutes, local authorities) created to further the economic performance of the cluster and the cluster region by promoting shared interests of the participating organizations.” Cluster initiatives are viewed as an important tool in regional economic
strategy implementation to support cluster organisations and sectoral specialisations. Being adaptable to new framework conditions combined with accessibility to market intelligence are key conditions of cluster initiatives (Sedlmayr et al., 2019). Donahue et al. (2018) theorise that within a cluster organisation (which is a type of cluster initiative), specific cluster initiatives can provide research and information to aid firms and other internal stakeholders about the opportunities available as well as prioritising these opportunities via shared action.

Donahue et al. (2018), summarise what strong cluster initiatives entail suggesting a strong cluster initiative is driven by the private sector, with interventions catalysed by a group of firms that are willing to work collectively to fill gaps in a cluster ecosystem and by staff with industry expertise and collaboration skills. Public investment is vital with research institutions providing the required innovation and talent. Furthermore, Ketels et al. (2006) discuss how important it is for cluster initiatives to be implemented and adopted as a tool for economic development. In Europe, Sedlmayr et al. (2021, p. 6) declare that “today, around 3,500 cluster initiatives and similar approaches can be found.”

Cluster initiatives are increasingly “managed by specialised institutions, known as cluster organisations, which take various forms, ranging from non-profit associations, through public agencies to companies” (EC, 2008a, p. 8). Enhancing the business environment, expanding the cluster, modernising innovation and technology initiatives and upgrading the workforce, combined with general cluster networking is the potential form a cluster initiative can take (Sölvell et al., 2003). A review of the literature on cluster initiatives and their definitions (section 4.3.1) is essential to comprehend the role they play for clusters, cluster members, and the regional governments alike. Fornahl and Hassink (2017) discuss the relatively new concept of cluster initiatives and how they are used to increase the competitiveness of a cluster. This can be achieved through initiatives such as specific programmes designed and implemented alongside events at home and abroad for cluster members to attend while promoting collaboration amongst the various actors present. To benefit greatly from clustering, cluster initiatives; be it innovation, organisational or managerial based, or cluster organisation creation, should involve the
formation of regional clusters that will ultimately support, manage and enhance regional development (Evgeny et al., 2016).

Günther and Meissner (2017, p. 4) highlight that the goals underlying cluster initiatives vary reasonably including goals such as “a dedicated increase of regional SME competitiveness, support of collective research, and reshaping regional industries.” EC (2016, p. 19) suggests that “over the last decade, Europe has become a global leader in the use of cluster based economic development tools. A large number of cluster organisations have been created, supported by a wide range of government programmes.” The European Commission has funded a number of actions and initiatives to support cluster organisations, namely:

- **The European Cluster Observatory** fosters the understanding the role clusters play in industrial change and transformation processes,
- **The European Strategic Cluster Partnership** and B2B missions aim at the internationalization of clusters,
- **The European Secretariat for Cluster Analysis (ESCA)** promotes cluster management excellence,
- **The European Cluster Collaboration Platform (ECCP)** facilitates knowledge exchange between European cluster managers.

For a cluster to be competitive, the existence of a number of connected successful companies is a prerequisite (Van Egeraat and Doyle, 2018). The presence of competition within a cluster is also an important feature; however, numerous examples of thriving clusters highlight cooperation as a success factor for innovation. Some cluster initiatives place an emphasis on regional and local areas with an aim of creating better inter firm connectivity, trust and dialogue in order to establish spillovers. They use a combination of competition and cooperation within the cluster to drive research and innovation across SMEs and large firms alike (Sölvell et al., 2003).

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13 For more information on such programmes, see DASTI/VDI/VDE/BMWi (2012). Clusters are Individuals Vol. II, DASTI: Copenhagen, available at www.vdi-de-it.de/publications/studies/clusters-are-individuals-2013-new-findings-from-the-european-cluster-management-and-cluster-program-benchmarking
In the literature, there are various names used to define who manages cluster organisations, who is responsible for implementing such initiatives and section 5.9 examines the term ‘cluster facilitator’ in greater detail later on in the thesis. However, for now it is more relevant to look at the numerous and differing definitions of cluster initiatives explored in the following sub-section.

4.3.1 Definition of Cluster Initiatives

A large body of literature is available regarding cluster initiatives and their definitions. While the terminology used may be somewhat different, numerous authors, researchers and scholars incorporate similar elements and key characteristics that define cluster initiatives. The author presents the most relevant definitions to this body of research. Sedlmayr et al. (2021, p. 6) suggest “clusters are about agglomeration, competition and cooperation. This can be achieved by cluster initiatives, Special Economic Zones, Industrial Parks and other similar initiatives.” The concept of a cluster initiative, is defined in a simplistic fashion by Alberti and Belfanti (2019, p. 1) who theorise a cluster initiative as “systematic efforts aimed at cluster development.” Ketels et al. (2012, p. 1), in more detail define cluster initiatives as “organised efforts to increase the growth and competitiveness of clusters within a region, involving cluster firms, government and/or the research community.”

The ‘Smart Guide to Cluster Policy’ report from the ECCP (2016, p. 12), in line with Ketels et al. (2012), define cluster initiatives as organised efforts to support the competitiveness of a cluster and thus consist of “practical actions related to the capacity of these clusters to self-organise and increasingly to pro-actively shape the future of the cluster.” The process is usually bottom-up, competitive, and often facilitated by cluster organizations, which are specialized intermediaries for SMEs. Sedlmayr et al. (2021, p. 231) view a cluster initiative as “an organised effort aimed at fostering the development of the cluster either by strengthening the potential of cluster actors or shaping relationships between them. They often have a character like a regional network.” Cluster initiatives can be managed by cluster organisations or act as a rather loose group of interacting actors without a managing entity. Based on experiences with cluster initiatives
in advanced and developing economies, Ketels et al. (2006, p. 9) are “convinced that in many situations they are indeed a very valuable policy instrument.” Less developed economies face entirely different challenges to those of a high developed and technologically advanced country (Günther and Meissner, 2017). In other words, specific clustering initiatives, for example, local and global programmes and events, to name but a few, can be successfully used in advanced or developing economies.

Sedlmayr et al. (2021, p. 29) from an industry perspective, argue clusters “offer SMEs, especially in developing countries\(^{14}\), an opportunity to stimulate each other’s business development and to establish an international profile through networking, cooperation and joint undertakings. International visibility matters in a globalized business world.” UNIDO (2014) discusses how cluster activities differ in developed economies to those in developing economies, suggesting that developed economies will use clusters to enhance innovation and common product development as core activities of their many cluster activities. Conversely, in developing economies, there is more of a focus on improving productivity, skill development, policy support, product quality and/or export ability.

According to Fornahl and Hassink (2017), excellence in cluster initiatives and cluster management offer a significant advantage to policymakers in designing and implementing tailored policies. Moreover, the advantages that clustering can potentially create are often supported by the aforementioned specific cluster initiatives. These initiatives are established mainly with the aim of enhancing members’ activities and services, which might be in the form of support for organisations and cluster firms alike (Laur et al., 2012). If individual cluster initiatives are to be successful, they need buy in and support from cluster members. This support is usually built on a foundation of trust and the role trust plays between members of an ecosystem is of extreme importance. The role trust plays in clusters and as part of cluster initiatives is examined in the next subsection.

\(^{14}\) For example, “Northern African regions with predominantly SME structures, such as Morocco or Tunisia (to mention just a few examples) have been able to improve their international position as car assembly hotspot through cluster formation in the past” (Sedlmayr et al., 2021, p. 29).
4.3.2 The Role of Trust in Clusters and Cluster Initiatives

In past decades, there has been an exponential increase in the interest of the role trust plays in economic performance (Granovetter, 1992; Sako, 1992; Platteau, 1994a and 1994b; Lane and Bachmann, 1996). During the late 1990s, Schmitz (1999, p. 146) noted how “it would seem that even the trust discussion is still in its infancy, in particular as far as developing countries are concerned.” Schmitz (1999, p. 141) defines trust as “the willingness to expose oneself to the possibility of opportunistic behaviour by others.” Waite and Williams (2009, p. 503), in reference to the work of Porter (2000), discuss how trust is not only a vital component between firms, but “also an important element of cluster formation and critical to cluster success.”

Trust facilitates co-operation, and when aligned with competition can become the foundation upon which the firms within a cluster experience reciprocal benefits (Gambetta, 1988; Putnam, 1995; Fukuyama, 1995; Cohen and Fields, 1999). Waite and Willams (2009, p. 502) suggest that trust “creates value by facilitating successful collective action.” Moreover, Schmitz (1999, p. 141) states “a cluster which competes on the basis of collective efficiency is a system of production which consists of a multitude of formally independent actors with a high density of transactions among them. For these to function smoothly and result in cumulative (not merely one-off) gains, trust is of great importance.”

In light of the research carried out by Laur (2015), Alberti and Belfanti (2019, p. 8) believe life in a cluster initiative is “dynamic, and throughout its life, the degree of involvement and roles the actors play should change.” Thus, actors should work collaboratively, requiring a certain level of trust, in the knowledge that each of their roles require adaptation and constant alteration. Clusters, to a degree, rely on personal relationships involving networks of people and institutions that co-operate and interact (Rosenfeld, 1996). As such, trust can “enable participants to act together more effectively to pursue shared objectives” (Putnam, 1995, p. 664). Waite and Williams (2009, p. 504) argue that trust plays “an important role in binding SMEs into value adding relationships
and overcome their resource disadvantages.” Schmitz (1999, p. 147) alludes to the fact that trust has not “ceased to be important for collective efficiency.”

Ketels et al. (2006), state that trust plays an integral role if cluster organisations (a type of cluster initiative) are to succeed due to their collaborative nature. Ketels et al. (2006, p. 31) reiterate “in a low-trust environment, collaborative efforts such as cluster initiatives face a clear challenge. Potential cluster initiatives that could provide significant benefits will not get started.” To increase the level of trust between actors, cluster initiatives can become an integral tool, and goals and ambitions must be established and constructed accordingly (Ketels et al., 2006). Ketels et al. (2006, p. 31) posit “the burden low trust puts on cluster initiatives should be taken into account when setting appropriate performance goals for a cluster.”

Ingstrup and Damgaard (2013, p. 558) highlight “social institutions such as trust and loyalty facilitate cooperation between small and medium-sized firms belonging to a particular industry in the same region for the sake of increasing their innovative capacity as well as the competitiveness of the region as a whole.” Waite and Williams (2009, p. 502), in reference to the work of Putnam et al. (1993) suggest that “co-operation is a demonstration of trust and the interaction of trust and co-operation may lead to the development, over time, of generalised norms of co-operation, which further increase the willingness to engage in social exchange.” The role of trust throughout the process of internationalisation is another aspect which requires investigation.

**Trust and Internationalisation**

Schmitz (1999, p. 147) discusses trust and its involvement in globalisation, noting that globalisation has both created and eroded trust. It has undermined the “socio-cultural ties and now demands new ties-from those who succeed in it. Those new ties are based on conscious investment in inter-firm relationships. The business partners do not necessarily have to change - but the basis of trust does.” Schmitz (1999, pp. 147-148) continues by adding “the second and more difficult hurdle is to prove honesty and competence. Both
filters play a role, the former seems to help the formation of the cluster but the latter carries increasing weight when local firms enter the international market.” Vicente (2016, p. 17) in reference to the work of Porter (2000), argues “the proximity of different firms and institutions and the repetition of their exchanges generate higher level of trust and coordination than a context of market transactions between actors from different locations.” Schmitz (1999, p. 141) speaking hypothetically about individual firms within a cluster as an example, suggests “what they make individually is useless to the outside world, what they make together conquers distant markets. This is a caricature but captures the essence of interdependence and the need for trust.”

Waite and Williams (2009, p. 509) state “successful export clusters include small firms with the ability to develop long-term trusting relationships, with common export goals, open communication channels, a commitment to information sharing and a will to work together for mutual benefit.” Günther and Meissner (2017, p. 7), based on the work of Gertler (1993), suggest “exchange of information and knowledge among cluster participants is one major step in the evolution of more formalized cooperative undertakings involving all cluster members. Especially information exchange is not limited to exchange of technical related or directly innovation-related information but instead involves a reasonable share of small talk and less formal information.” Additionally, to build lasting trust, this kind of frequent communication must occur among individuals and actors alike (Günther and Meissner, 2017). Having introduced cluster initiatives, the role of trust in clusters, cluster initiatives and internationalisation, the next sub-section investigates how these initiatives are developed and implemented.

4.3.3 Developing Cluster Policies and Initiatives: Aims and Implementation Process

The European Cluster Collaboration Platform (ECCP, 2020c) defines cluster policies as “an expression of political commitment, composed of a set of specific government policy interventions that aim to strengthen existing clusters and/or facilitate the emergence of new ones.” As part of its discussion of cluster policies, the ECCP also examines how modern cluster policies are meant to create a business ecosystem that is favourable to the development of new innovations and entrepreneurship, creating a favourable environment
for new winners to emerge, which supports the development of new industrial value chains and ‘emerging industries.’ A cluster organisation, which manages networking activities and provides support services to SMEs, does more than just support networking activities. Policy makers and academics alike use the term ‘cluster policy’ regularly.

Sedlmayr et al. (2021, p. 46) believe “a cluster policy is an expression of political commitment to strengthen existing clusters and/or facilitate the emergence of new ones. Cluster policies aim at establishing favourable business environments for innovation and entrepreneurship and the development of new value chains.” Cluster policies incorporate a variety of policy instruments, which are found in the fields of science, innovation and technology (Salonius and Käpylä, 2013; Meissner, 2015; Carayannis et al., 2016; Covi, 2016).

Günther and Meissner (2017, p. 5) suggest “cluster policy is the support of public authorities across different fields of activity (e.g., production, innovation, education) to a cluster.” Some of the more common approaches of cluster policies involve providing cluster management organisations with financial support to encourage networking, collaboration between actors and trust building (Sedlmayr et al., 2021). As such, clusters, perhaps viewed by some as complex in nature, require a method and an approach for their creation and development. Several authors and scholars have attempted to develop conceptual models to comprehend and analyse clusters and determine which initiatives are required in order to advance and enhance the cluster organisation (Sölvell et al., 2003; Sölvell, 2008; ITD, 2009; Ffowcs-Williams, 2012; Ketels et al., 2012; Morgulis-Yakushev and Sölvell, 2017). Bathelt and Li (2014) allude to the need for formal institutional structures, including science parks and incubators. These may be influenced and bolstered by policy and in turn enhance the innovative capability and culture. Success of a clustering policy relies on the role that the government, the cluster organisation and industry play in unison.

One of the primary aims of cluster initiatives is to “address barriers to competition” (World Bank, 2009, p. 123). According to Ketels et al. (2006), these barriers may emerge
from failings in the industry, government or academia sectors. When governments are involved in clusters, they can help identify potential barriers to competition and implement policies to help combat such barriers. Byrne (2016, p. 43) believes “targeted cluster initiatives and programmes are designed to affect a specific cluster, developed from data and information on the cluster.” The application of cluster initiatives relevant only to one specific cluster cannot be implemented generically across other clusters in the same region as they are forged for a distinct context (Bergman and Feser, 2000, 2020). Cluster initiatives need to be personalised to fit their member’s needs. Van Klink and De Langen (2001, p. 454) when discussing cluster policies, refer to the importance of taking a contextual and historical point of view: “no blueprints of cluster policies can be given, simply because different contexts require different policies.”

Furthermore, regarding how specific clusters require specific initiatives and programmes, EC (2016, p. 22) argues “clusters differ in their profile and needs, both across and within cluster categories, such as the automotive industry, medical devices or tourism. Locations, too, differ widely in their size, profile, and stage of economic development. While the general economic principles apply across all clusters and regions, how measures can be effectively implemented is highly dependent on the specific context.” Sedlmayr et al. (2021, p. 6) share similar beliefs and add “developing a cluster strategy is important for each type of cluster. Strategies differ according to the stage of maturity a cluster operates in.” Coletti (2010, p. 687) alludes to the point that innovative clusters do not and must not innovate in the same manner, and thus “policies and initiatives aiming at blindly replicating models of cluster organisations activities and cluster management tasks and skills may do more harm than good.”

Schretlen et al. (2011, p. 15) in reference to the work of Shapiro (2001), note “the purpose of reviewing cluster progress is to make changes where necessary, and to identify and build on strengths of the cluster and the cluster organisation.” Such reviews allow for effective decision making enabling the cluster organisation to determine if the cluster is developing in line with the plan and if the available resources are sufficient and being used optimally. Schretlen et al. (2011) argue that if governance discussions take place too early in the cluster's 'birth' or 'inception’, it may result in the strongest and most powerful
members dictating the governance arrangements without a clear picture of how the cluster is going to function.

Europe, since the early 2000s, has positioned itself as a global leader concerning the use of clusters as developmental tools for the economy. A wide range of government programmes have invested time and finance into numerous cluster initiatives that have been created (Lämmer-Gamp et al., 2012). The potential for combining the needs of society in a certain region, facilitated by using cluster initiatives as key players is endless (Lämmer-Gamp, 2014). A simplified timeline of the different phases of cluster policy use across Europe since the 1990s is shown in Figure 4.5. It depicts the evolution of cluster policy use across Europe and how it has developed from understanding and identifying clusters from the 90s to the early 2000s, to progressively creating better clusters, with the most recent emphasis being placed on how to make better use of clusters.

Figure 4.5: The Different Phases of Cluster Policy Use in Europe
Source: Fornahl and Hassink (2017, p. 137)

For cluster policy to be successful, certain monitoring and evaluation must take place i.e. periodic monitoring of clusters at certain timeframes that are written in the plans from the start. Monitoring occurs, mainly due to the limited nature of public funding, to examine if the cluster policy is effective or not and if there is a need “to take corrective action based on the results of the evaluations. This monitoring is an instrument to formalise the commitments made in the implementation roadmap. Policy-makers have to make tough choices as to which competitiveness clusters to support, to continue supporting or even in certain cases to stop supporting” (EC, 2016, p. 23).
Table 4.2 below, summarises and outlines the essential ‘Dos and Don’ts’ of cluster policy and what it does and does not support, follow, grow or focus on. In summary, the figure below displays clear and concise differences between what modern cluster policy should and should not ‘do’. An overriding trend amongst the ‘don’ts’ column involves generic policy implementation without careful reflection and narrow focus. The ‘do’s’ column provides the extra layer of detail required for successful implementation of a well-planned, strong cluster policy that focuses on tailor-made initiatives relevant to the cluster in question i.e. cluster policy, for example, should focus on the regions existing strengths and competencies, incorporating input from vital actors within the cluster including firms, investors, policy makers and academia.

<table>
<thead>
<tr>
<th>Don'ts</th>
<th>Do's</th>
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<tr>
<td>Support individual specialised firms</td>
<td>Support new activities, in particular those being undertaken by groups or networks of related industries</td>
</tr>
<tr>
<td>Create clusters from scratch (i.e. implementing ‘wishful thinking’ of policy-makers)</td>
<td>Facilitate the growth of clusters by building upon existing strengths (i.e. implementing evidence-based policy by building upon a comparative analysis of regional strengths and ‘entrepreneurial discovery’)</td>
</tr>
<tr>
<td>Fund large numbers of widely varied clusters</td>
<td>Fund strategic cluster initiatives that focus on promoting the strengths, linkages and emerging competences and which are in line with the aims of national/regional smart specialisation strategies</td>
</tr>
<tr>
<td>Follow growth trends without reflection</td>
<td>Capitalise upon regional competences to diversify into new activity areas and to develop emerging industries</td>
</tr>
<tr>
<td>Follow a narrow sectoral cluster approach</td>
<td>Follow a systemic cluster approach focusing on related industries by capturing cross-sectoral linkages</td>
</tr>
<tr>
<td>Develop and implement cluster policy in isolation from other policy areas</td>
<td>Adopt an inclusive and participatory cluster approach (i.e. involving businesses, investors, academics and policy-makers, and making links with related policy themes such as R&amp;D, innovation, entrepreneurship, access to finance, SME internationalisation etc.)</td>
</tr>
<tr>
<td>Support cluster initiatives that are only inward looking</td>
<td>Support cluster initiatives that have an international perspective on the positioning of the cluster in international value chains</td>
</tr>
<tr>
<td>Focus exclusively on strengthening regional partnerships</td>
<td>Build regional partnerships as a basis for joining European Strategic Cluster Partnerships</td>
</tr>
</tbody>
</table>

Table 4.2: Dos and Don’ts of Modern Cluster Policy
Source: Author based on EC (2016, p. 23)
Cluster policy requires the creation of a strategy, which can be actioned and analysed in a cyclical manner (Figure 4.6). Assessing any impact of activities that have been implemented, taking on board the current state of the regional economy and prioritising specific activities and fields to select, are all components of the cluster policy cycle (EC, 2016). The policy cycle is relevant to the process involved in the cluster life cycle itself, which incorporates certain requirements and actions at each respective stage.

![Cluster Policy Cycle Diagram](image)

**Figure 4.6: Cluster Policy Cycle**  
Source: Author based on EC (2016, p. 26)

Developing cluster initiatives include; brand building, market development facilitation, promoting networking and increased connectivity within the cluster and region, promoting collaborative research and innovation, facilitating the adoption of innovative practices and processes. Other contributing initiatives to a cluster’s growth are achieved by attracting new business to the region, financing education and training endeavours and delivering interests of the cluster to regional and national trade associations as well as regional and national governments (Mills et al., 2008).

Byrne (2016, p. 45) cites the work of Sölvell et al. (2003) that highlights “six main types of cluster initiative: general cluster networking, human resource upgrading, cluster expansion, business development, innovation and technology initiatives, and improving the business environment.” The World Bank (2009, p. 121) claims “what is understood by the concept of a ‘strong’ cluster differs depending on the economic development of
the underlying country. Cluster initiatives’ target strong clusters, and in advanced economies this usually means clusters with a strong competitive position and capacity to innovate.” Coletti (2010, p. 679), referring to the work of Porter (1998b) suggests “advanced clusters are supposed to have a strong internal rivalry which shifts the basis of competition from low wages to low total cost.”

It is argued that a cluster typically has a shared vision, however, the adoption of targets that can be quantified are not universally promoted (Sölvell et al., 2003; Sölvell, 2008; Gibson, 2015). In fact, to achieve quantifiable data depicting the implementation of a cluster initiative, it would be essential to gather strategic feedback from cluster members as well as auditing the activities of the network. The rationale behind this; to enable continuous improved management of the network (Ffowcs-Williams, 2012; Gutiérrez-Martínez et al., 2015). Therefore, cluster initiatives and their performance impact require a form of measurement, which provided the need for the development of the ‘Cluster Initiative Performance Model’ (CIPM) (see section 6.2.)

While cluster initiatives are mainly seen as the policies which support clusters, the common features of cluster initiatives are numerous. They focus on the business environment of a microeconomic nature combined with a long-term goal of enhancing the clusters competitiveness (Sölvell et al., 2003). There is a direct correlation between successful cluster initiatives and the presence of a functional information and communication system that bolsters the development of collaboration, trust and increased knowledge, expertise and information exchange (Ffowcs-Williams, 2012). Aziz and Norhashim (2008, p. 349) draw our attention to the fact that “tremendous changes in technology, political and social frameworks, as well as the impacts of globalisation, have put pressure on countries to become competitive.” The success of the cluster depends on a vast number of factors including the regional, national, political and economic environment (Sölvell et al., 2003).

The success of cluster initiatives is largely attributed to the quality and competency of the personnel overseeing the clustering process (Fromhold-Eisebith and Eisebith, 2008). The
creation and implementation of an action plan involving a set of activities is required to be undertaken for the cluster strategy to succeed. Schretlen et al. (2011, p. 11) suggest “it typically contains an overview of specific tasks and assigned responsibilities, detailed planning and allocation of resources (i.e., people, finance).” The time-line of an action plan may vary from months to years and it may be reasonable to develop action plans annually. According to Donahue et al. (2018, p. 1), successful cluster initiatives “begin with a combination of data and qualitative analysis to identify and prioritize cluster opportunities in service of broader economic development goals.”

The firms within the cluster require a strong level of trust in the local/national government initiatives. These characteristics of a successful cluster also involve inter-firm competition regarding the process of obtaining government funding/financing (Sölvell et al., 2003). Sedlmayr et al. (2021, p. 15) consider that “regional agglomeration is a key ingredient for successful cluster development.” Sölvell et al. (2003) believe that cluster initiatives are in most cases, set up as a government initiative, which normally require three years to come to fruition and thus take time to realise their success. The evolution of how the cluster initiatives are financed involves government funding and investment initially, moving towards a greater emphasis and importance being place on membership fees.

EC (2021, p. 1) notes how “membership of an industry cluster or SME support organisation varies widely across the EU. According to the Eurobarometer Survey on SMEs, more than half (51%) of all SMEs in Sweden are members of such groups, followed by 38% in Belgium and 36% in Spain, and overall, there are twelve countries where at least one in ten SMEs are members.” Those in charge of clusters and implementing cluster initiatives are known as cluster managers and are discussed in detail in the next section.
4.4 Cluster Management, Managers and Cluster Excellence

Cluster management, a task undertaken by designated cluster managers with a goal to achieve cluster excellence, and their concepts are reviewed in this section. To avoid confusion and overlapping of terminology as well as definitions, each of the three elements i.e. cluster management, cluster managers and cluster excellence will be examined independently of one another to obtain a clearer understanding.

4.4.1 Cluster Management

One aspect of clusters that has received significantly less attention in the literature is the concept of cluster management (Günther and Meissner, 2017). Schretlen et al. (2011, p. 3) suggest “cluster management can be defined as the organisation and coordination of the activities of a cluster in accordance with a certain strategy, to achieve clearly defined objectives.” Cluster management represents a continuous activity of a cyclical nature and is a complex, interactive and non-linear process. The main stages of the cluster management cycle (Figure 4.7) can be split into (1) Define; (2) Design; (3) Implement, (4) Monitor, (5) Evaluate, and (6) Revise.

Figure 4. 7: Cluster Management Cycle
Source: Author based on Schretlen et al. (2011, p. 8)
Cluster management involves the management of activities of the cluster members, enabling organisations and different actors to work collectively and more effectively while achieving synergy (Kaner et al., 2007). Günther and Meissner (2017, p. 5) define cluster management as “all organizational and managerial work within a cluster that contributes to improved interconnectedness between cluster members (internal relations) and between the cluster and surrounding actors (external relations).” The personnel working in a cluster organisation who steer the operationalisation of the cluster strategy work under the umbrella term of ‘cluster management’. It involves one or more individuals working with cluster actors and the steering committee. They “implement so-called ‘services’, and dedicated activities designed to promote trust building, networking, innovation, skills development and more” (Sedlmayr et al., 2021, p. 120).

Cluster management can be viewed to go beyond individual organisation management. It involves the facilitation and mediation of numerous cluster members. It is natural for cluster members to have their own agenda and objectives to strive for. Schretlen et al. (2011, p. 3) note a key challenge for cluster managers is to make sure these “agendas are united into common objectives and collective actions, that conflicting interests are resolved, and the relevant organisations see enough added value from their participation in cluster activities.”

Rarely does the cluster management have a clearly defined position in the overall network. However, these managers must pro-actively find their role, shape it accordingly and aim to become a respected actor with the support of the cluster members (Jones-Evans et al., 1999; Klofsten et al., 2015). It is suggested that cluster management is making a considerable contribution towards cluster development because of its activities and services cluster members can avail of (Moss, 2009). Günther and Meissner (2017, pp. 7-8), draw our attention to the fact that these “activities are in-line with the actual participant demands and needs; thus, multiple different clients (in sense of cluster participants) needs have to be fulfilled.” Therefore, the cluster management has to play an important role as a mediator between all the different triple helix actors (Laur et al., 2012; Tödtling et al., 2013; Klofsten et al., 2015).
Basyuk et al. (2016) believe the main objective of the cluster management is to implement the strategic objectives of the cluster organisation to promote the development of participants of the cluster to increase their competitiveness and profitability. To realise strategic objectives for the cluster, the cluster management staff must undertake certain tasks, namely:

1. Enhance interaction between triple-helix actors
2. Implement and promote joint innovation projects while bolstering collaboration, cooperation and dialogue between the members
3. Promote members outputs both locally and internationally
4. Design a program that develops the skills and competencies of the personnel of cluster members (Basyuk et al., 2016).

Günther and Meissner (2017, p. 5) propose that cluster management provides a number of professionally orchestrated services to its members including “research and innovation co-operations and ventures, technology and knowledge transfer services, manufacturing and marketing alliances, staff exchange, and other related means.” Targeting the enhancement of information and knowledge flow between members has occurred through the development of the cluster management’s communication structure (Breschi and Lissoni, 2003). This structure is by no means limited to within the cluster but also with other external actors and related clusters (Klofsten and Jones-Evans, 1996; Kenney, 2000; Sölvell, 2009; Klofsten et al., 2015).

Günther and Meissner (2017) highlight that more and more cluster management is concerned with internationalisation, including inter-cluster collaboration. Clusters and cluster organisations are seen as instruments to support SME internationalisation. Günther and Meissner (2017, p. 2) state clusters are a “somewhat fashionable term used to describe the orchestrated agglomeration of actors in innovation ecosystems, typically in one region or at least in geographic proximity.” Moreover, Günther and Meissner (2017), referring to the work of Boschma and Fornahl (2011), note how these agglomerations have been regularly analysed, yet little if no work has been carried out on the meaning of cluster management within such agglomerations. Cluster managers are required to achieve certain objectives and reach certain standards, of which their cluster
management can be assessed. Thus, the next sub section looks at the concept of cluster management excellence.

### 4.4.2 Cluster Management Excellence

It is important to keep in mind that “there is no golden recipe for excellence in cluster management” (Schretlen et al., 2011, p. 3). The concept and term ‘cluster management excellence’ has gained traction recently and Schretlen et al. (2011, p. 6) suggest “cluster management excellence is often linked to the strength and professionalism of the cluster organisation. By a cluster organisation one should understand organised efforts to facilitate cluster development, which can take various forms, ranging from non-profit associations, through public agencies to companies.” Furthermore, Schretlen et al. (2011, p. 6) suggests “a cluster organisation typically functions as a mediator between various cluster members and adds value by stimulating collaboration both within the cluster and between the cluster and the outside world. Cluster management excellence thus refers to the organised efforts allowing to achieve and maintain cluster excellence.”

Policy makers, introduce numerous initiatives and projects with an overall aim of augmenting the efficiency of current cluster managements’ efforts (ESCA, 2020). To achieve excellence in cluster management, Schretlen et al. (2011) suggest cluster managers must constantly monitor if the network is reaching its objectives or not. Different clusters require different management approaches as a cluster develops and responds to external/environmental factors (Schretlen et al., 2011). In other words, cluster managers and organisations are required to be adaptable to environmental changes, technological changes and external competition and market developments, to name but a few.

Sedlmayr et al. (2021, p. 6) support this argument, adding “clusters display different stages of maturity, from embryonic to advanced to specialised phases. The management requirements change in accordance with each stage of development.” Coletti (2010, p. 682) argues “cluster managers should facilitate the establishment of strategic alliances and networks, identifying core people with already established mutual trust, attracting
potential partners and helping them to create relationships which will bring enhanced cooperation.” Cluster management, therefore plays a role in instigating and co-ordinating, rather than immersing itself in the subject and daily activities of cluster members and actors (Glückler and Armbrüster, 2003; Carayannis and Meissner, 2016; Cervantes, 2016; Sedlmayr et al., 2021).

The European Commission found, that up to 10 years ago, the services and professionalism of cluster managers had not been acknowledged. The Commission believes that cluster organisations should have the ability to provide professional and essential support services to its members (EC, 2008). Coletti (2010) in line with this point, states, the EC began an Initiative for Excellence of Cluster Organisations in 2009, which will have as its main deliverable the establishment of an independent European Cluster Manager Association and a quality label for cluster organisations using the European Foundation for Quality Management Excellence Model.

Ketels et al. (2012) in relation to EU funding, discuss how accreditation schemes for cluster organisations have emerged. Thus, European cluster organisations can apply, and if successful, receive bronze, silver and gold labels through the accreditation process. The European Cluster Excellence Initiative (ECEI) has “become a clear success story with the benchmarking and labelling scheme being extensively used in numerous countries. As of today, more than 1,100 cluster organisations from 45 countries have been benchmarked and/or awarded a bronze label, around 130 a silver label and more than 100 a gold label, respectively. Today, cluster managers and policy makers alike recognise the three ECEI quality labels as a credible “International standard for cluster management” (ESCA, 2020).

Schretlen et al. (2011) note that clusters can influence the enhancement of innovation, regional development and competitiveness. Undoubtedly, cluster excellence matters, and the main questions of scholars and practitioners refer to the ways of realising it. One critical factor that is seen as essential for achieving cluster excellence refers to the excellence in cluster management. In the current literature regarding cluster management excellence, there is a particular focus on outputs regarding clusters and cluster organisations. Schretlen et al. (2011, p. 3) examine the notion of “cluster management excellence as a process rather than an output.” The concept of cluster management has
been reviewed and discussed and it is an opportune time to examine the roles and responsibilities of cluster managers in the next sub-section.

### 4.4.3 Roles and Responsibilities of Cluster Managers

Some of the most vital tasks performed by cluster managers involve encouraging cooperation while creating an environment in which exchanges between cluster members can occur and flourish (Coletti, 2010). Coletti (2010) draws our attention to the fact that most cluster managers have experience in the business world or research field associated with the cluster industry. The direct knowledge of the sector plays a crucial role for cluster managers to fulfil their duties competently and successfully. Thus, Coletti (2010, p. 687) believes “it is very unlikely that cluster management will become a regulated profession with formal qualifications and monopoly rights, or that a formal training will ever be compulsory across Europe in order to fulfil this role.”

However, since the work of Coletti (2010), a lot of research has taken place, examining how to achieve cluster management professionalism. Figure 4.8 displays five key building blocks on which cluster management professionalism can be built according to Sedlmayr et al. (2021). There are numerous examples of cluster organisations in Catalonia, Spain, who hire cluster managers who do not have a background or education in the sector in which they will work (Estévez, 2015). Estévez (2015) believes that elements such as strategic vision, communication skills, project management, match making capabilities, optimism, passion and promotion are prioritised as more important to create trust and build relationships and connections between cluster members rather than sectoral knowledge.
The skills and expertise required to be a successful cluster manager are plentiful. Table 4.3 summarises the skills and competencies required by cluster managers as discussed and investigated by numerous authors and scholars.

<table>
<thead>
<tr>
<th>Cluster Management Skills and Competencies</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Instigating and co-ordinating daily activities of cluster members and actors</td>
<td>Glückler and Armbrüster (2003)</td>
</tr>
<tr>
<td>• Supporting internationalisation</td>
<td>ECEI (2013)</td>
</tr>
<tr>
<td>• Strategic vision</td>
<td>Estévez (2015)</td>
</tr>
<tr>
<td>• Communication skills</td>
<td>Carayannis and Meissner (2016)</td>
</tr>
<tr>
<td>• Project management</td>
<td>Cervantes (2016)</td>
</tr>
<tr>
<td>• Match making capabilities, optimism, passion and promotion</td>
<td>Sedlmayr et al., (2021)</td>
</tr>
<tr>
<td>• Knowledge of the industries of cluster specialisation</td>
<td>ECEI (2013)</td>
</tr>
<tr>
<td>• Knowledge of the national characteristics of cluster policy</td>
<td>Semenov (2018)</td>
</tr>
<tr>
<td>• Skills to carry out ongoing projects in accordance with the cluster development strategy</td>
<td></td>
</tr>
<tr>
<td>• Control of financial transactions and transactions with tangible assets</td>
<td></td>
</tr>
<tr>
<td>• Support joint projects of cluster members</td>
<td>Schretlen et al., (2011)</td>
</tr>
<tr>
<td>• Flexibility, adaptability, openness to new knowledge</td>
<td>Semenov (2018)</td>
</tr>
<tr>
<td>• Leadership and management skills</td>
<td>Coletti (2010)</td>
</tr>
<tr>
<td>• Social skills including intercultural skills</td>
<td>Schretlen et al., (2011)</td>
</tr>
<tr>
<td>• Ability to form long-term and trusting relationships with people</td>
<td>ECEI (2013)</td>
</tr>
<tr>
<td>• Ability to develop an annual activity plan</td>
<td>Semenov (2018)</td>
</tr>
</tbody>
</table>

Table 4.3: List of Cluster Management Skills and Competencies
Source: Author based on the sources within
Overall, clusters are a key element of regional competitiveness and “their development needs effective policies and competent professionals” (Coletti, 2010, p. 687). Cluster managers should be competent and equipped with the skills to create and manage projects for cluster members, all of whom have differing needs and objectives (Scheer and Von Zallinger, 2007). Coletti (2010, p. 686) notes the EC “intends to back efforts towards the professionalisation of cluster managers through the development of a training programme for cluster organisations and cluster managers and a certification scheme for cluster management.”

Cluster managers, to be adjudged to display excellence in cluster management, are required to achieve certain objectives on a regular basis (Schretlen et al., 2011). These include:

1. Developing alongside key cluster stakeholders, the vision, mission and strategy.
2. Aligning cluster objectives with those of the region i.e. ensuring they are specific, attainable, measurable and timely.
3. Communicating the vision, mission and strategy to the cluster stakeholders as well as those not in the cluster.
4. Having identified the key uncertainties, the roadmap of action will be formulated based on future knowledge i.e. cluster managers are expected to obtain new knowledge and information in relation to identified uncertainties and thus, adjustment to the course of action will be required, based on this information and knowledge gained.

Schretlen et al. (2011) note excellence in cluster management includes constantly monitoring and regular evaluation, adaptive performance measurement systems, and active engagement of cluster stakeholders. In addition, key to excellence is regular review of cluster objectives as well as the cluster organization's objectives. Coletti (2010, p. 686) suggests that the cluster manager “is hence a networker and a facilitator of relations.” Schretlen et al. (2011, p. 17) suggest rather than solely focusing only on indicators often believed to characterise direct cluster performance (e.g., number of spin-offs developed, number of new products created etc.), “some cluster managers pay specific attention to the process rather than outcome related indicators.” To achieve excellence in an outcome sense, managers must achieve excellence in the process and thus the process should be prioritised and supported over the outcome. It is also important to note that to evaluate a
cluster’s efficiency, cluster input data i.e. total private/public investments are required (Schretlen et al., 2011).

Cluster management and cluster governance should not be viewed or treated as the same entity and these terms are separated and distinguished in the next sub-section.

4.4.4 Cluster Management and Cluster Governance

Schretlen et al. (2011, p. 22) theorise that “cluster governance and cluster management are two distinctive notions.” Cluster management, involves the process of managing of the cluster organisation while cluster governance is put in place to ensure the cluster is managed in the best way possible and to ensure oversight (Schretlen et al., 2011).

Basyuk et al. (2016, p. 182) denote “heterogeneity of organization participants requires the introduction of specific governance mechanisms. One of these control mechanisms can be a cluster manager.” In other words, cluster management should ensure a balance between collaboration and competition for resources is kept, to enhance the cluster’s innovative capability (Basyuk et al., 2016). A cluster manager is the facilitator who works on behalf of the companies within a cluster. Schretlen et al. (2011, p. 22) suggest that cluster management “is about the ability to build and maintain relationships with people, the ability to change mentalities, overcome resistance and cultural differences, create collaborative environment and inspire others.” Cluster management focuses on day-to-day activities like planning, human and financial resource allocation, to name but a few. Governance, in turn, among others refers to “appointing cluster managers and evaluating their performance, setting the vision and strategy of the cluster and approving action plans” (Schretlen et al., 2011, p. 20).

Furthermore, it is suggested that researchers should not only focus on cluster management, rather incorporate the notion of cluster governance also. This in turn will create a more holistic guide on how to achieve cluster excellence (Schretlen et al., 2011). During the late 1990s and early 2000s the emergence of literature investigating the governance of clusters became more popular (Mistri, 1999; Alberti, 2001; Ahedo, 2004). In France, the introduction of cluster governance became a key theme (Ehlinger et al., 2007; Bocquet et al., 2009; Bocquet and Mothe, 2009; Gomez, 2009).
Schretlen et al. (2011, p. 21) believe cluster governance involves the formation of relationships among cluster members which is not instantly present once the cluster is created. The requirement of cluster governance for all cluster participants may not be palpable at the beginning of a cluster’s life cycle. Schretlen et al. (2011) observed that clusters solely driven by cluster manager efforts, while disregarding the cluster members/stakeholders commitment and input are destined to fail. The onus is on each member of the cluster to participate to their full capacity, be it through knowledge sharing, collaborating, informal discussions or meetings. The key differences between cluster management and cluster governance are displayed in Figure 4.9 separating them using four variables i.e. Essence, Actors, Responsible Entity and Key Responsibilities.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Cluster Governance</th>
<th>Cluster Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essence</td>
<td>The intended collective actions of cluster stakeholders to advance the cluster and develop a sustainable competitive advantage</td>
<td>The organisation and coordination of the activities of the cluster in accordance with certain strategy, in order to achieve clearly defined objectives</td>
</tr>
<tr>
<td>Actors</td>
<td>Triple Helix actors (i.e., representatives of academia, industry, government)</td>
<td>Cluster managers (i.e., professionals appointed by cluster stakeholders)</td>
</tr>
<tr>
<td>Responsible entity</td>
<td>Cluster governance board</td>
<td>Cluster organisation</td>
</tr>
<tr>
<td>Key responsibilities</td>
<td>Making sure the cluster is well managed: appointing cluster managers, evaluating their performance, developing vision and strategy, approving cluster plans etc.</td>
<td>Managing and enhancing the overall performance of the cluster: carrying out day-to-day cluster activities such as planning, allocation of human and financial resources, monitoring cluster progress etc.</td>
</tr>
</tbody>
</table>

Figure 4.9: Cluster Governance and Cluster Management Differences
Source: Schretlen et al. (2011, p. 20)

An important point to note, highlighted by Schretlen et al. (2011, p. 21), referencing Gilsing’s (2000) work, is “one of the key prerequisites for cluster participants to consider the issues of cluster governance refers to a strong external pressure of (foreign) competition.” Without such an external threat, it often becomes difficult to convince cluster participants that there is a need for cluster. However, some clusters have emerged due to influence of digital manufacturing, green agenda, and other common challenges, which affect for example, Cyber Ireland in which security professionals' skills are not at the level needed for the sector to thrive.
A cluster requires a certain level of accountability by its members and participants. Schretlen et al. (2011, p. 23) suggests accountability is cluster members responsibility to account for their joint activities and related duties. Cluster-governing bodies, in practice have numerous accountability relationships which “include the relationships with Triple Helix actors, i.e., academia, industry and government from the region and nationally, as well as to the market and society in general.” It is important to be able to identify the characteristics of good cluster governance and Sedlmayr et al. (2021, p. 120) summarise the indicators for good cluster governance as:

- existence of a legal form is an important indicator for good cluster governance, since it demonstrates a certain level of commitment;
- clear definition of tasks and responsibilities of the cluster manager / management team and of interfaces / communication with steering committee members;
- existence of a governing body such as a steering committee or advisory board to conduct decision-making and support the cluster management in implementing the action plan, as well as to survey and review the progress of the cluster development;
- regular meetings and participatory approaches to involve cluster actors / members in decision-making processes and strategy orientation.

To be able to govern and manage clusters in a successful fashion requires foresight into the potential uncertainties associated with clustering. A number of these uncertainties are discussed in the following sub-section.

**4.4.5 Uncertainties in Clusters and Adaptive Cluster Management**

Irrespective of a cluster’s sector or maturity, an element of uncertainty is found in the majority of clusters. The uncertainty involves activities of the cluster organisation and if it is achieving its desired aims and objectives or not. Cluster managers are said to function in an environment dominated by uncertainty because of the difficulty in identifying if a cluster is being successful. Schretlen et al. (2011, p. 10) refer to the typical uncertainties that cluster managers have to deal with:

- The continuity of commitment of the key stakeholders;
- Financial instability;
- Changes in technological and regulatory fields;
- External competition;
- Market developments.

One must consider how cluster managers and cluster management can detect and reduce such uncertainties; remain flexible and adaptable through competent management foresight, pro-activeness and action. Therefore, it is important to consider the concept of ‘adaptive cluster management’. Overall, there seems to be a lack of theoretical concepts and empirical studies about the role and impact of cluster management. Günther and Meissner (2017, p. 11) conclude that future research, particularly empirical work, should “develop concepts to measure the quality of cluster management and relate it to performance indicators. In a first step, qualitative empirical work would be valuable before making attempts to use standardized characteristics.”

Cluster management, cluster governance, adaptive cluster management and uncertainties within clusters have been reviewed and the previous sections outlined, described and defined cluster organisations, and cluster initiatives their roles, functions, aims and objectives. The ability to accurately define the maturity of a certain cluster would be a major support to policy makers, helping save vital planning and implementing time in the knowledge that the initiatives and policies developed are relevant and impactful at that point in time to the cluster in question. Regarding cluster management and its role in the cluster life cycle (reviewed in the next chapter), Günther and Meissner (2017, p. 11) note “it is widely acknowledged that a professional cluster management is needed both in the early and also in the mature stage of a cluster.” Thus, the next chapter introduces and discusses the concept of cluster life cycles in order to ascertain how clusters begin, evolve and transition over a period of time, along different stages.
Chapter 5

5 THE CLUSTER LIFE CYCLE

5.1 Introduction
In contrast to the traditional view that clusters are static entities and path dependent tools, it has been proposed that clusters pass through different stages of a life cycle, similar to industries and products. It is therefore imperative to examine the concept of a ‘cluster life cycle’ (section 5.2), while providing definitions and case studies to understand why clusters emerge, grow, mature and potentially decline or rejuvenate. Section 5.3 provides such definitions from the literature of a cluster life cycle followed by an in-depth look at the different stages of a cluster life cycle (section 5.4). At this point, it is important to examine the heterogeneity and absorptive capacity of firms and clusters (section 5.5) before analysing cluster policy initiatives (section 5.6) and how they relate to specific stages of the cluster life cycle. The information provided will allow a better understanding of these stages and what kind of support is needed for cluster development at each stage. To conclude this chapter, the author draws some conclusions (section 5.7) and a summary (section 5.8) from the literature presented which provides the solid foundations for a methodology to be developed for the study in chapter 7.

5.2 Cluster Life Cycles
In order to evaluate and examine cluster development it is important to review the stages of cluster growth. An understanding of the cluster life cycle is of utmost importance to a clusters development, with numerous studies of late, suggesting that the life cycle is a crucial feature of clusters to help comprehend their function (Fornahl et al., 2015; Trippl et al., 2015; Belussi, 2018; Harris, 2020). However, in reference to the work of Belussi
(2009), Belussi and Sedita (2009) and Martin and Sunley (2011), Dyba et al. (2019) suggest it is challenging to identify and measure stages of the cluster life cycle, since clusters are constantly adapting to external conditions. Other authors note that their development trajectories are multi-faceted, path-dependent, and affected by a combination of evolutionary growth factors.

Clusters are normally recognised as pre-defined, isolated and successful structures (Bresnahan et al., 2001; Martin and Sunley, 2003) that can improve a firm’s competitiveness, innovation and growth. Suggestions from numerous approaches reveal that apart from industry-driven cycles, there is also a process specific to clusters that are responsible for promoting evolution, separate to the distinct industry life cycle (Pounder and St. John, 1996; Menzel and Fornahl, 2010; Fornahl et al., 2015). Martin and Sunley (2011, p. 1300) however, note that “Porter himself has not had that much to say about cluster evolution, beyond the brief discussion of some of the reasons for the birth, growth and decline of clusters.” Over a decade ago, Brenner and Schlump (2011) believed there to be an abundance of literature on clusters with little to no literature on the cluster life cycle, however, this has since changed.

In recent times there has been a large addition to cluster research and findings from multiple contributors discussing cluster development and the manner in which clusters, similar to industries, products and technology have a life cycle, involving stages (Porter, 1998; Brenner, 2004; Bergman, 2007; Klepper, 2007; Sölvell, 2008; Menzel and Fornahl, 2010; Ingstrup and Damgaard, 2013; Jia et al., 2015; Fornahl and Hassink, 2017; Ferrari et al., 2020). The ‘life cycle’ concept stems from a biological metaphor, with its application to show how industrial sectors progress along its phases from emergence and growth to maturity and decline, being found in the area of industrial economics i.e. the industry life cycle (Klepper, 1996). “It is important to realize that the economic factors that are believed to influence cluster emergence and growth do not occur in a vacuum” (Bahlmann and Huysman, 2008, p. 315). In other words, numerous external factors can influence how clusters actually become clusters and how they grow and develop. Moreover, it is argued that exogenous (industry-driven) and/or endogenous (cluster-specific) factors are responsible for a cluster’s evolution through different stages of the cluster life cycle (Lorenzen, 2005; Maskell and Malmberg, 2007).
Fornahl and Hassink (2017, p. 41) indicate that “the idea of the cluster life cycle has received considerable interest in the past few years, with academic studies describing a series of cluster stages following an evolutionary logic.” The cluster life cycle concept, when developed, was by no means exempt from criticism. Despite its far-reaching application as a concept, it received some criticism, more so in relation to its initial phase. Some determined it too resigned and deterministic (Knop et al., 2011; Martin and Sunley, 2011) with a distinct lack of attention involving external factors (Martin and Sunley, 2011; Rodríguez-Rodríguez et al., 2016) as well as the omission of the role agency (Martin and Sunley, 2006; Trippl et al., 2015; Hassink et al., 2019) and institutions play (Hassink et al., 2019; Harris, 2020). Fornahl and Hassink (2017) refer to the newly developing literature on the cluster life cycle concept and how it can inform policies with the underlying concept pertaining to the ability of clusters to renew themselves by generating new paths and thus prevent decline.

Today, cluster life-cycle approaches are stagnating, but recent advances by evolutionary and institutional economic geographers could contribute to the development of cluster life-cycles going forward (Harris, 2020). Consequently, “by applying this typology of path development to clusters, we can hopefully develop a better understanding of how actors can change the evolutionary trajectories of clusters over long periods of time in a path dependent manner” (Harris, 2020, p. 8). Cluster life cycle research has been augmented by the idea of multiple regional paths for development and external influence, which has been incorporated into numerous studies (Branco and Lopes, 2013; Rodríguez-Rodríguez et al., 2016; O’Connor et al., 2017; Carli and Morrison, 2018; Desmarchelier and Zhang, 2018; Mobedi and Tanyeri, 2019; Santner, 2018; Scur and Garcia, 2019).

Karlsson (2010) believes that while the policy interest in clusters is undeniable, theoretical interests may benefit from a better understanding of why clusters may appear highly productive, dynamically innovative, and highly concentrated at different stages of their life cycles, and yet show vulnerability at the end of the cycle. It is imperative to identify at what stage clusters are at in order to assess its innovativeness, productivity and to investigate if the cluster is still growing, maturing, stagnating and or ultimately
declining and if so does it have the capacity to rejuvenate itself. Martin and Sunley (2011) suggest in order to understand cluster evolution, it is important to consider not only the development of the cluster itself, but also how it has been affected by the (global) industry of which it is a part, and other similar clusters elsewhere with which it competes. Accordingly, the next section will examine definitions of a 'life cycle’, its conceptual framework and consider the key factors which distinguish the various life cycle stages.

5.3 Cluster Life Cycle Definitions and Theory

There are numerous life cycles involving different aspects of life, pertaining to living and non-living, in a biological, ecological, economical, technological and industrial perspective and thus, it is essential to review the meaning of the countable noun, ‘life cycle’. Kirkpatrick (1983, p. 729) defines a life cycle with regard to animals or plants as “the series of changes and developments that passes through from the beginning of its life until its death”, with regard to an idea, product, or organisation as “the series of developments that take place in it from its beginning until the end of its usefulness.” Both definitions incorporate the ideology of a beginning, which then progresses through certain stages in different ways before eventually declining and becoming obsolete. Life cycles are detectable throughout the economy and one could be sceptical to assume that only one single model of cluster evolution exists (Martin and Sunley, 2011). Martin and Sunley (2011, p. 1301) believe “a strict definition of the life cycle thus implies both an imminent logic and a necessary historical sequence.”

These definitions hold when applied to the concept of the cluster life cycle from an economics, geography and regional development perspective. The concept of the ‘life cycle’ when applied to economic phenomena is not new. It can be traced back to the 1950s when it was utilised to explain the projected growth and success of a product over time in which a four-or-five stage process was proposed (Martin and Sunley, 2001). Storper (1985) developed this idea when describing the evolution of technologies, firms and industries including entire national economies. Crespo (2011, p. 2027) suggests clusters cannot be structurally pre-defined or pre-established, rather take the form of an aggregation of individual actions of actors. The cluster’s evolution, from a long-term
perspective is exposed “to the occurrence of endogenous and exogenous transformations affecting the regional and/or technological dynamics.”

According to Martin and Sunley (2011, p. 1300), the idea of the ‘life cycle’ “implies some sort of ‘ageing’ process.” They also pose relevant questions such as “in what sense can clusters be thought of as having ‘lives’ or ‘ageing’ or passing through ‘life stages’?” Clusters emerge, grow, mature and can ultimately decline. However, contrary to the human body, clusters can escape this ultimate fate by transforming themselves and adapting to market trends and shocks. Although the concept of cluster development exists, the cyclic nature has been overlooked by static and generic policy approaches. The ability to connect cluster life cycles to policies and initiatives is a crucial step in deciphering at what stage of the life cycle the cluster is in and can allow for the creation of cluster specific initiatives and accurate policy recommendations (Fornahl and Hassink, 2017).

Crespo (2011, p. 2030) argues “it is not just a matter of how many links and actors there are, but also the context of interaction, the ego/alter attributes of heterogeneous actors and the aggregated resulting structure.” Menzel and Fornahl (2010, pp. 224-225) theorise that “focal points of activity, where most synergies exist between the actors, are supposed to move more quickly through the cycle while the actors at the edge of the cluster lag behind.” Thus, the focal points of the cluster affects the assignment of the cluster to one of the stages, even though they may possibly change as the cluster moves through its respective life cycle. As a cluster develops, it transitions slowly to the next stage; it does not jump between stages in a rapid manner, essentially because a cluster is made up of many moving pieces. It is argued that different firms and institutions rarely develop at the exact same speed together (Brenner and Schlump, 2011).

Numerous approaches exist to aid the further understanding of the movement of a cluster through a life cycle. Boschma and Fornahl (2011, p. 1295) note “there is increasing recognition that the existence and structure of clusters can only be understood when studying their dynamics over time,” a point which finds agreement from Audretsch and Feldman, (1996); Pouder and St. John, (1996); Swann et al., (1998); Maggioni, (2002); Brenner, (2004); Menzel and Fornahl, (2010); Ter Wal and Boschma, (2011). Conversely,
Lorenzen (2005) highlights a strong focus in literature and practice on the way clusters function with a disregard for their evolutionary development: e.g., how clusters become clusters, how and why they mature and then decline, and how they are able to adapt to environmental changes and reinvent themselves over time.

Martin and Sunley (2011, p. 1300) note that the life cycle concept, “though irresistibly heuristic as a metaphor may have limits as a characterization of how clusters evolve over time.” Within the vast literature, information focusing on how, when and where clusters actually become clusters is somewhat lacking (Orsenigo, 2001; Brenner, 2004) and what is required to increase the longevity of a clusters life, when other clusters simply decline after a certain period of time (Belussi and Sedita, 2009; Suire and Vicente, 2009; Menzel and Fornahl, 2010). Martin and Sunley (2011, pp. 1300-1302) emphasise “the appropriateness and plausibility of the metaphor that is transferred from one disciplinary domain (from biology in the case of the ‘life cycle’) to another (in this case, industrial clusters).” They also argue that the “metaphor of the life cycle carries obvious biological connotations of the progression of an entity through the various stages of its ‘life,’ from birth to death.” Bergman (2007) believes that the concept of a life cycle is simply a ‘discussion template’ that suits some clusters as well as being able to help us comprehend cluster idiosyncrasy that moves away from the ‘norm’.

After examining the definitions and theory of cluster life cycles in detail the next section aims to explore the different stages of the cluster life cycle with an aim to comprehend what essentially occurs in a cluster at each respective stage.

**5.4 Stages of the Cluster Life Cycle**

While there is universal agreement amongst scholars that clusters move through certain phases and stages, uncertainty is evident regarding the number of these stages, their origin and end, as well as their name. Indeed, Jia et al. (2015, p. 815) argue that “there are no unified methods to classify the stages of industrial cluster life cycles. There are also no

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15 The archetypical life cycle template (Martin and Sunley, 2011, p. 1303)
specific definitions of each stage.” Some authors describe a cluster life cycle with three stages, some with four, while others suggest five is the correct number of stages. Authors who have focused their work on the life cycle of clusters include Storper and Walker, (1989); Gilsing and Hospers, (2000); van Klink and De Langen, (2001); Martin and Sunley, (2006); Popp and Wilson, (2007); Maskell and Malmberg, (2007); Menzel and Fornahl, (2010); Harris, (2020); Baumgartinger-Seiringer et al., (2020); Götz, (2021).

Maskell and Kebir (2005) cited in Karlsson (2010) use the three term stage ‘existence,’ ‘extension’ and ‘exhaustion’ to describe cluster life cycle stages while Van Klink and De Langen (2001) portray the cluster cycle as a four stage evolution through the phases of ‘development,’ ‘expansion,’ ‘maturation’ and ‘transition’. However, Menzel and Fornahl (2010, p. 206) argue that there is a grey area with regards to Van Klink and De Langen’s theory, stating that “it is unclear in their study, which influences stem from cluster dynamics and which from the industrial environment.” Dyba et al. (2019, p. 2), in reference to the work of Maskell and Kebir (2005), Bergman, (2008) and Belussi and Hervás-Oliver (2016), propose that “clusters and their characteristics change as they go through the life cycle stages: emergence (existence), growth (expansion) and maturity (also called exhaustion or sustainment) and finally lock-in/decline or rejuvenation and transformation/renaissance.”

Van Klink and De Langen (2001) and Menzel and Fornahl (2007) utilise a four stage cluster cycle. They label the stages as ‘development,’ ‘growth’, ‘sustainment’ and ‘decline’. Menzel and Fornahl (2010) discuss the aspect of declining clusters seen in Grabher (1993) and highlight that economic advantages born from cluster dynamics are not permanent. They argue that key factors that were once viewed as advantages in the past actually cause clusters to decline over time (Jacobs, 1969; Martin and Sunley, 2006). Menzel and Fornahl (2010, p. 206) state “theories that explain the dynamics of functioning clusters are not sufficient to explain their evolution. . . . Clusters follow a kind of life cycle with different phases or stages of emergence, growth, and decline that differ in their characteristics.” Menzel and Fornahl (2010, pp. 208–209) argue that “few studies
exist on the emergence of clusters, mainly because an emerging cluster is hard to detect and can sometimes only be described in hindsight, as in Bresnahan et al. (2001).”

The existing methods of the cluster life cycle tend to have an underlying agreement of the existence of at least three stages i.e. an initial stage, a growth or expansion stage and a mature stage which can sometimes be paired with the option of decline (Maggioni, 2004). This decline phase is often referred to as the fourth stage which is defined by the clusters transformation i.e. reinvention or decline (Van Klink and De Langen, 2001; Brenner, 2001). Agreeing with the work of Boschma (2007) and Fornahl et al., (2010), Carli and Morrison (2018, p. 3) state that “the model sees clusters moving - more or less linearly – through four different stages of development: emergence, growth, sustainment and decline.” Cluster life cycle research also focuses on the underlying path dependency concept of cluster development (Sonderegger and Taube, 2010). Whilst determinant factors responsible for clusters’ emergence seem to remain largely governed by chance events, scholars have also discussed the importance of local path-dependence and economic environment.

It is believed that clusters, in relation to path dependency, are often established through the location of a firm or a number of firms that grow via spin-offs and companies created based on the initial firms (Malmberg and Maskell, 2002). De Sousa Ostapenko et al. (2021, p. 27) note “as clusters are not a static phenomenon; consequently, the dynamic approach became necessary, opening the way to the appearance of the cluster life cycle theory.” Clusters might follow several paths in terms of evolution, without necessarily following sequential stages and following a predetermined evolutionary logic. Tichy (1998) also identified four stages of a cluster life cycle, citing creation, growth, maturity and petrification as these stages. The fundamental dynamics behind a cluster life cycle development involves the sharing and exploitation of knowledge. These factors are found along the cluster life cycle concerning four stages of emergence, growth, sustainment and decline (Menzel and Fornahl, 2010). Crespo (2011, p. 2044) argues “clusters’ birth and their different cycle-length depend on the strength of regional and technological synergies to face the multiple transformations suffered by its surrounding landscape.”

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Karlsson (2010) discusses the importance of using a cluster’s life cycle as a magnifying glass to re-examine clusters, with an aim to unmask structural elements or relationships not normally considered or those that have been previously overlooked. Ingstrup and Damgaard (2013) note that clusters typically develop in line with a life cycle with one or more cluster facilitators promoting and implementing the process. The role of the cluster facilitators, in the literature, has been described as static which in turn leaves a gap about how their roles vary during a cluster’s life cycle. A summary of the academic disagreement that exists on the number and name of stages within a cluster life cycle is portrayed in Table 5.1.

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<td>De Sousa Ostapenko et al. (2021)</td>
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Table 5.1: Academic Disagreement on the Number and Name of Stages within a CLC

Source: Author based on the sources within

According to De Sousa Ostapenko et al. (2021, p. 23) there is still no universal agreement on a particular identification of stages or terminology, as is evident in Table 5.1, but “they all follow the same logic, pointing out the appearance, development, and exhaustion of the cluster phenomenon in parallelism to ‘life’ itself.” Menzel and Fornahl (2010) cited in Boschma and Fornahl (2011, p. 1295) proposed “a cluster life cycle model in which firms enter and exit the cluster, the capabilities of cluster firms develop and interact (and might converge), and inter-organizational linkages within and beyond the cluster are established and dissolved along the cluster life cycle.” It is pertinent to acquire an in-
depth knowledge and understanding of cluster life cycles including the analysis of cluster evolution. Martin and Sunley (2011, p. 1300) indicate “clusters come and go; they emerge, grow, may change in complexion and orientation, may undergo reinvention and transformation, and may eventually decline and even disappear. In short, they evolve.”

The four stage cluster life cycle as prescribed by Menzel and Fornahl (2007) is shown in Figure 5.1 and examined in detail below.

Figure 5.1: The Stages of the Cluster Life Cycle
Source: Author based on Menzel and Fornahl (2007, p. 34)
Emerging clusters

Menzel and Fornahl (2010) describe emerging clusters as being comprised of small companies with few employees spread over broad technological areas. Synergies during this stage tend to exist between parent organisations and spin-offs, normally a research facility or university (Shohet, 1998). At this particular stage, an emerging cluster is indistinguishable and there is a high probability that the cluster will not be recognised at all. Emerging clusters differ from areas with normal economic activity in two ways. Firstly, one or more companies provide a durable path/direction via local technology and secondly the local environment plays a key role i.e. certain conditions are given strong political support, which in turn gives the emerging cluster the potential to gain a critical mass. An example of this political support and funding with a positive outcome is evident in the work of Shin and Hassink (2011) on the Shipbuilding Industry Cluster in South Korea. The emerging phase ends in one of two ways. The first possibility is when the emerging cluster is able to reach a critical mass and when the growth rate of the cluster firms surpasses that of non-clustered firms, it will then become a growing cluster. A crucial element of this stage is to create synergies around a focal point. Arthur (1994) discusses one possibility, which involves increasing firms numbers through spin-offs and these are believed to be pertinent for the growth of a cluster. Organisations combined with a thriving entrepreneurial environment in an area that embrace start-ups tend to have a profound effect on how many potential spin-offs emerge (Menzel and Fornahl, 2010). They note that when spin-offs base themselves around thematic focal points, they play a part in generating synergies in the cluster.

The second possibility for the emerging stage to cease is when the cluster loses its ability to become a functioning one, which is when it is unable to form a focal point. Menzel and Fornahl (2010, p. 225) explain that two reasons exist for this. The first would be a thinning out process of the dispersed firms that have developed in different directions technologically with the second reason pertaining to a reduction of mass e.g. relocation of firms. A gap in the competence structure of the emerging cluster develops as firms become lost to the cluster, further limiting possibilities for interaction. Ultimately, the once emerging cluster may entirely disappear.
Growing clusters

Characteristics of a growing cluster include an increase in employment due to strong growth in the numbers of existing firms as well as high number of start-ups. Bathelt (2001) provides strong empirical evidence of this growth stage when discussing the contemporary biotechnology in Boston. Contrary to the emerging cluster, boundaries are now definable. Existing firms and start-ups locate themselves toward the growth centres of the cluster and firms at the edge of the cluster fall away and this decreases the heterogeneity. When a cluster emerges, the larger absorptive capacity amongst clustered firms allows them to capitalise on technological distances earlier and ensure the use of synergies occurs compared to non-clustered firms. If this occurs, they will in turn contribute to creating the actual cluster (Menzel and Fornahl, 2010). The boundaries of the cluster further narrow leading to a more focused cluster design. Cluster organisations are created to support members and lobby on behalf of the industry and provide for the clusters needs (Menzel and Fornahl, 2010). Pouder and St. John (1996) describe the end of the growing stage when the cluster slows down and mimics the industry average, thus arriving at the sustaining stage.

Sustaining clusters

Menzel and Fornahl (2010, p. 226) argue that a “sustaining cluster describes a state of equilibrium. A sustaining cluster shows neither a high growth compared to the respective industry nor a remarkable decrease in the number of companies or employees. Fluctuations are more of a cyclical than of a structural nature.” The cluster firms’ connections to external institutions and companies create new cluster knowledge and preserve open networks (Albino et al., 1999; Bathelt et al., 2004). Bresnahan et al., (2001) cited in Menzel and Fornahl (2010, p. 226) note that the “thematic boundaries of the cluster now move incrementally as new technologies are integrated into the cluster. During its development, the cluster has shaped its regional environment, whose development may even be equated with that of the cluster if it is very dominant.” Similar to the emerging and growth stage, there are two ways in which the sustaining stage can end. Menzel and Fornahl (2010, p. 226) argue that the first way follows that of a life cycle. “A decreasing diversity in an exhausted trajectory causes a decline. The second possibility is a step back in the cluster life cycle through the generation of new heterogeneity and an accompanying shift of the thematic boundary, which results in a
new growth phase.” The alteration of the development path normally occurs post a decline stage (Martin and Sunley, 2006).

Menzel and Fornahl (2010, p. 228) argue that if clustered firms are unable to keep the balance between “internal convergence and divergence by what may often be external knowledge, the position in a cluster may negatively affect the companies compared to non-clustered companies.” Non-clustered companies do not require this balance effect generated by knowledge created elsewhere as they rely more on external knowledge sources.

**Declining clusters**

A decrease in firm and employee numbers as a result of mergers, failures and rationalisations are said to define a declining cluster. Furthermore, start-ups tend to become rarer during this stage. Grabher (1993) provides an example of a declining cluster when discussing the old industrialised region of the Ruhr area in Germany. He notes that an area with a shrinking cluster is identifiable by a specific knowledge base with specialised workers and firms with a specific focus on certain markets and technologies. Only a few companies possess the competencies of such a cluster (Menzel and Fornahl, 2010). Competitive pressure, despite the decline has the potential to create higher innovation rates. However, these innovations occur within an already exhausted technology path and the cluster becomes ‘locked-in’ to a previously successful development path. Menzel and Fornahl (2010, p. 226) argue that the “reason for a lock-in lies not only in the exhausted regional trajectory, but also in the long existing, closed, and homogeneous networks, which are unable to renew the cluster by integrating new and often external knowledge.” A cluster in decline has lost the ability to maintain its diversity as well as its ability to adapt and adjust to changing conditions, be it technologically or market trends etc. For the declining stage of a cluster to end, three possibilities exist. The first is that it follows the cluster cycle and the cluster simply disappears. The other two possibilities involve an increase in heterogeneity. Menzel and Fornahl (2010) explain that firstly the implementation of new, yet related technologies occurs in line with the renewal of an existing development path. Another possibility of ending the decline stage is transitioning towards totally different fields and areas i.e. integrating entirely new actors into the cluster.
In short, if a cluster reaches the decline stage, it must aim to reinvent itself to survive. Identifying a cluster’s stage along the life cycle in a timely manner can potentially prevent the cluster reaching this decline stage if strategic change can be implemented effectively. During this potential decline stage cluster members will be required to generate a new wave of growth via innovation change (Romer, 1986). Østergaard and Park (2015, p. 835) note the importance of cluster survival for policy-makers as decline will wreak havoc in regional economies. In-depth empirical studies identifying patterns of how clusters decline is vital and there is a “systemic dimension that accounts for the fact that companies and organizations in a cluster are part of a complex production and innovation system and that, through various interconnections, both influence and are influenced by other companies and organizations.” The quantitative dimension showcases the perception of external actors and the ability of the firms to take collective action, while the qualitative dimension describes the learning and innovation processes of firms.

Important Points at Each Stage of the Cluster Life Cycle

Critical points that occur at each of these stages must be considered in tandem with the previous sections. Fornahl and Hassink (2017, p. 280) in reference to the work of Menzel and Fornahl (2010) summarise the four stages of the cluster life cycle noting that the need to access critical resources available in numerous knowledge and business networks is crucial during the ‘emergence’ phase. During the growth phase, clusters require strong ‘anchoring’ actions from firms, individuals and other actors that promote business growth. The next phase is ‘sustainability’ and at this stage “a cluster will require stronger orientation towards ‘diffusion’ activities within the local economy in areas such as investing and expanding outside the cluster.” The cluster in question will begin the decline stage, if unable to renew itself and continually adapt and adjust to the ever-changing environment and potential market shocks (Menzel and Fornahl, 2010). Finally, the exploitation of new knowledge by the cluster is an integral part across all stages of the cluster life cycle (Fornahl et al., 2007).

16 Moodysson (2008, p. 450) based on the work of (Edquist 1997) state “innovation systems are generally understood as dynamic networks of organizations that shape and are shaped by societal institutions and delimited by geographic, sectoral, and/or technological boundaries.”
Menzel and Fornahl (2010, p. 210) indicate that few clusters follow a rigid life cycle from emergence to growth and or decline. Clusters display long-term growth if “they are able to maintain their diversity.” Changes occur between the different developmental stages in the cluster life cycle. Sölvell (2008) discusses the factors responsible for augmenting change in each stage. At first, natural occurring factors combined with historical events can trigger the birth of clusters. However, during the growth stage, different factors like networking, human capital and knowledge infrastructure, to name but a few can drive change within the cluster. Furthermore, in the mature/sustaining stage a narrowed focus on firm efficiencies and economies of scale as the propeller of change for the cluster is found which are replaced by changes in the markets and technology during the decline/reinvention stage. The changes and shifts between these stages may be as a result of cluster policies or initiatives and or internal forces (Ingstrup and Damgaard, 2013).

Each stage contains its own important points, and therefore it is important to examine the cluster life cycle and the importance of firm heterogeneity and absorptive capacity of clusters in the next section.

5.5 Heterogeneity\textsuperscript{17} and Absorptive Capacity\textsuperscript{18} of Clusters and Firms during the CLC

Ter Wal and Boschma (2011) argue that if we are to truly understand cluster evolution, we must pay close attention to the ‘heterogeneity’ of firms within clusters and unravel one piece at a time, the co-evolution of firms, networks and industries. The heterogeneity of firms’ knowledge bases refers to the cognitive dimension of a cluster firm and according to Boschma and Fornahl (2011) plays a pivotal role in every cluster and may be a major factor in cluster evolution. It has been stressed that there is a need for an actor perspective to comprehend the functioning of clusters due to the fact that firm heterogeneity makes up the ‘backbone’ of every cluster (Boschma and Ter Wal, 2007; Giuliani, 2007). Menzel and Fornahl (2010, p. 228) believe “the development of the cluster through the different stages is not only quantitatively described by a growth and

\textsuperscript{17} The cognitive dimension of a cluster firm (Boschma and Fornahl, 2011)

\textsuperscript{18} Absorptive capacity is the ability to recognize, identify, assimilate and exploit new external information, and is considered to be critical for the innovation process (Cohen and Levinthal, 1990)
decline in the number of companies and employees, but also qualitatively by the diversity and heterogeneity of knowledge.”

Shohet (1998) cited in Menzel and Fornahl (2010, p. 225) argues that firms’ “heterogeneity hampers exchange and limits possibilities for local networks, and customer–supplier relations are scarce. Synergies in this phase mainly exist between spin-offs and their parent organization, often a research facility or a university.” Elola et al. (2012), as cited in Fornahl et al. (2015, p. 1923) explain with the example of four clusters in the Basque country in Spain that the original factor and demand conditions that led to their emergence were no longer significant in the later stages i.e. firms had to build and develop strategic capabilities. It was discovered that cluster transformation relied on learning processes specific to firms with less specialised, less rigid and outward-oriented firms’ endured stages of such transformation. These studies, highlight the importance of heterogeneity and how vital the exploitation of said heterogeneity is for cluster growth and rejuvenation.

Menzel and Fornahl (2010, p. 224) state “the dynamics of the cluster are described by the heterogeneity of knowledge, which is responsible for growth, the larger relative absorptive capacity between clustered firms that leads to a better exploitation of heterogeneous knowledge results in a convergence of companies’ activities due to mutual learning processes.” Menzel and Fornahl (2010, p. 206) suggest “the core premises of the model are that the movement of the cluster through the life cycle depends on the increase and decrease of heterogeneity among the cluster’s companies and organizations; and that the way firms exploit this heterogeneity distinguishes clustered from non-clustered companies.” Boschma and Fornahl (2011, p. 1296) in reference to Giuliani’s (2011) work, state “being part of a cluster does not necessarily mean you benefit economically from that, unless you are well connected to the local (and non-local) web of knowledge linkages.” This connectedness accompanied by the cluster’s heterogeneity and ability to adapt are vital elements of the cluster life cycle.
Menzel and Fornahl (2010, p. 218) hypothesise that clusters can be distinguished by a quantitative and a qualitative dimension. The quantitative dimension describes “the economic development of the cluster in terms of the number of active companies and employees. Because of the possible shift of the cluster into new industries, a description of the cluster according to its development is more appropriate than a description using its age, as old clusters can also grow when they move into new fields.” Menzel and Fornahl (2010, p. 218) also suggest that in addition to this quantitative element “the qualitative dimension describes the heterogeneity of companies’ competencies inherent in the cluster.”

According to Menzel and Fornahl (2010) heterogeneity of knowledge changes through the life cycle of a cluster. They argue that the way in which heterogeneity of knowledge is extracted and used, forms one of the principal differences between clustered and non-clustered firms. An increase in heterogeneity of knowledge within a given cluster can lead to a new growth stage. The work of Menzel and Fornahl (2010), as cited in Østergaard and Park (2015, p. 836) suggests an aforementioned four-staged cluster life cycle. These stages involve “emergence, growth, sustainment and decline – and argue that the diversity and the heterogeneity of knowledge within the cluster provide foundation for the cluster’s development. According to them, clusters decline when the heterogeneity cannot be sustained.”

The development of the heterogeneity during the stages is illustrated in Figure 5.2 and it is believed that as the cluster emerges, there are only a few companies and the heterogeneity increases strongly because every new company ventures into new technological areas of the cluster. In the growth phase, the technological path becomes progressively focused. The heterogeneity decreases until the cluster has matured and a distinct development path has taken shape. However, if the cluster has a too narrow focus, it loses its capability for renewal and declines. The heterogeneity of the cluster's knowledge is reflected in the connections between its quantitative and qualitative development.
Menzel and Fornahl’s (2010) ‘stages of a cluster life cycle model’, illustrate that clusters are advantageous for companies only between two certain points. The first being just after the emergence when a critical mass is achieved and clustered firms outperform their non-clustered firm counterparts. The second point is when the heterogeneity of the cluster has been exploited by the firms and the clustered firms development is less than that of non-clustered firms. Whilst the work of Arthur (1994) focused purely on the number of firms, Menzel and Fornahl’s (2010, p. 230) model discusses two additional aspects, “firstly, the heterogeneity between firms must decline to a certain threshold; and secondly, the heterogeneity is affected by changes of the companies’ knowledge base. It decreases, when firms adjust toward each other by mutual learning processes.”

Menzel and Fornahl (2010, p. 228) when discussing the work of Maskell and Malmberg (2007) on the cluster life cycle believe during the emergence of the cluster, the “larger absorptive capacity between the clustered companies enables them to exploit technological distances earlier and make use of more synergies compared to the non-clustered companies.” If this is achieved, they contribute to creating the actual cluster with the firms adjusting to one another during the growth phase to further develop optimal technological distances (Wuyts et al., 2005). However, in doing so, the thematic boundaries of the cluster narrow and the tendency to adjust to one another would create a sub-optimal technological distance between the firms. The narrowing of the boundaries

Figure 5. 2: Quantitative and Qualitative Dimensions of the CLC
Source: Menzel and Fornahl (2010, p. 218)
are illustrated by the arrows in Figure 5.2, and in short, the absorptive capacity referred to is a measure of an organisation’s ability to learn (Maskell and Malmberg, 2007).

Menzel and Fornahl (2007) offer, perhaps because of the possible shift of the cluster into new industries, a description of the cluster according to its development. They argue that it is more appropriate than a description using its age, as old clusters can also grow when they move into new fields i.e. when a firm or cluster adapts to the external environment and re-defines/re-invents itself. Therefore, they characterise the cluster using the following stages of development: emergence with only a few companies, growth with a growing number of companies and employees and sustenance, when the cluster is able to maintain its employment on a high level in more mature phases. A fourth stage is also added, the declining stage, to account for the fact that a cluster can decline and diminish.

Giuliani (2011, p. 1330) suggests “one way to explain how clusters move from an emerging to a sustained growth phase is to look at how cluster firms learn and innovate.” In other words, a cluster’s evolution is dependent on the heterogeneity and absorptive capacity ability of its members.

Rigby and Essletzbichler (2006, p. 66) cited in Menzel and Fornahl (2010, p. 208) compare the heterogeneity of production technologies for three industries on the state level in the USA in different stages of the cluster life cycle: meat packaging, sewing machines, and surgical instruments. No evidence was discovered of a “convergence of production technologies on the national level and heterogeneity persists in all three industries over time. However, when analysing differences in production technologies on the state level, plants located in the same state tend to employ production techniques that are relatively similar to one another compared to plants located in different states.” Martin and Sunley (2011, p. 1301) argue that “typically a cluster’s ‘life’ is portrayed as consisting of five main stages or phases emergence or birth, growth, maturity and decline and even ‘death’.”

Hilliard and Jacobson (2011, p. 1321) argue that “organisational capabilities” determine the extent of a firm’s fitness with the environment in which it operates, and as such
underpin growth and survival.” It is argued when one studies cluster evolution, that it is vital to examine the individual and joint actions of actors within the cluster. A cluster’s adaptive capabilities rely on numerous varying factors, namely members innovativeness, the rate of new firm formation and the foresight and willingness of firms to move into new areas and fields (Best, 2001; Hervás-Oliver and Albornos-Garrigos, 2007; Menzel and Fornahl, 2010; Martin and Sunley, 2011; Holm and Østergaard, 2015). In light of the work done by Menzel and Fornahl (2010), Fornahl and Hassink (2017, p. 155) suggest “the cluster life cycle identifies the evolutionary dynamics of clusters along the phases and processes of cluster emergence, growth, sustainment, decline, adaptation, renewal, or transformation.”

Ingstrup and Damgaard (2013) referencing the work of Enright (2003) regarding his five stage cluster life cycle, postulate that a potential cluster lacks several key inputs as well as critical mass making it challenging to reach its ‘potential’. Latent clusters are categorised as already realising their potential by achieving critical mass of firms. Finally, to reach its full potential, a working cluster requires a critical mass of knowledge, resources, activities and actors so that complex interactions and synergistic effects can occur between participating firms to give them a competitive advantage, compared with companies outside of the cluster. It is worth noting the absence of a decline or rejuvenation stage in Enright’s (2003) cluster life cycle framework, as is seen in several aforementioned life cycle models.

Having reviewed the heterogeneity and absorptive capacity of clusters and cluster firms, the following section examines cluster policies and the role they play during stages of the cluster life cycle.

5.6 Cluster Policy Initiatives and the Cluster Life Cycle

Cluster life cycles and their stages play an integral role in how policies are developed and implemented. A vast number of national and regional authorities have applied certain cluster policy measures (Brenner and Schlump, 2011). Clusters provide advantages to regions and the firms within, with the ultimate goal of cluster policy used to enhance a region or nations’ economic performance (Raines, 2000; EC, 2016). Elola et al. (2017, p.
argue “for cluster policies to be effective, the stages of the life cycle should be taken into consideration.” Within the literature, a survey conducted in a quantitative manner focussing on cluster policies and the ability to compare their impacts is still missing (Kiese, 2008). Elola et al. (2017, p. 1), in reference to the work of Boschma and Fornahl (2011) and Landabaso and Rosenfeld (2009), highlight “the policy implications of the cluster life cycle framework, however, is a scarcely addressed topic by cluster literature, even if this is important to identify the best timing for these interventions and the form they should take.”

It is argued that clusters and their life cycles are shaped by certain path-dependent forces, including public policies and local institutions that play pivotal roles (Menzel and Fornahl, 2010; Martin and Sunley, 2006, 2011; Elola et al., 2012). It cannot be assumed that implementing cluster policies is a simple and straightforward procedure. Brenner and Schlump (2011, p. 1367) believe “there are many obstacles that cluster-related policy has to face” including a difficult question involving how and when measures must be adjusted to cater for each different stage of the cluster life cycle. Brenner and Schlump (2011, p. 1381) maintain “that the literature rarely addresses the question of how policy measures depend on the life cycle stages explicitly. Nevertheless, the literature implicitly provides some insights about what measure should be used at which stage.”

Brenner and Schlump (2011, p. 1367) note the stages of the cluster life cycle differ strongly with respect to the problems and needs that can be addressed by policy. This fact “seems to be neglected in policy approaches quite frequently.” During 2011, in Europe, thirty-six cluster programmes out of a total of sixty-nine, had a special focus on clusters in particular stages of the cluster life cycle, mainly focussing on the embryonic/emerging stage (EC, 2016). In the past number of decades, cluster policies have refined their focus to a more regional level (Koschatzky, 2005). However, according to Brenner and Schlump (2011, p. 1367), when referencing the work of Maskell and Kebir (2006), there is still a lack of “focus on the different needs of clusters during the life cycle phases. Cluster policy measures should be adapted to the cultural and political circumstances as well as the cluster’s current life cycle stage.” Regarding cluster emergence and evolution, Elola et al. (2017, p. 2) conduct a case study of six clusters in the Basque country. They set up a taxonomy of nine policy measures (Table 5.2) that are “likely to have an impact on the emergence and evolution of clusters (education, public research, supporting R&D
and innovation, start-up support, network organization and cooperation support, infrastructure and local conditions, trade policies, demand-side policy instruments and other).”

<table>
<thead>
<tr>
<th>Policies</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>Policy measures aimed at improving knowledge base and skills of human capital</td>
</tr>
<tr>
<td>Public Research</td>
<td>STI policy (public institutions, research centres, universities)</td>
</tr>
<tr>
<td>Supporting (private) R&amp;D</td>
<td>STI policy (tax exemptions, R&amp;D subsidies, research projects)</td>
</tr>
<tr>
<td>Supporting start-ups</td>
<td>Measures to support new firm creation, SMEs</td>
</tr>
<tr>
<td>Supporting networks and co-operation</td>
<td>Supporting cluster initiatives/associations, measures to encourage inter-firm collaboration</td>
</tr>
<tr>
<td>Infrastructure and local conditions</td>
<td>Measures aimed at improving physical infrastructure and factor conditions (labour and capital)</td>
</tr>
<tr>
<td>Trade policies</td>
<td>Tariffs, import quotas, export subsidies, export promotion</td>
</tr>
<tr>
<td>Demand-side policy instruments</td>
<td>Local content, public procurement</td>
</tr>
<tr>
<td>Other</td>
<td>Promotion of national champions, fiscal policies, internationalisation</td>
</tr>
</tbody>
</table>

Table 5.2: Public Policies that Affect Clusters
Source: Author based on Elola et al. (2017, p. 4)

Within their case study, Elola et al. (2017) investigate two approaches to cluster policy. The first is referred to as the ‘narrow approach’ and the other the ‘broad approach’. The narrow approach to cluster policy “implies the existence of policies designed with the explicit purpose of directly supporting clusters, and those policies are in most cases supported and implemented by specific cluster programmes” (Elola et al., 2017, p. 2). The broad approach refers to the systemic, multi actor/level cluster policy, which incorporates the role of a wider set of activities that affect clusters which may not have been created and developed with this purpose (Borrás and Tsagdis, 2008; Uyarra and Ramlogan, 2012). Referring to the broad approach, Elola et al. (2017, p. 3) surmise “while important, the influence of policy may often be indirect, driven by policies such as infrastructure, research, education and training rather than policies directed at clusters per se.” Specific cluster policies may solely focus on the support of existing clusters and industries while the broad-based generic policies have the ability to promote the creation and emergence of new clusters and industries in a particular region (Asheim et al., 2015).
Elola et al. (2017, p. 5) suggest “it seems therefore quite clear that every policy measure can have a different impact over cluster evolution depending on the particular stage of the cluster life cycle.” In other words, policy measures should be adapted and shaped to represent the stage the cluster in question is at in the cluster life cycle (Van Klink and De Langen, 2001; Aragón et al., 2011; Shin and Hassink, 2011; Ketels et al., 2013; Flanagan and Uyarra, 2016). Furthermore, cluster policy that is constantly evolving can help strengthen and stimulate regional resilience (Bristow 2010; Dawley et al. 2010; Simmie and Martin 2010; Martin 2012). Resilience is defined in terms of the adaptability of the system. Fornahl and Hassink (2017, p. 182) note cluster policy is regarded as a catalyst adding to existing strengths and takes the role of a moderator. It comprised several elements: “at first, cluster mapping allowed to identify clusters – that is, a regional concentration of companies from one industry or field of technology – and cluster initiatives – organizations that have been founded to promote regional clusters.”

The true impact that public policies have on cluster evolution, from an empirical knowledge point of view is still lacking and the few studies that do exist suggest the policy measures have had an indirect impact on clusters (Van der Linde, 2003; Uyarra and Ramlogan, 2012; Brenner and Mühlig, 2013; Elola et al., 2017). However, it is believed that during the life cycle of a cluster, the timing of policy implementation is vital. Table 5.3 summarises the required policies at each stage of the cluster life cycle according to Brenner and Schlump (2011). It is apparent that each stage requires a certain policy measure to be introduced in order to help the cluster begin, grow, mature etc. It is also clear that each stage requires a different set of policy measures to be implemented, highlighting the need for more than a one-size-fits-all policy.
<table>
<thead>
<tr>
<th>Most Relevant Phase in the Cluster Life Cycle</th>
<th>Policy Measure</th>
</tr>
</thead>
</table>
| Initial                                     | Start-up promotion (science parks, incubators)  
|                                             | Co-operation support  
|                                             | Development of innovative culture  
|                                             | Establishment of laboratories  
|                                             | Research and development support |
| Initial/Expansion                            | Education and training (conferences, learning processes)  
|                                             | Networks (informal, institutionalised), joint activities  
|                                             | Seed funds, better access to capital, venture capital  
|                                             | Cluster marketing and service provision |
| Expansion                                   | Screening activities, access to new technology  
|                                             | Industrial co-ordination and co-operation |
| Expansion/Mature                            | Spin-off support (financing, collaborations, services) |
| Mature                                      | Development of human capital, specialised work force  
|                                             | Support services  
|                                             | Renewal of networks  
|                                             | Lighthouse projects  
|                                             | Set-up research institutes |

Table 5.3: Policy Measures and Timely Application in the CLC  
Source: Author based on Brenner and Schlump (2011, p. 1371)

Many academics have looked at the development patterns of life cycles, their drivers and how clusters and industries evolve (Audretsch and Feldman, 1996; Dalum et al., 2005; Bergman, 2007; Brenner and Mühlig, 2007; Menzel and Fornahl, 2007; Martin and Sunley, 2011; Brenner and Schlump, 2011; Fornahl et al., 2012). However, Fornahl and Hassink (2017, p. 227) highlight that “the development of cluster initiatives has only received casual attention in the research literature up to now.” Fornahl and Hassink (2017, p. 225) draw attention to “the cluster initiatives we observe in real economic life can be and factually are established in each stage of a cluster life cycle, starting from the cluster’s emergence until its final decline.” Brenner and Schlump (2011, p. 1364), in line with the work of Borras and Tsagdis (2008), state “quite often, policy or public action is seen as an inevitable and internal element of clusters.” It is worth noting that cluster policy can take numerous forms and thus it is crucial to find the form “that fits the characteristics of the cluster at which the policy aims. One of these characteristics is the stage in the cluster life cycle” (Brenner and Schlump, 2011, p. 1367).
Fornahl and Hassink (2017) developed a model of cluster initiatives’ life cycles that comprises the following stages:

1. **Pre-emergence:** Cluster actors identify the potential of a cluster initiative and try to transmit their idea to find other interested parties. This stage is characterised by an extensive and costly search process.

2. **Emergence:** A critical mass of actors within the cluster agree to collaborate. A rough concept of a formal governance structure for the cluster initiative is developed by the leading personalities. The actors seek external financial support.

3. **Consolidation and expansion:** Once created, the initiative develops its formal structure with the establishment of a formal cluster management and board. The range of cluster activities is gradually extended.

4. **Maturity:** The initiative has reached its full working aptitude. The actual challenges are known and fully met during this stage.

5. **Dissolution or reshuffle with subsequent new cycle:** The cluster actors reconsider their goal in regards to the cluster initiative i.e. the initiative is at risk of losing its ‘raison d’être’. The construction of a new concept with new fundamental targets for the initiatives must occur and initiatives that successfully undergo this transformation enter a new cycle.

Fornahl and Hassink (2017, p. 109) in relation to the cluster life cycle model, developed by Menzel and Fornahl (2010), argue “it is used to cautiously outline some assumptions on effects of CIs’ interaction on the life cycle stages of cluster emergence, growth, sustainment, decline and, potentially, renewal.” It is also assumed that cluster life cycle’s characteristics are dependent on the firms’ technological heterogeneity which is linked to the concept of technology cycles (D alum et al., 2005). Fornahl and Hassink (2017, p. 109) note that “over time, technological convergence takes place within a cluster, but technological divergence grows between them.” Fornahl and Hassink (2017, p. 203) suggest that the cluster life cycle theory and evolutionary approaches, on the other hand, “have stressed the importance of particular conditions and determinants for the emergence, growth and transformation of clusters (see Menzel and Fornahl, 2010). However, these theories have so far paid little attention to the role of policies for firm and cluster development.” The escalation of relationship building between different actors within a cluster is seen as a vital part of cluster policy and is identified as crucial in the early phases of the cluster life cycle (Brenner and Schlump, 2011).
Fornahl and Hassink (2017) suggest cluster policy initiatives are designed to promote the formation and development of industrial clusters, known as cluster projects. In contrast to the more organic clusters outlined by theory discussing organic cluster evolution, such cluster initiative programs provide political, organisational, and financial support to cluster projects. Both programmatic and project-based cluster policy initiatives have been influenced by cluster evolution literature. Cluster policy has become more important in recent times due to its ability to enhance competitiveness and aid industrial transformation and a principal focus of cluster policy is in relation to cluster initiative development that are managed by a cluster organisation. Fornahl and Hassink (2017, p 135) note “such cluster initiatives can also be described as industrial networks that pursue a commonly shared development objective.”

Ingstrup and Damgaard (2013, p. 560) postulate that even though some clusters “develop in a purely organic and laissez-faire manner through the cluster life cycle, most clusters grow with the support and intervention of cluster facilitators.” Spin-offs and lock-ins are two terms often connected to the theory of clustering and are discussed below.

**Spin-Offs**
Krugman (1991) believes that ‘historical accidents’ are the reason that clusters originally emerge. While Arthur (1994) argues the emergence of clusters occur as part of a vague/debatable process involving spin-off processes that form randomly in different areas. Crespo (2011, p. 2034) notes the emergence of a cluster is essentially nurtured by the arrival of firms into the region. The “particular mechanisms at play guiding the decisions of co-location of new entrants drive the potential cluster through the different emergent phases and produce different cluster structures.” Klepper (2001) focuses on a more firm-centred perspective and believes that spin-off companies acquire the successful companies’ routines and thus grow at an extremely high rate. Consequently, the cluster will develop in locations where these companies who have acquired superior routines have been established. Spin-offs can be responsible as one of the causes of geographic concentration of an industry (Arthur, 1994; Klepper, 2007).

**Lock-Ins**
It is argued that clusters can become ‘locked-in’ when technology paths are exhausted (Menzel and Fornahl, 2010). Karlsson (2010) suggests it has also become more common
to focus on specific points along the curve associated with the emergence of a cluster, its early development and expansion, its ability to exploit opportunities and resist competitive replication. It is also important to focus on its attainment of hyper growth and scaling, on its slowing near potential inflection points, and on its successful transition to a newly-launched cycle phase or perhaps the 'lock-in' and exhaustion of its final cycle phase. The work of Grabher (1993) cited in Østergaard and Park (2015, p. 837) argue that a “lock-in consists of factors that diminish a cluster’s ability to recognize and make adjustments to sudden changes.” Pouder and St. John’s (1996) approach discusses how innovation leadership in an industry moves from clustered to non-clustered firms due to a ‘technological lock-in’ process. It is said that “the lock-in comprises several dimensions like technology, network structure, and policy” (Menzel and Fornahl, 2010, p. 210). Grabher (1993, p. 256) describes the coal and steel district in the Ruhr Area as one example of a region that “became ‘locked-in’ by the very conditions that once made these regions ‘stand out against the rest’ [...] fell into the trap of rigid specialisation.”

Crespo (2011, p. 2044) notes the long-term survival of clusters “depends on the dimensions of viability, which are defined with respect to technological and regional dynamics. Different clusters’ life cycles are explained by different capacities to lock-in, adapt and take advantage of landscape transformations.” Fornahl and Hassink (2017, p. 155) insist “clusters do not only emerge and grow but can equally decline or even disappear over time, not only for reasons internal to themselves (for example, lock-in) but also due to technological breaks or radical market changes.” Ingstrup and Damgaard (2013, p. 559) note “at some point in time, changes in the surroundings of clusters can force them to either close down or reinvent themselves.” Mohan et al. (2002) suggest that at each respective stage there are different sets of interventions required i.e. for mature or declining clusters, it is vital to promote and encourage openness and innovation to help prevent regional lock-in and thus promote new industry creation. Particular strategic intervention is required at each stage of the life cycle but at different intensities.

Having reviewed the concept of cluster policy initiatives along the different stages of the cluster life cycle, the following section provides a conclusion and discussion on the topic of the cluster life cycle.
5.7 Conclusion and Discussion

Moving forward, it is apparent that there is still a need for an appropriate analytical framework regarding cluster evolution. It is evident that most scholars including Brenner (2004) and Menzel and Fornahl (2010) to name but a few, favour a life cycle approach compared with Martin and Sunley’s adaptive life cycle model. However, both of these models, according to Boschma and Fornahl (2011, p. 1296) provide “an evolutionary, contingent approach instead of a deterministic approach, and both value case study research of context-specific cluster dynamics over time.” They note that further and more in-depth study of “fundamental drivers and their integration in an analytical approach will certainly help to sharpen our theoretical understanding of cluster evolution, to generate testable hypotheses and to structure empirical research” (Boschma and Fornahl, 2011, p. 1296). It is imperative to note the need for further research in how network structures change over time in clusters and how this affects the performance of cluster firms as well as the cluster as a whole (Boschma and Fornahl, 2011). Hilliard and Jacobson’s augmentation looks at how important it is to look at not only single factors and elements of cluster evolution but also the “co-evolutionary structure of organisations and regions” (Boschma and Fornahl, 2011, p. 1297). This will also require regional studies to be more thorough and in-depth with empirical evidence playing a key role in future research of cluster evolution and as a result proliferating our understanding. “What does seem worth pursuing, however, is the conceptual and empirical exploration of the applicability of the adaptive cycle model as part of the research agenda on understanding cluster evolution” (Martin and Sunley, 2011, p. 1316).

For the purpose of this body of work, the author believes that three stages are not enough to obtain a holistic view of a cluster life cycle. Upon an extensive review of the literature, the author is of the opinion that the most relevant number of stages in a cluster life cycle is four i.e. emergence, growth, maturity and decline/rejuvenation stage. Scholars who favour the four stage life cycle include Drew, 1987; Tichy, 1998; Van Klink and De Langen, 2001; Swann, 2002; Belussi and Sedita, 2009; Martin and Sunley, 2010; Jia et al., 2015; Carli and Morrisson, 2018. Fornahl and Hassink (2017, p. 151) are in

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18 For more information on the adaptive life cycle model, see Martin and Sunley (2011, p. 1312)
agreement, adding “the emergence and subsequent processes of growth, stagnation, renewal, and possible decline of clusters along the cluster life cycle have been in the focus of evolutionary economics for a long time.” An in-depth look at the four stages as prescribed by Menzel and Fornahl (2007) is established, while the author believes that the inclusion of rejuvenation/reinvention is required to exist in line with their ‘declining cluster’ stage. This is based on dealing with the concepts of cluster uncertainties and competent cluster management, excellence and foresight by cluster organisations.

5.8 Summary

This chapter introduced cluster life cycles as a concept while providing an array of definitions from the literature. Clusters, like products and industries have a life cycle i.e. they are created, grow, plateau, decline and eventually if a rejuvenation process does not occur, die. In order to apply accurate and tailor made cluster specific policies effectively, one must consider at what stage of the cluster life cycle the cluster in question is positioned along the bell shaped curve (Figure 5.2 on page 132). This is predominantly because, for example, a relatively new and growing cluster will require different initiatives compared to an already established cluster that may be in the process/stage of slowing down and in need of change i.e. technological change or upskilling requirement for an ageing work force/human resources (Ketels et al., 2006). Handayani et al. (2012, p. 208) note “an industrial cluster evolves through their life cycle, so for formulation appropriate policy intervention, the government should conduct assessments to identify the phase of industrial cluster life cycle.”

Principally, this chapter sought to simplify the cluster life cycle concept, investigate the role of cluster initiatives implemented by policy makers and cluster organisations while conducting a thorough review of the cluster life cycle, its’ characteristics, and application to economic geography. All of the above elements are likely to have implications for the actors located in a region as well as impacting policy makers, economic developers and representative bodies tasked with developing cluster strategies. This chapter ends with a conclusion around the need for an appropriate analytical framework regarding cluster evolution.
Overall, the chapter lays down the foundations for Chapter 6 and Chapter 7, which introduces various cluster analysis methodologies, including V-LINC, successfully implemented in the academic thesis of Byrne (2016) to ensure the results of cluster analysis are more accessible and informative. It will explore the development of a new methodology and important policy implications for each cluster life cycle stage.
Chapter 6

6 RESEARCH DESIGN

6.1 Introduction

Chapters 3, 4 and 5 introduced and discussed a large body of literature on the topic of clusters, their abundant intricacies and how clusters, like industries and products for example, pass through different stages of a life cycle. Chapter 6 begins by reviewing the literature of the philosophy of research before establishing the existing concepts and theories in the area of cluster analysis. The chapter investigates different methods used to analyse and measure cluster performance, e.g. the ‘Cluster Initiative Performance Model’ (CIPM) (section 6.2), the Delphi Method (section 6.3) and section 6.4, the Location Quotient (LQ) concept. The last two methods reviewed are in relation to a strategic industry life cycle analysis in section 6.5 and the cluster life cycle identification model in section 6.6. This, in turn will allow comparisons and contrasts to be garnered between these aforementioned methods with that of the V-LINC method (section 6.7).

Having reviewed cluster life cycles in the previous chapter, the thesis now focuses on the methods both explored and used in the study. Kinash (2013, p. 6) describes methodologies as the “approaches and processes of our research. Methods are the specific ways in which we go about collecting our research data.” An overview of methodological issues is presented in this chapter, followed by an analysis of theoretical foundations, and a discussion of philosophical origins, research approaches, strategy, and ethical concerns. To begin, it is possible to collect, analyse, and implement data in relation to clusters using a variety of methods. Thus, reviewing research philosophies regarding such approaches
is a central part of this thesis. While several research philosophies exist, two commonly adopted ones are ‘positivism’ and ‘interpretivism’.

**Positivism:** according to Park et al. (2019, p. 3), studies aligned with positivism “generally focus on identifying explanatory associations or causal relationships through quantitative approaches, where empirically based findings from large sample sizes are favoured.” In short, the researcher is an objective analyst, disassociates themselves from the results, personal values, and works independently. The researcher should remain distanced from the results and remain objective throughout this approach (Saunders et al., 2016).

**Interpretivism:** is a philosophical approach to conducting research. Humans are different from physical phenomena because they create meanings; according to this philosophical viewpoint i.e. the researcher performs a certain role in observing the social world (Saunders et al., 2016). Interpretivist research aims to uncover new understandings and interpretations of the world we live in, for example, looking at organisations from different stakeholders’ point of view and the data collection associated with this method uses an inductive approach with a small sample. In most cases, the data obtained takes the form of qualitative information gathered from conducting interviews (Williams, 2000).

In positivist work, one aims to identify quantitative and qualitative data with propositions that can be tested (theory testing), whereas interpretive work aims to combine those data into systems of beliefs whose manifestations are specific to a specific research setting or cluster (theory building). Due to the hybrid nature of the author’s V-LINC methodology (see section 6.7) combining quantitative and qualitative forms of data, elements of both positivism (using quantitative data collected with reliability and representativeness) and interpretivism (gathering of qualitative and quantitative data via interviews) research philosophies are adopted throughout the research.
The section then investigates the V-LINC methodology used, its’ origin, flexibility and application, all consistent with the authors’ following three research objectives:

1. **Analyse the longitudinal development of a cluster to record, measure and analyse its evolution over a three-year period;**
2. **Create a new methodology to support cluster life cycle stage identification;**
3. **Support policy makers in developing and implementing accurate policy initiatives relevant to the cluster’s current stage along its respective cluster life cycle.**

With an aim to address these objectives, an assessment of various methodologies based on their suitability and appropriateness will ensue. Thus, the most appropriate combination of techniques or methodologies will be reviewed in an effort to realise the research objectives. All of this is incorporated to provide the best-nested methodology in order to be able to identify at what stage a specific cluster is positioned along the cluster life cycle.

**6.1.1 The Philosophy of Research**

A scholar’s philosophy of research guides and informs the beliefs with which they conduct research (Guba and Lincoln, 1994). According to Adkins (2021), the philosophy of research is underpinned by ontology and epistemology, with ontology referring to the assumptions made about the nature of reality and what is deemed to be a fact. The epistemological position of the research is seen as “the fundamental set of assumptions about the theory of knowledge and methods used to examine the nature of reality (Adkins, 2021, p. 159). This research focused on examining the linkages and relationships firms engage in on a daily basis over a three-year period while identifying a method for cluster life cycle stage identification.

**6.1.2 Framework**

The philosophy of research reveals the researcher’s presumptions about how their reality is constructed (Saunders et al., 2016), and are fundamental to the design of the research, and can have significant impact on quality (Easterby-Smith et al., 2008). The following sections address the philosophical underpinnings and strategic issues relating to the
methodology while exploring research approaches, time horizons and ethical approaches linked to the philosophy of research.

6.1.3 Research Paradigms

A research paradigm is a set of principles dictating “what should be studied, how research should be done, how results should be interpreted…” (Bryman, 1988, p. 4) and in this framework, the researcher assumes a certain nature of knowledge based on their own assumptions (Collis and Hussey, 2009). Objectivists and constructivists follow different paradigms, from the externality of reality (positivism) to the social interactive nature of reality (constructivist). Pragmatism is aligned with these paradigms because it contends there are multiple realities, therefore different approaches are required.

Adkins (2021, p. 161) notes positivism emerged in the mid-1800s from the work of Auguste Comté, who proposed “social sciences could be built on the same fundamental notions of the natural sciences.” In the absence of hidden emotions or underlying explanations, absolute laws of cause and effect would explain human behaviour, based solely on observation (Howell, 2013), and as a result of positivism, hypotheses can be created and tested, and knowledge can be generated by collecting facts in a value-free manner (Bryman and Bell, 2011).

Epistemologically, positivism necessitates complete separation of researcher and the external world. A positivist's ontological position can be branded as naive realism; that is, the belief that an external reality exists and can be fully understood (Howell, 2013). The ontological position of post-positivists holds that an external reality exists but can at best be understood imperfectly, and that so-called immutable laws cannot be proved, only falsified (Adkins, 2021). Popper (1994) cited in the Howell (2013) contended that social circumstances should be dissected in the sociologies to give clarifications, particularly given the difficulty in falsifying theories. This results in generalisation – the movement away from the subject being analysed to anyone sharing the same situation (Adkins, 2021).
The ontological stance of post-positivism that is taken can be defined as ‘critical realism’ (Bhaskar, 2008). Critical realism incorporates knowledge in the existence of two forms – transitive and intransitive. Transitive objects of knowledge and information are made and develop because of social collaboration, while intransitive articles are merely found. Adkins (2021, p. 162) in relation to the work of Howell (2013) argues “whilst critical realism can be rejected in the social sciences given a lack of intransitive knowledge, it is possible for the critical realist position to exist.”

Theories are verified through measurement in a way like positivism, despite the fact that epistemologically, all out detachment between researcher and the outside world is eliminated. The post-positivist approach is summarised in Table 6.1 along with its implications for the stages of data collection and analytic design.

<table>
<thead>
<tr>
<th>Research Paradigm</th>
<th>Ontology</th>
<th>Epistemology</th>
<th>Methodology</th>
<th>Inquiry Aim</th>
<th>Data Collection Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positivism</td>
<td>Belief in single identifiable reality that can be measured.</td>
<td>Belief in total objectivity; researcher and the investigation are totally separate.</td>
<td>Typically quantitative experiments. Belief in the falsification principle. Quantitative.</td>
<td>The ability to predict and control natural phenomena. Application of laws.</td>
<td>Experiments</td>
</tr>
<tr>
<td>Post-positivism</td>
<td>Reality exists, but unable to fully understand it because of a lack of absolutes. Theory tested through measurement.</td>
<td>Minimal interaction, although separation removed. Validity drawn from peers, not research subjects.</td>
<td>Researchers attempt to ask more questions than positivists due to unknown variables. Attempt to approximate reality.</td>
<td>Aim to get as close to the answer as possible; approximate reality.</td>
<td>Surveys</td>
</tr>
<tr>
<td>Constructivism</td>
<td>Multiple realities exist, relate to the individual. Knowledge is constructed through experiences and interactions.</td>
<td>Philosophical belief that understanding of reality is constructed by individuals and that researcher and subject of investigation are linked.</td>
<td>Create consensus through individual constructions. Qualitative.</td>
<td>Understand and interpret meaning of phenomena.</td>
<td>Case studies</td>
</tr>
<tr>
<td>Pragmatism</td>
<td>External, multiple realities; view chosen that best enables the research question to be answered.</td>
<td>Focus on the concept of inquiry as the process of knowledge-seeking.</td>
<td>Mixed methods: uses paradigms and methods that appear to fit the problem.</td>
<td>Combining facts and words/meanings to solve problems.</td>
<td>May use positivist and constructivist methods</td>
</tr>
</tbody>
</table>

Table 6.1: Summary of Research Paradigms
6.1.4 Research Approaches

There are two essential research approaches available to the researcher: inductive and deductive.

The deductive approach: tests existing theory through the development and testing of hypotheses so as to explain the causal relationships between variables, typically through the use of quantitative methods (Bryman and Bell, 2011; Saunders et al., 2016). The deductive method informs the researcher of the truth about the deductive procedure, but not the premise on which the process is based (Ormerod, 2010).

The inductive approach: typically associated with qualitative based research. Deduction, according to Adkins (2021) can examine the relationship between theory and empirical observation. The main focus of this research is to test existing theory and method, combining new elements within a ‘new’ context, that of longitudinal cluster analysis. The inductive approach is a method that begins with data collection so that the researcher can make broad conclusions about the phenomenon being studied (the theory); it is an iterative process where the researcher will shift between theory and data. (Bryman and Bell, 2011). The formation of theoretical conclusions is based on the results of empirical research. (Eriksson and Kovaleinen, 2008). In contrast to the deductive technique, which states what is happening, the inductive approach tends to focus on determining why a specific phenomenon is occurring (Saunders et al., 2016).

Although this research uses both qualitative and quantitative approaches, the overarching research approach was quantitative with the information/data gathered via firm interviews with staff personnel. Quantitative research designs are typically associated with the collecting of data in quantifiable terms before theory-led deductions are produced (Easterby-Smith et al., 2008).

6.1.5 Time Horizon

Two types of time horizon exist: longitudinal and cross-sectional. Cross-sectional studies are those restricted to a specific time-frame, while longitudinal studies are repeated over an extended period (Saunders et al. 2016). This study adopted the longitudinal approach and examined and analysed linkages cluster firms engaged in over a three-year period.
6.1.6 Ethical Considerations

Research ethics relate to the “standards of the researcher’s behaviour in relation to the rights of those who become the subject of a research project, or who are affected by it” (Saunders et al., 2012 p. 680). Denscombe (2002) and Yin (2014) identified the following principles of ethical research, which were met during this research with approval acquired from the university:

1. *Informed consent:* The subjects were informed of the nature and objective of the study, that participation was voluntary, and that withdrawal from the study was possible at any moment. This gave the subjects the necessary knowledge to make an informed decision.

2. *Protection from harm, including deception:* Due to the nature of the questions asked in the interviews, coupled with the fact that experimental investigations were not a part of this research, participants were not exposed to any danger of bodily or mental injury. At each pertinent stage, the goals of the interviews were made explicit, and participants were never misled as to why they were being asked to participate.

3. *Privacy, anonymity and confidentiality:* Questions of a particularly personal or delicate character were avoided in this study, as it focused solely on the business and social activities of the participants. The background of subjects was not relevant to this research so no information was sought or obtained pertaining to this. Anonymity was offered as part of the request to participate and was granted for anyone who requested it, including the option of signing a non-disclosure-agreement (NDA). Results of the interviews were published in such a manner as to avoid the potential for them to be linked to any individual or firm.

4. *Equitable selection:* No group of people or organisations were unfairly included or excluded from the research.

6.1.7 Overall Research Design

The philosophical viewpoint and general approach used in this study are outlined in this chapter. It lays the foundations for the qualitative and quantitative phases of the research design employed. The chapter established that the post-positivist paradigm of inquiry was adopted given the incomplete nature of knowledge and inability to develop immutable laws.
The following sections examine the various methodologies in the literature available for review.

6.2 Cluster Initiative Performance Model (CIPM)

Cluster initiatives can combine clusters with firms, government and the research community and are crucial for improving competitiveness and growth of clusters. Sölvell et al. (2003) developed the ‘Cluster Initiative Performance Model’ (CIPM). This model is used to define influencing factors for developing cluster initiatives that can support clusters. Boja (2011) suggests that the CIPMs evaluation is based on numerous elements:
- The amount of linkages between research and industry and their complexity
- The shift to a greater level of competitiveness globally
- The level of innovation realised via new technology development
- Cluster development based on the number of new firms and improving production and market position
- The degree of which objectives are achieved by the cluster.

The CIPM is comprised of four components i.e. the social, economic and political setting within a country; the cluster initiative objectives; the process by which the cluster initiative develops and ultimately the initiatives performance (Sölvell et al., 2003; Alberti and Belfanti, 2019). In 2003, the Global Cluster Initiative Survey (GCIS) identified more than 500 cluster initiatives worldwide, predominantly found across Europe, North America, Australia and New Zealand. The survey incorporated all four components of the CIPM and the results concluded:
1. All cluster initiatives are unique i.e. the settings and objectives varied in developed and developing countries and prosperous to weak regions economically.
2. Cluster initiatives are most commonly found in developed economies with an emphasis on technology intensive areas e.g. IT, medical devices, biopharmaceuticals. It must be noted that the majority of cluster initiatives active in the work of Sölvell (2003) were initiated in 1999 or later.
3. Most cluster initiatives are found where local governments play a critical role.
4. Where clusters are of national and or regional importance, cluster initiatives occur.

5. Cluster initiatives are introduced by government (32%), by industry (27%) or equally by both (35%).

6. The split between financing is as follows: government (54%), industry (18%) or both equally (25%).

7. Firms have the most influence in cluster initiative governance.

8. 50% of cluster members are located less than one hour’s travel distance. Cluster initiatives are found to have a wide membership base and seldom exclude overseas companies, small companies or competitors.

9. More than 95% of cluster initiatives involve ten or more active members with 40% being dependent on one key individual for future success.

10. Nearly all (89%) cluster initiatives have a devoted cluster facilitator who tends to have an industry background from the cluster.

Figure 6. 1: Cluster Initiative Performance Model
Source: Sölvell et al. (2003)

Ryzhkova and Prosvirkin (2015, p. 21) discuss the role cluster initiatives play in relation to competitiveness and how they “facilitate the improvement of values of competitiveness factors and the increase of general competitiveness of enterprise.” Moreover, Ryzhkova and Prosvirkin (2015, p. 21) argue that “cluster initiatives are a competitiveness factor of
modern enterprises.” Having implemented a cluster initiative, structured its objectives and developed it, cluster organisations and management are required to appraise its performance and therefore the CIPM is an extremely useful tool in this regard (Ketels et al., 2012). Upon implementation of cluster initiatives, it is critical to be able to assess if the initiatives are working positively for the cluster.

Boschma and Fornahl (2011, p. 1296) concerning the concept of longitudinal research, note “while it is hence crucial to define the appropriate framework, more efforts are needed to perform longitudinal studies on clusters. Few empirical cases have taken a longitudinal perspective so far because data availability on clusters over a longer period of time is a hard problem to tackle.” Ketels et al. (2012, p. 46) also alluding to longitudinal research, add “the data quality remains limited, especially in Europe, and there is no classification of cluster programs to draw on.” A growing number of longitudinal studies and analyses of clusters and cluster initiatives are clearly needed.

Having reviewed the Cluster Initiative Performance Model as a method and model to analyse clusters and their initiatives through empirical data and results, the following section introduces another method of cluster analysis; the Delphi Method.

6.3 The Delphi Method

The Delphi method was developed during the 1950s by the U.S Air Force and according to Moynihan (2018, p. 128) was used “to apply expert input in a systematic manner using a series of questionnaires with controlled opinion feedback. Key features were preservation of anonymity in the expert panel’s responses and iteration of the questionnaires.” Brett (2007, p. 98), in reference to the work of Delbecq et al. (1975), define the Delphi method as “a method for the systematic solicitation and collection of judgements on a particular topic through a set of carefully designed sequential questionnaires.” Additionally, Linstone and Turoff (2011, p. 1714) state that Delphi is primarily a “method for structuring a group communication process.” Concerning group processes, the aim of the methodology is to provide a collection of opinions from a specific group of experts rather than that of statistical result production (Day and Bobeva, 2005; Brett, 2007). Procter and Hunt (1994, p. 1004) state that the Delphi process can
produce “large and unwieldy amounts of information particularly if the researcher adopts a qualitative stance.” It is important to note that the Delphi is not viewed as a substitute for more traditional statistical analytical tools, rather as a way to gather expert opinion, which aids forecasting, and discussion (Rowe and Wright, 1999). While the author’s research involves working closely with a cluster organisation, the chosen methodology V-LINC, does not require the sole implementation of a Delphi method. However, certain elements of the Delphi is used to aid this identification process through the use of certain metrics.

Aims and Objectives of the Delphi Method

In short, the main objective of Delphi is to ascertain the most reliable consensus of a group of experts’ opinion (Linstone et al., 1975; Powell, 2003). Experts are sought with the understanding that they would likely respond more correctly to questions in their field than non-experts (Brett, 2007). Linstone and Turoff (2011) suggest that a key advantage of participation was allowing individuals to partake in a group discussion process at different times and places that were convenient to them.

There are a certain number of aspects within its framework that the author deems relevant to this research e.g. the identification of stages of a cluster life cycle (see Handayani et al., 2012). There are three main types of Delphi methods as outlined by Rauch (1979); classical, decision-making and policy Delphi (Hanafin, 2004; Tichy, 2004; Brett, 2007; Linstone and Turoff, 2011). The Delphi technique is a sequence of group interviews and questionnaires that are “separated by controlled quantitative and qualitative feedback between rounds” (Moynihan, 2018, p. 104).

Moynihan (2018, p. 104) suggests by “sharing many of the advantages of expert opinion interviews and panel surveys, the Delphi method adds reliability and validity through iterative rounds.” Additionally, Moynihan (2018, p. 129) posits “Delphi has primarily been used as a methodological forecasting tool, and follow-up studies have demonstrated the validity and long-term accuracy of the technique.” Okoli and Pawlowski (2004) believe Delphi is deemed the strongest method for a rigorous query of experts and
stakeholders in comparison to other methodologies utilizing traditional surveys and questionnaires i.e. Delphi studies provide richer data than traditional surveys due to their multiple iterations and the revisions resulting from feedback. More recently, it has been used to create alternative policy situations by emphasising the differences of opinion (Okoli and Pawlowski, 2004; Brett, 2007).

Moynihan (2018, p. 138), discusses the work of Powell (2003), which examines Delphi as a method, stating, “as a process, it does not attempt to create new fact but creates a process in which to gather data and knowledge.” In short, the Delphi method is ideally used in circumstances where reliable and accurate information is somewhat lacking and hard to attain (Linstone et al., 1975), combined with inadequate data on certain topics (Tapio, 2002). The gathering of preliminary data, also makes this an idyllic method for creating scenarios and establishing theories (Wiersma and Jurs, 2005; Day and Bobeva, 2005; Brett, 2007).

Moynihan (2018, p. 130), regarding the work of Saldanha and Gray (2002), summarises the main aim of Delphi noting “the principal aim is to achieve a consensus on statements, questions, forecasts, opinions or on the analysis of informed judgements of a group or panel of experts on specific issues or questions.” Moynihan (2018, p. 108) referencing the work of Okoli and Pawlowski (2004), supports this argument adding “the Delphi method is ideal in that it utilises a panel of experts to support the analysis process. The nature of the Delphi method lends itself to creating better question design, through participative evaluation and multiple evolving iterations rather than relying on the researchers question design.” Once there is a strong level of basic knowledge and understanding of clusters and their structures, Moynihan (2018, p. 108) believes, “the Delphi model as a research tool has been proven to be an enabler for decision making, and which caters for forecasting and consensus building.”

The following research study by Handayani et al. (2012) incorporates the use of the Delphi Method, which uses a conceptual assessment model to identify phases of industrial cluster life cycle in Indonesia. Handayani et al. (2012, p. 210) suggest the Delphi Method includes the “iteration of three activities:

• Collect the opinion of an expert group, generally using a survey/questionnaire
• Synthesize and statistically recapitulate these opinions
- Provide feedback to the participants and see if any revision is required.”

By using Delphi they aim to “develop the conceptual model i.e. define phases of cluster life cycle and identify assessment components, and design typology of cluster life cycle” (Handayani et al., 2012, p. 198). Handayani et al. (2012, p. 198) note the purpose of their research is to “develop an assessment model to identify phases of industrial cluster life cycle which comprises definition of the cycle phases, identification of assessment components, and characterization of each phase of cluster life cycle.” They describe their research using a three-step method:

1. Defining the stages of a cluster life cycle
2. Identifying the components and
3. Design typology of a cluster life cycle.

Handayani et al. (2012, p. 202) provide a detailed summary concerning clusters and their life cycles. They hypothesise that certain studies describe clusters by their age and growth, “often either as emerging (many new firms, rapid growth, frequent changes in firms and products), established or mature (fewer, larger firms, slower growth, fewer changes in products), or declining (stagnant or declining employment growth, more firm deaths than births, few or no changes in products).” Cluster life cycles allow clusters to redefine/reinvent themselves as a result of external factors changing e.g. markets and technology. As such, a potential reinvention of a cluster may revive a cluster in decline (Bianchi et al., 1997).

New clusters can form and grow, even with some established clusters declining. This is primarily due to continual cluster evolution involving changes to market trends, technology and competition. Some factors that cause clusters to evolve, for example, economic factors that give rise to a cluster can differ greatly from the factors that keep a cluster going (Handayani et al., 2012). However, the initial rationale for market/technological breakthroughs that cause a cluster to originate are extremely unpredictable (Bresnahan et al, 2001). Handayani et al. (2012) proposed the use of four dimensions to allow assessment of the stages of a cluster life cycle;

1. Concentration of industry
2. Market accessibility
3. Completeness of actors

Their model of cluster stage identification during a cluster life cycle aims to equip the government with the correct tools and knowledge to determine the initial condition of the cluster under investigation. The proposed model is expected to be used to distinguish the stages of the industrial cluster life cycle, and such a model could prescribe appropriate policy interventions for cluster development (Handayani et al., 2012). From a policy perspective, it is advantageous when gathering the information from experts, stakeholders etc. with the eventual aim to analyse how the cluster functions, in order to generate accurate policy recommendations (Aranguren et al., 2014). Identifying stages of a cluster life cycle is an area Handayani et al. (2012, p. 199) feel is “rarely done by the other researchers.”

Market accessibility i.e. a key factor used to improve the clusters competitiveness; when used as an assessment tool for industrial cluster growth, can be measured when one takes the clusters ability to access and enter global markets into consideration (Nadvi and Barrientos, 2004; Bergman, 2007). Thus, a cluster’s industrial growth will be intensified by its enhanced competitiveness (Porter, 1990; Bergman, 2007). Handayani et al. (2012, p. 201) note that few studies exist “in the field of assessment conceptual model, and there is no research that develops an assessment model for identifying phases of industrial cluster life cycle.” A cluster’s ability to gain access to global markets can be derived from increased capabilities and market accessibility, which are key factors to improving the industrial cluster’s competitiveness (Porter 1990; Bergman, 2007). Table 6.2 summarises various authors and their suggestions of what is present at each stage of the cluster life cycle. Each author has their own preferred name for each stage of the cluster life cycle that they feel is the most accurate and applicable.
<table>
<thead>
<tr>
<th>Researcher</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bianchi et al., (1997)</td>
<td><strong>Emergence</strong> A location with small number of firms</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> Innovation and policy intervention occurs</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong> High volume of innovation. Competitive in global market. Cluster is focussed on niche area of specialisation</td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong></td>
</tr>
<tr>
<td>Maggioni (2002; 2004)</td>
<td><strong>Emergence</strong> Co-location influences growth i.e. Exogenous growth</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> The structure of the cluster is altered and growth occurs by the role economic agglomeration plays</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong> Cluster's internationalisation ability improves via technology leadership. Cluster begins to decline</td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong></td>
</tr>
<tr>
<td>Wolter (2003)</td>
<td><strong>Emergence</strong> Demand for clusters products and services grow. New markets are accessed. Increasing number of firms</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> A change in technology occurs with new competition present among firms. Firms enter and exit the cluster</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong> Market expansion and differentiation</td>
</tr>
<tr>
<td>Andersson et al. (2004)</td>
<td><strong>Emergence</strong> Actors within the cluster begin to collaborate</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> New firms continue to join the cluster. Collaboration between firms is established</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong> Critical mass of the cluster is established</td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong> Cluster adapts to new trends through technological innovation</td>
</tr>
<tr>
<td>Maskell and Kebir (2005)</td>
<td><strong>Emergence</strong> Spillovers and economic growth begin in a region stemming from co-location process. Local competition begins</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> Increased entrepreneurship. Technology innovation and policy intervention is evident</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong> Number of firms declines</td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong> No new product, services or process is present</td>
</tr>
<tr>
<td>Menzel and Fornahl (2007; 2010)</td>
<td><strong>Emergence</strong> Few firms exist with very little collaboration and competition between firms</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> Firm numbers increase in tandem with employment figures. Cooperation can occur in this environment</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong> Firm and employee numbers plateau with the cluster focusing on a specific area/field</td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong> Number of firms and employees decline with little chance for cooperation and collaboration to occur. Negative sentiments towards the cluster and cluster organisation</td>
</tr>
<tr>
<td>Elola et al. (2012)</td>
<td><strong>Emergence</strong> Historical preconditions play a role. Local demand increases and anchor firms combined with entrepreneurship play a role in shaping the emerging cluster</td>
</tr>
<tr>
<td></td>
<td><strong>Growth</strong> Number of large companies joining the cluster increases as well as a marked increase in foreign investment and entrepreneurship. An influx of external knowledge and technology is evident</td>
</tr>
<tr>
<td></td>
<td><strong>Mature/Stagnate</strong> Strategic capabilities improve with local and national policies being implemented to bolster the cluster’s performance and competitiveness. Internationalisation is well established and international demand growth is visible</td>
</tr>
<tr>
<td></td>
<td><strong>Decline/Reinvent</strong></td>
</tr>
</tbody>
</table>

Table 6. 2: Definition and Characteristics of the Cluster Life Cycle  
Source: Author based on Handayani (2012)  

142
Handayani et al. (2012, p. 208) note that “the steps of development of a conceptual assessment model to identify phases of cluster life cycle involve determination phases, identification assessment components and design typology of cluster life cycle.” A theoretical and empirical approach was used to develop the assessment model i.e. expert opinions from use of Delphi Method were gathered and a literature review was completed (Figure 6.2).

Figure 6.2: Model to identify phases of an industrial cluster life cycle
Source: Handayani et al. (2012, p. 208)

Handayani et al. (2012) determined stages of a cluster life cycle and use the Delphi method throughout, involving dimensions, elements and criteria of clusters to identify assessment components. These components take the shape of a literature review (deductive) and the Delphi method (inductive), due to what Handayani et al. (2012, p. 209) describe as having “limited literature in this field.” Handayani et al. (2012) follow the four stages of a cluster life cycle as prescribed by Andersson et al. (2004) and believe them to be the most comprehensive model; agglomeration, emerging, developing, and mature stages. Handayani et al. (2012) suggest agglomeration is the initial phase in which new focal companies develop within a product group. In the emerging phase, other stakeholders join the agglomeration that marks the beginning of collaboration. During the developing phase, stakeholders collaborate to encourage growth in industrial clusters and open up new markets for their products. A cluster is considered mature when it reaches its critical mass. The last phase is decline or transformation.
Figure 6.3: Assessment to Identify Industrial Cluster Life Cycle Stage
Source: Handayani et al. (2012, p. 208)

Figure 6.3 presents the framework of assessment to identify stages of a cluster life cycle. The framework is composed of two main entities; the cluster and the government. It is suggested that the government is responsible for two main activities involving, 1. The assessment of cluster stage through its role as a facilitator, regulator and providing technical support 2. Implementation of a suitable policy intervention. Accurately identifying and assessing at what stage a cluster is at, is vital for formulating the appropriate policy, and Handayani et al. (2012) note the government should proactively conduct such assessments. It is noteworthy to look at certain advantages and disadvantages associated with the use of the Delphi method, as highlighted by Handayani et al. (2012) and seen in Table 6.3.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-disclosure element prevents influence of one person on another i.e. Anonymity is preserved</td>
<td>The method is time consuming to complete ca. 6 months</td>
</tr>
<tr>
<td>Can cover a larger and more heterogeneous geographic area</td>
<td>No direct verbal communication can take place via face-to-face meetings</td>
</tr>
<tr>
<td>Each respondent is given ample time to answer the questions posed</td>
<td>Respondents may not fully comprehend some aspects of the questionnaire</td>
</tr>
<tr>
<td>It can avoid social and psychological pressures</td>
<td>Assumes the questionnaire element can replace all human communication</td>
</tr>
<tr>
<td>Correct and proper documentation is required and this ensures validity and reliability of the Delphi results</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.3: Advantages and Disadvantages of the Delphi Method
Source: Author based on Handayani et al. (2012)
Overall, Handayani et al. (2012, p. 222) argue that there are “no papers that develop a model to identify phases of industrial cluster life cycle. We bridge this gap to develop assessment model.” Table 6.3 highlights that the Delphi method is not without its limitations, certainly, when compared with other methods of cluster analysis. Moynihan (2018, p. 278) when comparing the V-LINC methodology with that of the Delphi method, suggests “the data collection method is relatively efficient – especially in comparison to resource intensive qualitative method like a Delphi study.” The next section, having examined the Delphi method, looks at the Location Quotient Model.

### 6.4 Location Quotient Model

When aiming to identify clusters empirically, there are two variables most widely used in the literature i.e. the LQ and the number of employees (Sforzi, 1990; Brusco and Pabab 1997; DTI, 2001; Sternberg and Litzenberger, 2004; De Propris, 2005; Brenner, 2006; Carroll et al., 2008). Many authors argue that concentration of industry is a tool to identify industrial cluster growth, and this is measured using the LQ (Barkley and Henry, 1997; Maggioni, 2002, 2004; Mayer, 2003; Shields et al., 2004; Cortright, 2006; Maggioni and Riggi, 2008). Ketels and Protsiv (2020) suggest the LQ is a “standard measure of specialization in an industry and is computed as the ratio of two shares: share of employment in an industry in a given region and share of employment in an industry in all regions.”

Byrne (2016, p. 72) notes “the LQ has been adopted as the measure of choice in spatial studies investigating industrial clustering or agglomeration.” Thus, the LQ is an index, established around employment numbers and Brenner and Schlump (2011) suggest the number of employees seems to be an adequate variable to measure the development of clusters and the success of policy measures. However, it should be noted that policymakers might look at more than employment growth. Employment is the central endogenous variable in the model, while other variables that play a prominent role in the cluster literature are the number of firms, start-ups, innovations, networks, human capital, spill-overs, venture capital, etc. Byrne (2016, p. 72) in agreement with the work of Brenner and Schlump (2011), states that a LQ “measures to what extent an industry is
concentrated in a region by comparing the regional economy to a reference or national economy, generally using employment as the comparison.” If high LQ scores are discovered amongst related industries in a certain region, it suggests the existence of a cluster (Cortright, 2006).

**Limitations of LQ**

The LQ method is however, not without its limitations. The calculation only incorporates employee figures and employment data, disregarding the number or size of firms within the cluster (Figueiredo et al., 2009; van Egeraat et al., 2015). Probably the most important and significant issue involves the LQ’s inability to identify industrial clusters sufficiently (Rosenfeld, 1997; Bergman and Feser, 1999; Martin, 2001; vom Hofe and Chen, 2006; Crawley, 2009; Hobbs, 2010; van Egeraat et al., 2015). The LQ is an authentic method used to evaluate regional specialisation, however, it disregards a vital aspect of cluster definition i.e. the interdependencies between actors or sectors within a cluster (Bergman and Feser, 1999; Martin, 2001). Byrne (2016, p. 73) supports this argument adding “this suggests some misconception and confusion with respect to methodological approaches of cluster identification.” The next section introduces another method of cluster assessment incorporating the work of MacDonald and Hartt (2015) who developed a rubric to define at what stage the Nova Scotia Industry Wine Cluster is at in the cluster life cycle.

**6.5 Strategic Industry Life Cycle Analysis**

MacDonald and Hartt (2014) investigate the industry wine cluster of Nova Scotia. Although conceptually different, the industry life cycle and cluster life cycle share numerous similarities and this real life example implements a methodology that can be applied to cluster life cycles. Similar to a cluster life cycle, firms within industry may formulate strategies to both protect themselves against threats and take advantage of potential opportunities, through the use of an industry life cycle analysis (Greiner, 1972, Hill and Jones, 2012).

Industries encounter similar trends comparable with the evolution of clusters as they pass through their respective cluster life cycles (Karniouchina, 2013). MacDonald and Hartt
(2014) argue the industry life cycle comprises of five stages, producing a bell-shaped curve (Figure 6.4), similar to that of a cluster life cycle. These are the embryonic, growth, shakeout, mature and decline stages. Following identification and analysis of the stages, management can streamline the transition from one stage to the next and adapt its business model accordingly (Cusumano et al., 2006).

![Bell Shaped Curve of Industry Life Cycle Stages](image1)

**Figure 6.4: Bell Shaped Curve of Industry Life Cycle Stages**
Source: Hill and Jones (2012, p. 65)

The analytical approach implemented by MacDonald and Hartt (2014) comprised of five steps as seen in Figure 6.5. The steps involved graphing and analysing numerous aspects including the New World wine variables and industry life cycle, as well as Nova Scotia’s production that contributed to the identification of the stage the Nova Scotia wine industry is positioned in the industry life cycle. Following on from this, a rubric was created with numerous variables considered in order to identify the potential stage of the life cycle (Table 6.4) before determining the stage of the life cycle for each country (Table 6.5 on page 166).

![Analytical Approach to Nova Scotia Wine Industry Life Cycle](image2)

**Figure 6.5: Analytical Approach to Nova Scotia Wine Industry Life Cycle**
Source: MacDonald and Hartt (2014, p. 119)
### Table 6.4: Rubric for Determining Stage of Industry Life Cycle

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embryonic</strong></td>
<td>Increasing at a relatively slow rate as new entrants begin to grow production capacities. Low value is expected as production efficiency is lower in this stage.</td>
</tr>
<tr>
<td><strong>Production Quantity</strong></td>
<td>Low, slope is increasing but slowly as firm become more knowledgeable in industry. Less than production with difference increasing as demand also increases.</td>
</tr>
<tr>
<td><strong>Growth</strong></td>
<td>Increasing, slope increased, profitability has improved, firms are able to increase production to meet increasing demand. Level is increasing as industry’s production improves and demand is increasing. Typically remain relatively stable as customers’ demand for the new product is increasing, although will be lower than exports.</td>
</tr>
<tr>
<td><strong>Shake-Out</strong></td>
<td>Production is still increasing, although slope has decreased. Production is still increasing, although slope has decreased.</td>
</tr>
<tr>
<td><strong>Mature</strong></td>
<td>Slope decreased and stabilized as demand for the product has reached its peak. With larger firms have consolidated and begun building economies of scale, export levels have reached their peak, and have stabilized as demand has stabilized.</td>
</tr>
<tr>
<td><strong>Decline</strong></td>
<td>Demand for the product has decreased, so has production. May increase slightly as production levels begin to decrease, will remain relatively stable. Little change, land has already been developed and demand has peaked so there is no need to increase area. May increase slightly as production levels begin to decrease, will remain relatively stable.</td>
</tr>
<tr>
<td><strong>Domestic Supply</strong></td>
<td>Equal to or greater than production. Lessthan production with difference increasing as demand begins to increase slower. Supply level has peaked as demand has peaked. Supply quantity decreasing as demand has begun to decrease.</td>
</tr>
<tr>
<td><strong>Export Quantity</strong></td>
<td>Low, focus is on product innovation and developing distribution channels. Increasing as larger firms have consolidated and begun building economies of scale. Export levels have reached their peak, and have stabilized as demand has stabilized. Quantities have begun to decrease as demand has also begun to decrease, firms focus on lowering costs.</td>
</tr>
<tr>
<td><strong>Import Quantity</strong></td>
<td>Higher than export level, as customer base is not familiar with new product. May increase slightly as a result of firms exiting the industry and externally produce products are brought into meet demand. Remains stable, difference between exports has reached its maximum. May increase slightly as production levels begin to decrease, will remain relatively stable.</td>
</tr>
<tr>
<td><strong>Area of Land</strong></td>
<td>Increasing as there are high levels of entry into the industry. Little change even though several firms will leave the industry, large firms will consolidate smaller ones and continue to use the land. Decrease slightly as firms leave the industry.</td>
</tr>
<tr>
<td><strong>Hectolitres Per Hectare</strong></td>
<td>Low value is expected as production efficiency is lower in this stage. Production efficiency will reach its peak at this stage as product innovation has also reached its peak. Relatively constant as production methods are common knowledge throughout the industry. Little change. Little change, may increase as firms attempt to maximize production without increasing their costs, this may impact the quality of the product.</td>
</tr>
</tbody>
</table>

Source: Author based on MacDonald and Hartt (2014, p. 120)

MacDonald and Hartt (2014) considered it a wise move to employ strategies that have been successful in several New World wine countries in their early stages of growth in Nova Scotia. In addition to assisting the industry's growth, they would enable businesses...
to structure their operations in a manner that is more suitable for the future (MacDonald and Hartt, 2014).

<table>
<thead>
<tr>
<th></th>
<th>Production Quantity</th>
<th>Domestic Supply</th>
<th>Export Quantity</th>
<th>Import Quantity</th>
<th>Area of land</th>
<th>Hectolitre per hectare</th>
<th>Stage of Life Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Argentina</strong></td>
<td>Production slope is decreasing, was largest producer until 1990, still second largest producer</td>
<td>Less than production since 1995, when exports increase. Is decreasing with production</td>
<td>Exports increased steadily since 1994</td>
<td>Level of import has changed very little</td>
<td>Slight decrease of 10% since the beginning of the period</td>
<td>Very little change during the period, stable</td>
<td>Mature</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td>Third largest producer, increasing steadily until 1990 when slope increased</td>
<td>Exceeded by production during the period, difference increasing greatly since 1995</td>
<td>Export increasing since 1987, significant growth since 1995, largest export from 2001-10</td>
<td>Began to increase in 2006-07 when production levels fell slightly</td>
<td>Increased significantly (240%) over period, especially since 2001</td>
<td>Increased 55% over the period</td>
<td>Shake-Out</td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td>Production has increased over the period, although growth is slow</td>
<td>Exceeds production throughout this period, is increasingly steady</td>
<td>Have been stable, but have begun increasing in 2008</td>
<td>Steadily increasing exceeding production since 1973</td>
<td>Slowly increasing, 15% increase over the period</td>
<td>Increased 55% over the period</td>
<td>Embryonic</td>
</tr>
<tr>
<td><strong>Chile</strong></td>
<td>Production has exceeded domestic supply since 1991, when its slope increased after dipping over the previous decade</td>
<td>Has been decreasing since 1978, stabilising in the last decade</td>
<td>Increase in 1989. Largest exporter during 1997-2001 and again in 2011</td>
<td>Stable with a small increase in 2006-07</td>
<td>Area harvested has doubled since the beginning of the period</td>
<td>Increased 7% over the period, still the lowest of the countries examined</td>
<td>Late Growth</td>
</tr>
</tbody>
</table>

Table 6.5: Variable Analysis for New World Wine Countries
Source: Author based on MacDonald and Hartt (2014, p. 120)

The results garnered from this particular methodology revealed that Canada's wine industry is currently in the emerging phase of its life cycle (MacDonald and Hartt, 2014). The Nova Scotian wine industry, although only beginning in the 1980’s, is in the growth stage of its respective industry life cycle in which “production in the industry is still low, but the growth trend is significant. Consumer perception of Nova Scotian wine is improving, and wine tourism in the province has contributed a great deal to the growth of the industry” (MacDonald and Hartt, 2014, p. 130).
MacDonald and Hartt (2014, p. 130) argue that working closely with the Nova Scotia local government as well as the Canadian government can lead to an overall growth throughout the industry, and Nova Scotia wine would become more competitive on both a national and global scale. As the industry “continues to grow it is important that wineries within the industry form networks and cooperate with each other.” In other words, the ability to identify the life cycle stage of the industry in question allows for accurate policy recommendations to be generated. The industry life cycle analysis example produced various methods that can be utilised by the author with the aim of identifying cluster life cycle stages.

The next section investigates the cluster life cycle identification model used by De Sousa Ostapenko et al. (2021).

6.6 Cluster Life Cycle Identification Model

The work of De Sousa Ostapenko et al. (2021) sought to develop a framework for cluster dynamics, based on the cluster life cycle, regarded as one of the most prominent theory for cluster evolution analysis. They identified stages of emergence, growth, maturity, decline and renewal, keeping in mind that a clusters evolution does not necessarily occur in this sequence. De Sousa Ostapenko et al. (2021, p. 21) note that each stage of the cluster life cycle “has its own characteristics and parameters of identification.” Within their model, the following parameters were allocated: Number of Firms and Employees, Cluster Brand, Innovation, Network, Policies and Regulations, External Markets & FDI. Considering the changes that occur within the cluster according to these parameters can help identify the stages of its cluster life cycle. Their work concludes with a model of cluster life cycle identification to be used in future empirical research.
Figure 6. 6: Cluster Life Cycle Identification Model
Source: De Sousa Ostapenko et al. (2021, p. 26)

De Sousa Ostapenko et al (2021) argue the main parameters featured at each stage of the life cycle are as follows:

- Firms (Menzel and Fornahl, 2010; Desmarchelier and Zhang, 2018; Blažek et al., 2020)
- Employees (Menzel and Fornahl, 2010)
- Innovation (Bergman, 2008; Menzel and Fornahl, 2010; Trippl et al., 2015; Harris, 2020)
- Network (Menzel and Fornahl, 2010; Knop et al., 2011; Handayani et al., 2012; Fornahl et al., 2015; Trippl et al., 2015; Belussi, 2018; Pronestì, 2019)
- Cluster Identity / Brand (Davis et al., 2006; Menzel and Fornahl, 2010; Pronestì, 2019)
- Policies and Regulations (Bergman, 2008; Sölvell, 2009)
- External markets - exports /FDI (Sölvell, 2009; Elola et al., 2012).

Clusters are important in the economic development of countries and regions, as they provide numerous advantages to stakeholders, especially firms. When merged with the
Smart Specialisation Policies of the European Union, clusters become integral parts of regional development policies. Clusters, in general are associated with various benefits they provide to firms, however, depending on its development and evolution, co-location may or may not be beneficial to firms. Certain parameters discussed by De Sousa Ostapenko (2021) are relevant in the author’s own work in relation to cluster life cycle stage identification.

<table>
<thead>
<tr>
<th>Method</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster Initiative Performance Model (CIPM)</td>
<td>Sölvell et al. (2003)</td>
</tr>
<tr>
<td>The Delphi Method</td>
<td>Brett (2007); Linstone and Turoff (2011)</td>
</tr>
<tr>
<td>Location Quotient Model</td>
<td>Sforzi, (1990); Brusco and Pabab (1997); DTI, (2001); De Propris, (2005); Brenner, (2006); Carroll et al., (2008)</td>
</tr>
<tr>
<td>Strategic Industry Life Cycle Analysis</td>
<td>MacDonald and Hartt (2014)</td>
</tr>
<tr>
<td>Cluster Life Cycle Identification Model</td>
<td>De Sousa Ostapenko et al. (2021)</td>
</tr>
<tr>
<td>V-LINC Method</td>
<td>Byrne (2016)</td>
</tr>
</tbody>
</table>

Table 6.6: Summary Table of Methods Discussed within the Chapter
Source: Author

Having reviewed numerous methodologies to measure cluster performance as well as stage identification in a cluster and industry life cycle (Table 6.6), the following section contains an in-depth review of the V-LINC methodology.

6.7 V-LINC

V-LINC is a methodology for identifying, recording and analysing the linkages that firms in clusters engage in (Hobbs et al., 2014, 2016; Byrne, 2016; Moynihan, 2018). For the purpose of this body of work, it classifies these linkages, and groups them by geographic scope: Local linkages (L), National linkages (N), European linkages (EU) and International linkages (INT). Byrne (2016, p. 130) defines V-LINC (Visualisation of Linkages In Networks and Clusters) as “a hybrid methodology which records, visualises and analyses firm linkages to investigate cluster ecosystems. . . V-LINC consists of three elements: firstly, a method to collect firm linkage data; secondly, a software tool to visualise cluster ecosystems; and thirdly, analysis to produce targeted policy initiatives. It is a hybrid methodology as it brings together existing methods and new techniques to analyse a cluster.”
V-LINC records the business impact\textsuperscript{20} of linkages based on the perceptions of firm personnel who engage in the linkages with other companies and organisations. Data for V-LINC analysis of linkages is collected by structured interviews of company personnel. Likert scale questions are employed to gauge the business impact of individual linkages. V-LINC maps provide a visual representation of the relative reliance on local, national, European or international linkages of a company and when combined, of a cluster. V-LINC facilitates policy development at local and national levels, through the aggregation of data from a sample of firms. Confidentiality of firms’ linkages is maintained throughout (see section 6.8.1).

Qualitative data, collected through the interview process is converted into numerical data that can be processed in a quantitative manner. Groves et al. (2009, p. 4) describes this as a “systematic method for gathering information from (a sample of) entities for the purpose of constructing quantitative descriptors for the attributes of the larger population of which the entities are members.” Analysing the qualitative information gathered from the expertise RFG input and opinions into a quantitative structure is designed to be as accurate and replicable as possible (Jansen, 2010; Creswell, 2013). V-LINC visualises information on the geographic footprint of cluster ecosystems, whilst measuring the perceived business impact of cluster linkages. Through an understanding of the various linkages that firms in a cluster engage, targeted policy recommendations can be made to build on strengths and address cluster weaknesses. Linkages are defined by Hobbs (2010, p. 221) as “relationships that enable exchange of goods, services, personnel, information, ideas, expertise, grants and other supports to business that occur between two or more parties, over a sustained time period.”

The following sub-sections examine the development of the V-LINC methodology, starting with a detailed look at the V-LINC methodology framework as a whole. Furthermore, this enables one to answer the question: at which geographic level and linkage category do clusters’ most valuable linkages occur? V-LINC data is composed of three core elements: (1) define the linkage category, (2) define the geographic scope, and

\textsuperscript{20} Business Impact is the new term adopted and used since 2018, replacing ‘perceived significance’ as previously used by Byrne (2016).
(3) assess the business impact of each linkage reported by the personnel representing their respective firm.

**Linkage Categories:** Input and output linkages and how they are measured, plays an integral role in research studies on industry agglomerations (Porter, 1990, 1998b; Sölvell, 2006; Sölvell et al., 2009). Byrne (2016, pp. 131-132) discusses how “V-LINC builds on these value chain transactional approaches and records linkages across eight different linkage categories; Government Agencies, Industry Associations, Industry Peers, Inputs, Outputs, Research and Development, Specialist Service and Training linkages” (Figure 6.7). V-LINC assigns company linkages to one of eight categories.

![V-LINC Linkage Categories](image-url)

**Figure 6. 7: V-LINC Linkage Categories**
Source: Byrne (2016, p. 132)

Byrne (2016, pp. 131-132) states that “these linkage categories are derived from Marshall’s (1890) ‘Triad of External Economies of Industrial Localisation,’ Porter’s (1998a) ‘Diamond of Local Industrial Clustering,’ Leydesdorff’s (2012) ‘Triple Helix Cluster configuration’.” Detail of the types of linkages used in the V-LINC linkage categories as seen in Byrne (2016, pp. 131-132) are as follows:

- “Government Agency linkages (GA): are comprised of all forms of linkages to government departments and agencies including state support for enterprise. Regional authorities and local agencies such as city or county councils are also included;
• Industry Association linkages (IA): includes all memberships and relationships with organisations for collaboration, such as industry association groups, chambers of commerce and cluster organisations;

• Industry Peer linkages (IP): are defined as formal and informal relationships with companies: in similar or related industries, who share technologies or target complimentary markets;

• Input linkages (IN): are links with suppliers of raw materials, goods and services which have a critical impact on the end product or service of the surveyed firm;

• Output linkages (OU): relate to customers of a surveyed firm and channel sellers from both a goods and services perspective. Outputs may be with individual customers or broken down by customer segments and regions.

• Research and Development linkages (RD): include research and development relationships between companies and also with academic and research institutes;

• Specialist Service linkages (SS): relationships with vendors who supply other essential services to a surveyed firm, outside of inputs, where the expertise or capacity is not contained in-house e.g. services specific to an industry, distribution, IT, consultancy, marketing, financial and legal services.

• Training linkages (TN): are linkages with third parties who provide specific training or learning for employees, e.g. relationships with academic institutes in regard to inputting on course modules to address future skills needs.”

**Geographic Scope:**

**Linkage categories by geographic Scope:**

Geographic proximity of firms supports the development of local connections between firms and/or organisations. Porter (1998a, p. 226) believes, “a cluster is a form of network that occurs within a geographical location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions.” Modern advances in communication and technology have impacted this need for geographic proximity and allow connected firms to be more widely dispersed across a region or country. Firms may source inputs from a number of regions, engage in R&D with research organisations in foreign countries, and sell into multiple international
markets. Therefore, it is important to examine geographic scope of linkage categories, together with the business impact of linkages that occur over different geographic scopes.

Byrne (2016, pp. 132-133) in reference to the work of Christensen et al. (2012), states “clusters are not necessarily limited to administrative or geographical boundaries, but they have a geographical centre.” Various studies argue that clusters are defined by the times and distances people will travel for meetings and employment (Rosenfeld, 2002). Lublinski (2002) believes that two hours driving time is the maximum radius between the cluster’s epicentre and most distant member firms. Ketels et al. (2012) having completed a study of European cluster organisations, discovered that half of the cluster’s members are within a one-hour driving distance of their cluster organisation, which in turn facilitates frequent face-to-face interaction. From a separate study conducted across seven European countries, involving 143 cluster organisations, informative data, in line with the findings of Ketels et al. (2012), was also gleaned concerning cluster members’ locations and proximity with that of the cluster organisation.

Byrne (2016, p. 133) suggests “linkages outside the local region are regarded as external to the cluster. V-LINC also records the geographic scope of linkages outside the cluster, whether they occur at a “national” (outside the local region but within the country under investigation), “European” (outside national boundaries but within Europe) or “international” (outside of Europe) level.” Byrne (2016, p. 133), citing the work of Porter (1990, 1998b), proceeds to note that the method distinguishes itself from the likes of Porter “in that it recognises that clusters are dynamic and have linkages which occur with firms and organisations outside the cluster. The study of linkages and networks has the opportunity to shed light on the geographic boundaries of clusters and the geographic reach of clustered firms. Measuring the linkages that firms in a cluster engage in can uncover the boundaries of the cluster and where firms’ most important linkages exist – within or outside the cluster.”

Byrne (2016, pp. 133-134) explains the following definitions in relation to the V-LINC methodology; Business Impact of Linkages: “the impact of each linkage category relates
to the business impact of individual linkages based on the perception of expert respondents involved with these linkages.” The term ‘perceived business impact’ was formerly referred to as ‘perceived significance’ of firm linkages in the PhD theses of Byrne (2016) and Moynihan (2018) when implementing the V-LINC methodology. The business impact of the linkages is collected through a series of Likert scale questions during structured interviews. The Likert scale that is used “converts qualitative judgements into quantitative data which can be compared and subject to further analysis” (Byrne, 2016, p. 133). The linkage categories in V-LINC are derived from Porter’s (1990, 1998a and 1998b) discourse on the interactions and relationships of companies in a cluster. V-LINC responses, collected through structured interviews combine to reveal the impact of business linkages as perceived by expert company personnel.

The impact of the linkages are recorded and scored between 0 and 40 and then arranged into four impact bands based on their importance. When compiled, the business impact score for an individual linkage is designated into one of four perceived business impact bands for ease of interpretation as seen in Byrne (2016, p. 134):

“High” Band >30 to 40: Linkages in this range are perceived as highly impactful. They are viewed as critical linkages to the respondent firm and its future development. Substantial time is invested in the linkage. These linkages have a high frequency of interaction at multiple levels across the organisation involved and typically involve top-level management. Typically characterised by constant (even daily) face-to-face meetings, e-mail or telephone communications.

“Medium” Band >20 to 30: Linkages in this range are perceived to have medium business impact. While not mission critical they are important and may have a role in the development of the firm. Linkages in this category contain a number of points of contact which are in regular communication. Contacts are typically at multiple levels across the organisation.

“Low” Band >10 to 20: Linkages in this range are perceived to have low business impact value. Viewed as somewhat beneficial to the firm, they are not mission critical, but may in the future develop into more important relationships. Linkages in this category, typically contain few points of contact and there is a moderate frequency of contact.
between the parties involved at operational and administrative levels. Meetings occur on a more formalised basis.

“Tenuous” Band 1 to 10: Linkages with perceived business impact in this range are “tenuous,” they are not of value to the firm at present and are not judged to become critical in the future. Typically, linkages in this band have only a few points of contact, there is infrequent contact between the parties involved, and meetings are likely to be ad hoc.

When the business impact of linkages are unearthed, a more in-depth and meaningful understanding of the linkages and networks of a cluster can be gleaned. Byrne (2016) suggests there is great potential for the use of perceived business impact linkage data in cluster studies as the researcher can identify what type of linkages are most and least important to the cluster, what geographic scope is most important for linkages, and how important local cluster links are. Furthermore, it is possible to identify who are the most important organisations in the cluster to the firms; this data can act as an evaluation technique for organisations involved in supporting firms e.g. industry associations and government agencies.

6.8 A Method for Identifying Cluster Life Cycle Stages

Measuring and analysing cluster life cycle stages and at what stage a particular cluster is positioned is challenging for numerous reasons (see section 5.4). Having reviewed several cluster analysis methods and tools in this chapter, the author aims to develop a methodology for assisting clusters/cluster organisations in identifying what stage of the cluster life cycle it currently resides. Identifying the stage of a particular cluster allows for the creation and development of tailor-made, timely and purposeful policy initiatives, as opposed to applying one-size-fits-all cluster initiatives that may not be relevant or support the needs of the cluster in question. The proposed method is inspired by a combination of sources and authors, with the structure derived from the cluster research of MacDonald and Hartt (2014) providing the backbone for the method. Their research created a rubric for determining the stages of an industry life cycle, and as such, elements of this method are transferrable.
Having reviewed the cluster life cycle literature (Chapter 5), the author argues that any rubric for determining the stages of a cluster life cycle should consist of four stages, namely emerging, growing, maturing and declining. This decision is in line with the research of numerous authors (Swann, 1998; Tichy, 1998; Van Klink and De Langen, 2001; Wolter, 2003; Bergman, 2008; Sölvell, 2009; Menzel and Fornahl, 2010; Brenner and Schlump, 2011; Martin and Sunley, 2011; Ter Wal and Boschma, 2011; Shin and Hassink, 2011; Elola et al., 2012; Tavassoli and Tsagdis, 2014; Trippl et al., 2015; Belussi, 2018 and Pronestì, 2019).

The rationale for designing the cluster life cycle stage identification rubric is aligned with the work of De Sousa Ostapenko et al. (2021, p. 22) who suggest defining the stage in the cluster life cycle for a specific cluster “may allow for an analysis of the cluster’s environment going beyond the static understanding of local attributes’ influence on firm’s strategy and performance.” However, while cluster organisations will seek indicators in relation to e.g. number of new products or number of new companies in the cluster, regional and national governments will look to employment growth indicators to assess growth figures (Schretlen et al., 2011). The rubric developed (Table 6.7) in this study to identify the stage of a cluster life cycle in which the cluster is currently positioned incorporates the following three pillars under which four specific variables are assessed:

1. Economic Impact
2. Cluster Organisation
3. V-LINC Analysis

The rubric uses quantitative data gathered from primary and secondary sources, and is intended to be applicable to cluster organisations in different countries, regions and sectors to identify a cluster's life cycle stage.

In the next sub-sections, each of the pillars and variables assessed to inform at which stage of the CLC stage identification rubric a cluster organisation is positioned. These pillars and variables are outlined, described and their inclusion is justified.
6.8.1 Economic Impact

Economic impact measurement has become a powerful and persuasive tool to gauge the financial effect that a program, project, or policy has on a company, industry, region or country (AGS, 2020). Investigating the economic impact of a sector longitudinally, using specific variables allows an analysis of a sector/industry to identify if it is emerging, growing, maturing or declining. Economic impact, as one of the three pillars of this cluster life cycle stage identification method, is analysed in the rubric through four variables: Employment, Registered Firms, Exports and Average Wages of a specific sector.

Employment

Many scholars analyse the economic impact of a sector within a particular region and or country, using employment. Section 6.4 discussed how Location Quotients are used with employment data to identify industrial clusters concentration. In Europe there are over 2900 specialised clusters which Naumanen (2019, p. 5) defines as “statistically defined regional concentrations of traded industries that have more than 500 employees in a specific industry. Economic activities that are located in specialised clusters account for about 19% of European jobs and 22% of European wages.” Analysing the evolution of employment, within sectors and clusters can play a part in distinguishing at which stage of the cluster life cycle a particular cluster sits e.g. growing / declining / plateauing. According to Ting-Lin (2006, p. 547) “mature or emerging clusters face shortages of skilled labour for upgrading or transition.” Therefore, it is not surprising that the workforce is often the most pressing problem facing a cluster and a starting point for collective action and trust building.

O’Connor et al. (2017, p. 266) note that “employment trends across clusters offer insight, albeit within limits, on the relative positioning of clusters.” Employment is of particular interest for key performance indicators (KPIs) of relevance for economic development policy-makers and practitioners. Employment should be assessed at a local/regional or national level as appropriate to the cluster and its geographic scope under investigation. As a cluster moves through its respective stages, employment levels and patterns can provide an insight into what stage the cluster in question is currently positioned on the
cluster life cycle. Table 6.4 displays what is indicative of a sector that is Emerging, Growing, Maturing or Declining in terms of the variable: Employment.

Registered Firms
According to Porter (2000), the proximity of companies, customers, suppliers, and other institutions creates an environment of increased competition that results in higher pressure to innovate. The amount of available resources i.e. knowledge, expertise, skills, human resources, latest technologies etc. increase in tandem with the number of companies in the area. Co-location facilitates the creation of social networks, collaborative and competitive relationships as well as the dissemination of technology (Slaper et al., 2018). It is possible to detect if a sector and its associated location (region) is emerging, growing, maturing, or declining by tracking the evolution of the number of registered firms in a sector or NACE\textsuperscript{21} classification. Table 6.7 on page 182, displays what is indicative of a sector that is Emerging, Growing, Maturing or Declining in terms of the variable: Registered Firms.

Exports
Exports play an important role in an economy, influencing the level of economic growth, employment and the balance of payments while transport cost reductions, globalisation, economies of scale, and reduced tariff barriers have all contributed to exports becoming a greater share of national income (OECD, 2012). Moreover, O’Connor et al. (2017, p. 270) referencing Vernon (1966) state in terms of the cluster life cycle, “export trends offer additional perspective on relative performance, particularly in the light of the product-cycle origins of the concept and the changing geographical sources of competitive advantage explicit therein.” The importance of international customers for competitiveness is recognised by Pisa et al. (2016, p. 2) who note internationalisation ensures that firms are able to serve “many markets from existing manufacturing bases, obviating the need to establish production plants in other markets. It reduces the over-

\textsuperscript{21} NACE is the acronym (from the French 'Nomenclature statistique des Activites economiques dans la Communaut\'e\nPeurop\'eenne'-Statistical classification of economic activities in the European Community) used to designate various statistical classifications of economic activities developed since 1970 by the European Union (For more information visit www.eea.europa.eu).
reliance on domestic markets as well as the business risks associated with single market dependency.”

Exporting firms differ in characteristics from non-exporting firms e.g. size, productivity, performance and wages (Clerides et al., 1998; Bernard and Jensen, 1999; Melitz, 2003; Gourlay and Seaton, 2004; Melitz and Ottaviano, 2008) while also playing a lead role in shaping the local industrial landscape (Shin and Hassink, 2011). Furthermore, Van Laere and Heene (2003) argue that in an economic climate of increased global integration and competition, SMEs can thrive and remain competitive by improving three firm capabilities, namely innovation, learning, and internationalisation.

Investigating the exports of a sector within a particular region longitudinally, can unearth important information of why exports are important to the region and growth in exports is argued to help create employment (EC, 2020). Indeed, Katz and Istrate (2011) support this argument, suggesting more exports create more jobs with higher pay. Upgrading indigenous firms and preparing them to export is crucial for economic growth across all regions. Examining a sectors export ability and capacity within a region can help identify the sectors trajectory in relation to emergence, growth, maturity or decline and this supports the rationale for its inclusion within this method. Table 6.7 displays what is indicative of a sector that is Emerging, Growing, Maturing or Declining in terms of the variable: Exports.

**Average Wages**

Strong clusters and higher wages go hand in hand as Naumanen (2019, p. 5) states wages in a specific regional cluster are “driven by cluster effects and by location effects. The stronger the cluster and the better the location-specific business environment, the higher the cluster’s productivity and wages.” Further quantitative studies have found industries located within a strong and competitive cluster are associated with higher employment growth and wages (Gibbs and Bernat, 1998; Wheaton and Lewis, 2002; Bonte, 2004; Montana and Nenide, 2008; Delgado et al., 2014). Byrne (2016, p. 38) argues “a skilled and more specialised workforce, and better matching of workers to appropriate tasks will result in more productive employees and thus higher wages.”
Porter (1990, 1998) argued that evidence of clustering is found in productivity and echoed in wages. O’Connor et al. (2017, p. 270) suggest “wages’ trajectory over time, and across clusters, should reveal those economic activities where productivity is highest and thus also link to stages of life-cycle characteristics.” Examining the evolution of the average wages for a particular sector will provide an important insight to the sector’s trajectory. Table 6.7 displays what is indicative of a sector that is Emerging, Growing, Maturing or Declining in terms of the variable: Average Wages.

<table>
<thead>
<tr>
<th>Economic Impact</th>
<th>Variable</th>
<th>Emerging</th>
<th>Growing</th>
<th>Maturing</th>
<th>Declining</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employment</strong></td>
<td>Employment</td>
<td>Employment and demand for human resources increases slowly as the sector evolves (Jia et al., 2015).</td>
<td>Employment and demand for human resources increases (Menzel and Fornahl 2007; 2010).</td>
<td>Employment plateaus with fewer new job opportunities available (Menzel and Fornahl 2007; 2010).</td>
<td>Declining employment with more firm deaths than births (Menzel and Fornahl 2007; 2010; Handayani et al., 2012).</td>
</tr>
<tr>
<td><strong>Registered Firms</strong></td>
<td>Concentration of small firms with diverse knowledge bases in one geographical location (Ketels and Memedovic, 2008; Shin and Hassink, 2011; Abbasiharofteh, 2020).</td>
<td>Number of firms increases with more start-ups and spin-offs. Little to no exits. (Menzel and Fornahl 2007; 2010; Shin and Hassink, 2011; Abbasiharofteh, 2020).</td>
<td>Slowdown in spin-offs and start-ups as sector becomes saturated with SMEs. Firm numbers plateau (Menzel and Fornahl 2007; 2010; Fornahl and Hassink, 2017).</td>
<td>Firm number decrease with very few joining the sector and smaller micro firm closures (Shin and Hassink, 2011; Handayani et al., 2012; Abbasiharofteh, 2020).</td>
<td></td>
</tr>
<tr>
<td><strong>Exports</strong></td>
<td>Exports are low as the sector establishes itself and create a strong value chain locally and abroad (Ayakwah et al., 2019).</td>
<td>Increase in exports due to entry and expansion in to new global markets (Bahar et al., 2017).</td>
<td>Export increases slow with potential decrease when compared with the growth stage (Drayse, 2011).</td>
<td>Number and value of exports declines as limited product/service innovations present (Maskell and Kebir 2005).</td>
<td></td>
</tr>
<tr>
<td><strong>Average Wages</strong></td>
<td>Low average wages as the sector begins to emerge and establish itself (Naumanen, 2019).</td>
<td>Increases in average wages occur in tandem with the growth and success of the sector (Naumanen, 2019).</td>
<td>The more concentrated a region becomes in terms of employment, the higher is the region’s average wage growth (Ketels and Memedovic, 2008).</td>
<td>Average wages decline in combination with the number of jobs and new firms registrations created (Li et al., 2021).</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.7: Four Variables of the Economic Impact Pillar at Each Stage of the CLC
Source: Author
6.8.2 Cluster Organisation

The second pillar analysed in the CLC stage identification rubric is the cluster organisation. Ketels et al. (2012, p. 22) argue that cluster organisations typically follow a life-cycle, beginning with a project initiative that later evolves into a formal organisation. Out of all surveyed cluster organisations in Europe, “65% are legal entities (e.g. non-profit, endowments), whereas 35% are projects belonging to some form of organisation (e.g. regional economic development unit or formal cluster umbrella organisation).” As well as their capability, stage of development, organisational structure, mission and funding, cluster organisations differ greatly in their size (number of members, employees, and budget), capabilities (programs and initiatives), and funding (public and private).

To investigate a cluster organisation’s maturity Naumanen (2019, p. 3) suggests testing “constant monitoring and regular evaluation, adaptive performance measurement systems and active engagement of cluster stakeholders at all stages of the management cycle.” Monitoring cluster organisations under four variables can provide valuable data pertaining to a clusters ability, performance and direction. Cluster organisations are analysed in the rubric through four variables; Membership, Staff Numbers, Events (co)Organised and Funding.

Membership

The benefits a company may derive from cluster membership are dependent on the endowments of the particular cluster it belongs to (Steinfield et al., 2012). Cluster organisation membership benefits companies located in well-developed clusters, whilst knowledge spillovers and reputational benefits are enhanced when clusters are stronger because they attract a more qualified labour force (Ketels et al., 2012; Steinfield et al., 2012). According to Porter (2000), well-established clusters of companies perform better than comparable firms in other regions without clusters. Steinfield et al. (2012, p.113) believe “benefits of business cluster membership are positively correlated to business success.”

The European Observatory for Clusters and Industrial Change (EOCIC, 2020) analyses cluster strength across Europe. It identifies 2,950 regional clusters, which account for 1
in 4 of all EU jobs. Industry clusters support higher average wages (+13.5%) and more high-growth firms (+77%) than firms outside clusters. However, concerns are emerging over the content and quality of some of these initiatives. Given the prevalence of clustering, these apprehensions are non-trivial and have significant implications for their value/contribution to economic development. Cluster membership involves fees that are paid to the cluster organisation, a vital source of finance to drive the activities of a cluster organisation and it is important to analyse within the rubric.

Byrne (2016, p. 180) argues that cluster organisations that have a large membership and annual budget “have the capabilities to offer a number of services including supporting R&D collaborative projects, supports for SMEs (consulting and training on innovation, human resources, internationalisation, financing growth strategy, etc.), engagement in skills development, networking events and annual conferences.” As a cluster moves through its respective stages, its membership figures and patterns will provide an insight into what stage the cluster in question is currently positioned on the cluster life cycle. Table 6.8 on page 189 displays what is indicative of a cluster that is Emerging, Growing, Maturing or Declining in terms of the variable: Membership.

**Staff Numbers**

ESCA (2013, p. 12) note that focusing solely on the number of staff of the cluster organisation is not sufficient as clusters vary in size significantly. A relevant factor of “a cluster organisation - whether it is adequately staffed - therefore is the ratio of the number of cluster participants and the number of staff in the cluster management team.” Hence, the inclusion of both cluster membership and staff numbers are important considerations in the rubric. Byrne (2016, p. 45) referencing Ketels et al. (2012) states “cluster organisations are typically small and nimble organisations with half employing three or fewer employees.” In relation to the report ‘Strengthening Clusters and Competitiveness in Europe - The Role of Cluster Organisations’ by Ketels et al. (2012), in Figure 6.8 below, the y-axis represents the total number of cluster organisations surveyed (n=254), and in turn shows that the most common number of employees across the surveyed organisations was 2-3.
As a cluster moves through the life cycle stages, its staff numbers and employment within the cluster organisation provide an insight into what stage the cluster is currently positioned. Table 6.8 on page 189, displays what is indicative of a cluster that is Emerging, Growing, Maturing or Declining in terms of the variable: Staff Numbers.

**Events (co)Organised**

Lämmer-Gamp et al. (2014, p. 13) note that local and national “matchmaking is a core element of the service portfolio of every cluster organisation. Regular get-togethers, events or workshops, business missions or networking visits are the typical instruments.” Maskell et al. (2006, p. 997) describe the different types of events and trade fairs/missions in which cluster organisations participate on behalf of and with their members. At exhibitions, trade fairs and conventions, business people and professionals assemble regularly and it is here that the latest trends and most up to date findings, inventions and products are on display. Participation in such events can assist firms in the identification of the “current market frontier, take stock of relative competitive positions and form future plans. Such events exhibit many of the characteristics ascribed to permanent spatial clusters, albeit in a temporary and intensified form.”

Cluster organisations, by providing sequencing services such as internal match-making events both locally and nationally between cluster participants, organising workshops or
thematic events to further discuss the ideas generated by matchmaking are key aspects of the organisation of such events. Cluster organisations can also assist firms by venturing outside of the local and national areas with; trade missions to specific markets, participation at trade fairs on behalf of the cluster, connecting firms with other regions through inter-cluster events or connections with cluster organisations abroad. It is argued that a major challenge for SMEs is their lack of resources and capabilities to conduct such activities independently. The important roles of such events and trade fairs for cluster member firms and cluster organisations alike are numerous.

It is at these events that Maskell et al. (2006, p. 1005) suggest firms and cluster organisations may “learn and acquire important information, find suitable partners to complement their needs, establish trust with potential future partners and, sometimes even initiate durable inter-firm collaboration in research, production or marketing.” Organising and attending such events/trade fairs are deemed valuable while supporting firms to “develop global pipelines not only to exchange products or services, but also in order to benefit from outside knowledge inputs and growth impulses” (Maskell et al., 2006, p. 998).

As a cluster moves through its respective stages, the number of events organised and co-organised by the cluster organisation provides an insight into what stage the cluster in question is currently positioned on the cluster life cycle. Table 6.8 on page 189, displays what is indicative of a cluster that is Emerging, Growing, Maturing or Declining in terms of the variable: Events (co)Organised.

**Funding**

Funding plays a vital role in industry clusters growth and development (Birkinshaw and Hood, 2000). According to Ketels et al. (2012, p. 1) cluster organisations are “truly public-private partnerships. On average, they follow a 60/40 rule with 60% public financing. This holds both for older and more recently established cluster organisations, and across most countries in Europe.” Clusters require funding and Moynihan (2018, pp. 40-41) describes the benefits of this combination of public-private entities, including:
1. Cluster-wide approach;

2. Focus on long-term growth and development as well as on sectors’ interest;

3. Ability to create a level playing field through legislation;

4. Sector involvement in the evaluation of the cluster organisation (through membership contribution);

5. Improved communication both horizontally and vertically.

The funding models for cluster organisations vary, depending on public support from regional and national sources (Byrne, 2016). Annual amounts of funding are linked to a clusters potential growth trajectory based on the number of projects the members are involved in, combined with the overall budget. Increased funding suggests cluster growth while decreased funding can suggest the contrary i.e. cluster maturation or decline. Similarly, a cluster that relies less on public funding can be deduced to be more mature and self-sufficient in obtaining private sources of funding, due to its established status or reputation (Altman, 2021).

Figure 6.9: Sources of Revenue for European Cluster Organisations
Source: Ketels et al. (2012, p. 18)

Figure 6.9 displays a detailed breakdown of funding sources for cluster organisations in Europe. Ketels et al. (2012) discuss how cluster organisations with larger staff numbers sometimes have fewer revenues from membership, with their services providing more income (Figure 6.10).
As a cluster grows and evolves its funding requirements, sources and composition can provide an insight into what stage of the cluster life cycle it is at. Table 6.8 displays what is indicative of a cluster that is Emerging, Growing, Maturing or Declining in terms of the variable: Funding.
<table>
<thead>
<tr>
<th>Cluster Organisation</th>
<th>Variable</th>
<th>Emerging</th>
<th>Growing</th>
<th>Maturing</th>
<th>Declining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membership</td>
<td>Membership</td>
<td>Membership fees introduced and firms begin to join the cluster (Bianchi et al., 1997; Menzel and Fornahl 2007; 2010).</td>
<td>New firms continue to join the cluster and cluster membership increases (Andersson et al., 2004; Elola et al., 2012)</td>
<td>New membership requests slow down as the sector becomes saturated and critical mass is reached (Andersson et al., 2004; Maskell and Kebir 2005).</td>
<td>Membership decreases with firm deaths prevalent as the sector must reinvent itself (Menzel and Fornahl 2010; Handayani et al., 2012).</td>
</tr>
<tr>
<td></td>
<td>Staff Numbers</td>
<td>Most cluster organisations will have one cluster manager in the emerging stage of a cluster as they develop their activities (EARSC.org, 2021).</td>
<td>Typically, 1-5 staff members (EARSC.org, 2021). Strong correlation between the numbers of cluster staff and members (ECCP, 2021).</td>
<td>To meet member demands cluster staff can grow to 5+ as activities and services expand (EARSC.org, 2021).</td>
<td>Fewer cluster management staff are required as membership decreases (Ryvalova and Zizka, 2021).</td>
</tr>
<tr>
<td></td>
<td>Events (Co)Organised</td>
<td>Numerous introductory events to animate the cluster and create networking opportunities for potential members (Power and Jansson, 2008).</td>
<td>Increase in events locally and nationally with potential for international event organisation due to growth and needs of members (Andersson et al., 2004).</td>
<td>Events organised grow as clusters’ staff levels are at highest level as the cluster is well connected nationally and internationally (Conz et al., 2017).</td>
<td>Organisation of events declines alongside staff numbers and clusters ability to run events decreases (Hitters and Richards, 2002).</td>
</tr>
<tr>
<td></td>
<td>Funding</td>
<td>Cluster may be funded solely by public sources (seed investment from government agencies / HEIs) or sponsorship from key member firms (Waits, 2000).</td>
<td>Increased funding levels reported. Membership fees play an important role becoming a main source of revenue with members joining the growing cluster (Ketels et al., 2012).</td>
<td>Less reliance on public funding (Altman, 2021). Mature clusters deemed crucial for gaining support from policy makers (Skålholth and Thune, 2014).</td>
<td>Large reduction in the amount of funding (especially public funding) received by the cluster organisation as membership and impact declines (Treado, 2010).</td>
</tr>
</tbody>
</table>

Table 6. 8: Four Variables of the Cluster Organisation Pillar displaying Four Stages of the CLC  
Source: Author

### 6.8.3 V-LINC Analysis

The third pillar examined in the CLC stage identification rubric utilises primary data collected within a longitudinal V-LINC analysis. V-LINC allows an understanding of firm level information to be gathered, assessed and analysed annually to highlight the connections that make up a cluster’s ecosystem, locally, nationally across the EU and
Internationally (section 6.7). The data can complement the other variables assessed in the rubric, by providing a granular level of data pertaining to members of the cluster/sector. The analysis of firm linkages, across all eight categories, can provide insights into how connected a cluster ecosystem is locally, nationally and where member firms connect internationally. Byrne (2016, p. 240) suggests there is a “distinct need for regions to develop targeted policy initiatives based on their own conditions and circumstances, the V-LINC analysis results can support such developments.” Four key variables are analysed by V-LINC within the rubric (Table 6.9 on page 195) to support the determination of whether a cluster is Emerging, Growing, Maturing, or Declining. These variables included under this third pillar are: Value Chain Linkages, Knowledge Linkages, Economic Policy and Support Linkages and Linkage Evolution.

**Value Chain Linkages (OU/IN/SS)**

The V-LINC analysis provides a detailed account of participating firms’ value chain linkages. Suppliers are examined through the categories of Input (IN) and Specialist Service (SS) linkages and demand conditions are examined through Output (OU) linkages with customers. Differing elements determine if clusters need local suppliers and customers in order to thrive and succeed, or if clusters should focus on exporting globally and/or sourcing inputs from abroad. These factors include the characteristics of the companies, the region in question and the industry sector (Byrne, 2016).

Maskell and Malmberg (1999, p. 172) argue that firms’ competitive advantage is reliant on local factors and inter-firms networks in a global economy and they believe “the formation of the world market….increases the importance of heterogeneous, localised capabilities for building firm-specific competencies.” Porter (2000a, p. 16) notes that clusters include “suppliers of specialised inputs such as components, machinery, and services, as well as providers of specialised infrastructure.” From a demand perspective, Porter highlights the importance of local customers that are highly sophisticated and demanding, as they can drive firms to create tight knit links with customers that ultimately provide superior services and offer an insight into global markets. Marketing, design, production, distribution and support to the final consumer are activities included in the value chain and according to Byrne (2016, p.211) “global value chains occur when these activities are spread across multiple firms and/or countries.” The study of global value
chains contradicts cluster theory by emphasising cross-border relationships between firms in global production and distribution systems over local relationships (Gereffi and Kaplinsky, 2001; Gereffi and Fernandez-Stark, 2011) which suggests that international value chain linkages and connections portraying demanding and sophisticated characteristics can enable the upgrading of firms (Humphrey and Schmitz, 2002).

The measurement of value chain transactions has been the basis for research studies on industrial concentrations for decades (Porter, 1990, 1998b; Sölvell, 2006; Sölvell et al., 2009). Analysing firm data pertaining to value chain linkages in a longitudinal capacity, enables the author to identify the geographic scope i.e. Local, National, European or International, which is the most populous and impactful for the respondent firms and cluster. Table 6.9 on page 195, outlines expectations for the V-LINC value chain data under investigation, at each of the four stages of the cluster life cycle.

**Knowledge Linkages (RD/TN)**

When conducting a V-LINC analysis, formal knowledge exchanges can be assessed via the R&D and Training linkage categories. Byrne (2016, p. 230) notes that in order to assess knowledge linkages “a distinction should be made between informal knowledge linkages, or knowledge spillovers, and formal knowledge exchanges.” Formal and informal knowledge linkages accelerate innovation and it is argued that knowledge flows occur between local firms and organisations (Scott, 1988; Porter, 1990; Krugman, 1991). Furthermore, Feldman and Audretsch (1999) found that knowledge spill-overs are geographically confined to regions where new economic knowledge is generated.

Knowledge spillovers are often a result of informal exchanges of information through face-to-face contact, which is commonly regarded as an essential part of the flow of information i.e. tacit knowledge transfer (Feldman, 1999; Lundvall, 1999; Maskell and Malmberg, 1999; Lublinski, 2002). Byrne (2016, p. 231) referencing Roelandt and Hertog (1999) states that “knowledge exchanges can also take the form of formal exchanges and strategic alliances, e.g. R&D projects between firms, research institutes, universities and other institutions.” Giuliani and Bell (2005) allude to the fact that exposure to knowledge spillovers, alone, cannot guarantee enhanced innovativeness among firms. Concerning knowledge linkages, Lucas et al. (2009, p. 203) note “regions that boast high levels of fundamental research struggle at times to capitalise on the commercial opportunities this
presents.” Byrne (2016, p. 232) believes that knowledge linkages at different geographic levels “support various roles in firms’ absorption of knowledge and the innovation process; importantly this differs across regions and is linked to the stage of cluster maturity.”

Research suggests that globally competitive clusters are those in which firms successfully build and sustain a broad range of external and local links to gain relevant knowledge spill-overs and engage in formal knowledge exchanges (Schmitz and Nadvi, 1999; Rugman and D’Cruz, 2002; Bathelt et al., 2004; Wolfe and Gertler, 2004; Boschma and Ter Wal, 2007; Eisingerich et al., 2010; Bathelt and Li, 2014; Byrne, 2016). Thus, examining the knowledge linkages that the firms engage in during a longitudinal study, allows the author to make an informed decision at what part of the cluster life cycle a clusters’ knowledge linkages are at. Table 6.9 on page 195, displays what is indicative of a cluster that is Emerging, Growing, Maturing or Declining in terms of the variable: Knowledge Linkages.

**Economic Policy and Support Linkages (GA)**

Examining Government Agency linkages as part of a V-LINC analysis makes it possible to evaluate the relationships and connections between government and industry, including the perceived business impact of these linkages. Byrne (2016) notes that taking a closer look at the links between firms and government agencies, while linking the data to a policy and business support framework, enables a deeper understanding of how government and policy operate at cluster level. Government agencies play different roles for a cluster at different stages of the cluster life cycle and it is important to examine how government connections with cluster firms evolve in a longitudinal capacity. Table 6.9 displays what is indicative of a cluster that is Emerging, Growing, Maturing or Declining in terms of the variable: Economic Policy and Support Linkages.

**Linkage Evolution**

The term ‘Linkage Evolution’ refers to the tracking of linkages through a longitudinal V-LINC analysis, across all eight categories. ‘Retained linkages’ refer to those linkages recorded in a year which have been recorded in the year prior. ‘New Linkages’ refer to the individual linkages not previously reported in a previous year. The ability to assess all Retained and New linkages of the respondent firm group can provide invaluable
information e.g. the number of Retained/New linkages the firms maintain/create from each year, what business impact each link has to the firms (High, Medium, Low or Tenuous), in what categories they belong to and at what geographic scope (Local, National, European or International). It is important to interview the same cohort of approximately 10-15 firms over at least a three-year period to allow comparisons to be made at a cluster level.

In a three year longitudinal analysis there are no retained linkages recorded for Year 1 as no linkage data is gathered prior to this. It is interesting to be able to determine why particular linkages were created and or retained. The answers gleaned can help towards identifying the current stage of the cluster life cycle the cluster being analysed is at. Linkages are examined in relation to their business impact, categories and geographic scope. A cluster that retains linkages year on year demonstrates satisfaction with the relationships developed over-time and suggests it is an established cluster. If the majority of retained linkages are in the Low-Tenuous business impact band, one can deduce that the cluster under examination is in the emerging or declining stages of the cluster life cycle, due to respondent firms’ inability to attract and retain high quality impactful linkages.

An increase in New linkages is linked to the emerging or growth stage of a cluster where firms begin to enter new markets and as such create new connections across different categories and geographic scopes. Information can be gained through interpretation of data such as do the majority of the New linkages have High or Low business impact, are they predominantly found across one or two categories or evenly dispersed across the eight, and are they mostly found locally/within the same country of the cluster under investigation or further afield.

The information from both the New and Retained linkages can inform policy makers and organisations alike of any potential trends occurring / reoccurring etc. and what actions might be required to address such inclinations. Table 6.9 displays and describes what is indicative of each of the four cluster life cycle stages regarding the linkage evolution of the Retained and New linkages during a longitudinal analysis.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Emerging</th>
<th>Growing</th>
<th>Maturing</th>
<th>Declining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value Chain (VC) Linkages (OU/IN/SS)</td>
<td>Firms aim to build a strong base of local value chain linkages with the majority of their critical VCs found at a local and/or national level (Elola et al. 2012).</td>
<td>Increases in the number of VC linkages due to firm expansion and new market entry. External knowledge and technology improve firms VCs (Elola et al., 2012; Njøs and Jakobsen, 2016).</td>
<td>The cluster's internationalisation ability improves (Bianchi et al., 1997; Maggioni, 2002; 2004; Elola et al., 2012) yet at a slower pace than that of the growth stage.</td>
<td>Reduction in VC linkages with no new product or services developed. New technologies replace the clusters’ older, outdated versions and foreign VC linkages decrease (Maskell and Kebir, 2005).</td>
</tr>
<tr>
<td>Knowledge Linkages (RD/TN)</td>
<td>Mostly local knowledge linkages reported as firms establish themselves. Firms limited in their ability to share, exchange, transform or apply knowledge (Robinson et al., 1992; Lan and Zhangliu, 2012).</td>
<td>Firms place increased value on local and national knowledge linkages with high increase in linkage density (Balland et al., 2012; Broekel, 2015; Byrne, 2016; Juhász and Lengyel, 2017).</td>
<td>Mature clusters maintain large number of local knowledge linkages that firms value highly as well as an increased number of foreign knowledge links (Byrne, 2016).</td>
<td>Less demand for knowledge links due to the clusters decline with firms' productivity decreasing. Foreign knowledge linkages also decrease, as firms look closer to home to re-invent and avoid decline (Maskell and Kebir, 2005).</td>
</tr>
<tr>
<td>Economic Policy and Support Linkages (GA)</td>
<td>Firms require substantial support from GAs as the cluster emerges and thus the business impact of GAs to firms is high. Government plays a critical role in creating the conditions for emergence (Lucas et al., 2009).</td>
<td>Growing international demands by firms requires GA assistance and linkage volume can increase as well as their business impact. An increase in foreign GA linkages in line with the cluster's enhanced internationalisation occurs (Byrne, 2016).</td>
<td>GA linkage volume reported internally and externally to the local region remains constant and the large increases in the number of linkages in the Growth stage slows (Njøs and Jakobsen, 2016).</td>
<td>Cluster members maintain GA linkages with more of an emphasis on the importance of local and national GA linkages reported in the business impact. International GA linkages contract (Delgado et al., 2014).</td>
</tr>
<tr>
<td>Linkage Evolution (Retained and New)</td>
<td>Large volume of New linkages reported due to early stage of cluster creation and networking efforts (Porter, 2000). A clusters' industrial experience supports linkages retention.</td>
<td>As the cluster grows the number of Retained linkages dominate New linkages reported. However, New linkages continue to increase rapidly (Zemtsov et al, 2016).</td>
<td>Large retention of linkages as cluster focuses on a specific area/field (Menzel and Fornahl 2007; 2010). Number of New linkages slows down with some home-grown firms exiting the cluster to expand abroad (Belussi, 2018).</td>
<td>Low numbers of New linkages reported. Little chance for cooperation and collaboration to occur. A declining cluster struggles to retain linkages as members close down (Menzel and Fornahl 2007; 2010).</td>
</tr>
</tbody>
</table>

Table 6.9: Four Variables of the V-LINC Analysis Pillar displaying the four stages of the CLC  
Source: Author
The previous sections analysed the three pillars of Economic Impact, Cluster Organisation and V-LINC Analysis identified and used as part of the new CLC stage identification rubric proposed in this research. Each of the pillars’ four variables are described and the author identifies what is indicative for each variable at each of the four stages of the cluster life cycle (Tables 6.7, 6.8 and 6.9).

Chapter 6 examined cluster analysis methods and research from the literature in combination with an in-depth overview of the V-LINC analysis methodology. The data collection process of face-to-face interviews compared with online interviewing techniques were then analysed and assessed before introducing a new CLC stage identification rubric methodology that can be used to identify at which stage a cluster organisation is in the cluster life cycle.

Identification of at which stage a particular cluster is currently positioned can provide informed, context based, tailor-made decision making, which best suits the cluster in question and its strategic development. Table 6.10 below displays the rubric developed and applied by the author in the research to ascertain cluster life cycle stage identification.
The next chapter provides an in-depth review of the V-LINC methodology in its newly adapted format as well as incorporating an analysis of face-to-face interview techniques in comparison to online interviewing techniques.
Chapter 7

7 METHODOLOGICAL APPROACH

7.1 Introduction

In chapter 6, the research design of this study is presented, along with a general concept of research philosophy, followed by a review of six cluster analysis methods, including the V-LINC approach. Section 6.7 described the use of V-LINC methodology as a cluster analysis tool that is applied to the BioWin Health Cluster of Wallonia over a three-year period. The aim of this research is to support the development of cluster specific policy initiatives through the data and outputs provided. This can subsequently support the already present strengths, while addressing the weaknesses of the BioWin ecosystem. Section 6.8 then produced a body of work that created a method for identifying cluster life cycle stages based on three pillars and twelve variables. This chapter aims to dig a layer deeper regarding how V-LINC is adapted from a point in time analysis (as per the work of Byrne, 2016) and implemented in a longitudinal manner encompassing the ‘Retained’, ‘New’ and ‘Lost’ linkages concept (section 7.2).

The discussion section (section 7.3), details the confidentiality process (section 7.3.1), the reliability and validity (section 7.3.2) of the methods and the differences between the implementation and use of V-LINC in a one-year capacity, compared to that of a longitudinal research study as revealed throughout the results in this body of work. The next section then outlines the application of V-LINC methodology (section 7.4) to the BioWin Health Cluster of Wallonia. The findings have several implications for scholars who are interested in the how and why firm/cluster linkages develop, evolve, disappear, and increase/decrease in value over time. It is at this stage of the thesis that a note and discussion around the COVID-19 global pandemic (section 7.5) and the research impact it had on the body of work is required. Then, the concept of face-to-face interviewing
(section 7.6) is compared with that of an online interview (section 7.7). The chapter finishes with section 7.8 providing a summary of the V-LINC methodology.

This chapter aims to dig a layer deeper regarding how V-LINC is adapted from a point in time analysis (as per the work of Byrne, 2016) and implemented in a longitudinal manner encompassing the ‘Retained’, ‘New’ and ‘Lost’ linkages concept (section 7.2). This is proceeded by a discussion section (section 7.3) that examines the confidentiality (section 7.3.1), reliability and validity (section 7.3.2) factors that underpin the V-LINC method before identifying the right region to investigate (section 7.4.1) and an overview of firm data (section 7.4.2) is deliberated. Following on from this, the data collection process is analysed (section 7.5) as well as incorporating the impact that the COVID-19 pandemic had on the research and collection of data for Year 3 of the analysis (section 7.5.1-7.5.2). This leads to an in-depth review of face-to-face and online interview techniques, highlighting their similarities and differences (section 7.6-7.7). The chapter ends with a summary of the V-LINC methodology (section 7.8).

7.2 Adaptation of the V-LINC Methodology Longitudinally

The development of V-LINC methodology used in a longitudinal context is designed from the adaptation of the V-LINC method used in Byrne (2016), (in a one year cluster analysis) to collect firm linkage data, a methodological framework for applying V-LINC and its associated visualisation software. All the terminology used for linkages, geographic scope to name just a few remained constant throughout this research. It is recommended that a new methodology should incorporate and adapt the V-LINC method used by Byrne (2016), and test it longitudinally, conducting research for a period longer than twelve months.

This study sought to contribute to the research stream by demonstrating that once applied in a longitudinal capacity, the V-LINC methodology has the ability to track and trace;

1. ‘New’
2. ‘Lost’ and
3. ‘Retained’ linkages of firms.
This process occurs year on year, while providing empirical data and evidence from this data collected. The *New* linkages refer to the linkages added to the firm’s lists between Year 1 and Year 2, and Year 2 and Year 3 and conversely, the *Lost* linkages denote the linkages that were present in Year 1 but do not appear on firms lists in Year 2, and similarly from Year 2 to Year 3. The *Retained* linkages include all the linkages that were maintained from one year to the next.

A longitudinal application of V-LINC adapts the original V-LINC method and incorporates tracking and tracing of linkages as the cluster develops from one year to the next. As the cluster progresses year on year, it is crucial to track the evolution of the New linkages gained, the linkages Lost and the linkages that are Retained annually by the respondent firm group (RFG). Analysing the business impact of the New, Lost and Retained linkages from each year to the next, investigating what specific categories these occurred in, and at what geographic scope they take place, is vital in mapping the cluster’s overall performance and evolution. Moreover, the process incorporates the original data collection method used by Byrne (2016), and implements it over a three-year period that can be applied to various clusters and regions worldwide. The software tool is used to visualise the linkages firms in a cluster engage in and provide a visual of the linkages on geographic maps.

Conducting the research in Year 1 follows an identical process as applied and implemented by Byrne (2016) in their ‘point in time’ research study. A new element of the adapted V-LINC methodology is applied in Year 2, involving the first tracing of the data as it transforms over time and Year 3 is a follow on from Year 2. This research aims to implement a methodology that can be used to produce valuable data and results over a time frame of greater than one year. For instance, Byrne (2016, p. 247) notes “while V-LINC is applied to clusters at different stages of development, the methodology has the ability to contribute to literature on how firm linkages in a cluster change over time.” Due to the evolutionary nature of firms’ linkages, four new areas have to be addressed, adapted and formatted in order to gain a holistic view of the cluster, its members and their linkages by means of a longitudinal analysis:

(i) The overall reporting structure
(ii) Tracking and tracing of linkages
(iii) Comparison of linkages from Year 1 to Year 2 to Year 3 involving new, lost and retained linkages
(iv) Protocols and procedures for contacting firms for follow up interviews.

Having discussed the adaptation of the V-LINC methodology towards a longitudinal manner, the following sub section unveils the methodology framework.

7.2.1 V-LINC Methodology Framework

Byrne (2016, p. 135) highlights the six steps followed for a V-LINC cluster analysis. However, when analysing a cluster using the V-LINC methodology in a longitudinal capacity, the author emphasises the need for the inclusion of steps 7 and 8, in addition to the original six-step process:

Step 1: Regional Context
Step 2: Defining the Cluster and the Sample Population
Step 3: Firm Invitations
Step 4: Data Collection and Facilitation
Step 5: Data Validation, Upload and Visualisation
Step 6: Data Interpretation and V-LINC Reports and

**Step 7: Report back to Cluster Organisation**

**Step 8: Contact same firms to begin the process for the following year(s).**

**Step 1: Regional Context**

For the purpose of this body of work, the first six steps used in Byrne (2016) were abided to by the author. Byrne (2016, pp. 135-139) notes “before V-LINC is applied to a region, a review of the regional context is conducted to establish the characteristics of the region, the cluster and relevant economic policy to provide background and context for the
analysis. Additionally, descriptive information on the local partner organisation, who may be an industry association or cluster organisation, is presented. Explaining the regional context provides background information for the researcher before the V-LINC interviews take place and add context to the V-LINC results. Data on the population, area and gross domestic product (GDP) of the region is collected for the nearest administrative region to the cluster boundaries. Data on the employment and number of enterprises for the relevant industry sectors is stated. The composition of the cluster is examined, including the key players from industry, government and academia/research and the context of the cluster in relation to the rest of the country. An assessment of local and national economic policy is conducted and state supports for firms. Industry sectors can vary significantly and have different initiatives and support mechanisms for firms of different sizes.

These initiatives and supports may be distributed through specific state-funded agencies or through sector specific organisations. Then, the key characteristics of the local partner organisation - industry association or cluster organisation, is considered, e.g. when it was founded, its structure and objectives, number of employees, number of cluster members and how it is financed. Understanding the region’s environment, the cluster, cluster organisation and policy context is critical in developing targeted policy initiatives.

**Step 2: Defining the Cluster and the Sample Population**

The cluster should be identified through empirical analysis or a predetermined cluster is selected, but the firms under investigation may in reality simply be an agglomeration or industry specialisation. Defining the cluster involves delineating which industry sectors are incorporated in the cluster definition. Delgado et al.’s (2016) and Ketels and Protsiv’s (2013) cluster definitions can be used to define these. Secondly, the cluster’s geographic boundaries (i.e. what is local) are defined in collaboration with a local partner organisation using three suggested questions. A local partner organisation which has expert knowledge and connections with the cluster firms is required for V-LINC analysis. The local partner organisation may be a type of organisation for collaboration (OFC) which represents the cluster firms (e.g. trade association, chamber of commerce or cluster organisation). The first step in the methodology framework is to identify the firms in the local region who constitute the population of the cluster. It may be difficult to distinguish firms’ participation in the cluster and the cluster boundaries prior to the V-LINC analysis.
results, as these can inform the researcher of the firms’ connectedness and the cluster boundaries. To define the target population the methodology relies on two sources: first, national and regional databases are used to identify firms within the defined local region and industry sectors. Secondly, a list of firms in the cluster is developed by examining the local partner organisation’s membership list and identifying relevant firms. The cluster population is finalised by combining both sources and reviewing the list of firms with an expert from the local partner organisation. The local partner uses their expertise to revise the list and exclude unsuitable firms, e.g. firms that have incorrect industry classification codes and firms that have gone out of business or changed their focus or activity. Expert judgement from the local partner organisation ensures that the population is accurate and up-to-date. From the target population a sample of firms is identified to interview rather than a census, due to the resource-intensive nature of the face-to-face interviews. The sample is identified in collaboration with the local partner organisation, who reviews the population of firms in the cluster. In choosing the firms to interview, certain characteristics are considered: the size of the firms (SMEs or large firms), the firm origin (indigenous or foreign), the activities of the firm within the cluster, how involved the firm is in the cluster and access to key personnel within the firms identified. Therefore, a non-probabilistic sample is used, where the sample may not represent the population, in contrast to a probabilistic sample. Although this approach to sampling does not allow for generalising about the population, it permits the study to select firms, in collaboration with the local partner organisation, who are active cluster members and are more open to participating in the analysis. It allows for policy initiatives to be developed for the sample of firms who are more likely to participate in the initiatives and benefit for them, as opposed to firms that do not engage in the cluster.

**Step 3: Firm Invitations**

The selected sample of firms are invited to participate in the analysis. To garner their participation and commitment, the support of the local partner organisation is critical as they have direct relationships with firms. Relationships may be with the CEOs or at a senior management level in the firms, who are the preferred type of employees required to participate in the face-to-face interviews. A template invitation was created to invite firms (see Appendix A). In the template invitation, firms are provided with the aims of the study, a short description of what is involved and why they should participate. To
encourage firm participation, it is explained that there is value for both the firm and its cluster derived from their participation. The firm receives an individual firm report which provides an audit of the firm’s linkages and benchmarks their firm with the other participating firms in the cluster. An additional benefit for participating firms is acknowledgement in the V-LINC report and at international conferences. The data collected using V-LINC provides a more accurate understanding of the workings of the cluster, which informs the development of targeted policy initiatives. By participating in the analysis the firm is contributing to the understanding of their cluster, and supporting a process aimed at developing a more competitive and innovative cluster in their region. A confidentiality agreement between the firm and the researcher is also agreed. The invitations are sent to key contact points in the potential respondent firms, provided by the local partner organisation. This is followed up with a phone call to confirm receipt and to personally invite the firm to participate, whilst explaining the invitation and project in more detail.

Step 4: Data Collection and Facilitation

Interviews are arranged with the firms who agree to participate. The interviews typically take place at the firm’s premises or in the local partner organisation’s office. Personnel with knowledge of the linkages in the eight V-LINC linkage categories are identified and interviewed. In small firms with less than 50 employees, the CEO often possesses accurate information on all of the firm’s linkages. In larger firms however, and especially MNCs, the CEO or general manager may not have an in-depth understanding of all linkages across the eight categories. In this case, the study recommends that senior personnel should be interviewed across various functions such as logistics, production, purchasing, operations, research, HR and sales. The analysis is most effective when employees who co-ordinate or deal with the linkages on a day to day basis are interviewed. Data is collected through a face-to-face structured interview, where interviewees are asked the same questions in a precise manner for consistency (Campion et al., 1994). The interview structure is: 1) a discussion of the project and explanation of the data collection method; 2) the definition of a linkage, the linkage categories, geographic scope and perceived business impact are described by the interviewer; 3) firm characteristic data is collected, e.g. the number of employees, the year the firm was
established and market segment information; and 4) the interviewee is given the opportunity to discuss their opinion on, the firm’s role in the cluster, important local organisations and the firm’s key linkages. The linkage data is then collected for each linkage category systematically, for all relevant linkages the firm engages in.

To collect linkage data and to upload it to the V-LINC visualisation software, a data collection form has been created in Microsoft Excel. Each linkage category has a corresponding worksheet and a firm’s linkage data form consists of eight worksheets. For each linkage, the linked company name and their address or region is required. The link is assigned a geographic scope code, either L (local), N (national), EU (European) or INT (international).

At this point, the eight perceived business impact questions are asked to judge the impact of the linkage to the respondent firm. The excel form calculates the perceived business impact for each individual linkage. After the respondent has assessed their first linkage, this score can be used as a benchmark to speed up the assessment process. When all linkages have been recorded for a linkage category, the interviewee is given the opportunity to revise the perceived business impact scores. Where a number of respondents in the same firm provide an assessment of the same linkage, the average score for each component is calculated to summate the average perceived business impact of the linkage in question, to ensure that linkages are only recorded once.”

A face-to-face interview, as suggested by Byrne (2016, p. 139) “allows the interviewee to question anything they are unsure of, whilst also allowing the interviewer to answer any questions and clarify any ambiguities. A face-to-face interview also creates a relationship between the interviewer and interviewee; it is important for the interviewer to build trust especially as confidential linkage data may be discussed, which may not be as easy to acquire with questionnaires. Maskell et al. (2006, p. 1004) support this argument, adding “face-to-face interaction is widely held to be a necessary condition for establishing trustful relations and communicating sensitive, not well-established knowledge and information.” As the V-LINC methodology is developed to be applied
across different countries, the issue of language and cultural issues must be addressed.

Figure 7.1 displays the collection form used during an interview.

<table>
<thead>
<tr>
<th>Input</th>
<th>Link 1</th>
<th>Link 2</th>
<th>Link 3</th>
<th>Link 4</th>
<th>Link 5</th>
<th>Link 6</th>
<th>Link 7</th>
<th>Link 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linked Company Name</td>
<td>Input 1</td>
<td>Input 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
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<td>Belgium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City/County</td>
<td>Lodon</td>
<td>Brussels</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>Address</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social/Regional/National/International</td>
<td>1, N, EU or INT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Strength</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dignity</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Importance</td>
<td>Major Critical</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beneficial</td>
<td>4</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involvement</td>
<td>No of Contact Points</td>
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<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level of Contacts</td>
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<td>5</td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td></td>
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<td>75.0</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Investment</td>
<td>Frequency of Contact</td>
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<td>10</td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td></td>
<td>Time Commitment</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td></td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Linkage Value (out of 48)</td>
<td>28.4</td>
<td>27.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Figure 7.1: V-LINC Data Collection Form
Source: Author

Byrne (2016, p. 140) suggests “language and cultural issues that may arise in the data collection method are addressed in following manner. The survey questions are developed using easy to understand language and the questions use 10 point Likert scales to respond. The survey is conducted face-to-face, thus any concerns, questions or clarifications needed by the respondent can be dealt with by the interviewer. A representative from the local partner organisation is on hand if there is a need for explanation or translation to the domestic language. Therefore, the use of a single-language survey in English is adequate for this research.”

Step 5: Data Validation, Upload and Visualisation

Byrne (2016, p. 141) proceeds to discuss the validating, uploading and visualising of the data: “upon completion of the interview, data must be checked, validated and uploaded to the software by the researcher. To check and validate the data, any errors made while filling out the data collection form need to be identified and then rectified. The region and street address of the linkages are cross-referenced using Google Maps and input into the Excel worksheets. The geographic scope – local, national, European or international is
also checked at this point. V-LINC software uses Google Maps and a built-in “find” function added to the excel sheet, which checks if V-LINC can verify the correct address for each linkage on Google Maps. The find function permits the researcher to identify when the recorded address gives an incorrect location, thus ensuring accurate mapping of firms’ linkages.

Once the data has been checked and validated, it is then fit to be uploaded to the V-LINC software. Upon the uploading of the data to the software, it is visually assessed using the Linkage Data Display box (Figure 7.2 on page 213); and this is “to ensure the correct number and types of linkages were uploaded and that the linkages appear in the correct categories, to validate the data. At this point the firm linkage data is available on V-LINC software. Following on from this the data is then presented in visual maps and tabular form for the individual firms, and used to generate the individual firm reports. The firm linkage data is collated to provide results for the sample of firms which represent the cluster. Data is presented in tabular and visual form in the V-LINC software to exhibit the most important information regarding the linkages of the cluster” (Byrne, 2016, p. 141).

**Step 6: Data Interpretation and V-LINC Reports**

The researcher analyses the V-LINC data and visualisations combined with the information pertaining to the regional context and background. From here, specific policy initiatives are gleaned from the results incorporating the kinds of cluster initiatives and programmes as well as the factors of success (Byrne, 2016). Byrne (2016, pp. 141-143) highlights that “the policy initiatives are developed with the local partner organisation to add their knowledge and experience of the cluster. This expert judgement adds to the development of policy initiatives and improves the validity of the initiatives ensuring that they are: appropriate to the region and cluster, valuable to cluster members, and practical and achievable. It is important to note that, whilst the policy initiatives are developed for a sample of firms interviewed, if implemented, the initiatives aim to have the potential to build on the strengths identified but also address weaknesses for the entire cluster.

A template was created to provide a standardised format to present the firm and clusters results (V-LINC Firm Report and V-LINC Cluster Report), which provides replicability for different clusters and regions. The V-LINC firm report consists of the following:
1) Visualisation of the firm’s linkages, mapping their international, European, national and local connections. These maps can be used to support promotional material by the firm;

2) An audit of the firm’s linkages, showcasing the most to least significant relationships, their nature and at what geographic scope they occur. Findings may highlight areas that offer opportunities for firms to develop and/or strengthen individual linkages;

3) Benchmarking of firms with regard to the number and strengths of linkages they operate when compared to other respondents in the cluster. This allows comparison against firms they compete with in the cluster to identify their own strengths and weaknesses.

The structure of the V-LINC cluster report is organised as follows:

1) The importance and scale of the region, cluster and cluster organisation is documented and relevant national and regional policy is reviewed;

2) Findings from V-LINC analysis on the linkages of the sample of respondent firms are presented;

3) Visualisations of the respondent firms’ linkages on geographic maps at each of the four geographic scopes;

4) The key connectors of the cluster are identified and visualised – those firms and organisations which are strongly connected and linked to a number of the respondent firms;

5) Benchmarking against Porterian (1990; 1998b) cluster theory, comparing the V-LINC analysis results to Porter’s determinants of local clustering.

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22 Three main steps of benchmarking: “(1) Indicator-based measurement of cluster performance: A cluster entity is measured according with various indicators covering the whole spectrum of cluster management and related activities. The measurement can be conducted through a structured interview or survey. (2) Analysis of data and comparison with peer clusters: Based on the measurement results, data is analysed and compared in relation to peer clusters. (3) Derivation of recommendations: The benchmarking unveils relative strengths and weaknesses of the cluster entity. Now, specific recommendations for actions for further improvement can be developed. The benchmarking process should be conducted by impartial experts. This is especially important for the interviews and the development of recommendations for actions in order to avoid whitewashing of the performance” (Sedlmayr et al., 2021, p.167).
6) Targeted policy initiatives developed from the results of the analysis, presented with accompanying V-LINC maps. This section outlines the process involved in applying the V-LINC methodology to cluster or region under investigation.

**Step 7: Report back to Cluster Organisation**

Upon completion of the annual report for the overall cluster and its performance for Year 1, contact was made with BioWin via email and a short phone call. The detailed report was sent prior to the proposed face-to-face meeting with the cluster organisation. Following the email correspondence, a date was sought to sit down with the CEO/MD to go through the report in detail while further highlighting the policy recommendations gleaned from the data analysis. This process was repeated for Year 2 and Year 3.

**Step 8: Contact same firms to begin the process for the following year(s)**

The recruitment process for the second and third year of interviews followed the same procedures for year one firm invitations (step 3). The respondents were re-contacted via email, firstly providing the firms with an individual V-LINC report (Appendix B) (which involves being benchmarked with the best in class of the sample size population) i.e. the other sixteen firms, secondly with a highlight report (a condensed version of the full cluster report) of the BioWin cluster and ultimately asked for a new suitable date to conduct the third and final interview. Next, the development of visualisation software to geographically map cluster ecosystems is explained.

**7.2.3 Visualisation of the Cluster Ecosystem**

Byrne (2016, pp. 143-144) believes “a need was identified to improve the visualisation of cluster ecosystems. In particular, a method to visualise the linkages that firms and organisations in a cluster engage in is required, including the linkages internal and external to the cluster. The visualisation should take account of network diagrams which map linkages and networks aspatially and can identify who the key connectors in the network are. To visualise cluster ecosystems, the linkages recorded using the V-LINC data collection method needed to be geographically mapped. The visualisation software must include and be able to differentiate the three linkage characteristics: category, geographic scope and importance of the linkage. It should showcase where the
interviewed firms are and the locations of connections, or alters. The linkages should be mapped geographically as opposed to aspatial network maps.

To achieve these aims the V-LINC software was developed to map the ties between interviewed firms and their connections using the Google Maps API\(^2\). A linkage is drawn on the map between a respondent firm and its linked counterpart using their street address or general area. The maps have the functionality to display linkages for the eight linkage categories, at the four geographic scopes and the four perceived business impact bands. The firm linkage data for all the interviewed firms is displayed together to produce a picture of the linkages for the sample of firms in the cluster. The visualisations for the sample of firms in the cluster, when considered with the linkage and perceived business impact data, inform the discussion when developing policy for a cluster.

In network maps the ties and nodes are arranged for ease of viewing, with more highly connected nodes closer to the centre and nodes with one tie placed furthest away from the centre. This allows for the key connectors in network data to be identified. Identifying the key connectors in a cluster is valuable for a number of reasons. Firstly, key connectors are central to the functioning of the cluster, they facilitate the sharing of information and knowledge. Secondly, they can provide connections to other firms and organisations. Thirdly, these organisations can be conduits for implementing new policy initiatives across a cluster ecosystem. The difficulty with geographical maps of networks is that it is not easy to identify who the key connectors are, as it is not clear which organisation is most connected to actors in the network. To provide this data the V-LINC software was designed with the capability to identify key connectors in a network or cluster. Such connectors are identified through the number of linkages they have with the respondent firms and subsequently the importance of those linkages to respondents is reported. The perceived business impact of key connectors allows for an evaluation of their role and importance to the firms to be made, which is an important parameter in gauging how crucial the key connectors are.”

\(^2\) Google Maps APIs allow software developers numerous ways to embed Google Maps into web pages, and allows for either simple use or extensive customisation: [https://developers.google.com](https://developers.google.com)
Byrne (2016, pp. 145-146) discusses how “the linkage data displayed on the geographic maps needed to be summarised for the researcher, e.g. to showcase how many linkages were displayed and their nature: by category, geographic scope and perceived business impact. A data information box was designed to showcase the linkage information of any linkages selected to be displayed in V-LINC… This allows the researcher to quickly assess the number, type, geography and importance of the linkages displayed, which is not readily evident from examining the linkage map exclusively.” For example, in Figure 7.2, it is difficult to know that there are 1321 linkages visualised on the V-LINC map of the BioWin cluster. Moreover, the breakdown of linkages by category and geographic scope is presented. For example, there are 403 local and 362 national linkages which are difficult to see when displayed in a combined manner. Furthermore, the perceived business impact is also displayed in the Linkage Data Display represented by T (Tedious), L (Low), M (Medium) and H (High).

![Figure 7.2: V-LINC Visualisation of BioWin Cluster Linkage Data Display 2018-2020](image)

Byrne (2016, p. 146) notes that “colour is an attribute which can be used to describe different types of data. It is used in the V-LINC software to define different clusters so that multiple clusters from different regions can be compared simultaneously. Colour is also used to highlight linkages in a particular perceived impact band.” For example, Figure 7.2 shows that a different colour can be assigned to linkages displayed in 2018 (blue), 2019 (red) and 2020 (purple). Byrne (2016, p. 146) mentions that in order “to keep the map clear and uncluttered, certain data is only made available when selected.”
7.3 Discussion

This thesis identified the capabilities of the V-LINC methodology when applied to a cluster analysis and recognised the need for creating and using an adapted V-LINC methodology in a longitudinal cluster analysis as set out at the start of this chapter. This section closes with an insight into how firm linkage data is processed. The actions and procedures undertaken to guarantee reliability and validity of the data and methodology are then reviewed. Lastly, the alterations between V-LINC used in a one-year analysis compared to that of a longitudinal (three-year) analysis is presented.

7.3.1 Confidentiality

Byrne (2016, pp. 147-148) describes how “confidentiality of the individual firm linkage data is crucial as all of the linkage data is sensitive to the respondent firms and may be vital to their competitiveness. As the V-LINC data collection method interviews firms in a cluster who may be potential competitors, they need assurances that their data will not be shared with any other firms or the local partner organisation. The specific linkages each firm reports remain entirely confidential within the V-LINC results, analysis and visualisations. Individual linkage data are only viewed by the researchers conducting the interviews, no firm linkage data is released publicly and any information collected during the interviews will be used only after approval of the respondent firm. The firm holds a veto on publishing all material related to their input.”

Notably, individual company linkages or sensitive information the company does not want disclosed (i.e. specific customers or suppliers), can be input differently to the spreadsheet using a codified approach, starting with the firms name, followed by the linkage category abbreviation and number corresponding to the linkage and the country where the linkage is located. For example, the codified link JUMO_OU1-Germany, refers to the first output (customer) linkage from the interviewed company JUMO, who is linked with an organisation in Germany. The name of the firms or organisations in which the respondent firm is connected which is not crucial to the analysis; however, the type of link, location, and perceived business impact to the firm are vital. Byrne (2016, p. 148)
highlights “the location of the linked firm is required to map its position on the V-LINC software, the street address is not required for non-local linkages as the city or region provides an accurate position of the linkage. For local linkages, street address or area of the local region is required to create an accurate local map of the cluster. Regarding the visualisation of linkages, no firms or organisations have access to the V-LINC software other than the researcher. The V-LINC maps that are produced for the V-LINC reports, display the linkages of the respondent firms in the cluster. From these maps it possible to view a general area a respondent firm has a linkage to, but there is no information as to what firm or organisation the respondent firm is connected to in that region or city. Therefore, the confidentiality of the respondent firms’ linkages is ensured.”

7.3.2 Reliability and Validity

The V-LINC methodology, due to its hybrid nature, uses “qualitative techniques to collect the linkage data. The qualitative opinions of respondents are recorded and translated into quantitative data which can be visualised and analysed. However, critics of qualitative techniques site that they are less reliable than quantitative techniques which use secondary data. To judge the quality of the method, two dimensions have been suggested - reliability and validity. Reliability and validity refer to the ability to assess the results in terms of research effectiveness in measuring what was intended to be measured. Reliability relates to the consistency of the results, that they are free from errors of measurement” (Byrne, 2016, pp. 148-149). Byrne (2016, p. 149) in reference to the work of Dooley (2001) and Cooper and Schindler (2003) posits that “validity refers to the appropriateness, meaningfulness and usefulness of the specific inferences made from the measures. Additionally, practicality is concerned with the feasibility of the study, e.g. the convenience, the resources required and the reasonableness.”

Many authors have added to the literature in the discussion around criteria or standards regarding what arduous qualitative research is made up of (Mishler, 1990; Wolcott, 1990; Denzin and Lincoln, 1998). Byrne (2016, p. 148) alludes to “four widely accepted criteria upon which the rigour of quantitative research can be evaluated: reliability, replication, internal validity and external validity.” Other authors such as Lincoln and Guba (1985)
propose differing names to the quantitative criteria of evaluating qualitative work. These include “credibility, transferability, dependability and confirmability. Credibility involves ascertaining whether or not the results are credible or believable from the participants’ point of view. As qualitative research describes the subject under investigation from their perspective, therefore, the subject alone can judge the credibility of the results” (Byrne, 2016, p. 149).

Bryman and Bell (2007, p. 410) define ‘respondent validation’ as a way to sanction research credibility, which involves the researcher providing his or her consequential results to the participants in order to obtain their agreement/disagreement. Byrne (2016, p. 149) postulates that “transferability refers to the degree to which qualitative research results can be generalised or transferred to other contexts and settings. The transferability of the research is enhanced if the researcher conducts a thorough job of describing the research context and the assumptions that were central to the research.” This in turn offers a reference point(s) by which others can turn the transferability of the research findings in to other domains or frameworks (Bryman and Bell, 2007). The honesty and integrity of the research falls under the term dependability and is achieved by an external review taking place, performed by a researcher not involved in the research process. They investigate and examine the process and outcomes gleaned and it is suggested that accurate records of each stage of the research process should be developed and kept in a style that is accessible (Lincoln and Guba, 1985).

Finally, the level of impartiality within the research is in relation to confirmability. In other words to see can the results be confirmed and verified by others (Byrne, 2016). Byrne (2016, pp. 149-150) in reference to the work of Lincoln and Guba (1985) believe that “while complete objectivity is impossible in business research it is important that the researcher can be shown to have acted in good faith not allowing any personal values or theoretical inclinations to sway the research process or the findings from it. There are a number of strategies for enhancing confirmability, including a confirmability audit, an audit trail, triangulation, and reflexivity. Awareness of the criteria outlined above can ensure that the validity and reliability of the research is considered throughout the design of the methods, collection of data and analysis of results.”
These particular concerns are addressed by the V-LINC methodology in various ways. According to Byrne (2016, p. 150), “the methodology provides a consistent method to collect firm linkage data with explanations of the linkage categories, geographic scopes and perceived business impact of linkage. V-LINC builds on Hobbs’ (2010) *Four i Linkage Scale* so that the method is more applicable to other industry sectors and regions. The methodology is described in detail, when it is applicable and for whom, its advantages but also its limitations. This allows researchers to consider its applicability to other studies and take account of potential shortcomings, addressing the transferability of the methodology. The research provides a contextual description of each region, the cluster, cluster organisation and relevant policy to enhance its transferability.

The V-LINC methodology provides individual firm reports to each of the participants with a summary of the firm’s linkages. This is a means of obtaining respondent validation and invites feedback or disagreement from participants within the study. The policy recommendations are developed in collaboration with local partner organisations who provide context and external validity to the policy initiatives, whilst also validating the cluster analysis report upon completion. All firm linkage data is recorded in individual firm excel files and additionally, is stored in the V-LINC software. These are both available for external auditing, addressing dependability and confirmability. These procedures and techniques provide rigour to the methodology and reliability and validity to the results.”

While reviewing the reliability and validity of the V-LINC methodology is important, one must also investigate the importance of the application of V-LINC in the following section.

### 7.4 Applying V-LINC Methodology

V-LINC was applied to map, analyse and assess the BioWin cluster over a three-year period. The Wallonia region was visited from 2018-2020 to conduct firm interviews and analysis with BioWin, the cluster organisation, assisting to define the number and sample of potential firms to interview as well as defining the cluster population. A total of thirty-five firms were approached to take part in the three-year research and once seventeen
firms agreed to come on board, no further firms were contacted. Year 1 (2018) interviews occurred in the period of February 2018 to June 2018 and in similar fashion for the Year 2 (2019) interviews, they took place between February 2019 and June 2019. However, due to the COVID-19 global pandemic, firms were already aware of its arrival in February 2020 and as a result there was a three month lag in collecting the data, while the firms dealt with the first wave of COVID-19. Hence, there were no firms available for interview from February 2020 to June 2020. The nature of the interviews also changed from face-to-face to an online/video conference platform. Since the V-LINC interviews require face-to-face interaction, the new online method of conducting them required a number of tests prior to the first interview of Year 3 (2020). The final year (2020) interviews took place in the timeframe of June 2020 to December 2020.

Initially, BioWin reached out to their cluster members in Year 1 via email and letters to help arrange firm interviews sought after by the author and facilitated this by explaining the aim and importance of the research project as well as the V-LINC methodology. Without the cluster organisation’s input and assistance, the trust required to undergo each interview may not have been present, and therefore, the preferred sample size of seventeen companies may not have been reached. Upon completion of the interview and data collection process, in which the results were collated and analysed, BioWin was present in the process of reviewing and approving targeted policy initiatives and recommendations for the cluster. Byrne (2016, p. 153) refers to the work completed in their own research project stating “the cluster organisation provided expert knowledge of the history and workings of the cluster, and thus provided local context for the results. This expertise and local knowledge is invaluable when developing the policy initiatives for a cluster.”

7.4.1 Choosing the Right Region to Investigate

The BioWin cluster, located in the Wallonia region, as discussed in detail in section 2.2, provided the basis on which this research was built. Byrne (2016, p. 154) suggests “regions with good quality data are required, e.g. a known population of firms and local connections to a potential sample. Full participation from the local partner organisation
is critical for selecting the sample, organising the interviews and formulating the policy initiatives.” Conducting a longitudinal analysis of the BioWin Cluster, rather than a one-year analysis allows the author to identify at what stage of maturity the cluster is at along the cluster life cycle, from Year one to Year three. This informs BioWin, The Health Cluster of Wallonia, whether their cluster is emerging, growing, maturing or potentially declining/requiring a rejuvenation process in order to avoid ‘death’ and continue as a going concern. Applying V-LINC to a cluster over a three-year period, allows the clusters’ evolution to be tracked in tandem with its members and the linkages they engaged in.

Indeed, Byrne (2016, p. 154) refers to the lack of longitudinal data available during the time of their own research, stating “while longitudinal data was not available, the application of V-LINC to a range of clusters would provide results and further understanding of the differences between clusters at various stages of maturity. It was also decided to examine regions with cluster organisations at different stages of development. This would permit an investigation into the role and influence of a cluster organisation within a cluster and V-LINC’s ability to develop policy initiatives for different cluster organisations.” This certainly holds when assessing the BioWin Cluster and crucially determining the stage of maturity it finds itself at, thus, allowing the cluster organisation to plan accordingly and develop, implement and follow accurate, cluster specific policy recommendations and initiatives that may be required in order to help grow and develop the cluster further. The following section briefly examines the firm data regarding employee size etc.

### 7.4.2 Firm Data

Byrne (2016, p. 155) notes “the local region and cluster boundaries were defined for the region. Next, the population of firms in the cluster was established with each cluster organisation acting as the local partner organisation. From the population, a sample of firms with varying characteristics were selected to participate and were contacted by the local cluster organisation and the researcher.” This section identifies the firms that participated in the research, their origin (local or foreign), their size (from micro to large)
and the industry specific segment of the firm. Byrne (2016, p. 155) suggests “the data presented is for the specific firm interviewed in that region, and does not include operations in other regions. The definition employed in this study for the size of the firms is in line with the European Commission (EC, 2005) definition, and relates only to employee numbers as turnover data was more difficult to assess for individual firms. Micro sized organisations are classified as those organisations with fewer than 10 employees. A small firm is defined as an organisation with at least 10 employees and no more than 50 employees. A medium sized organisation is defined having at least 50 but fewer than 250 persons employed. A large firm is classified as an organisation with over 250 employees.”

The next section of this chapter aims to summarise the data collection and facilitation process amidst a global pandemic.

7.5 Data Collection and Facilitation

During Year 2 and Year 3 of the research, a global pandemic disrupted the typical face-to-face V-LINC interviews. Similar to the first two years of research, interviews were arranged with the cohort of participating firms via email. The interviews typically take place at the firm’s premises or in the local partner organisation’s office; however, all interviews for Year 3 were performed online through the medium of various video calling platforms.

The following sub-sections begin with an explanation of the COVID-19 pandemic, its impact on this body of work, followed by a detailed review of the concept of face-to-face and online interviewing techniques.

7.5.1 Impact of the COVID-19 Pandemic

In early 2020, the world encountered the COVID-19 (SARS-CoV-2) pandemic which has affected every country in the world and altered how we live, work and learn. COVID-19 has led to a dramatic loss of human life worldwide and presents an unprecedented challenge to public health, food systems and the world of work. The economic and social
disruption caused by the pandemic is devastating: tens of millions of people are at risk of falling into extreme poverty, while the number of undernourished people, currently estimated at nearly 690 million, could increase by up to 132 million by the end of the year (WHO, 2020).

The virus that causes COVID-19 can spread from person to person through respiratory droplets - small droplets from the nose or mouth of a person infected with the virus. These droplets are produced when a person coughs, sneezes or exhales. People can catch the virus either:

- directly, by breathing in the droplets produced when an infected person coughs or sneezes or
- indirectly, by touching surfaces (e.g. table, door handle) that an infected person has coughed or sneezed on and then touching their eyes, nose or mouth.

The virus cannot grow on surfaces but it can survive if they are not cleaned. Regular cleaning of frequently touched hard surfaces and of hands will therefore help to reduce the risk of infection. Due to the high transmission rates of COVID-19 public health advice in across Europe restricted movements of citizens to avoid contact with other people and social situations as much as possible by working from and staying at home where possible.

EC (2021, p. 6) ‘European Expert Group on Clusters Recommendation Report’ states “The coronavirus has shaken Europe to its core, testing our societies and economies and our way of living and working together. Our small and medium-sized enterprises, the lifeblood of our economy, have been particularly affected. Clusters have done a great job throughout these difficult times. When the coronavirus hit the EU, the cluster community - led by the European Cluster Alliance – immediately mobilised across EU borders. They reacted effectively to challenges like the need for more masks or ventilators. In a single week, clusters gathered over 1,100 offers, ensuring that more people could benefit from the life-saving medical equipment.”

In the interest of public safety, the educational systems worldwide have been affected, leading to the near-total closures of schools, universities and colleges. Most governments decided to temporarily close educational institutions in an attempt to reduce the spread of COVID-19 (UNESCO, 2020\(^ {25} \)). In response to school closures, UNESCO (2020) recommended the use of distance learning programmes and open educational applications and platforms that schools and teachers can use to reach learners remotely and limit the disruption of education. This approach has been adopted by the majority of countries in 2020, with priority been given to get pot primary and primary schools open in the first instance, followed by second level before looking at third level educational institutes as they are more prepared for online rather than face to face learning.

European countries have been grappling with waves of infections since September 2020, with rises in case numbers in Germany, Spain, Italy, Belgium, France and the Netherlands. New lockdowns and tough social restrictions were reintroduced across numerous European countries in October 2020 in an effort to contain the second wave; with schools and non-essential retail again closing which caused further economic and healthcare consequences for governments and their citizens during the pandemic (Amaro, 2020\(^ {26} \)). The V-LINC interviews are conducted face-to-face due to their complex nature, their need for visual aids as well as requiring instruction and guidance from the interviewer. Thus, video conferencing became the only alternative solution rather than a survey or phone interview to complete the final year firm interviews. The ability of the interviewer and interviewee to ‘share screens’ with one another greatly aided the process, allowing for further clarity or explanations if required by the respondent.

### 7.5.2 Research Impact of COVID-19 Pandemic

With the public health guidelines focusing on the reduction of face-to-face contacts as we wait for vaccination against COVID-19, many academic institutions have moved towards


conducting virtual interviewing as a replacement for face-to-face interviewing. In essence, the opportunity for conducting face-to-face interviews was effectively eliminated during Year 3 of this study as the researcher did not wish to put the health of individuals, good enough to give up their time to participate in this study, at risk by meeting face-to-face when many were working from home or keen to limit their risk of contracting COVID-19. Adaptability and flexibility were required to form a new approach to interviewing. Sutherland et al. (2020, p. 271) outlined “during the Covid-19 pandemic, a strategy to minimise face-to-face (FtF) visits and limit viral spread is essential. As the pandemic progressed, the need for an alternative to further minimise FtF consultations and capable of overcoming the limitations of telephone advice became urgent.” Individuals and companies adjusted by modifying digital aspects of their job very quickly. Interviewees began to accept online interview requests and a ‘new’ interview process became normalised.

The following section investigates face-to-face interviews further, while also looking at the advantages and disadvantages associated with this interview style.

### 7.6 Face-to-Face Interviews

Interviewing is the most used form of data collection in qualitative research (Creswell, 2013). The body of literature examining the traditional face-to-face interview is vast (Limb and Dwyer, 2001; Bryman, 2008; Dunn, 2010; Longhurst, 2010). During face-to-face conversations, the interviewer has the opportunity to create a positive interview environment (Opdenakker, 2006). Creswell (2013) notes that the most traditional form of generating qualitative data in research studies is obtained through face-to-face or in person interviewing (Dicicco-Bloom and Crabtree, 2006; Opdenakker, 2006; Gill et al., 2008). McCoyd and Kerson (2006, p. 390) maintain that the face-to-face interview process has evolved into a “gold standard” in regards to;

#### 1. Validity

It is possible for online interviews/surveys to present validity issues in relation to responses given by participants without face-to-face interaction in which the interviewer can clarify any queries posed (Nielsen, 2011). However, face-to-face interviews are believed to be preferred to online efforts because “1. The validity and reliability of the
data is presumed to be greater, and 2. More complex and comprehensive data can be gathered, utilizing an interviewer’s special skills” (Bale, 1979, p. 994).

2. Reliability and 3. Allowing for clarifications and follow up inquiry

The ability to sit face-to-face in the same room as the respondent has numerous advantages, as Byrne (2016, p. 76) speaking about the work of McNamara (1999) suggests “face-to-face interviews provide more reliability than questionnaires, as the interviewer is present and can ensure that the questions are understood. They allow the interviewer to explain the research project to the respondent(s) in person and give the interviewer the opportunity to clarify uncertain answers and ask follow up questions, which can provide additional information regarding the sector through participants’ experiences of particular linkages.”

4. Providing privacy and confidentiality

During one-on-one interviews, privacy and confidentiality, for the respondent, can be assured, thus, a level of trust can be developed between the interviewer and interviewee. This is an important factor when gathering potentially sensitive information on firm linkages and connections, which may play a vital role in the firms’ business operations (Byrne, 2016). It is also argued that “face-to-face interaction decreases the likelihood of refusal to answer a question. The interviewee can be more open and one-on-one interviews afford them an opportunity to elaborate” (Byrne, 2016, p. 7).

Disadvantages of Face-to-Face interviews

Logically, as is the case with many interviewing techniques, there are also disadvantages associated with conducting face-to-face interviews. The most common disadvantages are that they are;

1. Time consuming: interviews can be time consuming as a result of a) visiting/traveling to each participant and b) taking each interviewee through each step of the interview process c) transcribing data after the interview. Byrne (2016, p. 76) supports this argument, adding “data collected from interviews may take longer to analyse especially if the interviews must be transcribed and analysed. Critics of qualitative techniques cite that they are less reliable than quantitative techniques which use secondary data.”
to-face interviews, similar to questionnaires, are at risk of bias due to poorly fashioned questions or response bias. Cooper and Schindler (2003) refer to two forms of bias; ‘halo bias’ where a person will agree with interviewer/interviewee solely due to their perceived intellect, or ‘prestige bias’ where a respondent answers a question in a manner that can inflate answers, detracting from the accurate truth, which in turn makes them feel superior.

2. Costly and labour intensive: face-to-face interviews are also costly due to the logistics involved in visiting/traveling to interviewees. Deakin and Wakefield (2014, pp. 603-604) note “face-to-face interviews can be problematic due to time and financial constraints as well as other logistical considerations.” Moreover, Duffy et al. (2005, p. 10) also highlight that “face-to-face interviewing resources are limited and increasingly expensive.” Byrne (2016, p. 76), in a similar fashion, describes face-to-face interview techniques as “labour intensive”. However, it is argued that these techniques produce a superior level of ‘rich’ information and data at the cluster or firm level (Mazzarol et al., 2005).

It is an opportune time to discuss the process used for the collection of data in Year 3 of this research, as it had had to follow a new protocol due to the global pandemic.

Data Collection Process Year 3

Each of the Year 1 and Year 2 V-LINC firm interviews to understand individual companies’ linkages were conducted in a face-to-face manner. However, due to the impact of COVID-19 and health care restrictions at the time necessitated that all seventeen of the final year interviews were conducted online via video conferencing software. The recruitment process for the third and final year of interviews followed the same procedures for online interviews as was the case for the face-to-face, in years 1 and 2. Upon completion of the firm and cluster reports, within three months from the finishing point of the final interview, and thus, the completion of the data collection process, respondents were re-contacted via email. Firstly, they were provided with their firms’ individual report (involving a benchmarking process with the best in class of the cohort of respondent firms) i.e. the other sixteen firms. Secondly, the firms received a highlight report (condensed version of the full cluster report) of the BioWin cluster. To conclude
the firms were asked for a new suitable date (normally scheduled nine to twelve months since the previous interview) to conduct the subsequent interview.

Video conferencing software enables two or more people in separate locations to make contact and communicate using video imaging and audio in real time (Gough and Rosenfeld, 2006). Therefore, in order to conduct the final year interviews, access to internet and the ability to utilise video conferencing platforms and software, was a prerequisite. Upon reviewing face-to-face interviews, the following section looks at introducing and revealing ethical and rapport building factors involved in an online interview technique.

7.7 Introduction to Online Interviews: Ethics and Rapport Building

Due to updated GDPR guidelines, the author chose not to record any of the seventeen online interviews conducted in Year 3. As Deakin and Wakefield (2014, p. 609) highlight, “data security and consent online are just two examples that cross over with more traditionally considered ethics.” It is important for the author to gain full informed consent by each participant and thus verbal consent was sought from each interviewee prior to the online interview commencing. Deakin and Wakefield (2014, p. 610) adhered to identical practices during their own online interviews, noting it “was necessary in order to conform to ethical guidelines; however, it did not always produce the best environment to build rapport prior to the interview.” Orb et al. (2001, p. 93) argue “ethical issues are present in any kind of research. The research process creates tension between the aims of research to make generalizations for the good of others, and the rights of participants to maintain privacy.” In addition, Orb et al. (2001, p. 94) state that “a balanced research relationship will encourage disclosure, trust, and awareness of potential ethical issues” and this was ever present in the three years of interviewing conducted by the author.

27 For more information on GDPR visit https://gdpr-info.eu/
The author shares similar views to those of Deakin and Wakefield (2014, p. 610) who state while “in some instances differences were identified in terms of rapport between online and face-to-face interviews, this was not deemed to affect the quality of the conversations.” Deakin and Wakefield (2014, p. 612) highlight that the aspect of familiarity is also important. This suggests that the “familiarity of the interviewer to the respondent helped in maintaining the increased communication with the interviewees provided a greater familiarity, albeit an online familiarity, but one that was built up more than for interviewees who came across as more reliable.” Regarding the work of Sala (1998), Deakin and Wakefield (2014, p. 611) hypothesise whether one is able to establish a connection with participants they have never encountered. They discuss over the past two decades how online communication was viewed to have “a narrow or lean bandwidth, in contrast to the rich bandwidth of face-to-face interaction. However, we argue that the narrowness of online communication has been broadened by the use of synchronous communication alongside the accessibility of video as an option.” For the author, incidents, although rare, where the conversation would ‘drop’, the video would freeze or the other person was unable to hear did occur. Such limitations were overcome through use of the chat feature in which both parties can type text to one another until the video call resumed. Jones and Abdelfattah (2020, p. 1) allude to such issues noting “technical failures are cumbersome and detract from valuable interview time.”

To negate such issues, it is imperative to consider and understand how online methodologies can be used to collect data and to further develop these processes to ensure they will be as reliable and accurate as face-to-face data collection methods (Duffy et al. 2005). Deakin and Wakefield (2014, p. 604) note that while “traditional face-to-face interviews remain prominent, innovative communication technologies, such as Skype, have facilitated new modes of communication.” It is important to note that the research undertaken by the author satisfied the guidelines and principles as prescribed in MTU’s ‘Research Ethics Policy’ and ‘Research Data Management Policy’.

Having introduced the concept of the online interview process, the next headings analyse the advantages and disadvantages of online interviewing.
Advantages of Online Interviews

Within the vast amount of literature and existing debates around the advantages and disadvantages of online interviews, there is an increasing amount of support in favour of using online software and tools to complete interviews for research. Advantages of online interviewing include and are by no means limited to:

1. Greater speed of interviewing
2. Lower costs associated with travel
3. Online interview data can be used to complement other datasets
4. Reliance on location/geography is reduced which opens up the possibility to interview previously unattainable companies/individuals
5. Replicate and produce data as reliable as data collected from face-to-face interviews and
6. Video calling/conferencing as an option.

1. Greater speed of interviewing – Adaptability and Flexibility

Duffy et al. (2005, p. 2) state “the key advantages nearly always quoted first are greater speed and lower cost.” Curasi (2001, p. 1) also identifies advantages in online interviews, arguing “it has the potential of being a revolutionary way to collect primary and secondary data.” While the author found the initial one or two online interviews in Year 3 to be complex, due to little or no prior experience, it was soon overcome by the use of video, visual aids and screen sharing, which before long became second nature. The final month of online interviews, through the nature of remote working, allowed the author to conduct seven in ten days. Sometimes completing two or three per day and thus, further demonstrating the advantageous adaptability and flexibility offered by online interviewing. Duffy et al. (2005, p. 2) support this, adding “advantages can be considerable as it is possible to accumulate very large volumes of interviews in a short space of time.” This allowed the author and firms to avoid costs of a capital nature, due to the respondents having their own interviewing equipment and machinery (Duffy et al., 2005).
2. Lower costs associated with travel

Deakin and Wakefield (2014, p. 607) during their online interviewing experience, posit that “financial costs were minimised using Skype, and second, many participants took the opportunity of the option of an online interview over the face-to-face, in effect normalising the Skype interview.” Traveling by car or public transport to firms’ offices was no longer a requirement for the author’s final year interviews and the online proposition became the ‘new norm’. The costs associated with such travel became obsolete, yet the obtaining of important data remained possible.

3. Online interview data can be used to complement other datasets

Curasi (2001, p. 1) posit that “when the researcher's goal is not to quantify or generalise but instead to better understand a particular population, online data collection can complement other datasets, allow data triangulation and strengthen the trustworthiness of the findings.” Curasi (2001, p. 1) continues along this same thought process, suggesting “under some conditions online depth interviews can provide a useful complement to the traditional face-to-face interview.”

4. Reliance on location/geography is reduced which opens up the possibility to interview previously unattainable companies/individuals

Perhaps even more relevant to the author’s body of work is Deakin and Wakefield’s (2014, p. 603) argument stating “while potential research populations have become increasingly geographically dispersed, technological advancements and software have made communicating over large distances more feasible. Because of this, research is no longer limited to face-to-face accessible participants, as online methods have facilitated access to global research participants.” Online methods alleviate issues involving space, distance and travel, which accommodates the internationalisation of research without costs associated with said distance and travel (O’Connor et al., 2008).

Deakin and Wakefield (2014, p. 604) argue “an online interview should be treated as a viable option to the researcher rather than as an alternative or secondary choice when face-to-face interviews cannot be achieved.” Overcoming issues such as logistical factors, location and cost of travel that could hinder opportunities for both the researcher and participant alike to meet face-to-face is a substantial advantage of online video conference
calls involving qualitative research i.e. the participants are extremely accessible (Sedgwick and Spiers, 2009; Deakin and Wakefield, 2013; Hai-Jew, 2015; Hesse-Biber and Johnson, 2015; Winiarska, 2017). Location, once a very important factor in mixed-methodology interviewing processes, has been replaced by new technologies. For example, readily available Wi-Fi access means online video platforms like “Skype software can be downloaded to mobile technologies such as smart phones and tablets, and as such, the place of the interview becomes much more fluid and temporary” (Deakin and Wakefield, 2014, p. 609).

Due to the online element, flexibility increased allowing the author to interview in the morning, afternoon, and evening, regardless of location and geography. This was often found to be more convenient for the interviewees who were, for example, located in the U.S, and unable to fly back to Belgium due to travel restrictions in relation to COVID-19. The author shares similar views to the work of Deakin and Wakefield (2014, p. 607) in which their “PhD research was not an attempt by either of the researchers to replicate the face-to-face interview; it was more to provide an opportunity to talk to otherwise inaccessible participants.”

5. Replicate and produce data as reliable as data collected from face-to-face interviews

Online interviews “can produce data as reliable and in-depth as produced during face-to-face encounters” (Deakin and Wakefield, 2014, p. 604). It is argued that the responses and information gathered through online interviews is essentially of the same quality and accuracy as those produced by the traditional face-to-face methods (Denscombe, 2003).

6. Video calling/conferencing as an option

Video calling allows the researcher to not just speak to their interviewee but also see them and as such varying methods of video conferencing have been used during interviews, particularly where the research population is scattered geographically (Sedgwick and Spiers, 2009). Deakin and Wakefield (2014, p. 606) identify the advantage of the ever evolving online technology, noting “video calling provides the researcher with an opportunity to not just talk to their respondent but to see them in real time. Various methods of videoconferencing have been increasingly utilised in interview methods, especially where the research population is geographically dispersed.”
Online video conferencing, since 2014, has developed rapidly, particularly during 2020 and 2021 when the COVID-19 global pandemic occurred. Skype is now but one of numerous different platforms upon which online video calls and interviews can take place. For example, Microsoft Teams, Zoom, Google Hangouts, GoToMeeting, Skype for Business, ezTAlks Meetings\(^\text{28}\) are just a number of possible options for interviewers/researchers to use when conducting online interviews/research. It is important to highlight the research and findings mentioned in relation to online Skype interviews and the lack of current literature available on other video conferencing data. This involves areas in which researchers are in search of best practices, recommendations and comparisons for video conferencing across all platforms (Gray et al., 2020). The most up to date research focuses mostly on Skype (Sullivan, 2012; Deakin and Wakefield, 2013; Nehls, Smith and Schneider, 2014). Gray et al. (2020, p. 1294) conclude “to date, we found no peer-reviewed published studies examining other video conferencing platforms, such as Zoom, in the qualitative literature.” Deakin and Wakefield (2014, p. 604) discuss how “online interviews are presented as a second choice or alternative when this ‘gold standard’ of interviewing is not possible.

Gray et al. (2020, p. 1292) share similar views which highlight some aforementioned advantages of online accessibility while also adding more. These include “(1) convenience and ease of use, (2) enhanced personal interface to discuss personal topics (e.g., parenting), (3) accessibility (i.e., phone, tablet, and computer), (4) time-saving with no travel requirements to participate in the research and therefore more time available for their family.”

The next part of this online interview review examines the disadvantages associated with conducting online interviews

**Disadvantages and Challenges of Online Interviews**

Cooper (2009) reiterates the need for caution concerning online interviewing, noting that it is not as guileless as ‘point and click’. The vast amount of available literature, regarding

\(^{28}\) For more information on these platforms, visit [https://www.dgicommunications.com/video-conferencing-software/](https://www.dgicommunications.com/video-conferencing-software/)
interviews, depicts copious differences between face-to-face interviews and online, highlighting potential issues such as design of interview, ethical problems and the ability to build rapport (O’Connor et al., 2008).

Other disadvantages that will be examined include: 1. Loss of in person cues 2. Up to date technological requirements 3. Home life distractions.

1. Loss of in person cues

In the online interview, it is imperative to mention the loss of certain factors; otherwise subtle visual and non-verbal cues which may help contextualise the person being interviewed in a face-to-face setting (O’Connor et al., 2008). Deakin and Wakefield (2014, p. 605) in relation to work done by Chen and Hinton (1999), acknowledge that the “lack of non-verbal cues can prove challenging in some cases for both the interviewer and interviewee when using online tools for conducting interviews.” The author found that being able to actively point to an explanatory item or graphic aid when face-to-face was less time consuming i.e. showing the respondent to a specific place on a laminated sheet in order to help extract an answer to a particular question, may take much longer online when required to ‘unshare’ the screen and ‘reshare’ a new one to get the same message across.

2. Up to date technological requirements

Being recorded or simply being on video calls can make the interviewee feel uncomfortable. Participants will also need to have the latest software and a good internet connection and bandwidth to ensure a problem free interview (Hay-Gibson, 2009). Therefore, online interviews may exclude certain participants due to the requirement of technological competence, up-to-date software to maintain a solid internet connection for the duration of the discussion (Hay-Gibson, 2009).

3. Home life distractions

The COVID-19 epidemic forced millions of workers to work from home (teleworking) to stem the spread of the virus for the foreseeable future, where they once worked in their firms’ offices or buildings. Some interviewees were at home during the interview process which lead to distractions such as interruptions from family members or having to answer
the front door to name but a few. In order to overcome these distractions, a certain level of understanding from the interviewer was required as respondents completing interviews from home differed greatly from that of a strict office setting. Deakin and Wakefield (2014, p. 609) describe “disruptive environments at that particular point in time, and so finding the ideal time and space to conduct the interview relies upon the interviewee choosing a suitable location.”

Deakin and Wakefield (2014, p. 609) believe these types of distraction can interfere with the flow of an interview and may affect the interviewee’s concentration, and subsequently, the data gathered may be affected. Therefore, the location of the participant is an important logistical factor to consider when conducting online interviews. “Ensuring interviewees are in a location free from controllable distractions is an important element of preparation for online interviews.” This is naturally a difficult task due to the short notice and novelty of the new working way i.e. teleworking, and peoples inability to separate their work from their private lives in their homes.

While the author has presented information from the literature regarding online interviews, the next section summarises the V-LINC methodology concept.

### 7.8 Summary of V-LINC Methodology

Chapter 6 introduced V-LINC, a hybrid methodology, first implemented and seen in the work of Byrne (2016), combining qualitative and quantitative cluster analysis techniques and a visualisation software to record, analyse, visualise and compare firm linkages to investigate a cluster ecosystem. The framework used in implementing the V-LINC methodology was showcased in combination with the manner in which V-LINC was established and developed. In order to gain trust with the RFGs and obtaining their support, it is imperative that the research is conducted confidentially while adhering to ethical guidelines. Thus, the discussion section addresses these points also exploring the reliability and validity for studies of a qualitative manner. Lastly, the application of V-LINC to the BioWin cluster over a three-year period is presented. The current research undertaken, tracking the evolution of the BioWin cluster over a three-year period, addresses the potential uses of V-LINC.
It is applied in line with the beliefs of Byrne (2016, p. 247) when he suggests “V-LINC can be used to collect network data over time. A sample of firms from a cluster could be interviewed and analysed over a period of three years. This would involve a commitment to sustained engagement with case-study populations and regions, to track changes in perceptions of linkages; development of new linkages and the extinction of existing linkages. V-LINC maps would, in this instance, show the development of the network over a period of time, i.e. where new linkages have developed or previous linkages discontinued. It would be important to consider how and in response to what stimuli, individual linkages change over time. As development agencies seek to strengthen particular industry sectors, a longitudinal cluster analysis may help to assess if policies which promote networking, training, R&D, or local collaborations have been a success. This research would provide answers to questions such as ‘how do clusters develop,’ ‘why has a cluster developed’ and assess the impacts cluster related policy initiatives have on the development of industry sectors and networks in a region.” Additionally, Moynihan (2018, p. 278), regarding the application of V-LINC in a longitudinal manner, argues further that the “application of this methodology to clusters at their different stages of maturity and development will aid in the understanding of the role cluster organisations play in a cluster’s growth.”

The next chapter presents the results of this PhD project by applying the V-LINC methodology to a cohort of 17 member firms of the BioWin cluster and secondary and primary data pertaining to the variables connected to the pillars of Economic Impact, Cluster Organisation and V-LINC Analysis. The categorisation of cluster life cycle stages is also examined and in particular, the BioWin cluster life cycle stage that is determined.
Chapter 8

8 V-LINC CLUSTER ANALYSIS RESULTS

8.1 Introduction

Chapter 8 presents the Year 1 (2018) report and results from the V-LINC data analysis (section 8.2). The next part presents the policy recommendations (section 8.2.1) upon review of the Year 1 data. The V-LINC report considers economic data for the region under review in order to provide context for the analysis and results. The V-LINC analysis results are presented in tabular form as well as other visualisations with discussion. The key connectors for the region are annually identified and the results are summarised. Consequently, accurate policy recommendations and initiatives are developed for the region. Section 8.3 focuses on the comparative element of the 2019 results and presents the findings gathered between Year 1 (2018) and Year 2 (2019). The policy recommendations and closing remarks are then reviewed (section 8.3.1). Following on from this, the chapter presents the results of the Year 2 to Year 3 V-LINC data analysis and comparison (section 8.4) with a review of the policy recommendations developed from the V-LINC analysis in section 8.4.1. The chapter finishes with section 8.5 that examines the categorisation of cluster life cycle stages and the identification of same (section 8.5.1).

8.2 BioWin V-LINC Analysis Year 1 (Full Report)

V-LINC has been applied to a sample of seventeen firms based in Wallonia, all of which are members of the BioWin Health Cluster - 3 MNCs and 14 SMEs. Seventeen face-to-face interviews were held with personnel from these companies to gather information
concerning their firms’ key relationships for the year 2018 and these meetings uncovered 404 firm linkages in Year 1. The term ‘Respondent Firm Group’ (RFG) is used when describing the summary of firm data gathered for all respondent firms that participated in the analysis. Table 8.1 displays the firms that were part of the BioWin cluster analysis, the percentage of linkages reported in each of the eight linkage categories and the total number of linkages their respective firm engages in for Year 1. The table, as a visual aid, enables the researcher to differentiate the total number of linkages per category for the BioWin cluster.


<table>
<thead>
<tr>
<th>Company</th>
<th>GA</th>
<th>IA</th>
<th>IN</th>
<th>IP</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
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<tbody>
<tr>
<td>Arlenda SA</td>
<td>0%</td>
<td>33%</td>
<td>0%</td>
<td>0%</td>
<td>42%</td>
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<td>12</td>
</tr>
<tr>
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<td>10%</td>
<td>17%</td>
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<td>7%</td>
<td>34%</td>
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<td>33%</td>
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<td>18</td>
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<tr>
<td>Bone Therapeutics SA</td>
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<td>11%</td>
<td>15%</td>
<td>11%</td>
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<td>11%</td>
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<td>Caprion Biosciences SA</td>
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<td>28%</td>
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<td>DNAlytics</td>
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<td>Immunxerts</td>
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<td>20%</td>
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<td>29%</td>
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<td>11%</td>
<td>6%</td>
<td>35</td>
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<tr>
<td>JUMO Automation</td>
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<td>13%</td>
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<td>0%</td>
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<td>13%</td>
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<td>MaSTherCell</td>
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<tr>
<td>Novasep SA</td>
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<td>12%</td>
<td>4%</td>
<td>19%</td>
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<tr>
<td>SynAbs SA</td>
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<td>4%</td>
<td>15%</td>
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<tr>
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<td>14%</td>
<td>17%</td>
<td>24%</td>
<td>10%</td>
<td>10%</td>
<td>0%</td>
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<tr>
<td>Xpress Biologics</td>
<td>13%</td>
<td>6%</td>
<td>32%</td>
<td>3%</td>
<td>19%</td>
<td>10%</td>
<td>10%</td>
<td>6%</td>
<td>31</td>
</tr>
<tr>
<td><strong>RFG Average</strong></td>
<td>12%</td>
<td>12%</td>
<td>17%</td>
<td>7%</td>
<td>22%</td>
<td>12%</td>
<td>13%</td>
<td>4%</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total(n)</strong></td>
<td>49</td>
<td>49</td>
<td>69</td>
<td>28</td>
<td>89</td>
<td>49</td>
<td>53</td>
<td>18</td>
<td>404</td>
</tr>
</tbody>
</table>

**Most Populous(Rank 1-8)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>GA</th>
<th>IA</th>
<th>IN</th>
<th>IP</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>4th</td>
<td>4th</td>
<td>2nd</td>
<td>7th</td>
<td>1st</td>
<td>4th</td>
<td>3rd</td>
<td>8th</td>
</tr>
</tbody>
</table>

Table 8.1: BioWin Distribution of Linkages by Category and by Firm Year 1 (2018)  
Source: Author

Table 8.1 provides the percentage of linkages each firm report across the eight linkage categories combined with the total number of linkages they engage in. It distinguishes the total numbers of linkages per category for the cluster. Table 8.1 reports that the most frequent linkages are in Outputs which account for 22% of all linkages reported; followed by Inputs (17%) and Specialist Services (13%). This is in line with expectations, as firms exist due to continued development of revenues derived from...
satisfied customers and the importance of the value chain as a whole. Inputs and Specialist Services are the spine of a firm’s product and service offering. The least frequent linkage categories are Training (4%) and Industry Peers (7%) of all linkages. This may indicate a disjoint with firms in the same industry and perhaps due to firms’ employees being highly qualified, there is not a current need for training providers.

Table 8.2 and Figure 8.1 display the linkages reported at each geographic level for each of the eight linkage categories. Table 8.2 distinguishes the dominant geographic scope for each category and shows that 29% of Output linkages in this study are within Belgium, whilst a further 36% serve the European market. The total linkages for international export (35%) is greater than that of the combined linkages reported for both local (13%) and national (16%) Output.

These results highlight the importance of the European and international markets for BioWin. When we examine the linkages for those firms who export their goods, sixty-three European and International linkages were reported (when the two large firms are removed from the analysis), accounting for 73% of all RFG Output linkages. Supports for further access to international distribution channels can benefit the BioWin Health Cluster as its firms grow.

<table>
<thead>
<tr>
<th>Geographic Scope</th>
<th>Local</th>
<th>National</th>
<th>European</th>
<th>International</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Agencies</td>
<td>37%</td>
<td>49%</td>
<td>4%</td>
<td>10%</td>
<td>49</td>
</tr>
<tr>
<td>Industry Association</td>
<td>45%</td>
<td>35%</td>
<td>8%</td>
<td>12%</td>
<td>49</td>
</tr>
<tr>
<td>Input</td>
<td>19%</td>
<td>33%</td>
<td>39%</td>
<td>9%</td>
<td>69</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>50%</td>
<td>11%</td>
<td>29%</td>
<td>11%</td>
<td>28</td>
</tr>
<tr>
<td>Output</td>
<td>13%</td>
<td>16%</td>
<td>36%</td>
<td>35%</td>
<td>89</td>
</tr>
<tr>
<td>Research &amp; Development</td>
<td>41%</td>
<td>31%</td>
<td>20%</td>
<td>8%</td>
<td>49</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>26%</td>
<td>36%</td>
<td>26%</td>
<td>11%</td>
<td>53</td>
</tr>
<tr>
<td>Training</td>
<td>72%</td>
<td>22%</td>
<td>6%</td>
<td>0%</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total (n)</strong></td>
<td><strong>126</strong></td>
<td><strong>119</strong></td>
<td><strong>98</strong></td>
<td><strong>61</strong></td>
<td><strong>404</strong></td>
</tr>
</tbody>
</table>

Table 8.2: Distribution of Linkage Categories by Geographic Scope
Source: Author
The majority of Inputs (81%) are sourced from outside the Wallonia area while R&D (72%) and Specialist Service linkages (62%) are sourced from across Belgium. Firms record 94% of their Training linkages across Wallonia (72%) and Belgium (22%). Local and national linkages i.e. those within Wallonia and Belgium, total 61% of all linkages. It is clear that there are pockets of Belgium that are important and heavily linked to the BioWin Health Cluster firms, namely Brussels, Ghent, Louvain-la-Neuve, Liege and Namur as these are some of the most populated cities within Belgium.

Tables 8.3 to 8.7 show the percentage of linkages (by category) that fall into the impact bands. The impact of each linkage category relates to the business impact of individual linkages based on the perception of expert respondents involved with these linkages. Table 8.3 shows the combined impact results for all linkages. Tables 8.4 to 8.7, break the data into local, national, European and international linkages.

In Table 8.3, when the proportions of high business impact linkages are analysed, 22% of Outputs are rated by the RFG to be of highest impact, followed by Government
Agencies (16%), and Industry Association linkages (16%). Table 8.3 showcases that the respondent firms are heavily connected to their ecosystem through relationships that are valuable to them and via strong links through the various local industry associations. In all eight linkage categories, the majority of linkages are in the top two impact bands (e.g. High and Medium bands); overall 76% of all linkages reported are in these bands. Training linkages are of least impact to the firms with 39% in the Low impact band. It is also interesting to discuss the impact accorded to linkages at the differing levels of geographic scope within the research. This is assessed in Tables 8.4 to 8.7, where the data is sorted and analysed across local, national, European and international scopes.

<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IN</th>
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<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
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<tbody>
<tr>
<td>Business Impact</td>
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<td></td>
</tr>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>16%</td>
<td>16%</td>
<td>7%</td>
<td>11%</td>
<td>22%</td>
<td>12%</td>
<td>11%</td>
<td>6%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>63%</td>
<td>57%</td>
<td>61%</td>
<td>64%</td>
<td>57%</td>
<td>57%</td>
<td>79%</td>
<td>56%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>20%</td>
<td>27%</td>
<td>29%</td>
<td>25%</td>
<td>17%</td>
<td>31%</td>
<td>9%</td>
<td>39%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>Total</td>
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<td>49</td>
<td>49</td>
<td>69</td>
<td>28</td>
<td>89</td>
<td>49</td>
<td>53</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 8.3: Business Impact per Linkage Category
Source: Author

Table 8.4 focuses on the business impact of 126 local linkages in Wallonia. Local level is the most populous geographic scope with 31% of all linkages recorded, 15% of which are reported to be in the High impact band. Categories with most links in the High impact band are Output (33%) and Government Agency (28%) linkages. It is important to qualify these results with the fact that 13% of all Output linkages (n=12) are reported at local level.

<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IN</th>
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<th>RD</th>
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<th>TN</th>
<th>Total(n)</th>
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<tbody>
<tr>
<td>Business Impact</td>
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<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>28%</td>
<td>9%</td>
<td>8%</td>
<td>0%</td>
<td>33%</td>
<td>15%</td>
<td>21%</td>
<td>8%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>56%</td>
<td>64%</td>
<td>69%</td>
<td>71%</td>
<td>58%</td>
<td>65%</td>
<td>71%</td>
<td>54%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>17%</td>
<td>27%</td>
<td>23%</td>
<td>29%</td>
<td>8%</td>
<td>20%</td>
<td>7%</td>
<td>38%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
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<td>0%</td>
<td>0%</td>
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<td>0%</td>
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</tr>
<tr>
<td>Total</td>
<td></td>
<td>18</td>
<td>22</td>
<td>13</td>
<td>14</td>
<td>12</td>
<td>20</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 8.4: Business Impact per Linkage Category – Local
Source: Author

Table 8.5 presents the business impact data for 119 linkages across Belgium (outside the Wallonia region), 10% of which are in the top impact quartile. The most important linkages at national level are Industry Association (29%), Output (21%) and Specialist
Service (11%) linkages, respectively. Of the 24 Government Agency linkages recorded nationally, three quarters of them are reported in the high to medium business impact bands.

<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IN</th>
<th>IP</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>4%</td>
<td>29%</td>
<td>0%</td>
<td>0%</td>
<td>21%</td>
<td>7%</td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>71%</td>
<td>41%</td>
<td>57%</td>
<td>67%</td>
<td>64%</td>
<td>40%</td>
<td>79%</td>
<td>75%</td>
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<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
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<td>29%</td>
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<td>7%</td>
<td>53%</td>
<td>11%</td>
<td>25%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>17</td>
<td>23</td>
<td>3</td>
<td>14</td>
<td>15</td>
<td>19</td>
<td>4</td>
<td>119</td>
</tr>
</tbody>
</table>

Table 8.5: Business Impact per Linkage Category – National

Source: Author

The business impact of all European linkages are displayed in Table 8.6. Approximately 85% of the European linkages are reported across four categories; Input, Output, Research and Development and Specialist Services. Approximately 18% of all European linkages are reported to be in the High impact band (18 of 98). Government Agency (50%), Industry Peer (38%) and Output (25%) linkages are reported to be the strongest connections at this geographic scope. The share of linkages reported across the eight linkage categories in the Low impact band ranges from 7% to 30%. Input and Output are the only categories to report linkages in the tenuous category.

<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IN</th>
<th>IP</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>50%</td>
<td>0%</td>
<td>15%</td>
<td>38%</td>
<td>25%</td>
<td>10%</td>
<td>7%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>50%</td>
<td>75%</td>
<td>59%</td>
<td>38%</td>
<td>53%</td>
<td>80%</td>
<td>79%</td>
<td>0%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
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<td>25%</td>
<td>19%</td>
<td>25%</td>
<td>16%</td>
<td>10%</td>
<td>14%</td>
<td>100%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>0%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
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<td>8</td>
<td>32</td>
<td>10</td>
<td>14</td>
<td>1</td>
<td>98</td>
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</tbody>
</table>

Table 8.6: Business Impact per Linkage Category – European

Source: Author

Table 8.7 reports the business impact for the 61 international linkages. Over fifty percent (51%) of all international linkages are recorded in the Output category alone. These are viewed as important to the respondent firms with 16% of these linkages (n=5) reported in the High impact band and another 59% (n=18) in the Medium band. The Output category showcases that respondent’s customers are based across the globe, with 70% of all outputs linkages reported across European and international geographic scopes. It is important to note that Research and Development and
Government Agencies also recorded linkages in the High and Medium impact bands at an international level.

<table>
<thead>
<tr>
<th>Category</th>
<th>Business Impact</th>
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<th>IN</th>
<th>IP</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>20%</td>
<td>16%</td>
<td>0%</td>
<td>0%</td>
<td>16%</td>
<td>25%</td>
<td>0%</td>
<td>0%</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>60%</td>
<td>67%</td>
<td>67%</td>
<td>100%</td>
<td>58%</td>
<td>25%</td>
<td>100%</td>
<td>0%</td>
<td>39</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>20%</td>
<td>17%</td>
<td>33%</td>
<td>0%</td>
<td>26%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>14</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>31</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>61</td>
</tr>
</tbody>
</table>

Table 8.7: Business Impact per Linkage Category – International
Source: Author

Table 8.8 reports the number and percentage of linkages reported in each of the impact bands for each geographic scope, to compare the overall impact of linkages. Porter (2000) believes ‘once a cluster forms, the whole group of industries becomes mutually supporting. Benefits flow forward, backward, and horizontally,’ therefore, it is important to look closely at the impact of local linkages. Local linkages account for 126 of the 404 reported, 15% of which (n=19) are reported as having a High impact. The largest proportion of linkages reported in the High impact band are found at a European level (18%) when compared with national (10%), local (15%) and international (13%) scopes.

The respondent firms engage in more linkages across the local Wallonia region (n=126) than at any other geographic scope. Respondents seem less likely to engage in international linkages which are at further distances (perhaps due to the fact that these links are harder to form and maintain). While national linkages account for 29% of total linkages (119 of 404); they are reported as having the least impact to the respondent firms with only 10% of these linkages appearing within the High impact band. Approximately 24% of all linkages were reported by the respondent firms in the Low to Tenuous impact band.
Geographic Scope | Local | National | European | International | Total
---|---|---|---|---|---
Business Impact
High | >30 to 40 | 15% | 10% | 18% | 13% | 57
Medium | >20 to 30 | 63% | 61% | 60% | 64% | 250
Low | >10 to 20 | 21% | 29% | 17% | 23% | 92
Tenuous | >0 to 10 | 0% | 1% | 4% | 0% | 5
Total (n) | 126 | 119 | 98 | 61 | 404

Table 8.8: Business Impact by Geographic Scope of Linkages
Source: Author

**BioWin Key Connectors Year 1**

Figure 8.2 illustrates the key connectors in the BioWin Health Cluster for 2018. Essentially, the key connectors are those organisations who connect the cluster. They are identified through the number of linkages they have with respondent firms and the business impact of those linkages to respondents is presented in Table 8.9.

![Map of BioWin Health Cluster](image)

Figure 8.2: Key Connectors BioWin Health Cluster
Source: Author

<table>
<thead>
<tr>
<th>Key Connector</th>
<th>BioWin</th>
<th>DGO6</th>
<th>AWEX</th>
<th>VWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>12%</td>
<td>27%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>65%</td>
<td>64%</td>
<td>67%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>23%</td>
<td>9%</td>
<td>33%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total (n)</td>
<td>17</td>
<td>11</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 8.9: Impact of Key Connectors BioWin Health Cluster
Source: Author
In terms of the key connectors identified in the BioWin Health Cluster analysis, strong linkages exist with Input, Industry Associations and Government Agency organisations. The standout Industry Associations and Government Agencies linked to the RFG are BioWin, DGO6 and AWEX respectively. Each of the RFG reports an Industry Association connection with BioWin, which is natural, as all the RFG are members of the cluster. However, this also provides an opportunity for feedback for the organisation from its members. Furthermore, the RFG report that 77% of the linkages to BioWin are reported in the High-Medium impact bands showcasing the importance of the cluster organisation to its members.

Directorate General for Economy, Employment and Research (DGO6) and AWEX are heavily linked to the RFG, highlighting the importance of these linkages for Government Agencies support to the clustered firms. DGO6 is responsible for policy-design and is the implementing body for regional research and innovation policy in Wallonia. Its mission is to implement and monitor the aid granted in the field of economic policy - including the support granted within the framework of EU programmes and encouraging the development of enterprises, especially SMEs. Wallonia Foreign Trade and Investment Agency (AWEX) is a public interest organisation in charge of the promotion of foreign trade and the attraction of foreign investments for Wallonia in Belgium. DGO6 has slightly stronger connections to the RFG reporting 91% of its links to the RFG in the High and Medium bands as opposed to AWEX who reports 67% in same.

There is a strong connection with VWR, which is a key component supplier for seven of the RFG. VWR (acquired by Avantor in 2017) is a global provider of specialist materials and customised solutions for life sciences and advanced technology markets as well as research industries. It is interesting to see that 67% of the linkages are categorised in the Medium impact band.

The next sub-section prescribes the policy recommendation upon careful analysis of Year 1 (2018) data.
8.2.1 BioWin Policy Recommendations Year 1 (2018)

Policy Recommendations

To facilitate BioWin’s progression, there is a need to build upon existing strengths and implement evidence based policy. It is appropriate to forge strategic cluster initiatives that focus on promoting the strengths, linkages and emerging competencies - which are aligned with the regional strategies for smart specialisation regionally\textsuperscript{29} and for the cluster.

1. Seek to further connect cluster members with local Wallonia suppliers

The data pertaining to Input and Specialist Service linkages reported by the RFG in Tables 8.4-8.5 on page 243, suggests there is an opportunity for BioWin to run a series of cluster matchmaking workshops to support members in their efforts to develop partnerships and business cooperation with local suppliers.

The rationale for these matchmaking workshops is twofold; 1) approximately 48% of Input linkages are sourced from across Europe and globally. Importing inputs comes with longer lead times for delivery of goods as well as more expensive transport costs (both in terms of distance and the requirement for cold storage transport in certain instances). On the other hand, 2) the local Input (n=13) and Specialist Service linkages (n=14) reported in Table 8.4 show that the proportion of linkages reported in the High-Medium impact bands is greater at a local level than at national (Table 8.5). This suggests that local Input and Specialist Service linkages are more important to the respondent firms, and more value can be provided for firms were BioWin to further support members to facilitate new supply linkages.

It is important for BioWin to understand why the RFGs are purchasing materials and or services from outside Wallonia, as costs could be reduced if local options are available. Are the items/resources needed by the cluster firms unavailable locally? Does the local area lack the resources and/or expertise to meet the firms’ needs and requirements? Perhaps BioWin could support local businesses to be created to rival national and European firms to compete for members’ input requirements.

\textsuperscript{29} The Walloon Region S3 Priorities can be found at http://s3platform.jrc.ec.europa.eu/regions/BE3/tags/BE3
A series of workshops to firstly bring together and analyse cluster members requirements and subsequently local targeted suppliers to outline the potential market would be crucial in assessing the possibility of increasing local inputs for members. BioWin, as the cluster organisation, can take the lead in this instance, to organise and promote specific events in the local area where local suppliers, who are underutilised or unknown to the firms within the BioWin cluster, can meet and discuss what they can produce/ofer and the associated costs. The benefits of this initiative is threefold, 1) BioWin provides more value for their cluster members through facilitating new local connections, 2) BioWin can support the sector through the provision of cost and time savings for cluster members and thus support economic growth in the local region through increased trade, 3) BioWin has an opportunity to increase its membership by bringing new sub-sector suppliers on board as members into the cluster.

Figure 8. 3: Local Input Linkages in Wallonia Compared with European Linkages
Source: Author

This policy initiative is in line with the European Commission's (EC, 2017) White Paper on the Future of Europe and its start-up and scale-up Initiatives outlined the need for more industrial cooperation and strategic connections within regional and local eco-systems.

2. Facilitate and develop further Internationalisation opportunities for cluster members through attendance at global events and marketing?

Whilst the development of a strong local supply network is critical for any cluster to grow, so too is a connection to new demanding customers and the larger European/global markets (see Figure 8.3). To be cognisant of alignment with
BioWin’s vision of supporting Wallonia by implementing its strategy which achieves international recognition for the excellence of its academic, clinical and industrial research environment in the field of health technology and medical technologies, continued guidance and support for the cluster members to increase and renew internationalisation in the area of output and sales is of high importance.

![Figure 8.4: Importance of Internationalisation for Clusters across Europe](source)

Output linkages are the most frequent linkages accounting for 22% of all linkages reported. Global Output linkages (35%) are greater than that of the combined linkages reported at both local (13%) and national (16%) levels, showcasing the significance of the European and global markets for BioWin members. Further support and continued guidance from BioWin in this area will help members stay cognisant of changes in European and international markets.

Further efforts from BioWin to inform and collaborate with members regarding global events and fairs, will continue to play a crucial role in facilitating levels of internationalisation. BioWin’s global contacts and the introductions at international events can support potential new collaborations for their members and further enhance global market presence. BioWin can provide a showcase for its members by representing their shared interests and continuing to mentor SMEs in dealing with larger international firms that could open up opportunities in the global marketplace.
Of the 89 Output linkages, 63 are reported across Europe and internationally. It is imperative to continue to support the cluster firms in order to enhance internationalisation as well as nurturing and supporting certain SMEs who are yet to establish strong international links. A well-established basis for internationalisation is evident in Tables 8.6 and 8.7 on page 244, and it is important to build on the successful foundations that are already visible in this area. While the number of Output linkages are far greater in the European and international scopes (63 of 89), the local linkages are still deemed most impactful for the RFG (Table 8.8 on page 245). Whilst global events and trade fairs represent opportunities for SMEs to be represented by BioWin on the global stage, there are opportunities for cross cluster match making through the European Cluster Collaboration Platform https://www.clusterCollaboration.eu/ and The Competitiveness Institute http://www.tci-network.org/.

3. Prioritisation of facilitating Research and Development B2B and Academic linkages

![Diagram](image)

Figure 8. 5: Importance of bridging academic and industrial communities
Source: BioWin Leaflet (2018, p. 1)

There is an ever-growing need to assist firms operating in the BioWin Health Cluster, to self-innovate and develop through increased R&D activity, not only with academia and research institutions, but also through collaborative business-to-business links. R&D linkages were the joint third most frequent linkages reported by the RFGs,
emphasising the integral role played by academia and research as a key component in the firms’ day-to-day lives. Two universities; The University of Liege and The University Catholique de Louvain, were close to making the top 4 Key Connectors list and are undoubtedly held in high regard by the RFGs. Successful clusters often gather round prestigious universities on whose quality research they can avail of. Silicon Valley is near Stanford University, with similar high-tech clusters are gathered around MIT near Boston in the United States and Cambridge University in the UK.

Over 40% of all R&D linkages are based in the local region with a further 31% across Belgium. At a local level, 80% of R&D linkages are in the High-Medium bands for impact, confirming the Wallonia region’s importance for the respondent firms concerning R&D. In order for B2B linkages to flourish, strengthening such connections should be a focus. The ability for local firms within the same industry and niches to interact, share knowledge, information and expertise with one another will be an extremely powerful tool and BioWin can use the clustering model to assist cluster members, by continuing to encourage R&D collaboration at local, national and global events. It is evident in Figure 8.6 (national R&D linkages), that there is not one link (no blue lines shown) to Antwerp, a city that could potentially offer the RFG numerous opportunities for R&D collaboration.

![Figure 8.6: Showcase of the Local and National R&D linkages](image)

Source: Author

In Tables 8.4 and 8.5 on page 243, there is a strong case to further develop connections and collaborations between academia and the cluster firms. GSK, for example, with the help of BioWin, Flanders Bio and Flanders Vaccines, held a large and successful
one day workshop called ‘GSK meets Belgian Universities’ in which solely academia
were invited to attend. The aim was to create a platform for Belgian academics and
GSK scientists to exchange skills, knowledge and expertise. GSK were unable to
invite all the desired people without the help of BioWin who used their vast network
to increase the total attendee figures. Are BioWin able to create similar forums and
research groups for innovation to enhance and grow vital connections between cluster
member firms and academia/research and development? This is in line with BioWin’s
goal of bridging academic and industrial communities to create innovation. Due to the
success of the 2018 event, it was held again in 2019.

Closing Remarks
The Year 1 (2018) report has described and applied the V-LINC methodology for
identifying and analysing the linkages that clustered firms in the Wallonia region engage
in. It showcases for industry players, business support organisations and policy makers
how the biomedical ecosystem operates both within Wallonia and the external
relationships forged beyond the region – to provide a baseline analysis for the region.
The data collected proposes the following initiatives for the BioWin cluster:

1. Seek further connections for cluster members with local Wallonia suppliers.
2. Further facilitate and develop Internationalisation opportunities for SME cluster
   members through attendance at global events and marketing.
   locally and nationally in Belgium.

There is a need for long-term partnership and buy-in from the key industry,
government and academic stakeholders to ensure the Walloon region and its
constituent firms benefit from the BioWin cluster. This analysis is applied again in
2019 and 2020 in the following sections, to understand the longitudinal development
and progress made by the cluster and its firms with an aim of mapping its overall
evolution. The following section presents the comparative results and elements for
2019, focusing solely on the data analysis and comparison for Year 1 (2018) data to
Year 2 (2019).

When considering the data reported in Year 1 with Year 2, the longitudinal analysis shows an overall increase of 55 linkages for the RFGs from Year 1 to Year 2. When employment numbers are considered, there was an 8% increase (n=231) in overall employment from Year 1 to Year 2, which indicates positive growth for the RFG as a whole. Two firms recorded a decrease in employment numbers between 2018 and 2019, whilst five firms remained the same size. Thus, ten firms recorded an increase in employment, one of which reported a significantly large increase to move up a firm size category from medium to large. Total employment for the respondent group was 2,988 in 2019 with 231 jobs added between Year 1 and Year 2.

When analysing the RFG data for 2018 to 2019 from this point onwards, data for the firms that participated in the research is compared under three subheadings:

- **Retained Linkages:** investigating changes in Categories, Business Impact and Geographic Scope.
- **New Linkages:** investigating changes in Categories, Business Impact and Geographic Scope.
- **Lost Linkages:** investigating changes in Categories, Business Impact and Geographic Scope.

<table>
<thead>
<tr>
<th>Category</th>
<th>Linkages Y1 2018</th>
<th>Linkages Y2 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported</td>
<td>Reported</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>No.</td>
</tr>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>No. (%)</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Government Agencies</td>
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<td>56</td>
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<tr>
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<td>44 (90%)</td>
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</tr>
<tr>
<td></td>
<td>9 (18%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>Industry Association</td>
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<td>56</td>
</tr>
<tr>
<td></td>
<td>47 (96%)</td>
<td>9 (18%)</td>
</tr>
<tr>
<td></td>
<td>2 (4%)</td>
<td>8 (28%)</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>20 (71%)</td>
<td>4 (14%)</td>
</tr>
<tr>
<td></td>
<td>8 (28%)</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Input</td>
<td>69</td>
<td>82</td>
</tr>
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<td></td>
<td>61 (88%)</td>
<td>20 (29%)</td>
</tr>
<tr>
<td></td>
<td>7 (10%)</td>
<td>3 (4%)</td>
</tr>
<tr>
<td>Output</td>
<td>89</td>
<td>109</td>
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<td>17 (19%)</td>
<td>17 (19%)</td>
</tr>
<tr>
<td>Research &amp; Development</td>
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<td>57</td>
</tr>
<tr>
<td></td>
<td>40 (82%)</td>
<td>17 (35%)</td>
</tr>
<tr>
<td></td>
<td>9 (18%)</td>
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<tr>
<td>Specialist Service</td>
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<td>57</td>
</tr>
<tr>
<td></td>
<td>41 (77%)</td>
<td>16 (30%)</td>
</tr>
<tr>
<td></td>
<td>12 (23%)</td>
<td>3 (16%)</td>
</tr>
<tr>
<td>Training</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>16 (89%)</td>
<td>3 (16%)</td>
</tr>
<tr>
<td></td>
<td>3 (16%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>Total</td>
<td>404</td>
<td>459</td>
</tr>
<tr>
<td></td>
<td>342 (85%)</td>
<td>117 (29%)</td>
</tr>
<tr>
<td></td>
<td>62 (15%)</td>
<td>62 (15%)</td>
</tr>
</tbody>
</table>


Source: Author

30 The percentage of the New and Lost linkages are taken from the 2018 base year figures per category
Table 8.10 presents the number of linkages recorded by the RFG associated with each of the eight V-LINC categories, highlighting the differences from 2018 (Year 1) to 2019 (Year 2). When the two data sets are compared, all but one category recorded more links gained than lost. Looking in detail at the creation of 55 new links from Year 1 to Year 2, it must be noted that there is not simply 55 New links, period. In short, each category gained New linkages, Lost linkages and Retained certain linkages from the previous year, and as such the overall calculation shows a healthy increase, which is more complex than at first glance.

Up until this point of the V-LINC tables (as per Year 1 results and tables) have focused on explaining two variables e.g. Companies by Linkage Category, Linkage Category by Geographic Scope etc. However, in this longitudinal results section of the Year 2 report, in order to share more detail whilst reducing the number of tables included, Tables 8.11 to 8.13, report the detail of three variables; the Business Impact and Geographic Scope of the Retained, New and Lost Linkages by Category.

To make this as easy for the reader to interpret and understand Tables 8.11 to 8.13 on page 259 share the same format. Business Impact by Linkage Category of the Retained, New and Lost Linkages is reported on the left hand side of each table and the Geographic Scope by Linkage Category of the Retained, New and Lost Linkages is displayed on the right hand side (shaded in light grey).

To showcase this, at first glance the Output category records an increase of 20 links (Table 8.10), however, this has been brought about by the creation of New links i.e. 37 New customers, whilst simultaneously 17 linkages have been Lost. Similarly, Inputs recorded 13 New linkages overall as a category, though, this figure includes 20 New linkages created while 7 of the 2019 Inputs were Lost. Table 8.10 showcases that 117 New linkages are developed, whilst another 62 linkages recorded in Year 1 are Lost (and therefore not reported) in Year 2.

Tables 8.11 to 8.13, explore the Business Impact and Geographic Scope of the Retained, New and Lost Linkages in Year 3 by Category. This shows that four categories report
an overall increase in their linkage numbers, three categories have lost linkages and one has reported the same number between Year 2 and 3. The analysis will now discuss the Retained, New and Lost Linkages in the subsequent sections.

**Retained Linkages**

Of the 459 linkages reported by the RFG in 2019 (Table 8.10), there is an 85% retention rate of linkages previously reported by the respondents in Year 1 to Year 2. Four categories retain more than this 85% average across all categories, these are Industry Association (96%), Government Agencies (90%), Training (89%) and Input (88%). Whilst, Industry Peers (71%), Output (82%), Research and Development (82%) and Specialist Services (77%) are below this average and we see more turnover in these categories.

In Table 8.11, it seems that the categories where there is more turnover of linkages e.g. Industry Peers, Output and Research and Development report more of their Retained linkages in the High and Medium business impact bands. For example, Specialist Services had the second lowest proportion of retained linkages (77%) from Year 1 to 2 but they report that 90% of the Retained linkages in this category are in the High and Medium bands. Similarly, 81% of Retained Output linkages with customers are reported in the High and Medium impact bands. On the other hand, in categories where there is less turnover of linkages e.g. Industry Association and Training for example, report less of their Retained linkages in the High and Medium business impact bands in these categories, than those categories with lower than average retention rates mentioned above. Perhaps this showcases the longer term connection and trust developed with these organisations – but also that they are not as critical to the value chain of respondents.

Table 8.11 also looks at the geographic scope of the Retained linkages. Both Local (31%) and national (31%) linkages are the most populous, then European accounts for a quarter of all Retained linkages and international total 13% of all Retained linkages. Table 8.11 emphasises the importance of the linkages across Belgium with 62% of all the linkages retained from Year 1 to Year 2 at these geographic scopes. Reviewing Table 8.11, one can observe that there are a few differences to that of Table 2 (see
Appendix C), in the retained cohort the proportion of international Output linkages and local Government Agency and Research and Development linkages are greater, showcasing the role these customers, research institutions and suppliers play in the respective value chains of respondents.

**New Linkages**

In Table 8.10, the 117 New linkages account for 25% of all the linkages (n=459) reported in Year 2. Respondents’ customers (OU=37) record the highest proportion (32%) of New linkages reported. Showcasing how within the value chain of respondent firms there is constant upgrading, development and growth of relationships with new customers. The other categories which see a significant increase in New linkages are Inputs, Research and Development and Specialist Services. The Training category was the least populous category among the 117 New links created between 2018 and 2019 (n=3), which potentially points to the fact that firms are hiring extremely skilled workers who may not require a large amount of training or upskilling.

When one starts to assess Business Impact, it is evident that nearly two-thirds (63%) of all New linkages reported in Year 2 are found in the High to Medium business impact band. This demonstrates that firms were developing High impact linkages during the first and second year. In the most populous category (Outputs) 60% of the new customers are found in the High to Medium business impact bands (Table 8.12), indicating their importance to the respondent firms whilst, 82% of Government Agency links are found in the High to Medium impact band. Both of these findings are a confirmation of the important role of the government and customers to the respondent firms.
Note to Table 8.11-8.13: The Tenuous impact band was removed from the following tables as it only represented 0%-1% of all linkages reported between Year 1 and Year 2.

### Table 8. 11: Business Impact and Geographic Scope of Retained Linkages Year 2 by Category

<table>
<thead>
<tr>
<th>Linkage Category</th>
<th>Business Impact Retained Linkages Y1 - Y2</th>
<th>Geographic Scope Retained Linkages Y1 - Y2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>18%</td>
<td>55%</td>
</tr>
<tr>
<td>Industry Association</td>
<td>15%</td>
<td>55%</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>15%</td>
<td>60%</td>
</tr>
<tr>
<td>Input</td>
<td>18%</td>
<td>51%</td>
</tr>
<tr>
<td>Output</td>
<td>23%</td>
<td>58%</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>20%</td>
<td>55%</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>22%</td>
<td>68%</td>
</tr>
<tr>
<td>Training</td>
<td>0%</td>
<td>69%</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>196</td>
</tr>
<tr>
<td>Percentage</td>
<td>18%</td>
<td>57%</td>
</tr>
</tbody>
</table>

### Table 8. 12: Business Impact and Geographic Scope of New Linkages Year 2 by Category

<table>
<thead>
<tr>
<th>Linkage Category</th>
<th>Business Impact New Linkages Y1 - Y2</th>
<th>Geographic Scope New Linkages Y1 - Y2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>9%</td>
<td>73%</td>
</tr>
<tr>
<td>Industry Association</td>
<td>11%</td>
<td>22%</td>
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<tr>
<td>Industry Peers</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>Input</td>
<td>20%</td>
<td>60%</td>
</tr>
<tr>
<td>Output</td>
<td>16%</td>
<td>43%</td>
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<tr>
<td>Research &amp; Dev.</td>
<td>0%</td>
<td>53%</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>6%</td>
<td>69%</td>
</tr>
<tr>
<td>Training</td>
<td>0%</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>61</td>
</tr>
<tr>
<td>Percentage</td>
<td>11%</td>
<td>52%</td>
</tr>
</tbody>
</table>

### Table 8. 13: Business Impact and Geographic Scope of Lost Linkages Year 2 by Category

<table>
<thead>
<tr>
<th>Linkage Category</th>
<th>Business Impact Lost Linkages Y1 - Y2</th>
<th>Geographic Scope Lost Linkages Y1 - Y2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Industry Association</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>Input</td>
<td>0%</td>
<td>57%</td>
</tr>
<tr>
<td>Output</td>
<td>6%</td>
<td>65%</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>0%</td>
<td>33%</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>8%</td>
<td>67%</td>
</tr>
<tr>
<td>Training</td>
<td>0%</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>Percentage</td>
<td>5%</td>
<td>58%</td>
</tr>
</tbody>
</table>

Note to Table 8.11 to 8.13: The Four business impact bands are: H = High (30 to 40), M = Medium (20 to 30) and L = Low (10 to 20). The Geographic Scopes used are: L = Local Linkages (Wallonie); N = National Linkages (Belgian); EU = European Linkages and INT = International Linkages.
The geographic scope of the New linkages reported are found on the right-hand side of Table 8.12. Over 57% of the New linkages developed in 2019 are found outside of Belgium, showcasing the ability of respondent firms’ to develop linkages abroad. This is interesting as when European and international scopes are examined for all linkages in Table 2, these respective scopes account for approximately 44% of all linkages reported in 2019. The geographic scope of the Output linkages (Table 8.12) are mostly found outside of Belgium which implies a strong internationalisation strategy amongst the clustered firms within the BioWin cluster.

**Lost Linkages**

Table 8.10 on page 255, showcases the 62 linkages that were Lost between Year 1 and Year 2 and their respective categories (reported in Year 1 but not reported subsequently in Year 2). Output, Specialist Services and Research and Development linkages are the three categories that record the highest proportion of Lost linkages between 2018 and 2019. Furthermore, of these Lost customer linkages, over 70% of them are reported in the High-Medium business impact band, which is an element worth monitoring in the following year assessment. Perhaps there are other reasons which explain why respondents have discontinued a relationship with a customer or supplier, e.g. shift in raw material requirements, manufacturing process, better price point from a competitor, shift in the product or service necessitates a change of supplier or customer etc. The V-LINC methodology reporting for respondents includes a circular process for participating firms to ensure that such Lost linkages are highlighted for firms - so that they have the necessary information to hand to take corrective measures if required.

Considering these losses and in which categories allows respondent firms to assess how and why this occurred and if it is intentional and known, or not commonly understood. The categories with the least number of Lost linkages, found in Year 1 results but not reported in Year 2, occur across the Industry Association (n=2) and Training (n=3) categories. These encouraging figures for Lost Training linkages may simply be as a result of the low number of linkages across the category i.e. (TN=18). Therefore, there is a less dramatic turnover of linkages observed year after year, and hence this could explain why only three linkages were lost between Year 1 and Year 2. Each category is analysed in detail in Table 8.13 where the Business Impact of the Lost linkages is
examined. One reason for assessing such impact is the ability to indicate when High and Medium business impact linkages are Lost which may be due to various reasons i.e. staff redundancy, downsizing etc.

The data showcases that 63% of linkages Lost (n=39) are found in the High and Medium impact bands. On the opposite end of business impact, 35% (22 of the 62) of Lost linkages are in the Low impact bands. One would expect a greater number of Low and Tenuous links to be lost over time rather than those with a High or Medium impact to the firms as more impactful linkages are of more benefit to the firms and therefore, more costly to develop, as in the majority of instances they require face-to-face meetings to build trust and develop these relationships over time.

The right-hand side of Table 8.13 also reports the geographic scope of the Lost linkages. Output linkages show an extremely high percentage loss (76%) of global customers. Three quarters of the seventeen international linkages Lost between Year 1 and 2 are with customers of the RFG, which is interesting as such Lost linkages may adversely affect the individual firms' performance. The information above is an example of important information shared with the relevant firms impacted by such losses to understand why these connections ended, and to draw their attention to same.

There was a 2:1 ratio of Lost to New linkages for the Industry Peer category in 2019. A cluster's competitiveness is sharpened by both collaboration and competition, and the consistent loss of Industry Peer links over time is worrying and something that should be discussed. When one delves deeper into the Industry Peer data gathered between 2018 and 2019 numerous observations can be made. Overall, eight Industry Peer linkages were Lost and the local scope (n=4) provided the highest proportion of Lost linkages, followed by European (n=2), international (n=1) and national (n=1). The rationale for losing so many local connections could be numerous and varying. Potentially, as firms grow and become better equipped with skills, knowledge and expertise that they acquire year on year, might mean they no longer require such local Industry Peers connections and are becoming more self-sufficient.
It is interesting to see that the largest proportion (32%) of all Lost linkages occurs at a national level (Table 8.13), however, these are more than replaced with the addition of 36 New European linkages in Table 8.12. The same is true for all other linkage categories where more New linkages are created than Lost. The longitudinal analysis provides some further detail on how linkages have been Retained, developed and Lost between Year 1 and 2 in the V-LINC analysis of BioWin members. This data is pertinent to evaluate the BioWin Health Cluster by benchmarking the results against Michael Porter’s (1998b) Competitive Diamond of Local Clustering. This is undertaken in the next section.

**Evaluating the BioWin Health Cluster**

The performance of the BioWin cluster in 2019 can be considered based on the four main features of cluster locations, outlined in Porter’s Diamond model, Porter (1998b).

- **Local Input Factors**

Comparing the BioWin Health cluster with Porter’s (1998b) Competitive Diamond of Local Clustering is useful to analyse the determinants of a cluster in the Wallonia region. Firstly, considering reliance on local Input factors, it is apparent that the firms in Wallonia have many Training, Industry Peer, Industry Association, Government Agencies and Research and Development linkages (Table 2). Similarly, regarding demand conditions, these firms serve sophisticated and demanding customers with the V-LINC findings showing empirically that these customers are not only locally in Wallonia or national across Belgium but are spread across Europe and further afield internationally.

Cluster theory, although subtle on the topic of export sales reliance, suggests a high and stable proportion of exports can have a positive impact on clustering. However, with most Output linkages being reported as European and international linkages (Table 2), it is imperative that the BioWin firms continue to further their pursuit of these markets to enable growth and development for the cluster. With only 29% (Table 2) of all Output linkages being spread across the local and national region, perhaps firms could supplement their international successes by further targeting markets and customers in Belgium which will support and buttress further growth and development.
A third determinant of Porter’s cluster model involves firm strategy and rivalry: competition should be intensive but also involve cooperation among local rivals. While quite a large proportion of firms surveyed compete directly with one another, Table 2 reports that 50% (n=12) of all Industry Peer linkages reported by the RFGs are recorded at local and national (Wallonia and Belgium) scopes respectively. The 71% (Industry Peer) of linkages reported in the High and Medium bands in Table 3b and 3c (Appendix C) highlight good cooperation, collaboration and willingness among firms to share knowledge and expertise with each other, while fast tracking their own learning and productivity in a proactive manner. Porter (1998a) notes that Industry Peer linkages with other firms within the same sector are key drivers of a cluster regarding innovation and economic growth, as they provide competitive pressure for firms to be innovative and creative.

With regard to the fourth determinant, of competitive local clustering: related and supporting industries, strong connections are depicted both at local and national level with 56% of the 459 linkages operating across Belgium. Numerous local and national connections are reported in the data with Training (95%), Research and Development (63%) and Specialist Services (55%) reporting most of their linkages at this geographic scope (Table 2). This research brings the author to the conclusion that overall, the cluster is continuing to evolve, grow and advance. The biomedical health cluster is extremely diverse, with large MNCs and an abundance of Micro and Small firms addressing different segments of the sector. These smaller firms face scaling challenges and further supports from a European type cluster organisation could enhance their opportunities to further grow and support the Wallonia region.

The authors believe that the BioWin Health cluster can be considered an exemplar when compared with the best performing European cluster focused models that operates across a number of the most competitive countries in Europe (including Denmark, France, Germany and Norway). A thorough understanding of the VLINC results of the BioWin Health cluster in Wallonia has sought to identify cluster type policy initiatives, which can strengthen and support the BioWin cluster. These recommendations are outlined in the next section.
8.3.1 Policy Recommendations Year 2 (2019)

To facilitate BioWin’s progression, there is a need to build upon existing strengths and implement evidence based policy. It is appropriate to forge strategic cluster initiatives that focus on promoting the strengths, linkages and emerging competencies - which are aligned with the regional strategies for smart specialisation regionally.

1. Further enhance and facilitate cluster members’ ability to reach crucial foreign markets

It is imperative that BioWin continues to support the cluster firms in order to enhance internationalisation as well as nurturing and supporting certain SMEs who are yet to establish strong international links. These objectives are in line with the cluster organisation: “BioWin works proactively to promote the international technological assets of Wallonia in the field of Health and above all, to position the expertise, skills and potential of Walloon innovation players in the various strategic themes of the cluster” (BioWin, 2019). Figure 8.7 visualises the RFG capability to source vital raw materials, goods and services from new suppliers, not only in Belgium but across Europe and the rest of the world i.e. East Coast of the US and Canada, and new connections in France, Switzerland and the UK.


Ratten et al. (2007, p. 368) note that “one of the most important enablers of internationalisation was found to be the use of networks or membership in a cluster.” They discuss the vital role that membership in networks or clusters play in improving internationalisation for SMEs, combined with the driving factors of internal resources and capabilities within a strong industry structure. SME internationalisation, in the
BioWin Cluster, relies on the members’ ability to connect and maintain linkages with foreign businesses and markets. The data from the RFG, contradicts what is perceived as the norm for SMEs and internationalisation, as the literature pertains to small firms focusing solely on their own domestic market and neglecting international opportunities (Dana et. al., 1999a; 1999b).

When we take a closer look at the data and figures for Year 2, Output linkages (n=109) are the most frequent linkages accounting for 24% of all linkages reported (Table 8.10 on page 255). When the data is compared with that of Year 1 there is a 28% increase (Year 1 = 61 INT linkages, Year 2 = 78 INT Linkages). Of the 78 international linkages, the Output category is responsible for 55% (n=42) of the total. This records a 31% increase on the overall number of international Output linkages from Year 1 to 2. Of the 109 Output linkages (Table 8.10), 78 are reported across Europe and internationally accounting for 72% of the total linkages in this category. Internationalisation is evident for the RFG in Tables 3d and 3e and it is important to build on the successful footholds that are already visible in this area. Such European Output linkages are predominantly found across France, Germany and the Scandinavian countries.

Support for further access to international distribution channels is pertinent to the members and can benefit the BioWin Cluster as its firms grow. Further efforts from BioWin to inform and collaborate with members regarding global events, trade missions and fairs, will continue to play a crucial role in facilitating levels of internationalisation. BioWin’s global contacts and the introductions at international events and trade fairs can support potential new collaborations for BioWin’s members and further enhance global market presence.

BioWin can continue to provide a showcase for its members by representing their shared interests and continuing to mentor SMEs in dealing with larger international firms that can open opportunities in the global marketplace. Interestingly, whilst the number of Output linkages are far greater in the European and international scopes (78 of 109), the local and national linkages are deemed to have the most impact for the RFG with 94% of these linkages being reported in the High to Medium impact band (Table 8.10).
2. Facilitate increased B2B meetings and encourage collaboration amongst cluster members to increase collaboration and competition

Additional monthly/bi-monthly networking/coffee mornings for different segments of the cluster to allow CEOs access to fellow CEOs and thus encourage collaborative approaches and projects amongst local companies is sought after from the information gathered during the interview process.

The need for more inter-firm interaction is evident in the figures of the Industry Peer category. Engelberg et al. (2018, p. 1948) believe that “a group of similar firms that are co-located lowers the average cost of information acquisition for these firms. Given that peer firms around the same location are more likely to have similar fundamentals, learning about a firm in an industry cluster is likely to help in valuing other similar firms within the same area.” The value of collaboration, knowledge sharing and connectivity between Industry Peer firms is unrivalled, powerful and cannot be overlooked. Brown and Bell (2001, p. 11) note that “firms are beginning to pay closer attention to their own connections with one another, to recognise the common problems they face and to look for relationships and alliances which provide collective solutions and enable their competitive advantage to be maintained.”

The data pertaining to Industry Peer linkages portray a smaller percentage decrease of 14% (Year 1=28, Year 2=24). Of the linkages Lost and gained, the Industry Peer category showcased a ratio loss of 2:1 (loss=8, gain=4). An interesting point to note is that of the 24 linkages for Year 2, exactly 50% are found within Belgium and the other half are found at a European and international scope. Perhaps increasing the number of Industry Peer linkages locally could help the RFGs grow in areas of knowledge and expertise as well as reducing time between contact due to differing time zones as is found with international peers.

At a local level, Industry Peers is perceived as one of the lowest in relation to business impact (27% in the Low to Tenuous band). It is important to promote and grow collaboration between clustered firms as Keeble and Nachum (2002, p. 79) believe that
“clustering enhances competitive advantages and growth by enabling firms to tap into a collective learning process, which operates through skilled labour mobility within the local labour market.” Furthermore, it is believed that “interconnectedness is of course also a fundamental characteristic of all strong definitions of clustering itself” (Keeble and Nachum, 2002, p. 79).

3. Support the attraction and retention of talent to Wallonia through state-of-the-art facilities and local amenities

Considering the increase in the total employment of the RFG, it is evident that the BioWin cluster and its surrounding area is in a growth and evolution phase. In order to sustain this growth, potential investment in the local catchment area may play an integral role. This combined with the announcement of 300+ additional jobs for the evolving Charleroi BioPark (4 firms, 3 of which are included in the RFG) over the next 12 months is in line with the growth pattern gleaned from the Year 2 analysis. Earle (2003) notes that due to the global workforce being more mobile than ever before, companies now, not only compete for talent nationally but also at an international scope. Furthermore, with these firms and clusters alike competing for the top of the class workforce and talent, it is imperative to be able to offer the same if not better amenities as rival clusters locations may be more appealing to the latest set of graduates.

Niedomysl and Hansen (2010, p. 1647) state “how to attract and retain skilled labour is now a central part of regional policy debates.” This holds true when one considers the 17 face-to-face interviews 70% (12 of 17) revealed the need for improved facilities and investment in amenities serving all cluster members in the local area of Charleroi and it’s BioParks i.e. a café, a restaurant and gym were but a few suggestions mentioned. Earle (2003, p. 249) suggests that “it makes sense that if an organisation can provide an environment in which people enjoy being, that makes them feel energised and valued by their employer, then they will want to stay there.” Hence, it is argued that it is often

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31 Empirical research on the positive effects of clustering on the economic performance of regions is vast, namely: increasing the productivity and innovation capacity of cluster firms, stimulating new business formation and increasing the innovation capacity of firms (Porter, 2000a).
the corridors, cafes, bars and similar meeting points where information is exchanged the most (Maskell et al., 2006).

Furthermore, as workforces grow, quality homes, schools and neighbourhoods are important. These are places where people actually want to live, work and to raise families. Such facilities and amenities can act as a magnet for talent to draw them towards Wallonie, whilst also providing informal/ad-hoc networking and collaboration that could occur between firms through more face-to-face contact and interaction rather than working in isolation. Niedomysl and Hansen (2010, p. 1647) argue that “regions that can provide a variety of amenities spanning from urban rhythms to recreational outdoor experiences have a competitive advantage in attracting talented people, assuming that they can provide employment opportunities.”

In a research project involving 663 people, commissioned by the American Society of Interior Designers, it was found that “employees who were pleased with their physical workplaces were 31 per cent more likely to be satisfied with their jobs than those who were not” (Earle, 2003, p. 248). Thus creating an attractive place to work and live in Gosselies and the surrounding local areas will enable the members of the BioWin cluster to not only attract top talent from across the globe, but also more importantly retain them on a long-term basis. There is a role to play here for the cluster to advocate on behalf of the members and collaborate with regional and local authorities to address this need.

**Closing Remarks**

This report has described and applied the V-LINC methodology for identifying and analysing the linkages that firms in The Wallonia region engage in for 2019. It showcases for industry players, business support organisations and policy makers how the biomedical ecosystem operates both within Wallonia and the external relationships forged beyond the region – to provide some commentary on the growth, expansion and even contraction of linkages through the respondent firm group since the 2018 baseline analysis for the region. These relationships, from 2018 and the current cohort of connections in 2019 are displayed in the linkage maps throughout the report and align
with the upcoming joint action events in 2020 organised by BioWin and AWEX. Such events for the RFG to avail of are set to take place in Korea, USA, Japan, and Australia to name but a few and will undoubtedly encourage the creation of new global linkages for the cluster members like in 2019.

The data collected proposes the following initiatives for the BioWin cluster:

1. Further enhance and facilitate cluster member’s ability to reach crucial foreign markets.
2. Facilitate increased B2B meetings and encourage collaboration amongst cluster members to increase collaboration and competition.
3. Support the attraction and retention of talent to Wallonia through state-of-the-art facilities and local amenities.

There is a need for long term partnership from the key industry, government and academic stakeholders to ensure the Walloon region and its constituent firms benefit from the BioWin cluster. This analysis will be applied again in 2020 to understand the longitudinal development and progress made by the cluster and its constituent firms. The next section presents the results for the BioWin cluster for Year 3 V-LINC analysis.

8.4 BioWin V-LINC Data Analysis and Comparison Year 2 (2019) data to Year 3 (2020)

When considering the data reported in Year 2 with Year 3 (Tables 1-5) (see Appendix D), the longitudinal analysis shows an overall decrease of 1 linkage for the RFGs from Year 2 to Year 3 (Table 8.14). While this loss of one linkage overall, from Year 2 to Year 3 may appear to be negative, it must be highlighted that this occurred during a global pandemic (COVID-19). When employment numbers are considered, a 12% increase (n=354) was reported by the RFG from Year 2 to Year 3 during the data collection process. This indicates positive growth for the respondent firms as an overall cohort.

Between Year 2 and 3, two firms recorded a decrease in employment, whilst six firms maintained their employment level, and nine respondent firms recorded an increase in employment, one of which nearly grew by three times its 2019 employment. Total
employment for the respondent group was 3,342 in 2020 with 354 jobs added between Year 2 and Year 3 in the midst of the COVID-19 pandemic.

The detail in each of the tables is broken down into three variables displaying the data for the Retained, New and Lost linkages. The left hand side of the tables in plain white represent the business impact of the linkages with the right hand side in light grey displaying the linkages’ geographic scopes for all categories from Year 2 to Year 3.

When analysing the RFG data for Year 3 (2020) from this point onwards, data for the firms that participated in the research is compared with the Year 2 (2019) data under three subheadings:

- **Retained Linkages;** investigating changes in Categories, Business Impact and Geographic Scope.
- **New Linkages;** investigating changes in Categories, Business Impact and Geographic Scope.
- **Lost Linkages;** investigating changes in Categories, Business Impact and Geographic Scope.

<table>
<thead>
<tr>
<th>Category</th>
<th>Linkages Y2 2019</th>
<th>Linkages Y3 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported</td>
<td>Retained Y2-Y3</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>56</td>
<td>60</td>
</tr>
<tr>
<td>Industry Association</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Input</td>
<td>82</td>
<td>84</td>
</tr>
<tr>
<td>Output</td>
<td>109</td>
<td>112</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>57</td>
<td>53</td>
</tr>
<tr>
<td>Training</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>459</td>
<td>458</td>
</tr>
</tbody>
</table>

Source: Author

Table 8.14 presents the number of linkages recorded by the RFG associated with each of the eight V-LINC categories, highlighting the differences from 2019 (Year 2) to 2020 (Year 3). When the two data sets are compared, four categories record more links gained than lost, with just an overall total loss of one link in 2020 (n=458), in comparison to the

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32 The percentage of the New and Lost linkages are taken from the 2019 base year figures per category
previous year (n=459). It must be noted that there is not simply one linkage lost, in reality each category Retained, gained and Lost linkages between Year 2 and 3, and this analysis shows the complexity behind how such changes occurred.

Up until this point, the V-LINC analysis focused on explaining two variables e.g. Companies by Linkage Category, Linkage Category by Geographic Scope etc. However, in this longitudinal results section of the Year 3 report, in order to share more detail whilst reducing the number of tables included, Tables 8.15 and to 8.17 on page 276, report the detail of three variables; the Business Impact and Geographic Scope of the Retained, New and Lost Linkages by Category. To make this as easy for the reader to interpret and understand, Tables 8.15 to 8.17 share the same format. Business Impact by Linkage Category of the Retained, New and Lost Linkages is reported on the left hand side of each table and the Geographic Scope by Linkage Category of the Retained, New and Lost Linkages is displayed on the right hand side (shaded in light grey).

To showcase this, at first glance the Output category records an increase of 3 links (Table 8.14), however, this has been brought about by the creation of New links i.e. 29 New customers, whilst simultaneously 26 linkages have been Lost. Similarly, Inputs recorded 2 New linkages overall as a category, though, this figure includes 11 New linkages created while 9 of the 2019 Inputs were Lost. Table 8.14 showcases that 67 New linkages are developed, whilst another 68 linkages recorded in Year 2 are Lost (and therefore not reported) in Year 3. Tables 8.15 to 8.17, explore the Business Impact and Geographic Scope of the Retained, New and Lost Linkages in Year 3 by Category. This shows that four categories report an overall increase in their linkage numbers, three categories have Lost linkages and one has reported the same number between Year 2 and 3. The analysis will now discuss the Retained, New and Lost Linkages in the subsequent sections.

**Retained Linkages**

Of the 458 linkages reported by the RFG in 2020 (Table 8.14), there is an 85% retention rate of linkages previously reported by the respondents in Year 2 to Year 3. Five categories retain more than this 85% average across all categories, these are Industry Association (96%), Government Agencies (95%), Training (94%), Input (91%) and
Specialist Service (86%). Whilst, Industry Peers (67%), Output (75%) and Research and Development (81%) are below this average and we see more turnover in these categories.

These categories are analysed further in Table 8.15, it seems that the categories where there is more turnover of linkages e.g. Industry Peers, Output and Research and Development report more of their Retained linkages in the High and Medium business impact bands. For example, Industry Peers had the lowest proportion of retained linkages (67%) from Year 2 to 3 but they report that 93% of the retained linkages in this category are in the High and Medium bands. Perhaps this highlights that respondents are highly selective about which competitors they collaborate with (Industry Peers) and trust is a big part of these relationships. Similarly, 88% of retained Output Linkages with customers are reported in the High and Medium impact bands.

On the other hand, in categories where there is less turnover of linkages e.g. Industry Association and Training for example, report less of their Retained linkages in the High and Medium business impact bands in these categories, than those categories with lower than average retention rates mentioned above. Perhaps this showcases the longer term connection and trust developed with these organisations – but also that they are not as critical to the value chain of respondents.

Table 8.15 also looks at the geographic scope of the Retained linkages. Local, as was the case in the Year 2 analysis, is still the most populous geographic scope (32%), whilst national changes places with European and international links account for 16% of the total. Table 8.15 emphasises the importance of the linkages across Belgium with 60% of all the linkages Retained from Year 2 to Year 3 at these geographic scopes. If Table 2 (see Appendix D) the distribution of linkage categories by geographic scope is compared with the distribution of the Retained linkages by geographic scope in Table 8.15; one can observe that there are a few differences, in the retained cohort the proportion of international Output linkages and local Specialist Supplier linkages is greater, showcasing the role these customers and suppliers play in the respective value chains of respondents.

**New Linkages**

In Table 8.14, the 67 New linkages account for 15% of all the linkages (n=458) reported in Year 3. Respondents’ customers (OU=29) records the highest proportion (43%) of New
linkages reported. Showcasing how within the value chain of respondent firms there is constant upgrading, development and growth of relationships with new customers. When compared with the numbers of New linkages reported in Year 2 the overall number (n=117) reported was nearly twice that of Year 3 (n=67), perhaps this is a result of the COVID-19 pandemic which caused problems worldwide for the development of B2B connections. However, with the constraints of COVID-19 it was pleasing to see respondent firms developing over two thirds of these new Output linkages in export markets (Table 8.16).

The other categories which see a significant increase in New linkages are Government Agencies and Inputs. These new connections can potentially be explained by connections with Government Agencies regarding COVID-19 supports and initiatives for SMEs and new inputs required to support firms working within and throughout the COVID-19 pandemic. The Training category was the least populous category among the sixty-seven New links created between 2019 and 2020 (n=1), which potentially points to the fact that firms were mostly focused on keeping their doors open and people in jobs as a priority focus – where training took a back seat.

When one starts to assess business impact, it is evident that 85% of all New linkages reported in Year 3 are found in the High to Medium business impact band. This demonstrates that although there has been a large reduction in relation to New linkages forged in Year 3 (n=67) when compared with Year 2 (n=117), firms were more selective in developing High impact linkages i.e. only 63% of the New linkages reported in 2019 were in the High to Medium impact bands. In the most populous category (Outputs) 86% of the new customers are found in the High to Medium business impact bands (Table 8.16), indicating their importance to the respondent firms whilst, all New Input links are found in the High to Medium impact band. Both of these findings are a confirmation of the important role of the supply chain to the respondent firms.
Note to Table 8.15-8.17: The Tenuous impact band was removed from the following tables at is only represented 0%-1% of all linkages reported between Year 2 and Year 3.

### Table 8.15: Business Impact and Geographic Scope of New Linkages Year 3 by Category

<table>
<thead>
<tr>
<th>Linkage Category</th>
<th>Business Impact New Linkages Y2 - Y3</th>
<th>Geographic Scope New Linkages Y2 - Y3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>14%</td>
<td>43%</td>
</tr>
<tr>
<td>Industry Association</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>0%</td>
<td>75%</td>
</tr>
<tr>
<td>Input</td>
<td>27%</td>
<td>73%</td>
</tr>
<tr>
<td>Output</td>
<td>17%</td>
<td>69%</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>0%</td>
<td>88%</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Training</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>49</td>
</tr>
<tr>
<td>Percentage</td>
<td>12%</td>
<td>73%</td>
</tr>
</tbody>
</table>

### Table 8.16: Business Impact and Geographic Scope of Retained Linkages Year 3 by Category

<table>
<thead>
<tr>
<th>Linkage Category</th>
<th>Business Impact Retained Linkages Y2 - Y3</th>
<th>Geographic Scope Retained Linkages Y2 - Y3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>17%</td>
<td>64%</td>
</tr>
<tr>
<td>Industry Association</td>
<td>19%</td>
<td>52%</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>19%</td>
<td>69%</td>
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<tr>
<td>Input</td>
<td>32%</td>
<td>42%</td>
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<tr>
<td>Output</td>
<td>31%</td>
<td>57%</td>
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<tr>
<td>Research &amp; Dev.</td>
<td>17%</td>
<td>59%</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>22%</td>
<td>59%</td>
</tr>
<tr>
<td>Training</td>
<td>0%</td>
<td>71%</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>219</td>
</tr>
<tr>
<td>Percentage</td>
<td>23%</td>
<td>56%</td>
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</table>

### Table 8.17: Business Impact and Geographic Scope of Lost Linkages Year 3 by Category

<table>
<thead>
<tr>
<th>Linkage Category</th>
<th>Business Impact Lost Linkages Y2 - Y3</th>
<th>Geographic Scope Lost Linkages Y2 - Y3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Government Agencies</td>
<td>33%</td>
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</tr>
<tr>
<td>Industry Association</td>
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<td>Industry Peers</td>
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<td>22%</td>
</tr>
<tr>
<td>Input</td>
<td>4%</td>
<td>65%</td>
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<td>Output</td>
<td>0%</td>
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<tr>
<td>Research &amp; Dev.</td>
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<tr>
<td>Specialist Service</td>
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<td>0%</td>
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<td>Training</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>4%</td>
<td>53%</td>
</tr>
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Note to Table 8.15 to 8.17: The Four business impact bands are: H = High (30 to 40), M = Medium (20 to 30), L = Low (10 to 20) and T = Tenuous (0 to 10). The Geographic Scopes used are: L = Local Linkages (Wallonie); N = National Linkages (Belgian); EU = European Linkages and INT = International Linkages.
The geographic scope of the New linkages reported are found on the right-hand side of Table 8.16. Over 55% of the New linkages developed in 2020 are found outside of Belgium, showcasing the ability of respondent firms to develop linkages abroad. This is interesting, as when European and international scopes are examined for all linkages in Table 2 (see Appendix D), these respective scopes account for approximately 43% of all linkages reported in 2020. The geographic scope of the Output linkages (Table 8.16) are mostly found outside of Belgium. In terms of the New international customers gained (n=7), five are found on the East coast with the remaining two on the West coast of the US. Perhaps these linkages were supported by the two trade fairs held in the US where BioWin and its member firms were present, namely Bio International Convention in 2019 and Digital – Bio US in 2020. On the other hand, what is quite surprising is the limited number of new linkages developed to the Eastern/Asian markets despite similar focused trade missions/online conferences in Japan, China and South Korea run by BioWin in collaboration with AWEX for members.

Lost Linkages

Table 8.14 showcases the 68 linkages that were lost between Year 2 and Year 3 and their respective categories (reported in Year 2 but not reported subsequently in Year 3). Output, Input and Research and Development linkages are the three categories that record the highest proportion of Lost linkages between 2019 and 2020. All three of these categories Lost more linkages between Year 2 and Year 3 than the previous analysis for Year 1 to Year 2, potentially showcasing the difficulties posed by Covid-19. Input and Research and Development categories both reported two additional Lost linkages in Year 3 when compared to those Lost between Year 1 and 2. Furthermore, respondent firms reported nine more Lost customers for 2020 (Lost OU=26) when compared with the same period in 2019 (Lost OU=17). It would be pertinent to analyse this trend of customer losses over the coming years, to see if this is related to the pandemic or natural churn.

35 China Healthcare Summit - Life Science Event, China, Oct 9th 2020 and BioJapan Event, October 14th 2020 with AWEX.
36 Bio Korea from 18th – 23rd May 2020
Considering these losses and in which categories allows respondent firms to assess how and why this occurred and if it is intentional and known, or not commonly understood. The categories with the least number of Lost linkages, found in Year 2 results but not reported in Year 3, occur across the Training (n=1) and Industry Association categories (n=2). These encouraging figures for Lost Training linkages may be simply be as a result of the low number of linkages across the category i.e. (TN=18). Therefore, there is a less dramatic turnover of linkages observed year after year, and hence this could explain why only four linkages were lost between the beginning and the end of this three-year study.

Each category is analysed in detail in Table 8.17 where the Business Impact of the Lost linkages is examined. One reason for assessing such impact is the ability to indicate when High and Medium business impact linkages are lost which may be due to various reasons i.e. staff redundancy, downsizing etc. In 2019, 57% of linkages Lost (n=39) are found in the High and Medium impact bands. On the opposite end of business impact, 41% (28 of the 68) of Lost linkages are in the Low impact bands. One would expect a greater number of Low and Tenuous links to be lost over time rather than those with a High or Medium impact to the firms as more impactful linkages are of more benefit to the firms and therefore, more costly to develop, as in the majority of instances they require face-to-face meetings to build trust and develop these relationships over time.

Seventeen of the twenty-six Lost Output linkages are in the Medium impact band, so it is important to draw the attention of the affected firms as customer relationships are vital to the day-to-day operations of any business. Perhaps there are other reasons which explain why respondents have discontinued a relationship with a customer or supplier, e.g. shift in raw material requirements, manufacturing process, better price point from a competitor, shift in the product or service necessitates a change of supplier or customer etc. The V-LINC methodology reporting for respondents includes a circular process for participating firms to ensure that such Lost linkages are highlighted for firms so that they have the necessary information to hand to take corrective measures if required.

The right-hand side of Table 8.17 also reports the geographic scope of the Lost linkages. Regarding Output linkages, the Year 3 results, similar to that of Year 2 (76%) again show an extremely high percentage loss (77%) of global customers. Two thirds of the eighteen international linkages Lost between Year 2 and 3 are with customers of the RFG, which is interesting as such Lost linkages may adversely affect the individual firms'
performance. Of the twenty customer linkages Lost across Europe (n=8) and internationally (n=12) (Figure 4), half were in the High to Medium business impact band, only 12 months previously. The information above is an example of important information shared with the relevant firms impacted by such losses to understand why these connections ended, and to draw their attention to same.

As was the case in the Year 1 to 2 analysis, in the Year 2 to 3 analysis there was a 2:1 ratio of Lost to New linkages for the Industry Peer category. A cluster's competitiveness is sharpened by both collaboration and competition, and the consistent loss of Industry Peer links over time is worrying and something that should be discussed. When one delves deeper into the Industry Peer data gathered between 2018 and 2020 numerous observations can be made.

Examining the analysis another layer deeper showcases that between Year 1 and Year 2, eight Lost linkages were reported across the four geographic scopes; local (4), national (2), European (1) and international (1). The rationale for losing so many local connections could be numerous and varying. Potentially, as firms grow and become better equipped with skills, knowledge and expertise that they acquire year on year, might mean they no longer require such local Industry Peers connections and are becoming more self-sufficient.

Linkages found in Year 2 results but not reported in Year 3 were split across three scopes, namely local (3), European (3) and international (2) with no Lost linkages at a national level. These figures may have also occurred for numerous reasons, with the global pandemic potentially being a large contributing factor, as collaborations were reduced so firms could focus on their own business, with keeping their doors open as a central objective.

It is interesting to see that the largest proportion (34%) of all Lost linkages occurs at a European level (Table 8.17), however, these are more than replaced with the addition of 25 New European linkages in Table 8.16. The same is true for local linkages where more New linkages are created than Lost. On the other hand more international and national linkages are Lost than created (New).
The longitudinal analysis provides some further detail on how linkages have been retained, developed and Lost between Year 2 and 3 in the V-LINC analysis of BioWin members. Whilst it is important this analysis took place immediately prior to and during the COVID-19 pandemic, this data is pertinent to evaluate the BioWin Health Cluster by benchmarking the results against Michael Porter’s (1998b) Competitive Diamond of Local Clustering. This is undertaken in the next section.

**Evaluating the BioWin Health Cluster**

The performance of the BioWin cluster in 2020 can be considered based on the four main features of cluster locations, outlined in Porter’s Diamond model, Porter (1998b).

- **Local Input Factors**

Comparing the BioWin Health cluster with Porter’s (1998b) Competitive Diamond of Local Clustering is useful to analyse the determinants of a cluster in the Wallonia region. Firstly, considering reliance on local Input factors, it is apparent that the firms in Wallonia have many Training, Industry Peer, Industry Association, Government Agencies and Research and Development linkages (Table 2). Similarly, regarding demand conditions, these firms serve sophisticated and demanding customers with the V-LINC findings showing empirically that output linkages are not only found locally in Wallonia or across Belgium but are spread across Europe and further afield internationally.

Cluster theory, although subtle on the topic of export sales reliance, suggests a high and stable proportion of exports can have a positive impact on clustering. However, with most Output linkages being reported as European and international linkages (Table 2), it is imperative that the BioWin firms continue to further their pursuit of these markets to enable growth and development for the cluster. With only 30% (Table 2) of all Output linkages spread across the local and national markets, perhaps firms could supplement their international successes by further targeting customers in Belgium which will support and buttress further growth and development of the region.
A third determinant of cluster strength involves firm strategy and rivalry: Porter argues competition should be intensive but also involve cooperation among local rivals. While quite a large proportion of firms surveyed compete directly with one another, Table 2 reports that 65% (n=13) of all Industry Peer linkages reported by the RFGs are recorded at local and national (Wallonia and Belgium) scopes respectively. The 85% of Industry Peer linkages reported in the High and Medium bands in Table 3b and 3c highlight strong cooperation, collaboration and willingness among firms to share knowledge and expertise with each other. Porter (1998a) notes that Industry Peer linkages are key drivers of a cluster regarding innovation and economic growth, as they provide competitive pressure for firms to be innovative and creative. Thus, the loss of such Industry Peer linkages over the three-year research period is a point worth highlighting.

With regard to the fourth determinant, of competitive local clustering: related and supporting industries, strong connections are depicted both at local and national level with 57% of the 458 linkages operating across Belgium. Numerous local and national connections are reported in the data with Training (89%), Government Agency (75%) and Specialist Services (66%) reporting most of their linkages at this geographic scope (Table 2). A thorough understanding of the V-LINC results of the BioWin Health Cluster in Wallonia has sought to identify cluster type policy initiatives that can strengthen and support the BioWin cluster. These policy recommendations are outlined in the next section.

8.4.1 Policy Recommendations Year 3 (2020)
To continue BioWin’s progression, there is a need to build upon existing strengths and implement evidence-based policy. It is appropriate to forge strategic cluster initiatives that focus on promoting the strengths, linkages and emerging competencies - which are aligned with the regional strategies for smart specialisation.

1. Reinforce the members’ interaction with an already strong US market while continuing to open up potential new markets/customers in the Eastern part of the globe
It is imperative that BioWin continues to support the cluster firms in order to enhance internationalisation as well as nurturing and supporting certain SMEs who are yet to
establish strong international links. This recommendation is in line with the cluster organisation itself, BioWin works proactively to promote the “international technological assets of Wallonia in the field of Health and above all, to position the expertise, skills and potential of Walloon innovation players in the various strategic themes of the cluster” (BioWin, 2020). Figure 8.8 portrays the Lost Output linkages (n=27) across USA, South Korea, India, Brazil, Italy, France and Norway.

However, it is important to note that of the customers Lost in the Eastern part of the globe e.g. South Korea and India, there were no new customers gained in this area. SME internationalisation, in the BioWin Cluster, relies on the members’ ability to connect and maintain linkages with foreign businesses and markets. The data from the RFG, contradicts what is perceived as the norm for SMEs and internationalisation, as the literature pertains to small firms focusing solely on their own domestic market and neglecting international opportunities (Dana et. al., 1999a; 1999b).

When we take a closer look at the data and figures for Year 3, Output linkages (n=112) are the most frequent linkages accounting for 24% of all linkages reported (Table 8.14 on page 272). Upon review of the seventeen RFG’s data and comparing it with the data from Year 2, there is a 6% decrease (Year 2=78 INT linkages, Year 3=74 INT Linkages). Of these 74 international linkages, the Output category is responsible for more than 50% (n=39) of the total. A 10% decrease on the overall number of international Output
linkages from Year 2 to 3, which could be attributed to the COVID-19 global pandemic amongst other factors. Continuing with a focus on the 112 Output linkages (Table 8.14), 78 are reported across Europe and internationally accounting for 70% of the total linkages in this category. Internationalisation is evident for the RFG in Table 8.14 and it is important to build on the successful footholds that are already visible in this area. European Output linkages are predominantly found across France, Germany and the Scandinavian countries.

The Year 3 international Output linkages, are found predominantly to the western part of the global market and the East Coast of North America. The cities in which these linkages are most frequent include, Austin and Houston in Texas, Washington, Philadelphia and New York. Perhaps there are still opportunities for the BioWin Cluster to focus on strengthening connections with a potential large market on the west coast of America as well as a rather untapped market in Asia with only Tokyo and Seoul representing RFG Asian customers.

Support for further access to international distribution channels is pertinent to the members and can benefit the BioWin Cluster as its firms grow. Further efforts from BioWin to inform and collaborate with members regarding global events, trade missions and fairs, will continue to play a crucial role in facilitating levels of internationalisation. BioWins’ global contacts and the introductions at international events and trade fairs can support potential new collaborations for BioWin members and further enhance global market presence. BioWin can continue to provide a showcase for its members by representing their shared interests and continuing to mentor SMEs in dealing with larger international firms that can open opportunities in the global marketplace. Interestingly, whilst the number of Output linkages are far greater in the European and international scopes (79 of 112), the local and national linkages are deemed to have the most impact for the RFG with 91% of these linkages being reported in the High to Medium impact band (Table 8.14).
2. Buttress Industry Peer Linkages through increasing opportunities for collaboration and networking between members

The need for more inter-firm interaction is evident in the figures of the Industry Peer category. The value of collaboration, knowledge sharing and connectivity between Industry Peer firms is unrivalled, powerful and cannot be overlooked. Brown and Bell (2001, p. 11) note that “firms are beginning to pay closer attention to their own connections with one another, to recognise the common problems they face and to look for relationships and alliances which provide collective solutions and enable their competitive advantage to be maintained.”

Data pertaining to Industry Peer linkages lost and gained, showcase a ratio loss of 2:1 (loss = 8, gain = 4). An interesting point to note is that of the 20 linkages reported in Year 3, exactly 65% are found within the local Wallonia region (n=12) and nationally (n=1) with the remainder found at a European and international scope. Perhaps having a continued increase in the number of Industry Peer linkages locally could help the RFGs grow in areas of knowledge and expertise as well as reducing time between contact due to differing time zones as is found with international peers. The 4 New linkages gained in Year 3 were all found at a local level, and this is a positive step in the right direction. Furthermore, of the four geographic scopes, local linkages were the only scope to record a positive increase in linkage volume.

Eight out of the seventeen respondent firms report no Industry Peer linkages. Does this mean they are closed off to collaboration? Showcasing successful collaborations / partnerships / exchanges between members could encourage some of these laggards to ‘build’ the bridges and trust so as to be able to arrive at creative solutions to shared issues or target larger markets together. It is important to highlight that the lost Industry Peer linkages in 2020, did not occur solely at one geographic scope, there were Lost linkages locally (3), across Europe (3) and internationally (2). The four linkages gained were all found at a local level. However, it is also essential to emphasise the new way of conducting meetings and work via online video platforms, for example, Zoom or Microsoft Teams to name but a few, that has occurred as a result of the COVID-19 pandemic. As such, meetings, regardless of geographic location and time zones can occur.
more easily than before and the RFG may look at increasing Industry Peer linkages as a whole.

At a local level, Industry Peers is perceived as one of the strongest in relation to business impact (84% in the Medium band). It is important to promote and grow collaboration between clustered firms as Keeble and Nachum (2002, p. 79) believe that “clustering enhances competitive advantages and growth by enabling firms to tap into a collective learning process, which operates through skilled labour mobility within the local labour market.” Furthermore, it is believed that “interconnectedness is of course also a fundamental characteristic of all strong definitions of clustering itself” (Keeble and Nachum, 2002, p. 79).

3. **Identify and promote the significance of the role Local suppliers can play, particularly during a global pandemic affecting supply chains. Ability to increase local input linkages?**

The effect the COVID-19 pandemic has had on global supply chains since 2020 is unprecedented. Queiroz et al. (2020, p. 1) discuss how “the coronavirus (COVID-19) outbreak shows that pandemics and epidemics can seriously wreak havoc on supply chains (SC) around the globe.” The impacts of the COVID-19 pandemic on supply chains have gained a great deal of attention from scholars (Choi 2020; Govindan et al. 2020; Ivanov 2020a; Lin et al. 2020; Sarkis et al. 2020) in addition to industry experts (Business Insider 2020; Deloitte 2020; Forbes 2020a, b; Harvard Business Review 2020). The COVID-19 pandemic is already devastating supply chains globally (Queiroz et al., 2020) and members of the BioWin cluster will have undoubtedly experienced this in the past year.

During the beginning of the final year of this study i.e. February 2020, COVID-19 cases were continuously increasing across the US, Europe and Asia. With these outbreak increases came border restrictions, quarantines and lockdowns. Consequently, an enormous dip in the international trade occurred which saw a decrease of between 13%

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37 Empirical research on the positive effects of clustering on the economic performance of regions is vast, namely: increasing the productivity and innovation capacity of cluster firms, stimulating new business formation and increasing the innovation capacity of firms (Porter, 2000a).
Many authors and scholars allude to the importance of strengthening connections with local suppliers during such pandemics. In the same breath, Sharma et al. (2020 p. 2) note that supply chains must “assess the environment, anticipate the demands of consumers during the lockdowns and endeavour to provide satisfactory services by collaborating with the local suppliers.” Of the seven Lost Input linkages between 2019 and 2020, each geographic scope was affected i.e. local (2), national (1), European (2) and international (2). There were no New local linkages recorded to replace the recently Lost links (Figure 8.9) and this is something that might require further attention.

The spread of Inputs across Belgium (49%), and outside of Belgium (51%) is notable as every second supplier of the RFG is found at a European/international level. The data pertaining to European suppliers, due to the idyllic location of the BioWin cluster at the heart of Europe, reports 42% of all Inputs at this geographic scope. It is quite apparent that these European Inputs are held in high regard by the RFG when 29 of the 35 linkages are reported in the High-Medium business impact band. Conversely, at the local level, there are as many High business impact linkages as there are low (n=5). The qualitative data collected from the firm interviews revealed that local firms are unable to provide and cater to the needs of the RFG supply requirements. However, 11 of the 17 firms did state (during the V-LINC interview process) that they would be willing to source Inputs locally if they were available and of the same standard/quality or higher. This is turn could potentially lead to an increase in employment in the Wallonia region as well as promoting
Delving deeper into the Input linkages, regarding their business impact, local suppliers have the lowest percentage in the High-Medium band (64%). This is in stark contrast with the remaining three scopes that have a much higher number of linkages in the High-Medium business impact band i.e. Europe (83%), national (78%) and international (75%). However, to get a holistic view, it is important to note that Local suppliers i.e. Inputs account for only 17% of all Inputs reported by the RFG.

Six of the nine New Inputs are across Europe with two international and one national linkage recorded. This is positive for the BioWin members as it demonstrates their ability, even during a global pandemic, to create new connections and linkages with suppliers outside of Belgium. It is of course too difficult to predict how these linkages will develop in the future and thus to ascertain if local suppliers will eventually become important to this cohort of firms. Sharma et al. (2020, p. 2) go further and state “organisations need to develop Sustainable Supply Chains (SSCs) according to the social context, customer demand and the availability of the local partners so that the order fulfilment will be made possible without the loss of business and also the buyer–supplier relationship can be managed.”

**Closing Remarks**

This report has described and applied the V-LINC methodology for identifying and analysing the linkages that firms in the Wallonia region engage in for 2020. It showcases for industry players, business support organisations and policy makers how the biomedical ecosystem operates both within Wallonia and the external relationships forged beyond the region – to provide a some commentary on the growth, expansion and even contraction of linkages through the respondent firm group since the 2018 baseline analysis for the region. The current cohort of connections in 2020 are displayed in the linkage maps throughout the report and align with the upcoming joint action events in 2020/21 organised by BioWin and AWEX. Such events for the RFG to avail of are set to take place in Korea, USA, Japan, and Australia to name but a few and will undoubtedly...
encourage the creation of new global linkages for the cluster members as previously occurred in 2019.

The data collected proposes the following initiatives for the BioWin cluster:

1. Reinforce the member’s interaction with the already strong US market while continuing to open up potential new markets/customers in the eastern part of the globe.
2. Buttress Industry Peer Linkages through increasing opportunities for collaboration and networking between members.
3. Identify and promote the significance of the role Local suppliers can play, particularly during a global pandemic affecting supply chains. Ability to increase local input linkages?

The type of information gleaned from this analysis can support the remit of cluster organisations as their membership evolves and in turn can change the supports and focus of the cluster over time. Thus, allowing clusters to be a more effective cooperation partner. There is also a need for long-term partnership from the key industry, government and academic stakeholders to ensure the Walloon region and its constituent firms benefit from the BioWin cluster. This longitudinal analysis has been applied from 2018 to 2020, in order to record, measure and visualise BioWin’s evolution and business relationships developed, maintained and Lost over the three years. The following section reviews the method used to categorise the life cycle stages of a cluster, using the BioWin cluster as the cluster under investigation.
### 8.5 Categorising the Cluster Life Cycle Stage

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
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<tbody>
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<td>Employment</td>
<td>Indicative CLC Stage: Growth</td>
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<tr>
<td>Registered Firms</td>
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<td>Exports %</td>
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Table 8.18: Empirical Model for Identification of Cluster Life Cycle Stage for the BioWin Cluster

Source: Author

The data sources for Table 8.18 are described below. The data collected for pillars 1 and 2 are collected from secondary sources i.e. offices of central statistics, industrial reports and various other sources mentioned below. It is important to note that the locations for such information and data vary for each country and sector. For example, information for the services sector will be different to that of the manufacturing or tourism sector to name but a few and each country has its own particular way of collecting such data. Certain data was collected from interviews and direct contact with the MD of BioWin, Ms Sylvie

\(^{38}\) The COVID-19 pandemic played a role in reducing the number of events BioWin (co)organised in Belgium and abroad during 2020 as well as all figures pertaining to Year 3.
Ponchaut and with Ms Florence Hennart, Qualified Attaché - Economist in the Department of Economic Policy at the SPW.

1. **Economic Impact Variables: Data Sources**

**Employment:** The figures for employment, as presented in Table 8.18 are derived from the life sciences sector in the Wallonia region for the years 2018, 2019 and 2020. As data for this particular sector is not publicly available, the figures are calculated by combining NACE codes 21.1, 21.2, 72.11 and 86.901 to represent the overall sector. For confidentiality reasons the figures pertaining to each of these individual NACE codes cannot be disclosed. However, if you have further questions on same please contact the author directly.

**Registered Firms:** The figures for registered firms, as presented in Table 8.18 are derived from the life sciences sector in the Wallonia region for the years 2018, 2019 and 2020. As data for this very particular sector is not publicly available, the figures are calculated by combining NACE codes 21.1, 21.2, 72.11 and 86.901 to represent the overall sector. For confidentiality reasons the figures pertaining to each of these individual NACE codes cannot be disclosed. However, if you have further questions on same please contact the author directly.

**Exports:** The figures for exports, as presented in Table 8.18 pertain to the percentage of Walloon exports in the life sciences sector of total exports of the Wallonia region. These figures are taken from the BioWin Annual Report 2018, p. 14, BioWin Annual Report 2019 p. 12 and BioWin Annual Report 2020 p. 11.

**Average Wages:** The figures for average wages, as presented in Table 8.18 above pertains to the life sciences sector in the Wallonia region. As data for this very particular sector is not publicly available, the figures are calculated by combining NACE codes 21.1, 21.2, 72.11 and 86.901 to represent the overall sector. For confidentiality reasons the figures pertaining to each of these individual NACE codes cannot be disclosed. However, if you have further questions on same please contact the author directly.

2. **Cluster Organisation Variables: Data Sources**

**Membership:** The figures for the cluster organisation membership, as presented in Table 8.18 is calculated using data on the number of small, medium and large firm members multiplied by the membership fees for 2018, 2019 and 2020. Information membership is

**Staff Numbers:** The figures for the cluster organisation staff numbers, as presented in Table 8.18 are sourced from the BioWin annual reports for 2018, 2019 and 2020. Information for total staff numbers is found at: BioWin Annual Report 2018, p. 41, BioWin Annual Report 2019 p. 37 and BioWin Annual Report 2020 p. 37.

**Events:** The figures for the number of events (co)organised by the cluster organisation as presented in Table 8.18 are sourced from the BioWin annual reports for 2018, 2019 and 2020. Information for these event figures is in the BioWin Annual Report 2018, p. 37, BioWin Annual Report 2019 p. 34 and BioWin Annual Report 2020 p. 27.

**Funding:** The figures for the percentage breakdown of funding received by the cluster organisation, presented in Table 8.18 are sourced from an interview with the Managing Director of BioWin, Dr. Sylvie Ponchaut on April 26th 2021.

3. **V-LINC Analysis: Data Sources**

**Value Chain Linkages (OU/IN/SS):** Data pertaining to the value chain linkage figures, as presented in the table above, are drawn from Table 8.2 for Year 1, Table 8.10 for Year 2 and Table 8.14 for Year 3. These tables display the distribution of linkage categories by geographic scope for 2018, with the linkage evolution for 2019 and 2020 presented in the latter two tables.

**Knowledge Linkages (RD/TN):** Data pertaining to the knowledge linkage figures, as presented in the table above, are drawn from Table 8.2 for Year 1, Table 8.10 for Year 2 and Table 8.14 for Year 3. These tables display the distribution of linkage categories by geographic scope for 2018, with the linkage evolution for 2019 and 2020 presented in the latter two tables.

**Economic Policy and Support Linkages (GA):** Data pertaining to the economic policy and support linkage figures, as presented in the table above, are drawn from Table 8.2 for Year 1, Table 8.10 for Year 2 and Table 8.14 for Year 3. The tables display the distribution of linkage categories by geographic scope for 2018, with the linkage evolution for 2019 and 2020 presented in the latter two tables.
**Linkage Evolution:** Data pertaining to the linkage evolution figures, as presented in the table above, are drawn from Table 8.2 for Year 1, Table 8.10 for Year 2 and Table 8.14 for Year 3. These tables display the distribution of linkage categories by geographic scope for 2018, with the linkage evolution for 2019 and 2020 presented in the latter two tables.

All figures under the V-LINC Analysis pillar are obtained from the 51 firm interviews conducted by the author between 2018-2020.

**8.5.1 Cluster Life Cycle Stage Identification**

In this section, the cluster life cycle stage identification rubric is applied to the BioWin Health Cluster of Wallonia (Table 8.18 on page 297). To undertake the analysis, one fills the relevant data under the three indicators 1. Economic Impact 2. Cluster Organisation and 3. V-LINC Analysis. Each pillar incorporates four variables in order to identify the relevant life cycle stage a cluster is at for each individual variable. Clusters grow at different speeds and not all elements of a particular cluster will emerge, grow, mature and decline at the same time, and therefore there are difficulties associated with cluster life cycle stage identification. Some parts of a cluster organisation may be ‘ahead of the rest’ while other parts advance at a slower trajectory, making it difficult to pinpoint what exact stage a cluster is at (Menzel and Fornahl, 2010).

Reviewing the figures and information attained from the BioWin cluster and analysing the ‘indicative cluster life cycle stage’ column in Table 8.18, the author concludes that the BioWin Health Cluster is in the *growth stage* of the cluster life cycle. The breakdown of life cycle stages identified for each variable is as follows: 7 Growth, 4 Mature and 1 Decline. Consequently, the following sub-section discusses the policy implications for a growing cluster.

The next section summarises Chapter 8, including the presentation of figures for Year 1 to Year 3 pertaining to the BioWin cluster as well as the results of the new cluster life cycle stage identification rubric applied to the BioWin cluster.
8.6 Summary

Chapter 7 exhibits the advantages and value of the V-LINC methodology as a tool for cluster analysis as well as the benefits of utilising the method in a longitudinal capacity. V-LINC provides a deeper understanding of cluster operations and helps obtain a holistic view of the evolution of a cluster’s ecosystem. The V-LINC reports and results for the BioWin cluster are presented in Chapter 8 and the linkage data pertaining to the RFG, gathered from the individual firm interviews over the three years was checked, validated and uploaded to the V-LINC software. The data was tabulated and visualised, and a V-LINC report for the BioWin cluster was generated. The report contains 1. Results of the cluster analysis, 2. Visualisations of the cluster ecosystem from a local perspective and outside the cluster 3. Policy initiatives to assist the development of the BioWin cluster.

The results highlighted how the Triple Helix structures are operating within the cluster and further afield. The objective of the analysis is to map the evolution of the participating firms’ linkages longitudinally, to track and assess how the BioWin ecosystem is developing annually whilst recommending tailor-made policies to strengthen the cluster and region.

The reports were provided and presented to the BioWin cluster organisation to showcase strengths and address weaknesses. These reports outline recommendations based on the shared results of the respondents, which can be implemented to further develop and grow the cluster organisation and increase its benefit to members. Firms participating in the V-LINC analysis received individual firm reports visualising their linkages and reporting same from most to least valuable. Furthermore, each respondents’ firm was benchmarked against the other BioWin member firms participating in the research. These annual V-LINC reports allowed the firms to track and evaluate their development, while also being able to compare their results with those of their peers.

Reporting of three V-LINC analyses from Year 1 (2018) to Year 3 (2020) allowed the development of a new element to the analysis. This sought to understand and analyse the Retained, New and Lost linkages, which are created, developed and/or lost during the course of a longitudinal V-LINC analysis. This new longitudinal data is then fed into a
new methodology; the ‘CLC stage identification rubric’, along with other economic and cluster data to identify at which stage of its life cycle the BioWin cluster organisation is currently in (section 8.5). The three pillars of data on which this judgement is made are 1) Economic Impact; 2) Cluster Organisation and 3) V-LINC analysis. The application of this rubric indicates that the BioWin cluster is in the growth stage of the cluster life cycle.

In Chapter 9, the particular results, findings and implications for policy are discussed further. Additionally, Chapter 9 presents the conclusions of this PhD research, including the empirical, theoretical and methodological contributions of the thesis and its potential as a tool for future research.
Chapter 9

9 CONTRIBUTIONS AND CONCLUSION

9.1 Introduction

This body of work aimed to contribute to the cluster literature through the formation of a structured methodology to identify cluster life cycle stages that can be applied globally, across all industry sectors. As such, this research sought to fill the gap in the literature on how to structure the process of data accumulation and analysis, using specific metrics and variables to assist policy makers and cluster organisations in cluster stage identification. The paper also implements the use of the V-LINC analysis (Byrne, 2016) adapting it in a longitudinal capacity to assess, analyse and map a cluster’s evolution, to ascertain the linkages and relationships the cluster firms annually engage in. The research proposes a new empirical model for the identification of the life cycle stage of a cluster (Table 6.10 on page 196) combined with policy recommendations for the cluster under investigation.

This thesis has presented an in-depth review of the Wallonia region and the BioWin cluster (Chapter 2) in addition to the theory and findings of countless authors and scholars on the subject of industry clusters (Chapter 3), incorporating the role and functions of cluster organisations, cluster initiatives and cluster management (Chapter 4). Chapter 5 introduced the concept of cluster life cycles followed by Chapter 6, which examined the philosophy of research as well as a reviewing various methodologies for cluster analysis before introducing a new method to assist in cluster life cycle stage identification. Chapter 7 investigates the methodological approach taken by the author for this thesis, while Chapter 8 contains V-LINC reports and results combined with policy recommendations.
before presenting the results used to decipher the current cluster life cycle stage of the BioWin cluster.

This final Chapter 9 begins with a description of the policy implications typically found at each stage of the cluster life cycle as well as highlighting the policy implications for the BioWin cluster that is identified as being positioned in the growth stage of the cluster life cycle. These two sections provide vital information for clusters and cluster organisations by collating and summarising a large amount of literature in relation to policy implementation at each of the cluster life cycle stages. Providing support and developing policies that fit the need for the cluster in question can provide numerous advantages and benefits for the cluster and cluster organisation alike and thus its inclusion (sections 9.2 and 9.3) within this concluding chapter is warranted.

The chapter then collates the principal findings of the thesis and if the research objectives have been realised. Each aspect of the contributions of the research is presented i.e. the thesis contributes to methodological, theoretical, and empirical knowledge in order to assist cluster policy-making. Lastly, the conclusion of the overall study is presented. Accordingly, on methodological, theoretical and empirical grounds, this thesis contributes to a better understanding of cluster policy-making, based on the following results. Towards the latter part of the chapter, a section devoted to the future research is provided before the conclusion which incorporates how the three research objectives were realised.

9.2 Stages of the Cluster Life Cycle – Policy Implications

Clusters and their constituent parts grow at varying rates (Menzel and Fornahl, 2010), and thus, policy implementation that is successful for one cluster might not be successful for another. Kitson et al. (2004) and Motoyama (2008) discuss how policy makers can fall into the trap of thinking the same drivers are crucial for all industry clusters and regions and as such, the same generic policies can be universally applied. Brenner and Schlump (2011) suggest there is a marked increase in the area of creating and supporting local
clusters, however, while designing such policy programmes, policy makers often exclude important factors related to the stages of the cluster life cycle. A cluster in the emerging stage of a cluster life cycle will require differing supports to that of a mature cluster for example. Implementing relevant tailor-made policies and initiatives in a timely manner to reflect current stages of the cluster life cycle is crucial and Crespo et al. (2014) in line with this, note that cluster policies created and applied need to be tailored to the cluster’s evolution.

Christensen et al. (2012) notes that clusters and cluster organisations, are always evolving. They are at different stages of development when their age, financial sources, economic performance and development etc. are examined. To provide clusters with optimal financial and technical support to further develop their knowledge and innovation capacities, policy makers need a clear picture of cluster organisations and its stage of development (Christensen et al., 2012). This supports the need for a method that can accurately identify the cluster life cycle stage of a cluster under analysis (Table 6.10 on page 196). Byrne (2016, p. 239) referencing Wolfe and Gertler (2004) notes that many cluster studies do little more than “create lists of the critical factors for cluster development from studies of successful cases. Such lists do not provide effective guidance for policy makers where their region may be affected by different conditions and circumstances.” Therefore, it is important to highlight the policies typically implemented at each of the four cluster life cycle stages i.e. emerging, growing, maturing and declining. An overview of specific policies at each stage is provided in a summarised format in Table 8.1.

Section 5.6 touched on the concept of cluster policy initiatives and the cluster life cycle and this section takes more of an in-depth look at what this means in relation to the stages of the cluster life cycle. Table 8.1 below describes cluster policies typically found at each of the four cluster life cycle stages, under four key headings:

- Networking
- Internationalisation
- Skills and Training Development
- Research and Innovation.
Typical Cluster Policy at CLC Stages

<table>
<thead>
<tr>
<th>Networking</th>
<th>Internationalisation</th>
<th>Skills and Training Development</th>
<th>Research and Innovation</th>
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<tr>
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<tr>
<td>Growing</td>
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<tr>
<td>Declining</td>
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**Networking**
- Bolster and support networking and knowledge exchange. Networking among different actors is core to any emerging cluster (Lucas et al., 2009; Brenner and Schlump 2011; Broekel et al., 2015; Giuliani, 2018; Abbasiharofteh, 2020).
- Increase the cluster's visibility at events and fairs (Lucas et al., 2009). Support collaborative relationships between firms and suppliers via matchmaking/trade fair events (Wickham, 2005).
- Promotion of knowledge ties between academia and firms in a maturing cluster (Lucena-Piquero and Vicente, 2019). Further develop the clusters enhanced reputation through attending and networking at global events (Wickham, 2005).
- Connect established firms with new spin-offs/start-ups that have access to new technologies, expertise and skills to aid the renewal process and spark new innovations / transitions (Staber and Sauter, 2011).

**Internationalisation**
- Attract FDI and MNC investment (Buckley and Ruane, 2006). Development of core identity of the cluster globally (Staber and Sauter, 2011).
- Promote cluster and region globally to support firms in reaching and expanding global markets (Wickham, 2005; Shin and Hassink, 2011; Fornahl and Hassink, 2017).
- Maintain the cluster's openness to external knowledge and companies, external networks, and external talent (Fornahl and Hassink, 2017).
- Connect firms with complementary foreign firms in similar sectors to support the rejuvenation of the cluster (Puig et al., 2014).

**Skills and Training Development**
- Bolster access to education and training i.e. conferences, training institutions (Menzel and Fornahl, 2010). Upgrading skills and qualifications of employees (Andersson et al., 2004).
- Provide access to new technology through the screening of activities and top quality infrastructure and training facilities (Abbasiharofteh, 2020).
- Investment in education and workforce upskilling. Refresh existing knowledge base i.e. provision of regional development gateways (Staber and Sauter, 2011).
- Utilise Smart Specialisation Strategies to redesign activities and support the development of human resources (Brenner and Schlump, 2011; Fornahl and Hassink, 2017).

**Research and Innovation**
- Link clusters to Science and Technology Parks i.e. incubators. Support Research and Development and concept of shared projects (Fornahl and Hassink, 2017).
- Develop intra cluster joint research projects. Facilitate knowledge codification e.g. Patents and scientific publications (Lucas et al., 2009; Abbasiharofteh, 2020).
- Restructuring intra- and inter-cluster knowledge networks to increase opportunities for innovation diffusion and to develop local and non-local research projects (Abbasiharofteh, 2020).
- Encourage moves into new innovative technologies or sectors (Sadler, 2004). Support innovative capacity in firms to accelerate diffusion of technology and Research (Lucas et al., 2009).

Table 9. 1: Indicative Policy Focus at Each Stage of the Cluster Life Cycle
Source: Author, with references within

While the above table focuses on cluster policy at each of the four cluster life cycle stages, the following section investigates the policy implications relevant to the BioWin Cluster, as a cluster positioned in the growth stage of the cluster life cycle.
9.3 Policy Implications for BioWin in the Growth Stage of the Cluster Life Cycle

Cluster policy initiatives are part of the toolkit for growing clusters and as a result are important to BioWin’s development. Wickham (2005, p. 14) argues the key to an effective cluster organisation “centres on the timing of its policy initiatives and the changing life cycle needs of the industry cluster.” However, cluster research rarely explores the policy implications of cluster life cycle frameworks (Elola et al., 2017) in spite of the importance of determining the best timing for these interventions and the form they should take (Landabaso and Rosenfeld, 2009). Van Klink and De Langen (2001, p. 454) add that “no blueprints of cluster policies can be given, simply because different contexts require different policies.” Clusters at different life cycle stages require different policy interventions i.e. policies implemented and developed for a growing cluster will not work for an emerging cluster (Fornahl and Hassink, 2017). “Cluster policies work most effectively where they succeed in aligning initiatives across senior levels of government with the current capabilities and future potential of local concentrations of firms” (Lucas et al., 2009, p. 206).

The cluster life cycle stage identification rubric (Table 8.18 on page 290) identified that the BioWin cluster is in the growth stage, therefore, policies developed and implemented must align with the needs and requirements of a cluster in this stage (Table 8.1). When the V-LINC longitudinal analysis study is reviewed, certain policies recommended by the author for the BioWin cluster do not feature in Table 8.1, and the detail for these recommendations can be found in the annual BioWin V-LINC reports in section 7.2.1, 7.3.1 and 7.4.1. However, a number of policies in Table 8.1 are consistent with the recommendations from the V-LINC analysis e.g. support the development of internationalisation and provision of quality facilities.

Numerous policy initiatives are relevant to a growing industry cluster. De Sousa Ostapenko et al. (2021, p. 24) referencing Desmarchelier and Zhang (2018) suggest that a cluster enters “a growth stage when it concentrates a critical mass of heterogeneous actors that generate several positive externalities attracting newcomers and fostering the creation of spinoffs.” When a cluster has established and gained enough economic strength, focal firms become the trailblazers for development (Pronesti, 2019). The
growth stage exhibits considerable increases in employment attributed to a large number of start-ups and general business growth, which in turn sees the formation of specialized labour markets, including the establishment of innovative networks or customer-supplier relationships (Sölvell, 2009; Menzel and Fornahl, 2010; Martin and Sunley, 2011).

BioWin, as the cluster organisation, together with its triple helix of partners from industry, government and academia will benefit from an informed understanding of the cluster life cycle and where it is currently positioned. This can assist the cluster in ensuring sustainability and growth by further developing tailored policies and programmes in line with its stage of development to support its core values, economic growth and regional development goals (Aziz and Norhashim, 2008). Table 8.1 showcases typical policy initiatives found during the growth stage of a cluster life cycle. The next section analyses the empirical contributions of this research.

9.4 Empirical Contributions

This section sets out to outline the empirical contributions of the research. Firstly, the findings from the analysis of the value chain linkages are presented, secondly the analysis of the knowledge linkages are reviewed and lastly, the economic policy and support in the region is summarised.

9.4.1 The Value Chain

One of the most important features of an industrial cluster is its value chain (Moynihan, 2018). Firms that participate in collaborative competition with local competitors can specialise in more specific parts of a value chain since transaction costs are reduced (Porter, 1990; Monteiro et al., 2013). Size, performance, average wages and productivity, are some of the factors that separate exporting firms from non-exporting firms (Clerides et al., 1998; Bernard and Jensen, 1999; Melitz, 2003; Gourlay and Seaton, 2004; Melitz and Ottaviano, 2008), and Byrne (2016) believes it is the industry sector that influences a cluster’s focus, be it locally or internationally.

When analysing supplier linkages for the BioWin Cluster over the three-year period, the most predominant scope geographically is found at a European level and while focusing
on the business impact of the firms’ suppliers, the results showcased the most important suppliers are also based across Europe. The BioWin cluster sources the majority of their most important suppliers and most valuable customers from outside of the Wallonia region and Belgium. The V-LINC results reveal, even for the SME firms, the global market for both suppliers and customers are of vital importance and therefore, the cluster will benefit from a further strengthening of these value chain connections.

BioWin, in terms of the cluster and cluster organisation, can be applied to the work of Byrne (2016, p. 229) where the question “how can a cluster and cluster organisation help build and sustain international value chain linkages?” is posed. Large multinational corporations combined with large indigenous firms, who focus on exporting, have the ability to provide smaller local firms with higher value and more refined customers. In the absence of such exposure, local SMEs may fail to take advantage of crucial opportunities to experience enhanced technological developments, expertise, or knowledge that may lead to the improvement of their services provided. In addition to offering training, information days and workshops, cluster organisations and industry associations can help SMEs develop their internationalisation strategies and gain experience from companies with export expertise through networking.

Cluster organisations can arrange trade missions for cluster members looking to target particular fields and markets. Here, they represent the cluster and region at trade fairs, support and promote business-to-business collaboration across different regions, while connecting with other global cluster organisations. Qualitative information gathered throughout the three years of firm interviews unveiled that such platforms provide SMEs with opportunities they may not otherwise be able to take advantage of due to limited resources, contacts, and capabilities. In summary, Byrne (2016, p. 230) states “clusters and cluster organisations play a vital role in preparing firms for international markets.” The prospect of continuing to leverage an already strong and existing internationalisation strategy from V-LINC results is displayed in the policy recommendations for BioWin (sections 7.2.1, 7.3.1 and 7.4.1).
9.4.2 Knowledge Linkages

The concept of ‘knowledge spillovers’ and knowledge transfer is briefly discussed in chapters 2 and 4 (Marshall, 1890; Porter, 1990; Krugman, 1995; Bathelt et al., 2004; Owen-Smith and Powell, 2004; Wolfe and Gertler, 2004). There is empirical evidence that regional clustering can promote innovation and the dissemination of knowledge gained from private firm and research institute investments can be exploited by third-party firms. It is argued that new economic knowledge plays a greater role in clustering industries (Audretsch and Feldman, 1996; Baptista, 2000; Howells and Bessant, 2012). In addition, Pavan (2020) argues that modern economies can reap greater benefits in terms of market growth, innovation, and productivity, by investing part of their knowledge generation resources in clustered industrial sectors, rather than investing in non-clustered industrial sectors.

Based on the assessment of the categories; Industry Peers, Industry Associations, Research and Development and Training, the V-LINC methodology measures informal spillovers as well as formal exchanges of knowledge. One of the more salient results of the V-LINC analyses over the three years highlighted that of the total Research and Development linkages reported between 2018 and 2020, 67% of them were located in Belgium. This demonstrates the importance of local and national institutes and the vital role academia and research play in the firms’ day-to-day lives. Additionally, there was an average of fifty-three Research and Development linkages recorded per year with an average of 70% of these linked to academia.

In Year 1 (2018) of the research, both the University of Liege and the Université Catholique de Louvain were reported as ‘Key Connectors’ within the cluster for the RFG, further showcasing their importance to the firms, cluster and region as a whole. Although twenty Research and Development linkages were Lost between 2018 and 2020, they were adequately replaced with twenty-five New linkages. The average business impact measured for the Research and Development linkages over the three years displays substantial importance for clustered firms with 71% of the links classed in the High to Medium impact bands.
The Training linkage category was the least populous category averaging eighteen links per year, while overall, losing four and gaining four respectively. These linkages averaged 67% of links reported in the High to Medium impact band annually, highlighting their importance to the RFG. On average, there were 93% of the Training linkages located across Belgium with the vast majority of links predominantly found at a local geographic level, suggesting an ecosystem in which local knowledge linkages are a vital cog in the firms’ activities with significant value placed on local linkages compared to non-local knowledge sources.

According to these findings in combination with results of V-LINC analysis, globally competitive clusters are constructed by firms that have built and sustained both local and external linkages. Certain knowledge spillovers can be gained enabling formal knowledge exchanges to occur (Schmitz and Nadvi, 1999; Rugman and D’Cruz, 2002; Bathelt et al., 2004; Wolfe and Gertler, 2004; Boschma and Ter Wal, 2007; Eisingerich et al., 2010; Bathelt and Li, 2014). There was a strong agreement by firms, from the information gathered during all fifty-one interviews, that these linkages: both Research and Development and Training alike, had a positive effect on their businesses and there was unanimous agreement about the unwavering support and services provided by these research organisations.

9.4.3 Economic Policy and Support
This research aimed to assess the impacts national/regional cluster policy and local cluster initiatives have on the growth and development of inter-firm linkages in a cluster network. The cluster organisation is evaluated each year from 2018-2020, through the business impact data reported by the respondent firm group. Identifying the linkages between Government Agencies and cluster organisations at cluster levels and correlating them with the policy and business support context in Wallonia provides a greater appreciation of the importance of government and policy at cluster levels. Porter (2009, p. 1) suggests the aim of economic policy is “to enhance competitiveness, which is reflected in the productivity with which a nation or region utilises its people, capital, and natural endowments to produce valuable goods and services.”
The economic policy landscape in Belgium is well developed with cluster policy soundly supported. Chapter 4 investigated traditional approaches to economic policy, focusing on two approaches, firstly, the improvement of the overall business environment that affects each firm and secondly, how policy implementation can improve individual firm and employee competitiveness. These can include, for example, loans and grants for small businesses, incentives for FDI, and trainings for employees. In a modern and competitive economy, it is argued that cluster policy is better aligned with competition than industrial or firm-level policies (Porter, 2000a; 2009).

The linkages between firms and government agencies are also evaluated within this body of work. Evaluating the results regarding economic policies and supports, provide some interesting observations. Having progressed from the industrial development policies during the 1980s, by integrating inward investment from domestic as well as international firms, which was previously viewed as too ambiguous, new policies for regional development were adopted in order to enhance endogenous growth and inward investment (Swords, 2013). During the 2000s, clustering became the de facto formula for achieving economic growth. The underlying concepts of firm proximity and specialisation have remained important elements of policy 'tools' in recent years, even though explicit references to clusters in the Porterian sense have diminished (Spencer et al., 2010; Swords, 2013).

The BioWin cluster and cluster organisation is supported by both regional (Wallonia) and national (Belgium) cluster policy. The Walloon and Belgian governments have rigorously supported clusters since the early 2000s providing cluster members with tax incentives and collaborative R&D project funding. Competitive clusters’ aims and objectives include promotion of the region and firms within in tandem with the bolstering of innovation and new technology efforts, to name but a few. Competitiveness can be defined as the sum of all factors that influence an organisation's ability to continue in a business environment (Baierle et al., 2019). Support for clusters in Belgium is in line with Porter’s (2009) idea that when selected clusters are certified, they can receive matched funding and get preference when applying to existing or new national programs. The policy support has allowed BioWin to develop a large cluster membership (more than 230
members in 2021) and assist in delivering a wide range of services. All of these factors have led to BioWin being recognised as one of the best in class European cluster organisation; The Silver Label in recognition of Cluster Management Excellence was awarded to BioWin in August 2021 (ESCA, 2021).

BioWin’s perceived importance and business impact to its members is apparent when the data pertaining to the cluster organisation is analysed and summarised for each of the three years (2018-2020). An average of 72% of all BioWin business impacts were reported in the High to Medium impact bands. Each firm interviewed recorded Industry Association linkages with BioWin and the respondent firms place substantial value on the services and assistance provided by the cluster organisation. Other data gained from V-LINC analyses showed that Government Agency (92%) and Industry Association (96%) categories retained the most linkages year after year and demonstrates that for the member firms, once part of an Industry Association such as BioWin, tend to continue to subscribe or retain membership with these associations.

In order to obtain funding, BioWin is obliged to submit an annual application to the government, stating its aims and objectives for the upcoming year, along with the necessary documentation. BioWin can provide support to their members, particularly SMEs, to apply for European funds, which can in turn support existing public funding for Research and Development activities. The cluster’s membership has increased steadily since 2006, and in turn, BioWin has had to adapt to the needs of their members over the past 15 years, highlighting the constant need for adaptability, flexibility and remaining up to date with new market and technology trends. The cluster analysis of a region is undoubtedly necessary so governments, researchers, and industry can gain a more comprehensive understanding of how clusters operate within a region. Such an analysis must account for policy supports and overall landscape both locally and nationally and not just for the individual firm linkages.

Cluster organisations, like BioWin, are sometimes viewed as policy instruments and subsequently the role of BioWin served as one of the numerous focal points of the firm interviews, with questions like “how can BioWin improve its services”, “did BioWin help
your firm create new linkages” and “what must BioWin continue to do as the cluster organisation?”.

In relation to BioWin, this is an opportune time to present the V-LINC analysis summary of results from Year 1 (2018) to Year 3 (2020) in the next sub-section, providing a holistic view of the evolution of the RFGs linkages over the three year period.

9.4.4 Year 1 (2018) to Year 3 (2020) V-LINC Analysis Results

The three V-LINC reports (2018, 2019 and 2020) for the BioWin Health Cluster are presented in Chapter 7. Using the V-LINC method, the linkage data from each of the fifty-one interviews was tested, validated and uploaded appropriately to the software. The interviews over the three-year period yielded 404 linkages in 2018, 459 in 2019 and 458 in 2020, totalling 1321 linkages. Having visualised the data in tabular form using the V-LINC software, an analysis was conducted that produced an annual report presented to the cluster organisation, BioWin. The report comprised of:

1. Results of the cluster analysis performed by the author

2. Visualisations of the cluster ecosystem both locally and outside of Wallonia

3. Policy recommendations to aid develop the BioWin Cluster.

In addition to this, individual firm reports were developed each year and given to the participating firms. These individual reports visualised the firms’ linkages, from strongest to weakest i.e. highest to lowest business impact, and ultimately benchmarked the firm with that of their peers in the cluster (see Appendix B for a sample V-LINC firm report).

In addition to steps 1 to 3, a comparison of the linkage data involving Retained, New and Lost linkages from one year to the next was conducted for Year 2 and 3. In essence, the objective of the V-LINC analysis is to identify specific and relevant action steps that contribute to the achievement of the cluster's goals. For example, helping to bolster firms’ (and as a result, the entire cluster’s) competitiveness, especially SMEs, through internationalisation and enhanced innovation and access to new technology. The results of the V-LINC longitudinal analysis can also be used to compare and contrast each year with the next while providing a clear and concise overview of the clusters evolution over a three-year period. The level of detail within the reports allow firms the opportunity to see:
1. Where i.e. geographic scope local/national/European/International
2. What strength of i.e. business impact High/Medium/Low/Tenuous and
3. Which categories i.e. Government Agencies, Industry Association, Industry Peers, Input, Output, Research & Development, Specialist Service, Training linkages were created, lost and retained throughout the course of the research.

The results discussed under these headings provide insights into the workings of the BioWin Cluster and its members, while trying to identify the stage of the cluster life cycle the cluster is currently positioned. Chapter 7 exhibits the importance of the V-LINC methodology in evaluating an individual cluster such as BioWin. The study showed that Output and Input linkages were the most populous categories each year as well as having the highest business impact, suggesting a competent and functioning supply chain and the important role the two categories play in the overall value chain. The spread of Inputs across Belgium (49%), and outside (51%) is notable as every second supplier of the RFG is found at a European/international level. Smaller firms sustained by customers for their ability to deliver specialised services, is in line with Porter's (1998b) cluster theories of competition and collaboration.

Throughout the longitudinal research, firms recorded two thirds of their Industry Peer linkages with other firms in Wallonia and across Belgium. Overall, local and national linkages make up more than half of all linkages reported, suggesting a robust ecosystem of suppliers locally. However, when one takes a closer look at the Industry Peer category, the analyses show a steady decline in the number of linkages year after year i.e. 2018 – 29 to 2020 – 20. BioWin, although an established cluster since 2006, displays numerous characteristics of a growing cluster as discussed in Chapter 6. The three-year cluster analysis uncovered a consistent growth in employee numbers, the number of firms, increased investment publicly and privately and an increase in the number of international customers to name but a few.

9.4.5 Data Review Year 1 (2018) to Year 3 (2020)

Throughout the following section, the overall evolution of the cluster is assessed and results from Year 1 through to Year 3 are discussed and investigated. When the data
pertaining to employee numbers from Year 1 to Year 3 is analysed, an extremely positive growth can be seen i.e. employment numbers grew extensively by 21% over the three year period. Table 8.1 displays the total number of linkages per category recorded by the RFG from Year 1 to Year 3. In total, there was an overall increase of fifty-four linkages across the eight different categories, and this includes New, Lost and Retained linkages throughout the three-year period. The Output category recorded the highest number of New linkages from 2018 to 2020 with an increase of twenty-three within that timeframe and it was the Industry Peer category where the only decrease in overall linkages was recorded (n=-8). Clusters and the clustering concept are built on a rich foundation of collaboration and inter-firm relationships and as such recording a 29% decrease in Industry Peer linkages should not be overlooked. Industry Peers was the only category that recorded a total decrease in linkages over the three-year period, having gained eight New linkages while losing sixteen.

The cohort of firms that participated in the research, collectively across the eight categories reported one hundred and eighty-four new linkages and one hundred and thirty lost linkages within the three-year period. Having already mentioned the Industry Peer category as a stand out figure, the categories of Input and Output linkages must also be highlighted, as these displayed the largest increase in linkages of all the categories. Output linkages, when New (n=67) and Lost (n=44) linkages are taken into account, recorded an increase of 23 links at the end of the three years. Similarly, Inputs displayed the second largest increase in linkages (n=15). Two categories recorded neither an increase nor a decrease in linkages for their respective categories from Year 1 to Year 3 i.e. Specialist Service and Training linkages.
When examining the Retained linkages, it is important to note that 303 linkages remained constant i.e. were retained by the RFG from Year 1 to Year 3 of the analysis. These figures represent the same linkages reported in Year 1, Year 2 and Year 3 of the analysis by the respondents amidst all the New and Lost links reported. Table 8.2 displays the business impact per category of the 303 linkages that were reported by the RFG in all three of the years i.e. in 2018, 2019 and in 2020. In order to quantify the importance of these linkages to the firms and understand why they were retained over the course of the three years, one must take into consideration their overall business impact. Industry Peers (93%), Outputs (88%) and Government Agency linkages (86%) all recorded the highest business impact of all linkages over three years. It is quite apparent from Table 8.3 that these particular linkages were retained for a reason for the course of this research i.e. nearly 80% of the linkages are found in the High-Medium business impact band. It is also worth highlighting that zero tenuous linkages were retained and can be viewed as a logical rationale.

<table>
<thead>
<tr>
<th>Category</th>
<th>Linkages Year 1</th>
<th>Linkages Year 3</th>
<th>Difference</th>
<th>New Linkages</th>
<th>Lost Linkages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Agencies</td>
<td>49</td>
<td>60</td>
<td>11</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Industry Association</td>
<td>49</td>
<td>57</td>
<td>8</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>28</td>
<td>20</td>
<td>-8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Input</td>
<td>69</td>
<td>84</td>
<td>15</td>
<td>29</td>
<td>14</td>
</tr>
<tr>
<td>Output</td>
<td>89</td>
<td>112</td>
<td>23</td>
<td>67</td>
<td>44</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>49</td>
<td>54</td>
<td>5</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>53</td>
<td>53</td>
<td>0</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Training</td>
<td>18</td>
<td>18</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>404</strong></td>
<td><strong>458</strong></td>
<td><strong>54</strong></td>
<td><strong>184</strong></td>
<td><strong>130</strong></td>
</tr>
</tbody>
</table>

Table 9.2: Linkages by Category – Differences Between Year 1 (2018) and Year 3 (2020)
Source: Author
Note to Table 9.3 to 9.5: The Four business impact bands are: H = High (30 to 40), M = Medium (20 to 30), L = Low (10 to 20) and T = Tenuous (0 to 10). The Geographic Scopes used are: L = Local Linkages (Wallonie); N = National Linkages (Belgian); EU = European Linkages and INT = International Linkages.

<table>
<thead>
<tr>
<th>Business Impact of Retained linkages Y1 - Y3</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Tenuous</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Agencies</td>
<td>9</td>
<td>28</td>
<td>6</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>Industry Associations</td>
<td>8</td>
<td>25</td>
<td>14</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>4</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Inputs</td>
<td>12</td>
<td>28</td>
<td>18</td>
<td>0</td>
<td>58</td>
</tr>
<tr>
<td>Outputs</td>
<td>20</td>
<td>29</td>
<td>7</td>
<td>0</td>
<td>56</td>
</tr>
<tr>
<td>Research &amp; Development</td>
<td>3</td>
<td>22</td>
<td>8</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>Specialist Services</td>
<td>9</td>
<td>20</td>
<td>7</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>Training</td>
<td>0</td>
<td>11</td>
<td>5</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>65</strong></td>
<td><strong>172</strong></td>
<td><strong>66</strong></td>
<td><strong>0</strong></td>
<td><strong>303</strong></td>
</tr>
</tbody>
</table>

Table 9.3: Business Impact and Geographic scope of Retained Linkages per category 2018-2020

<table>
<thead>
<tr>
<th>Geographic Scope by Linkage Category</th>
<th>L</th>
<th>N</th>
<th>EU</th>
<th>INT</th>
<th>No.</th>
<th>H</th>
<th>M</th>
<th>L</th>
<th>T</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Agencies</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>18</td>
<td>2</td>
<td>11</td>
<td>5</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Industry Association</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>12</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Input</td>
<td>6</td>
<td>6</td>
<td>14</td>
<td>5</td>
<td>31</td>
<td>7</td>
<td>20</td>
<td>4</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Output</td>
<td>11</td>
<td>6</td>
<td>24</td>
<td>24</td>
<td>65</td>
<td>11</td>
<td>35</td>
<td>18</td>
<td>1</td>
<td>65</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>4</td>
<td>25</td>
<td>0</td>
<td>16</td>
<td>9</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>8</td>
<td>8</td>
<td>4</td>
<td>0</td>
<td>20</td>
<td>1</td>
<td>15</td>
<td>4</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Training</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>35</strong></td>
<td><strong>61</strong></td>
<td><strong>43</strong></td>
<td><strong>183</strong></td>
<td><strong>27</strong></td>
<td><strong>107</strong></td>
<td><strong>48</strong></td>
<td><strong>1</strong></td>
<td><strong>183</strong></td>
</tr>
</tbody>
</table>

Table 9.4: Business Impact and Geographic scope of New Linkages per category 2018-2020

<table>
<thead>
<tr>
<th>Geographic Scope by Linkage Category</th>
<th>L</th>
<th>N</th>
<th>EU</th>
<th>INT</th>
<th>No.</th>
<th>H</th>
<th>M</th>
<th>L</th>
<th>T</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Agencies</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Industry Association</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>15</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Input</td>
<td>5</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>15</td>
<td>1</td>
<td>6</td>
<td>8</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Output</td>
<td>4</td>
<td>7</td>
<td>12</td>
<td>20</td>
<td>43</td>
<td>2</td>
<td>28</td>
<td>11</td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>20</td>
<td>0</td>
<td>7</td>
<td>13</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>7</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>20</td>
<td>1</td>
<td>15</td>
<td>4</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Training</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
<td><strong>31</strong></td>
<td><strong>32</strong></td>
<td><strong>32</strong></td>
<td><strong>128</strong></td>
<td><strong>6</strong></td>
<td><strong>70</strong></td>
<td><strong>50</strong></td>
<td><strong>2</strong></td>
<td><strong>128</strong></td>
</tr>
</tbody>
</table>

Table 9.5: Business Impact and Geographic scope of Lost Linkages per category 2018-2020

Categories of New Linkages

When analysing the New linkages created between Year 1 and Year 3 (Table 8.4) in relation to their categories, it is evident that the RFG forged the most new links with customers (Outputs) and suppliers (Inputs) together totalling over half (52%) of all the New linkages reported. The category to report the next highest number of New linkages
is Research and Development (n=25). The Training (2%) and Industry Peer (4%) categories recorded the least amount of New linkages over the three years.

**Business Impact of New Linkages**

Inputs reported 87% of all New linkages in the High to Medium impact band highlighting the quality new suppliers the member firms created new connections with. Output linkages reported a large proportion (71%) of new links also in these strong High to Medium business impact bands. Another stand out category for New linkages involved Specialist Services, which recorded 80% in the High to Medium business impact bands. On the opposite end of the business impact scale, both Training and Industry Association categories recorded 50% of their New linkages in the Low impact band respectively.

**Geographic Scope of New Linkages**

From a geographic scope perspective, nearly three quarters (73%) of the new Output linkages are recorded across Europe and internationally, demonstrating the RFGs ability to attract customers from outside of Belgium and across the globe. Similarly, Inputs recorded a high proportion of New linkages outside of Belgium also – 61%. Only 19% of all the new supplier linkages forged are sourced locally in the Wallonia region, perhaps identifying a need for better local suppliers expertise, knowledge and skills to help attract the business of the RFG, and in turn keeping revenue and employment generated locally. Table 8.4 displays that the European scope was the most populous accounting for nearly a third (32%) of all New linkages created between 2018 and 2020.

**Categories of Lost Linkages**

The categories that lost the most linkages during the three-year study include Outputs (n=43), Research and Development (n=20) and Specialist Services (n=20). The Output category accounts for exactly a third of all Lost linkages reported by the RFG from 2018-2020. While it should be noted that Outputs reported the most Lost linkages, this was counteracted by the same category reporting the most new linkages (Table 8.4). Training and Industry Association linkages Lost the least amount of linkages (n=4) over the three years and demonstrates that once part of an industry association, the RFG tend to stay connected year after year. Almost 50% of the Lost Input linkages occurred at a local level and is an important point to note.
Business Impact of Lost Linkages

From a business impact point of view, worryingly, the Lost customers amassed 70% of their linkages in the High to Medium business impact category and it is interesting to see if the RFG are aware of the loss of such strong impactful linkages. Specialist Services display a similar trend with 80% of all the Lost linkages reported in the High to Medium impact bands. Of the 128 Lost linkages, nearly 60% are reported in the High to Medium business impact band and must be highlighted.

Geographic Scope of Lost Linkages

There is quite an even share of the volume of Lost linkages per scope with each geographic scope reporting between 24-27% of the Lost links respectively. An eye catching figure in Table 8.5 involves Outputs, which as a category shows a loss of 77% of all the 43 linkages lost outside of Belgium i.e. European and international scopes. The international scope itself accounts for nearly 50% of all the Lost Output linkages. To summarise, between Year 1 (2018) and Year 3 (2020), the RFG reported 303 Retained, 183 New and 128 Lost linkages across each of the eight categories, displaying all levels of the business impact scale within each of the four geographic scopes.

Having reviewed the empirical contributions of this body of work to the literature, the next section examines the theoretical contributions of this research.

9.5 Theoretical Contributions

The empirical findings discussed inform the theoretical contributions of this research. This thesis contributes to scholarly literature that investigates visualisation for cluster theory, frameworks to assess cluster theory and how linkage analysis can assist the development of economic policy.

9.5.1 Longitudinal Cluster Analysis

In reference to the work of Michael Porter, Moynihan (2018, p. 270) argues “although linkages that firms and organisations within a cluster engage in are at the very core of Porter’s (1998b) theories, to date very little emphasis has been placed on visualising these
linkages geographically.” The capacity to visualise clusters and the relationships they engage in over an extended period of time i.e. more than 12 months, as an explanatory tool can clarify the complexities of how clusters function and in doing so, help inform not only academics and researchers, but non-cluster experts alike, on how to interpret such data. Research results can be disseminated in a simpler fashion, with the use of visualisation aids and thus, make data easier to understand. A major contribution to the literature takes the shape of the adaptation (of a point in time analysis) of the reporting mechanisms as well as the protocols involved in a longitudinal V-LINC analysis.

Using the BioWin cluster as an example, adapting the V-LINC methodology from a point in time analysis tool (<12 months), which has been tried and tested across numerous sectors globally, and adapting it in a longitudinal manner can help comprehend the evolution of the relationships cluster firms’ engage in on a daily, weekly, monthly and yearly basis. In doing so, the concept of Retained linkages, New linkages and Lost linkages are created (Table 9.6).

<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained linkages</td>
<td>Linkages reported and maintained from one year to the next.</td>
</tr>
<tr>
<td>New Linkages</td>
<td>Linkages added to the firms’ lists having not been reported in the year prior.</td>
</tr>
<tr>
<td>Lost Linkages</td>
<td>Linkages no longer on the firms’ lists having been reported in the year prior.</td>
</tr>
</tbody>
</table>

Table 9.6: Description of New Categorisation of Linkages
Source: Author

By collecting information about the Retained, New, and Lost linkages on an annual basis, the categories and geographical scopes in which they occur, along with their respective business impacts, policymakers and organisations can learn about potential trends that may be occurring / reoccurring and what actions might be required to address such inclinations. This method can be used for example to flag certain 'lost' links (primarily those of high business impact) in order to inform individual firms of such losses and help them understand why such a link may have been lost.
This method can provide granular data for each firm and the cluster overall, across the three new terms at a local, national, European or global scope. The existence of a cluster is often a critical starting point for clusters and regions alike, thus, providing circumstantial evidence of active networks and linkages between related firms in the same geographic proximity can offer invaluable insights when creating and developing policies to support and strengthen the network.

9.5.2 Indicative Policy Focus for Individual Cluster Organisations

The enabling of enhanced informed policy decisions, stems from the advantages of the rich vein of information visualised and easily accessed by cluster organisations and policy-makers, through the use of the V-LINC software (Byrne, 2016). Table 6.10 on page 196, provides a conceptual model that adds to the literature and theory on identifying stages of a cluster life cycle. Providing a method/rubric for cluster organisations to ascertain at what stage of the cluster life cycle their particular cluster is at has numerous benefits. A tool or model of this type can be beneficial to policy makers and cluster organisations alike, so long as they avoid making the mistake (once believed by authors and scholars) of developing and implementing cluster policies using a one-size-fits-all approach.

Throughout this thesis, cluster policies are a recurring theme, and tailor-made, specific, and relevant policies for clusters are crucial. Until now, the number of methods or rubrics is existence to assist in identifying cluster life cycle stages for clusters that are being investigated is nominal. The data required to complete such a model can be gathered via a longitudinal analysis of a cluster, as is the case in this body of work using the BioWin cluster as a case study. The principal advantage for clusters who communicate and share their analyses in a simple and accessible way, relates to public presentation and dissemination activities. Numerous clusters, according to Wolfe and Gertler (2004), list factors based on successful case studies, that are vital for cluster development. Byrne (2016, p. 239) argues “such lists do not provide effective guidance for policy makers where their region may be affected by different conditions and circumstances.” Moreover, numerous authors and scholars believe governments should not form clusters ab initio
(Martin and Sunley, 2003; Cortright, 2006; OECD, 2009; Muro and Katz, 2010). It is advised that implementing policy initiatives to help close the gap on cluster components in a region that may be lacking is what is required (Porter, 2000a).

The policy recommendations prescribed through the V-LINC analysis, do not aim or try to define a group of firms as a cluster nor does it try to create a cluster. The BioWin cluster ecosystem has specific and differing development requirements to that of other clusters and therefore a generic cluster policy or programme for economic development cannot be implemented. The V-LINC results highlight and address the region and cluster’s strengths and weaknesses in which specific policy initiatives can be accurately developed. This research displayed how firm linkages and category analysis via the V-LINC analysis, resulted in relevant and specific annual policy initiatives over the three-year period. The initiatives and recommendations can be utilised by the cluster organisations and shared with other economic development agencies.

Subsequently, this lead to the creation of Table 9.1 on page 300, titled ‘typical cluster policy at each cluster life cycle stage. Rather than focusing solely on the growth stage of a cluster life cycle i.e. the stage the BioWin cluster is identified at the time of this research, the table created provides a holistic view of policy at each of the four stages – emerging, growing, maturing and declining. The author chose four headings for which to analyse and compile typical policy measures i.e. networking, internationalisation, skills and training development and research and innovation. It is important to note that such policies are by no means limited to said four headings. Based on the cluster life cycle stage their cluster is at, this table assists cluster organisations and policy makers, to name but a few, in determining which stage-relevant policies to implement for their particular cluster.

To summarise, there is a definite requirement for regions and clusters alike to develop and implement targeted policy initiatives in line with their own specific and relevant conditions and circumstances. The V-LINC analysis and results can provide support for such required developments as well as referring to Table 9.1.
9.5.3 Clarity and Distinction given to Important Cluster Theory Terminology

A major contribution to the existing clustering literature is Chapter 4, in which several terms that are incorrectly used interchangeably are addressed and clarified. It is incorrect to refer to a cluster, cluster organisation or cluster initiative interchangeably, as they each serve a different purpose in stimulating competitiveness. Throughout this chapter, the author sought to clarify the differences between these key concepts as well as examine their role in economic and regional development by creating separate, clear and concise definitions and understandings. The aim of this chapter is to provide a clear explanation and definition of the above cluster terminology within the theory.

The following section investigates the methodological contribution of this thesis, having reviewed the theoretical contributions in detail.

9.6 Methodological Contributions

9.6.1 A Method to Analyse the Longitudinal Development of Clusters

The principal methodological contributions of the research are outlined in this section including: a new method to analyse clusters longitudinally, encompassing firm linkages and network theory in cluster analysis supported by the visualisation software to map linkages and clusters, and a new method to identify cluster life cycle stages. In brief, the author takes a base method (point-in-time V-LINC analysis) and applies it longitudinally with new elements added i.e. concept of Retained, New and Lost linkages. Adapting any method from its original state requires a change in the reporting mechanism for terminology and visualisations as well as the protocols for re-contacting the cluster organisation and participating firms.

The V-LINC methodology and its application, is a methodological contribution to recent methodologies in the area of cluster analysis. The main characteristics of the V-LINC method are summarised in Figure 9.1 and can be compared and contrasted with other methods of cluster analysis. Byrne (2016, p. 241) summarises V-LINC's function: “VLINC collects firm linkage data at the micro-level for a sample of firms; when this data is aggregated it provides an overview of a cluster (or potential cluster). A qualitative,
bottom-up approach is taken, where face-to-face expert interviews are conducted with key personnel in participating firms. Linkage data collected is uploaded to V-LINC software which visualises and analyses the data. Key outputs of the analysis are visualisations of the cluster network and targeted policy initiatives designed specifically for the cluster under investigation, developed in collaboration with a local partner organisation.”

The adaptability of this methodology allowed for its implementation in a longitudinal capacity from 2018-2020, gathering crucial data annually in order to map, analyse and assess the evolution of the BioWin Health cluster. The annual results are compiled and compared to the previous year's results. This created the method of visualising the ‘Retained’, ‘Lost’ and ‘New’ linkages reported each year by the respondent firms.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>V-LINC</th>
</tr>
</thead>
</table>
| Aim             | • Visualise and analyse a cluster through firm linkages.  
                  • Develop targeted policy initiatives. |
| Level           | Micro/Meso |
| Perspective     | Bottom-up |
| Techniques      | Qualitative - Expert interviews, network theory, visualisation software. |
| Visualisation   | Interactive geographic visualisation of firm/cluster linkages. |
| Advantages      | Cluster visualisation; type, geography & importance of linkages; key connectors; targeted policy initiatives. Applied to three regions in this thesis. |
| Limitations     | Small sample size, no quantitative analysis of data. |

Figure 9.1: Characteristics of V-LINC Methodology  
Source: Byrne (2016, p. 241)

The concerns around cluster studies regarding the method to identify a cluster is omnipresent. Byrne (2016, p. 242) argues “what may be considered a cluster, either by name or analysis, may actually be an agglomeration or industry specialisation due to limitations in quantitative and qualitative analyses which do not satisfy all characteristics of the cluster definition.” V-LINC methodology investigates linkages in related companies and assesses the linkages of a sector jointly, in order to prescribe relevant and targeted policy initiatives to enhance the regions innovative and competitive capabilities. Thus, the need to define whether the particular sector/region under investigation is or is not a cluster is not required as well as there being no need to apply a cluster measurement

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definition i.e. there is no universal agreement in the cluster literature as discussed in Chapter 3. Hence, V-LINC can be applied to a number of “geographic industry concentrations/agglomerations/specialisations models, identified through quantitative or qualitative techniques, or predetermined” (Byrne, 2016, p. 242).

There is widespread agreement amongst scholars that regional economies and clusters, through their network interaction, can be investigated and assessed (Bergman and Feser, 1999; Ter Wal and Boschma, 2009; Giuliani and Pietrobelli, 2014). By placing individual firm linkages at the heart of the analysis, a network theory perspective is integrated organically by the V-LINC method. The mapping of linkages in this method incorporates a vital geographic component by using social network analysis diagrams. In the same breath, it should be noted that V-LINC does not use or apply social network analysis techniques. Egocentric data was accumulated due to BioWin’s large membership (230+ members). Byrne (2016, p. 243) highlights: “a major limitation of ego-centric data is that several network properties can’t be assessed, such as distance, centrality, and network positions without a full census of cluster participants.”

V-LINC’s methodological contribution involves the examination of the linkages firms in a cluster engage in i.e. 1. Linkage type 2. Geographic scope and 3. Business impact. Firstly, current network analysis have the tendency to concentrate on particular linkages related to the value chain or innovation and if they are present or absent. V-LINC, on the other hand, investigates firm linkages across eight different categories and secondly, in doing so separates itself from that of the work of Porter i.e. V-LINC acknowledges that clusters have a dynamic capacity/dynamic in characteristic and the linkages and relationships firms enter into, occur with partners outside of a cluster. This research, not only examines eight categories, it also investigates cluster dynamics at four different geographic scopes – local, national, European and international, all without predetermining the most important geographic scale. Lastly, being able to classify the business impact of firm linkages can answer questions like what network types (government supports, value chains, knowledge flows) and at which geographic scope do clusters’ most impactful linkages occur?
One aim of this study is to create and develop a methodology that uses qualitative and quantitative data in a vigorous and replicable manner. The subsequent methodology used in this research i.e. longitudinal study of BioWin cluster using V-LINC analysis to examine the cluster, resulted in richer data providing a detailed assessment, which is different to that of a one year/point in time study. This research provides answers to questions such as ‘how clusters develop,’ ‘why a cluster has developed’ and the impact of cluster-related policies on the development of sectors and networks of an industry region must be assessed.

Qualitative and quantitative research has been progressively combined in recent years (Teddlie and Tashakkori, 2009), predominantly where the data gathered is qualitative by design, numerically recorded and statistically processed. Through implementing the V-LINC methodology, the strength of linkages in the BioWin cluster were assessed and in essence, with quantitative techniques being used allowed qualitative data to be gathered, recorded and analysed. Analysing the functioning of the cluster in order to better inform cluster organisations who prescribe policy recommendations is an invaluable task (Aranguren et al., 2014). The primary methodological contribution of this research is the development of a framework for identifying cluster life cycle stages which can be an extremely useful tool to discover areas for further study.

9.6.2 A Method to Identify Cluster Life Cycle Stages

The ability to develop and implement a method for cluster life cycle stage identification is unrivalled. Thus, the creation of the conceptual model (Table 6.10 on page 196), is a much needed tool in an already sparse area of cluster literature. The rubric incorporates the Economic impact of the cluster and sector, the cluster organisation itself and the V-LINC analysis results allow for the stages of a cluster life cycle to be identified. When the V-LINC analysis results are dovetailed with the 1. Economic impact of the region/cluster and 2. Cluster organisation data and figures, the stage of the cluster life cycle the cluster under investigation is at can be revealed. Numerous variables under each of the three headings allow for accurate calculation of the clusters evolution. Not all parts of a cluster develop and progress at the same time or speed (Menzel and Fornahl, 2010).
and consequently, the right policy initiatives are required for the current need of the cluster (based on the stage of the cluster life cycle it is located in) at that particular time. Cluster life cycle theory launched itself to be one of the prominent research areas on clusters (Lazzeretti et al., 2019), and with that came the requirement for understanding cluster evolution (Pronesti, 2019).

Accordingly, a one-size-fits-all policy initiative to enhance cluster development will not succeed and the need for a timely policy intervention based on the clusters’ current needs is vital. In support of this argument, Pavan (2020, p. 116) states it is extremely important to underline the fact that although it has been possible to identify a generic set of common rules, the “one-size-fits-all type of cluster policy does not exist. On the contrary, the correct implementation of the cluster policy must follow a single universal criterion, namely the choice of the alternative which better suits the peculiarities of the environment as a whole.” Kitson et al. (2004) and Motoyama (2008) in particular, discuss Porter’s concept that theorises ‘drivers’ are present and are of equal importance everywhere. According to Porter, regional economic growth is a universal process, that “if you pull the right levers, the ‘drivers’ will respond in similar ways with similar outcomes” (Kitson et al., 2004, p. 996).

This body of work treats clusters as a dynamic phenomenon having linkages and connections both inside and outside of the cluster. Existing studies that examine economic performance of clusters assume that all firms within a particular geographic boundary benefit from being part of the cluster (Pouder and St. John, 1996; Porter, 2000a). However, it cannot be assumed that all firms participate equally when engaging with local firms and actors, which also means they cannot be assumed to benefit from their location in a cluster (Byrne, 2016). According to Byrne (2016), another limitation exists when one focuses solely on the firms within a cluster as firms in related and supporting industries outside the clusters boundary may play a pivotal role in a cluster. This limitation is addressed when the V-LINC method is used by identifying linkages with firms outside the local region and or outside the industry sector. Cluster analysis should also incorporate the limitations associated with identifying firms within the cluster that are not in related/supporting industry and thus do not contribute to the cluster directly or indirectly.
Having reviewed the contributions (empirical, theoretical and methodological) to the literature of this research, the next section examines the limitations of the research

9.7 Limitations

Despite the theoretical and practical implications, this study has several limitations. To employ this research appropriately and consistently in the future, in a robust manner, it is necessary to acknowledge such limitations. The longitudinal nature of the research, involving face-to-face firm interviews, makes it a time-consuming process. Time and resources were spent organising interviews and follow-up meetings with a large number of people in a large number of locations. However, in order to gain an in-depth analysis of firms’ linkages, face-to-face interviews were a prerequisite where an optimum environment could be created to build trust, that is otherwise not attainable through, for example a postal or telephone survey.

As previously noted in section 7.5, the Year 3 (2020) interviews had to be conducted online due to the global COVID-19 pandemic that occurred and this in itself posed many new problems and was a limitation in its own right. The online nature of an interview process was difficult and is in line with what Byrne (2016, p. 244) described, stating “it is not possible to build the trust required to gain an in-depth analysis of firm’s strategically important linkages through a postal, online or telephone survey. In-depth personnel interviews facilitate a deep understanding of firms’ linkages, and provide context and rationale for individual perceived significance scores.” Personnel interviews provide context and rationale for individual perceived significance scores, and facilitate a deeper understanding of links between companies (Byrne, 2016). During the three-year period of the V-LINC analysis, companies grew and matured significantly. If that trend continued, a subsequent follow-up or further longitudinal analysis may identify an increased number of companies eligible for participation.

Attracting cluster firms to participate in the research can be difficult in its own right, but organising them to re-interview three years in a row is even more challenging. This combined with changes in respondent personnel from year to year led to differing data
being collected on behalf of the same organisation. With this also comes the time consuming nature of having to re-explain the V-LINC method that will be completed with the new respondent. This particular limitation was overcome through experience gained in dealing with firms and firm personnel year after year as well as refining the explanatory parts of the V-LINC process, only focusing on the key points.

In addition, if in Year 1 the respondent provides anonymous linkages (see section 7.3.1), and for various reasons the same respondent is not present or does not participate in the following years interview, the new respondent may not have any knowledge of the anonymous linkages recorded, thus rendering those linkages unusable. Another factor to be considered is the scoring element of the interviews i.e. one person may perceive 7 out of 10 as a very high score in their own opinion, while another person might perceive a very high score to equate to 10/10 for the same linkage. This limitation was dealt with in a consistent fashion, with the author making notes on the master excel spreadsheet if the firm employee being interviewed was the same or not. The figures for each interview were processed in an identical manner and thus this limitation was overcome.

The V-LINC methodology requires the partnering of a local organisation e.g. cluster organisation from the cluster under investigation to help facilitate the research effectively. To begin, the sample firms selected with the help of the cluster organisation, may not provide a holistic representation of the population. This ‘non-probabilistic’ sample of firms allows the researcher and cluster organisation, for example, to select a mixture of important firms active in the cluster ranging from a large MNC or SME to a micro firm with less than 5 employees. The cluster organisation can help arrange the interviews with the selected firms, help the researcher build trust with the respondents and review the policy recommendations in order to provide feedback to ensure such policies can be attained. There can be some limitations associated with the organisations help. Firstly, their help in selecting the firms who will participate in the research may have biases based on if firms participate in the cluster actively or not and thus, non-active firms may be excluded from their ‘list’. Having members from numerous sectors within the cluster alleviated this bias and provided a holistic representation of each area of expertise i.e. biotech, medtech, biopharma, bio manufacturing are all represented.
Uploading the data to the V-LINC site using the software while cleaning the data can be labour intensive and time consuming. This holds true, especially for the Year 2 and Year 3 data sets of the analysis process when these additional data sets are uploaded. However, through constant repetition and familiarisation with the uploading process and software, the time it took to complete each upload reduced drastically. The software does not provide an option to recognise when linkages have been retained, lost or newly created since the previous data collection occurred. Thus, the time consuming nature of having to meticulously go through each individual Microsoft excel spreadsheet to identify such linkages was ever present. These linkages, once identified require separate spreadsheets and must be input manually.

This body of work treats clusters as a dynamic phenomenon having linkages and connections both inside and outside of the cluster. Existing studies that examine economic performance of clusters assume that all firms within a particular geographic boundary benefit from being part of the cluster (Pouder and St. John, 1996; Porter, 2000a). However, it cannot be assumed that all firms participate equally when engaging with local firms and actors, which also means they cannot be assumed to benefit from their location in a cluster (Byrne, 2016). According to Byrne (2016), another limitation exists when one focuses solely on the firms within a cluster as firms in related and supporting industries outside the clusters boundary may play a pivotal role in a cluster. This limitation is addressed when the V-LINC method is used by identifying linkages with firms outside the local region and or outside the industry sector. Cluster analysis should also incorporate the limitations associated with identifying firms within the cluster that are not in related/supporting industry and thus do not contribute to the cluster directly or indirectly.

Having identified the limitations associated with the research, the next section discusses the area of potential future research.

9.8 Future Research

The V-LINC methodology applied within this thesis builds on Byrne (2016) framework, addressing its use over a 12-month period and extending it to a longitudinal analysis in order the map the evolution of a cluster through analysing firm linkage data. The
application of V-LINC to the BioWin Cluster is a starting point to understanding how firm linkages within a cluster evolve and change over a period of three years. This research and use of V-LINC, aimed to build on the work of Moynihan (2018, p. 278) who noted “the further application of this methodology to clusters at their different stages of maturity and development will aid in the understanding of the role cluster organisations play in a cluster’s growth.” The following headings provide potential future research ideas and studies.

**Comparative Studies**

To determine the applicability of the new methodology (section 6.8), it would be beneficial to use the method to examine other types of industry clusters, e.g. service-based or traditional industries such as tourism or agri-food to name but a few. Of course, this does not mean it cannot be applied to another biomedical cluster in a different country or even another region in Belgium i.e. the Flanders region. The proposed methodology and framework can be expanded to, for example, other biomedical clusters in e.g. Ireland or multiple countries, using the new framework and method developed in this research. In doing so, the results garnered from different clusters of similar fields can provide interesting results and data on the current cluster life cycle stage of the clusters under review and further validate the method used.

Furthermore, this can equip cluster organisations with the correct tools and information to identify tailor-made cluster policies that are relevant and applicable to supporting the cluster in its respective cluster life cycle stage. In summary, when a potentially large sample size of V-LINC datasets covers multiple sectors and regions, it also allows for the statistical analysis of the links the respective cluster participants engage in. This study could investigate the work of Bathelt et al. (2004) that suggests that firms will engage in networking on a local and global scale, depending on factors specific to their own organizations.
Application of New Methodology Using Two and/or Three Pillars

While the new methodology in this body of work was applied longitudinally, it could also be utilised in a one-off twelve-month research project to try identify the cluster life cycle stage of a cluster. This concept will require the sourcing of prior information and data on the cluster in question from the previous year in order to investigate how the figures relating to e.g. economic impact and cluster organisation have evolved from the previous to the current year. Furthermore, while the third pillar of the new methodology i.e. V-LINC analysis, plays a vital role in accurately identifying cluster life cycle stages, the method could be applied to a cluster using only the first two pillars (section 6.8).

While the results will not be as accurate as a fully comprehensive review using all three pillars, including V-LINC, the method has been designed to allow for easy application to clusters in different countries and sectors without necessarily conducting a V-LINC analysis. However, to obtain a holistic and accurate insight of the cluster under examination and its cluster life cycle stage, it is strongly recommended that a V-LINC analysis is conducted. Cluster organisations wishing to identify the life cycle stage their cluster currently resides, in order to implement accurate and relevant policy initiatives can utilise and apply the rubric and framework, be it with two or three pillars, to help inform policy makers.

9.9 Conclusion

This study sought to accomplish three objectives and to examine cluster analysis methods in order to develop a new method to identify cluster life cycle stages. To provide the theoretical foundation/framework for this body of work, an in-depth review of the cluster literature involving cluster theory and analysis took place. Throughout the entire study, the author reviewed the plethora of cluster literature, attended academic conferences both local and abroad, and had face-to face dealings with cluster organisations and policy makers within the Wallonia region. The research also aimed to provide critical insights into how cluster policy and S3 strategies have been developed, delivered and implemented in Belgium.
Realising the Research Objectives

This body of work set out three research objectives of which the details of how they were realised are shown below:

1. **Analyse the longitudinal development of a cluster to record, measure and analyse its evolution over a three-year period**

The BioWin cluster, its 17 member firms who participated in the research and the linkages they engage in on a daily basis were successfully tracked and traced for three consecutive years from 2018-2020 via annual firm interviews. Chapters 7 and 8 provide a greater depth of information and detail regarding how this objective was realised via the annual V-LINC reports and policy recommendations. The adaption of the base method i.e. a point in time V-LINC analysis, longitudinally, provides new terminology including Retained, New and Lost linkages, which allow for a richer vein of data and information to be gathered, analysed and visualised. The linkage data from each of the fifty-one interviews is tested, validated and uploaded appropriately to the software, with the interviews over the three-year period yielding 404 linkages in 2018, 459 in 2019 and 458 in 2020, totalling 1321 linkages. Each individual link was assessed based on its category, geographic scope and business impact.

2. **Create a new methodology to support cluster life cycle stage identification**

Section 6.8 provides the details of the new method created and developed to assist policy makers and cluster managers alike in determining the stage their cluster is at along the cluster life cycle. Table 6.10 on page 196, displays the Cluster Life Cycle Stage Identification Conceptual Model, which is applied to the BioWin cluster to identify its current life cycle stage using the carefully selected three pillars and twelve variables. Applying this model to different sectors and industries across different countries can provide vital information to cluster organisations, regional and national governments as well as policy makers. This model is successfully applied to the BioWin health cluster of Wallonia, in which the cluster is identified as being in the growth stage of its respective cluster life cycle (see Table 8.18, page 290).
3. Support policy makers in developing and implementing tailor-made policy initiatives relevant to the cluster’s current stage along its respective cluster life cycle.

The author created and developed Table 9.1 on page 300, which summarises the typical cluster policy at each cluster life cycle stage under four headings; Networking, Internationalisation, Skills and Training Development and Research and Innovation. This table allows for a complete review of cluster policies at each of the four life cycle stages acting as a reference point for cluster organisations/policy makers when considering tailor-made initiatives that are appropriate to their respective life cycle stage.

This thesis aimed to examine the stages of cluster life cycles and the factors influencing movement between these stages, through the development of a new cluster analysis methodology. It sought to build on the V-LINC methodology (Byrne, 2016) that combines the use of network theory and cluster analysis techniques to analyse, record and visualise cluster firm linkages providing a deeper understanding of how the clusters’ ecosystem functions, over a three-year period. After analysing the RFG data annually, tailor-made cluster policy initiatives were developed while highlighting the importance of the V-LINC cluster analysis that provides an insight into how a cluster in a specific region functions. Byrne (2016, p. 251) states “V-LINC can answer questions such as: which actors participate in a cluster, how are these actors connected, how does a cluster interact locally within its ecosystem, what connections does a cluster have outside its region, and what policy initiatives can be implemented to build on regional strengths and address weaknesses.”

Byrne (2016, p. 250) notes “a cluster is a geographic concentration of linked firms that are active in related or supporting industries. A cluster can incorporate different types of networks which can be defined by various criteria, e.g. the type of network or geographic scope of the network.” Including inter-firm networks in the analysis of the cluster adds a critical dimension of power relations within it (Denney et al., 2020). Considering the regional past and potential future developments are a prerequisite for investigating cluster evolution (De Sousa Ostapenko et al., 2021). The identification model proposed by Menzel and Fornahl (2010) was a distinct catalyst for the growth of research on the cluster life cycle. The model allows (internal) cluster dynamic measurement as well as cluster dynamic development.
life cycle stage identification, which has since been replicated and deployed by numerous authors (Shin and Hassink, 2011; Elola et al., 2012; Branco and Lopes, 2013; Tavassoli and Tsagdis, 2014; Elola et al., 2017; O’Connor et al., 2017; Santner, 2018; Viederytė, 2018; Mobedi and Tanyeri, 2019; Dyba et al., 2020).

The V-LINC method was applied in a longitudinal capacity (2018-2020) to the BioWin Health Cluster of Wallonia, in order to investigate the cluster, produce tailor-made policy initiatives for BioWin and to develop its strengths and combat its weaknesses. It was implemented to help identify what stage of the cluster life cycle the BioWin cluster is currently in. Hanks et al. (1994, p. 25) note that an accurate life-cycle model could provide “a timetable for adding levels of management, formalizing organization procedures and systems, and revising organization priorities. It could help management know when to let go of cherished past strategies and practices that will only hinder future growth. The benefits of such a model to new-venture founders could be significant.” Certain countries across Europe have supported clusters and their policies since the early 90s while some have introduced the clustering concept much later with other countries not embracing the concept at all.

De Sousa Ostapenko et al. (2021, p. 27) argue “clusters play a crucial role in regional and national economic development, providing various advantages to stakeholders, and especially firms. For that reason, they became an integral part of regional development policies, including converging with Smart Specialization Policies adopted by the European Union.” The European Union promotes clusters as an essential component of its economic development and strategy i.e. smart specialisation. Clusters are viewed as building blocks used when designing smart specialisation strategies as well as a driving force for implementing such strategies – BioWin and the Wallonia region has its own S3. Clustering and cluster policy are of great importance to regions and countries alike and it is vital to comprehend how they can be effectively applied to each region.

This thesis will inform cluster policy makers by showcasing first-hand learning from a successful, competitive, and well established cluster like BioWin. The lessons and
information gathered over the three-year study can be analysed in order to fast track cluster policy making by using a best-in-class cluster example in BioWin, to shape and form such policy initiatives and recommendations. Clusters and cluster policies, like regions, come in different shapes and sizes. Despite the fact that best practices can be shared, there is no one-size-fits-all cluster model and each region must design its own strategy to contribute to its own local competitive advantages, assets and strengths relative to its international competitors. In support of this argument, Fornahl and Hassink (2017, p. 1) state “one-size-fits-all cluster policies have been rightly criticized in the literature. One promising approach is to focus cluster policies on the specific needs of firms depending on the stage of development (emergence, growth, sustainment or decline) their cluster is in.” By tracking and mapping the RFG linkages longitudinally, based on the data obtained from the V-LINC analyses used in combination with the cluster life cycle rubric (section 6.14) the author could distinguish at what stage of the cluster life cycle the BioWin cluster is positioned. This occurred in tandem with an extensive review of the literature of cluster life cycles (see Chapter 5) which provided the foundation for cluster life cycle comprehension.

This research presented the BioWin cluster located in the Wallonia region in the south of Belgium, and the cluster organisation can be titled as a ‘best-in-class’ organisation supported by regional and national policy. BioWin was awarded the Silver Label for cluster management excellence in August 2021, which supports the best-in-class title. With over 15 years’ experience, BioWin develops a strategic plan for the cluster and its members annually as well as constantly updating and renewing their services. BioWin plays a prominent role in its ecosystem holding both titles of cluster organisation and industry association. Thus, BioWin has the capacity to act as a leading European cluster organisation while also focusing on the development of their members networking ability and skills, which is more associated with the roles of an industry association.

By using a longitudinal V-LINC analysis, a scholarly study has been conducted to examine the impact of the BioWin cluster by presenting the results of their three-year analysis, which includes the member firms of the cluster, combined with an explanation of their status within the cluster life cycle. Furthermore, the firms who participated in the
V-LINC analysis received individual firm reports (see Appendix B) each year that provided a comparison of their own firm data against not only against their own information but also with the other 16 participating firms. From a cluster theory and methodological perspective, with the theme of cluster life cycles and longitudinal studies at its core, this research has contributed to the cluster analysis literature by providing a new cluster analysis method for life cycle stage identification. This has been proposed and validated in this study using the cluster analysis visualisation tool, comprised of network analysis mapping and tracking and tracing of Retained, New and Lost linkages from year to year.

V-LINC, by design, can be replicated within different regions, clusters, sectors, organisations and across different countries (see Byrne, 2016; Hobbs et al., 2014, 2016; Moynihan, 2018). Data from V-LINC can be leveraged to help form policy initiatives and recommendations to support the growth and development of a cluster. Having acknowledged the limitations of the research, it is hoped that the data in this study will serve as a solid foundation for future development of both the V-LINC methodology and new cluster life cycle stage identification method with further validation in different industry sectors and geographical regions.
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APPENDICES
Appendix A – Company Invitation Cover Letter

Dear Mr Harte,

I’m writing to you to ask if your firm would be interested in participating in a PhD research project which seeks to analyse the biotechnology and health cluster in Wallonie. As Company X is a prominent member of the BioWin Cluster and has been proposed by Ms. Timmermans, your input would entail a one hour meeting with a member of staff who has good knowledge of the linkages your firm engages in. Having worked closely with BioWin your company has been carefully selected as 1 of 20 companies to be part of this research.

The overall goal is to assess and map the BioWin cluster’s ecosystem. We are extremely interested in how BioWin’s characteristics may change over time in an effort to measure the impacts of policy support and to ensure policy supports for industry are of relevance and fit for purpose. The project is a collaboration between BioWin; Service Public de Wallonie and Cork Institute of Technology (Ireland).

Selected firms will benefit from participating by receiving a V-LINC firm report which audits your firm’s linkages and benchmarks your firm with other participants in the Biomedical Cluster in Wallonia. Please see short PowerPoint attached explaining the research.

I look forward to arranging an appointment for this interview to take place, on a day that is convenient to both parties in the coming weeks.

With kind regards,

Conor Harte

PhD Student, V-LINC Research Group,

Munster Technological University,

Rossa Avenue,

Cork, Ireland.

M: (+353) 87 2854493 W: (+32) 474 104162 E: conor.m.harte@mycit.ie
Executive Summary

The BioWin biomedical health cluster is a strong and rapidly growing industry sector and hub for central Europe. It is important that industry players, academia, business support organisations and policy makers understand how the BioWin Biomedical health cluster ecosystem operates both within Wallonie as well as its external relationships forged outside the local region, so that collaboratively, they can buttress growth and employment through supportive policy.

The aim of this study is to examine the ecosystem to determine the nature and extent of linkages that bio health firms have with other companies, industry associations, government agencies and academia. Data was gathered between March 2018 and September 2018 via face to face interviews with respondents from 17 bio-health companies in Wallonie. These companies are referred to in this report as the respondent firm group (RFG). Linkages with other organisations are grouped into eight categories and four geographic scopes. Comparisons between Company X linkages and those of the RFG are summarised below. Company X recorded 29 individual linkages, 6% of all linkages reported by the RFG.

<table>
<thead>
<tr>
<th>Company X</th>
<th>Respondent Firm Group (RFG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of Linkages</td>
<td></td>
</tr>
<tr>
<td>Output linkages are the most frequent, followed by Industry Association and Input linkages.</td>
<td>Output linkages are most frequent followed by Inputs and Research and Development.</td>
</tr>
<tr>
<td>Training followed by Industry Peer linkages are the least frequent linkage category.</td>
<td>Training are the least frequent linkage category.</td>
</tr>
<tr>
<td><strong>Perceived Impact of Linkages</strong></td>
<td></td>
</tr>
<tr>
<td>Industry Peer and Specialist Service linkages were perceived to have had the most impact.</td>
<td>Specialist Services were perceived to have most impact, followed by Government Agency and Output links.</td>
</tr>
<tr>
<td>Training, Government Agency and Industry Association linkages were perceived to have the least impact. There were no Research and Development linkages recorded.</td>
<td>Training and Input linkages were perceived to have the least impact.</td>
</tr>
<tr>
<td><strong>Geographic Scope of Linkages</strong></td>
<td></td>
</tr>
<tr>
<td>Linkages were spread with 31% local, 7% National, 31% European, and 31% International.</td>
<td>Linkages were geographically spread: 34% local, 28% National, 25% European, and 13% International.</td>
</tr>
<tr>
<td>European linkages have the highest perceived impact to the firm followed by local and International linkages.</td>
<td>Local linkages were deemed the most important, followed by International linkages.</td>
</tr>
<tr>
<td>National linkages had the least recorded impact.</td>
<td>National and European linkages were perceived to have the least impact.</td>
</tr>
<tr>
<td><strong>Linkage Categories and Geographic Scope</strong></td>
<td></td>
</tr>
<tr>
<td>European linkages are predominant in Inputs.</td>
<td>European linkages are the predominant level for Inputs</td>
</tr>
<tr>
<td>Outputs are mostly found at an International scope.</td>
<td>Outputs are mostly found at a European scope.</td>
</tr>
<tr>
<td>There were no Research and Development linkages recorded.</td>
<td>Local linkages dominate in Research and Development.</td>
</tr>
</tbody>
</table>

Mapping / Graphical Presentation

Training (TN). There are four geographic scopes; local (L) within Wallonia, national (N) within Belgium, European (EU) within Europe, and international (INT).
Each individual linkage is depicted by a line; while its geographic scope is represented on the map. Maps are presented in the following section for Company X on the left side and all the linkages for the RFG on the right side at four geographic levels; local, national, European and international.

**Firm Linkages**

**RFG Linkages**

**Local Linkages**

**National Linkages**

**European Linkages**

**International Linkages**

Figure 1 compares the number of linkages reported by Company X, in each linkage category, against that of the RFG.

Figure 1: Distribution of Linkages per Category: Company X vs. RFG

Each linkage is given a perceived impact score out of 40 to identify the strength of the relationship between your company and the linked firm/organisation. Figure 2 compares the median perceived impact score, by linkage category, for Company X against the RFG.

Figure 2: Median Perceived Impact Score by Linkage Category Company X vs. RFG

Figure 3 expresses the geographic scope of Company X’s linkages compared to the RFG.

Figure 3: Geographic Scope of Linkages [distribution expressed as a percentage]

This report has recorded the nature and extent of Company X and 16 other respondent firms' linkages with other parties, including value chain and knowledge flow perspectives. The appendix gives details of all of Company X’s individual linkages reported by the firm. From this list Company X’s most and least significant linkages can be identified.
Appendix: Company X Linkages Ranked by Business Impact

<table>
<thead>
<tr>
<th>No.</th>
<th>Linkage Category</th>
<th>Linkage Name</th>
<th>Country</th>
<th>Geographic Scope</th>
<th>Perceived Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IP</td>
<td>Company X - IP1</td>
<td>Switzerland</td>
<td>EU</td>
<td>34.5</td>
</tr>
<tr>
<td>2</td>
<td>SS</td>
<td>Company X - SS1</td>
<td>Belgium</td>
<td>L</td>
<td>31.5</td>
</tr>
<tr>
<td>3</td>
<td>IN</td>
<td>Company X - IN1</td>
<td>Germany</td>
<td>EU</td>
<td>28.5</td>
</tr>
<tr>
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</table>

V-LINC Analysis of BioWin’s Biomedical Health Cluster Ecosystem: Longitudinal Data & Perspectives from Year 2.

Conor Harte, John Hobbs,
Faculty of Business and Humanities, Cork Institute of Technology, Ireland.

E-mail: conor.m.harte@mycit.ie; john.hobbs@cit.ie;

Abstract

Since its creation in 2006, BioWin is recognised internationally as a leading cluster in the area of health biotechnology and medical technologies from its base in Wallonia (the southern region of Belgium). The depth of health science actors in Wallonia has created an ecosystem that promotes innovation and excellence, while allowing the region to develop unique and highly specialised capacities in health biotechnology and medical technologies. Included in these actors are 10 large companies in Biopharma (Baxter, IBA, IRE Elit, GSK Vaccines, Kaneka Eurogentec, Janssen Pharmaceutica, Alten, UCB, XPE Pharma & Science and Zoetis), 5 universities (Université Catholique de Louvain, Université Libre de Bruxelles, Université de Liege, Université de Mons and Université de Namur) and over two hundred and fifty highly specialised and innovative SMEs.

V-LINC, a methodology which identifies, records and analyses the linkages that firms in clusters engage in, is applied to the BioWin Health Cluster in the Wallonia Region of Belgium as part of a three-year longitudinal study. To ascertain how BioWin’s members maintain and develop linkages and supply chains with the support of cluster initiatives. V-LINC was developed in Cork Institute of Technology to enrich academic literature on clusters. V-LINC visualises information on the geographic footprint of cluster ecosystems, whilst measuring the perceived business impact of cluster linkages. Understanding the linkages that firms in a cluster engage in, allows targeted policy recommendations to be developed to build on strengths and address cluster weaknesses. These strengths and weaknesses are highlighted and analysed in this report for 2019 (Year 2) and subsequently benchmarked against the data collected in 2018 (Year 1) of the analysis.
As the biotechnology and medical technologies sector in Wallonia develops and expands it is important that industry players, business support organisations and policy makers understand how the ecosystem operates both within Wallonia along with the external relationships forged beyond the region, so that collaboratively, they can deliver growth and employment through supportive policy.

Keywords: V-LINC, industry cluster, ecosystem, BioWin, mapping.

This paper was supported by a collaboration between the Faculty of Business and Humanities, School of Business and Registrars’ office in the Cork Institute of Technology

Introduction

This report is a research collaboration between the Cork Institute of Technology, BioWin Health Cluster of Wallonia and Service Public de Wallonie (SPW) who partnered to apply V-LINC to the biomedical health cluster in Wallonia. This research is part of a three-year longitudinal study of the BioWin cluster to ascertain how its members maintain and develop new linkages and supply chains with the support of the cluster. BioWin, among its many objectives, aims to train, attract and retain in Wallonia a motivated, innovative, excellent core of human capital, to support the improvement of collective infrastructures and technological platforms, whilst promoting the strengths of the Walloon region’s medical technologies internationally.

Companies specialising in bio-therapeutics avail of synergies created with local and neighbouring academic and research centres as well as utilising support services (includes expertise in bio-manufacturing of biologics) connected to BioWin. Wallonia as a region is at the forefront of clinical Research and Development in cell therapy. SPW actively promotes the Wallonia region in collaboration with the Wallonia Export and Foreign Investment Agency (AWEX). They work in synergy to continue to grow the high value sector - bio health. Wallonia has a strong reputation in the area of bio-
therapeutics and this work is a representation of the cluster combining the information from the participating Respondent Firm Group (RFG).

The report begins with an explanation of V-LINC, a methodology which records, categorises and measures the business impact of linkages that cluster firms participate in, along with the facility to show linkages on geographic maps of appropriate scale. Linkages between firms and other organisations are at the heart of how clusters function. Linkages are defined (Hobbs, 2010; p 221) as “relationships that enable exchange of goods, services, personnel, information, ideas, expertise, grants and other supports to business that occur between two or more parties, over a sustained time period.”

Next, the report comments on the scale of the BioWin health cluster in Wallonia, then reviews findings from V-LINC analysis on the linkages of a sample of firms in Wallonia. The analysis includes: the distribution of linkages by category, by geographic scope, and by their impact as perceived by company employees who engage in the linkages. V-LINC maps illustrate the linkages at different geographic scopes. Arising from the analysis a judgement is made about the extent of cluster activity in the health sector in Wallonia.

Finally, the report shifts to a longitudinal perspective comparing the results from Year 2 data collected from 17 BioWin member firms to the data recorded and analysed in Year 1 for the 20 firms analysed in 2018. This comparison allows cluster impacts to be assessed over the first two years of research. The report closes with recommendations on how to strengthen and support the BioWin Health Cluster in Belgium.

V-LINC: Visualisation of Linkages in Networked Clusters

V-LINC\textsuperscript{40} is a methodology for identifying, recording and analysing the linkages that firms in clusters engage in. It categorizes these linkages, and groups them by geographic scope: Local linkages, within Wallonia; National linkages, across Belgium (outside Wallonia); European linkages, outside Belgium; and International linkages, outside

\textsuperscript{40} The V-LINC methodology is outlined in Byrne, E., Hobbs, J., and Doran, J. (2018), further methodological detail is provided in Byrne, E. (2016) PhD thesis section 4.2.1 defines each of the linkage categories and outlines the perceived business impact bands used by V-LINC
Europe. Furthermore, V-LINC records the business impact of linkages based on the perceptions of firm personnel who engage in the linkages with other companies and organisations. The data required for the V-LINC analysis is collected by structured interviews of company personnel. Likert scale questions are employed to gauge the business impact of individual linkages engaged in by respondent companies. V-LINC maps give a visual representation of the relative reliance on local, national, European or international linkages of a company and when combined, of a cluster (Figure 2). V-LINC facilitates policy development at local and national levels, through the aggregation of data from a sample of firms. Confidentiality of firms’ linkages is maintained throughout.

V-LINC assigns company linkages to one of eight categories (Figure 1). Besides linkages along the supply chain, namely those which provide Inputs and Specialist Services to firms, and Output linkages which provide markets for goods produced, V-LINC adds five other categories of linkages: those with Industry Peers, with Industry Associations, with Research & Development partners, with Training partners and with Government Agencies. The linkage categories in V-LINC derive from Porter’s (1990, 1998a and 1998b) discourse on the interactions and relationships of companies in a cluster.

V-LINC responses collected through structured interviews combine to reveal the impact of business linkages as perceived by expert company personnel. Likert scale responses convert qualitative judgements into quantitative data which are subject to further analysis. The impact of the linkages is recorded and scored between 0 and 40, then arranged into four impact bands based on their importance: High (30 to 40), Medium (20 to 30), Low (10 to 20), or Tenuous (0 to 10). This enables one to answer the question: at which geographic level and linkage category do clusters’ most valuable linkages occur. The rationale for applying V-LINC to the BioWin Health Cluster in Wallonia is outlined in the next section.
Figure 1: The Eight V-LINC linkage categories analysed for each firm.

Wallonia, with its young and ambitious population, boasts numerous colleges and universities held in high esteem globally. This diverse population is made up of many different cultures and languages. BioWin is at the forefront of promoting collaborative projects between industry and academia as well as research centres with the underlying aim of developing products and services for the global market (win-health.org, 2019).

The BioWin health cluster promotes scientific excellence is achieved by networking and having a presence at world renowned events and fairs for health and biotechnology. Another key component involves developing and consolidating partnerships with other clusters from around Europe and the rest of the world. In order to achieve scientific objectives an optimal environment must be created to allow these types of collaborations and exchanges to flourish as well as acquiring the adequate private and public funding.

BioWin have created and defined four strategic areas in order to support Wallonia’s health sector from an industrial and academic perspective. These areas include; helping foster the evolution in human and animal health R&D projects, promoting Wallonia’s world class levels of expertise, bringing together and maintain a work force of highly qualified individuals and aiding the formation of collaborative technological infrastructures. BioWin’s strategy seeks; to closely monitor technological developments (use of Smart Specialisation to identify new and emerging areas of development), to bring players together, to speed up innovation and to enhance excellence (biowin, 2020).
Wallonia is at the heart of the biopharmaceutical sector which is the main industrial activity in regard to driving economic growth in the region. The pharmaceutical industry employs 35,700 FTE in Belgium (direct jobs) of which 54% are working in Wallonia. The sector accounts for 27% of all regional exports. In the past 13 years the BioWin cluster has been able to combine health innovation actors within the region and enhance the visibility of the biotech, pharma and medtech ecosystem at an international level. This in turn has led to growth in employment and the region’s industry (biowin, 2020).

BioWin connects its members to possible collaborators, via global networking events and working closely with the AWEX (Wallonia Foreign Trade and Investment Agency) and the WBI (Wallonia Brussels International), as well as their own events which focus on different areas such as R&D, strategic or business partnerships and collaborations). Furthermore, BioWin has created its own smart specialisation strategy, identifying 6 key technological areas in which their members are active: bio-pharmacy, cell therapy, medical devices, bio-manufacturing, data science and radiation applications in healthcare (portail.wallonie.be, 2019).

This research has been funded through a collaboration between the Faculty of Business and Humanities, School of Business and Registrars’ office in the Cork Institute of Technology. In this research the V-LINC analysis is applied to a sample of seventeen firms based in the Wallonia region, with a specific focus on SMEs whose market is not just targeted on the local/national region but on European and international markets alike. 16 face to face meetings and 1 online Zoom meeting were held with personnel from these companies to gather information regarding their key relationships. These meetings uncovered 459 firm linkages (Table 1) in contrast with 478 firm linkages recorded in Year 1. The term Respondent Firm Group (RFG) relates to the summation of data for the seventeen health cluster respondent firms.

**V-LINC Analysis Results: BioWin Health Cluster, Wallonia**

Table 1 lists the seventeen firms who participated in the Year 2 (2019) V-LINC analysis. Three firms less than were analysed in the Year 1 (2018) RFG for a number
of reasons which are articulated in the section which compares and analyses the Year 2 data with the Year 1 cohort later in this report. Table 1 includes the percentage of linkages each firm report across the eight linkage categories along with the total number of linkages they reported. It also distinguishes the total numbers of linkages per category for the cluster (sum of all respondents). Table 1 report’s that the most frequent linkages are in Outputs which account for 24% of all linkages reported; followed by Inputs (18%) and Research and Development (12%). This is in line with expectations as firms exist due to continued development of revenues derived from satisfied customers. Inputs and R&D are the spine of a firm’s product and service offering. The least frequent linkage categories are again Training and Industry Peers at 4% and 5% of all linkages, respectively. This may indicate a disjoint with firms in the same industry and perhaps due to firms’ employees being highly qualified the need for Training providers at present is limited. Firms may also believe it is most appropriate to train their own employees in house.
<table>
<thead>
<tr>
<th>Company</th>
<th>SIZE</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
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<td>12%</td>
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<td>4%</td>
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<td>13%</td>
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<td>13%</td>
<td>29%</td>
<td>23%</td>
<td>10%</td>
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<td>20%</td>
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<td>9%</td>
<td>6%</td>
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<tr>
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<td>3%</td>
<td>44%</td>
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<td>24%</td>
<td>34%</td>
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<td>9%</td>
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<td>17%</td>
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<td>8%</td>
<td>13%</td>
<td>4%</td>
<td>24</td>
</tr>
<tr>
<td>GSK Vaccines</td>
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<td>28%</td>
<td>11%</td>
<td>17%</td>
<td>11%</td>
<td>17%</td>
<td>0%</td>
<td>6%</td>
<td>18</td>
</tr>
<tr>
<td>Novasep</td>
<td>Large (&gt;250)</td>
<td>17%</td>
<td>8%</td>
<td>4%</td>
<td>13%</td>
<td>25%</td>
<td>13%</td>
<td>8%</td>
<td>13%</td>
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<td>12%</td>
<td>5%</td>
<td>18%</td>
<td>24%</td>
<td>12%</td>
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<td>4%</td>
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<td>2nd</td>
<td>1st</td>
<td>3rd</td>
<td>3rd</td>
<td>8th</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Distribution of Linkages by Category and by Firm\(^\text{41}\)

**Linkage categories by geographic Scope:** Geographic proximity of firms, provides the opportunity for the development of local connections between firms or organisations. Face-to-face interactions play an integral role in cluster theory and are associated with producing higher growth and innovation in clusters. Porter (1998a, p

\(^{41}\) Note to Table 1: The eight linkage categories are: Government agencies (GA); Industry association (IA); Industry peers (IP); Inputs (IN); Output (OU); Research & development (RD) Specialist service linkages (SS) and Training (TN).
226) believes, “a cluster is a form of network that occurs within a geographical location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions.” Modern advances in communication and technology have impacted this need for geographic proximity and allow connected firms to be more widely dispersed across a region, or even countries. Firms may source Inputs from several regions, engage in R&D with research organisations in foreign countries, and sell into multiple international markets. Therefore, it is important to look at the geographic scope of linkage categories, and their business impact over these different geographic scopes.

Table 2 and Figure 2 display the linkages reported at each geographic level for each of the eight linkage categories. Table 2 distinguishes the dominant geographic scope for each category and when we focus on individual categories, it is apparent that 29% of Output linkages in this study are within Belgium, whilst a further 33% serve the European market. It is interesting to note that the proportion of linkages for international export (39%) is greater than that of the combined linkages reported for both local (14%) and national (15%) Output. These results, although contradictory to Porter’s findings above, highlight the significance of the European and international markets for BioWin respondent firms.

This is not in line with the norm for SMEs, as smaller firms tend to be less inclined to export than larger firms (Dana et. al., 1999a; 1999b). Hirsch., S. & Adar., Z (1974 p. 41) note that “large firms can afford to assume more risks than small ones; in addition, their risks from foreign operations are less than those of small firms because the large firms benefit from economies of scale in foreign marketing.” The analysis of several hundred firms across Denmark, The Netherlands and Israel determined that with a small proportion of exceptions “the size of firms is indeed positively correlated with the ratio of exports to sales” (Hirsch and Adar, 1974 p. 41). However, this does not seem to be the case within the data reported by the respondent firm group in this analysis as exporting to foreign markets is a key part of small and medium sized enterprises in the RFG.
When we examine the linkages for those cohort of 14 SME firms who export their goods, a total 64 European and international linkages were reported (the three large firms are discounted in this instance), accounting for 59% of all RFG Output linkages. Supports for further access to international distribution channels can benefit the BioWin Health Cluster as its firms grow.

<table>
<thead>
<tr>
<th>Geographic Scope</th>
<th>Local</th>
<th>National</th>
<th>European</th>
<th>International</th>
<th>Total (n)</th>
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<td>Government Agencies</td>
<td>36%</td>
<td>43%</td>
<td>11%</td>
<td>11%</td>
<td>56</td>
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<tr>
<td>Industry Association</td>
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<td>11%</td>
<td>16%</td>
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<td>Industry Peers</td>
<td>46%</td>
<td>4%</td>
<td>33%</td>
<td>17%</td>
<td>24</td>
</tr>
<tr>
<td>Input</td>
<td>18%</td>
<td>32%</td>
<td>40%</td>
<td>10%</td>
<td>82</td>
</tr>
<tr>
<td>Output</td>
<td>14%</td>
<td>15%</td>
<td>33%</td>
<td>39%</td>
<td>109</td>
</tr>
<tr>
<td>Research &amp; Development</td>
<td>33%</td>
<td>30%</td>
<td>28%</td>
<td>9%</td>
<td>57</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>33%</td>
<td>32%</td>
<td>28%</td>
<td>7%</td>
<td>57</td>
</tr>
<tr>
<td>Training</td>
<td>78%</td>
<td>17%</td>
<td>6%</td>
<td>0%</td>
<td>18</td>
</tr>
<tr>
<td>Total (n)</td>
<td>135</td>
<td>124</td>
<td>122</td>
<td>78</td>
<td>459</td>
</tr>
</tbody>
</table>

Table 2: Distribution of Linkage Categories by Geographic Scope

The spread of Inputs across Belgium (50%), and outside of Belgium (50%) is eye catching as every second supplier of the RFG is found at a European/international level. Specialist Service linkages (65%) are predominantly sourced from across Belgium, while the firms record 50% of their Industry Peer linkages with other firms from Wallonia (46%) and Belgium (4%). Overall, local and national linkages, i.e. those within Wallonia and Belgium as a whole, make up 56% of all linkages.

The V-LINC maps in Figure 2 visualise respondent linkages across the Wallonia region, as well as in Belgium as a whole. The maps also clearly show connections across Europe and internationally with a strong focus on connections in the US. There are geographic pockets of Belgium that are important and heavily linked to the BioWin Health Cluster’s firms, namely Brussels, Ghent, Louvain-la-Neuve, Liege and Namur.
Porter (1998b) places great emphasis on support from organisations and businesses, within the cluster locality. The word local or locally appears in each element of his diamond of local industrial clustering. If local linkages are critical to the functioning of a cluster, Table 2 shows that local linkages make up 29% of all linkages reported in the study, the remaining 71% of linkages being distributed amongst national (27%), European (27%) and international (17%) linkages. The firms report a large proportion of Training (78%) and Industry Peers (46%) linkages within Wallonie highlighting the importance of geographic scope and using the local area and what it has to offer.

**V-LINC Business Impact Findings**

Tables 3a to 3e show the percentage of linkages (by category) that fall into each of the impact bands. These relate to the business impact of individual linkages based on the perception of expert respondents involved with these linkages. Table 3a shows the combined impact results for all linkages. Tables 3b to 3e, break the data into local, national, European and international linkages.
<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>16%</td>
<td>14%</td>
<td>13%</td>
<td>20%</td>
<td>21%</td>
<td>14%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>59%</td>
<td>50%</td>
<td>58%</td>
<td>52%</td>
<td>53%</td>
<td>54%</td>
<td>68%</td>
<td>67%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>25%</td>
<td>36%</td>
<td>29%</td>
<td>27%</td>
<td>24%</td>
<td>32%</td>
<td>14%</td>
<td>33%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>56 (12%)</td>
<td>56 (12%)</td>
<td>24 (5%)</td>
<td>82 (18%)</td>
<td>109 (24%)</td>
<td>57 (12%)</td>
<td>57 (12%)</td>
<td>18 (4%)</td>
<td>459</td>
</tr>
</tbody>
</table>

Table 3a: Business Impact by Linkage Category

<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>17%</td>
<td>21%</td>
<td>0%</td>
<td>22%</td>
<td>25%</td>
<td>6%</td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>53%</td>
<td>37%</td>
<td>100%</td>
<td>52%</td>
<td>50%</td>
<td>65%</td>
<td>78%</td>
<td>67%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>30%</td>
<td>42%</td>
<td>0%</td>
<td>26%</td>
<td>25%</td>
<td>29%</td>
<td>11%</td>
<td>33%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>21 (16%)</td>
<td>22 (16%)</td>
<td>11 (8%)</td>
<td>14 (10%)</td>
<td>15 (11%)</td>
<td>19 (14%)</td>
<td>19 (14%)</td>
<td>14 (10%)</td>
<td>135</td>
</tr>
</tbody>
</table>

Table 3b: Business Impact by Linkage Category - Local Linkages

<table>
<thead>
<tr>
<th>Category</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>0%</td>
<td>17%</td>
<td>38%</td>
<td>27%</td>
<td>17%</td>
<td>13%</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>100%</td>
<td>50%</td>
<td>38%</td>
<td>45%</td>
<td>67%</td>
<td>38%</td>
<td>56%</td>
<td>0%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>0%</td>
<td>33%</td>
<td>25%</td>
<td>24%</td>
<td>11%</td>
<td>50%</td>
<td>31%</td>
<td>100%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
<td>6%</td>
<td>0%</td>
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<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>6 (5%)</td>
<td>6 (5%)</td>
<td>8 (7%)</td>
<td>33 (27%)</td>
<td>36 (29%)</td>
<td>16 (13%)</td>
<td>16 (13%)</td>
<td>1 (1%)</td>
<td>122</td>
</tr>
</tbody>
</table>

Table 3c: Business Impact by Linkage Category – National Linkages

<table>
<thead>
<tr>
<th>Category</th>
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<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>17%</td>
<td>11%</td>
<td>0%</td>
<td>0%</td>
<td>21%</td>
<td>20%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>50%</td>
<td>33%</td>
<td>50%</td>
<td>63%</td>
<td>38%</td>
<td>60%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>33%</td>
<td>56%</td>
<td>50%</td>
<td>38%</td>
<td>40%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>6 (8%)</td>
<td>9 (12%)</td>
<td>4 (5%)</td>
<td>8 (10%)</td>
<td>42 (54%)</td>
<td>5 (6%)</td>
<td>4 (5%)</td>
<td>0 (0%)</td>
<td>78</td>
</tr>
</tbody>
</table>

Table 3d: Business Impact by Linkage Category - European Linkages

12
In Table 3a, it is apparent that when the proportions of linkages are analysed by band, Outputs 21% are rated by the RFG to be of highest impact, followed by Inputs (20%) and Specialist Services (18%) respectively. It is obvious from Table 3a that the respondent companies are heavily connected by relationships that are valuable to the firms and via connections with various Industry Associations. In all eight linkage categories, most linkages are in the top two impact bands (e.g. High and Medium bands); overall 73% of all linkages reported were in these bands. Industry Association as well as Training linkages seem to be of least impact to the firms with 36% and 33% of linkages found in the Low and Tenuous categories. It is also interesting to discuss the impact accorded to linkages at the differing levels of geographic scope within the research. This is assessed in tables 3b to 3e, where the data is sorted and analysed across local, national, European and international scopes.

Table 3b focuses on the impact of 135 local linkages in Wallonia. This ‘local’ level is the most populace geographic scope (containing 29% of all linkages), 14% of which are reported to be in the High impact band. The most important linkage categories reported by the RFG in the High impact band are Output (27%), Specialist Services (21%) and Research and Development (21%) linkages. It is important to qualify these results with the fact that only 14% of Output (n=15) are reported at local level which further displays the importance of the European and international markets for the RFG. On the other hand, 33% of Specialist Services (n=19), and 33% of Research and Development linkages (n=19) are reported at the local level. On the opposite end of the impact scale, only one Tenuous link is reported. Twenty nine percent of Training linkages are reported in the Low impact band with the next lowest scored category being Inputs at 27%. It is important to note that these Training linkages at a local level (n=14) account for 78% of the total Training linkages recorded by the RFGs.

Table 3c presents the impact data for 124 linkages that occur across Belgium (and outside the Wallonia region), 17% of which are in the High impact quartile. The most important linkages at national level, (High impact), are Output (25%), Input (22%) and
Industry Association (21%) linkages, respectively. As is the situation with the local linkages (Table 3b), 33% of Training linkages at national level are reported in the Low impact band. Government Agencies report the majority of its linkages at a national level (n=23) the category accounts for 19% of all national linkages.

Approximately 83% of all the European linkages are reported across four categories Input, Output, Research and Development and Specialist Services. Of all European linkages, 19% are reported to be in the High impact band (23 of the 122). Industry Peer (38%) and Input (27%) linkages are reported to be the strongest connections at this geographic scope. It is important to note that over a quarter (27%) of all European linkages are in the Low and Tenuous impact bands. Input and Output are the only categories to report linkages in the Tenuous category.

Table 3e reports the impact for the 78 international linkages for Year 2. These are viewed as important to the respondent firms with 21% of these linkages (n=9) reported in the High impact band and another 38% (n=16) in the Medium band. The Output category highlights that respondent’s customers are based across the globe, with 72% of all Output linkages reported across Europe and internationally (Table 2, 3d and 3e), once again, displaying the importance of globalisation for this sector. Only 28% (31 of 109 links) of all respondent firm’s customers are based in Wallonia (local) or Belgium (national) and in turn contradicts Hirsch and Adar (1974) argument that predominantly only larger firms risk exporting to foreign and global markets. It is important also to note that Research and Development, Specialist Services and Government Agencies also recorded linkages in the High and Medium impact bands at an international level.

Table 4 reports the proportion of linkages reported in each of the impact bands for each geographic scope, to compare the overall impact of linkages across the four geographic scopes. Porter (2000) believes ‘once a cluster forms, the whole group of industries becomes mutually supporting. Benefits flow forward, backward, and horizontally,’ therefore, it is important to look closely at the impact of local linkages. Local linkages account for 135 of the 459 reported, 80% (n=108) of which are reported in the Medium to High impact band. Thus, the largest proportion of linkages are reported in the High and Medium impact band when compared with national (72%), European (73%) and
international (62%) scopes respectively. European linkages scored the highest number (n=23) of the 122 linkages reported in the High impact band totalling 19%.

The respondent firms engage in more linkages across the local Wallonia region (n=135) than at any other geographic scope. Respondents seem less likely to engage in international linkages, which are at further distances (perhaps due to the fact that these links are harder to form and maintain). However, it has already been noted the importance of internationalisation to the RFG as 71% of all Outputs linkages are reported across Europe and further afield (Table 2, 3d and 3e). Local, national and European linkages, each account for between 27-29% of all linkages recorded. This is interesting when compared to the importance Porter believes clusters place on local connections and proximities and the role it plays in firms’ competitiveness. It is imperative to note that the local region, when mentioned, refers to that of Wallonie and the national region refers to the rest of Belgium i.e. we discuss only two regions north and south.

<table>
<thead>
<tr>
<th>Geographic Scope</th>
<th>Local</th>
<th>National</th>
<th>European</th>
<th>International</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td><strong>Business Impact</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>14%</td>
<td>17%</td>
<td>19%</td>
<td>18%</td>
<td>77</td>
</tr>
<tr>
<td>Medium</td>
<td>66%</td>
<td>55%</td>
<td>54%</td>
<td>44%</td>
<td>258</td>
</tr>
<tr>
<td>Low</td>
<td>19%</td>
<td>28%</td>
<td>25%</td>
<td>38%</td>
<td>121</td>
</tr>
<tr>
<td>Tenuous</td>
<td>1%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>3</td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td>29%</td>
<td>27%</td>
<td>27%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td><strong>Total (n)</strong></td>
<td>135</td>
<td>124</td>
<td>122</td>
<td>78</td>
<td>459</td>
</tr>
</tbody>
</table>

Table 4: Impact by Geographic Scope of Linkages

**Key Connectors**

Figure 3 illustrates the key connectors in the BioWin Health Cluster, strong linkages exist with organisations linked to firms’ Output, Industry Associations, Government Agencies and Research and Development. However, the standout Industry Association - BioWin and Government Agencies - The Directorate General for Economy, Employment and Research (DGO6), The Walloon Export and Foreign Investment Agency (AWEX) and The Federal Agency for Medicines and Health Products (AFMPS) are the strongest linked organisations to the RFG. The key connectors are those organisations who connect the cluster, they are identified through the number of
linkages they have with respondent firms and the business impact of those linkages to respondents is presented in Table 5.

![Figure 3: Key Connectors BioWin Health Cluster](image)

<table>
<thead>
<tr>
<th>Key Connector</th>
<th>BioWin</th>
<th>DGO6</th>
<th>AWEX</th>
<th>AFMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>12%</td>
<td>25%</td>
<td>10%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>65%</td>
<td>67%</td>
<td>70%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>24%</td>
<td>8%</td>
<td>20%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total (n)</td>
<td></td>
<td>17</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 5: Impact of Key Connectors within the BioWin Health Cluster

Each of the RFG reports an Industry Association connection with BioWin, which is natural as all the RFG are members of the cluster. However, this also provides an opportunity for feedback for the organisation from its members. Furthermore, these RFG report that 77% of the linkages to BioWin are reported in the High and Medium categories showcasing the importance of the cluster to its members. DGO6, AFMPS and AWEX are heavily linked to the RFG, which highlights the importance of Government Agencies support to the firms within the BioWin Health Cluster. Directorate General for Economy, Employment and Research (DGO6) is responsible for policy-design and is the implementing body for regional research and innovation policy in Wallonia. Its mission is to implement and monitor the aid granted in the field of economic policy - including the support granted within the framework of EU programmes and encouraging the development of enterprises, especially SMEs.
The AFMPS is responsible for ensuring medicines and health products are of the highest quality stemming from ensuring companies adhere to having the best medical devices, accessories and raw materials for the preparation and production of drugs. Wallonia Foreign Trade and Investment Agency (AWEX) is a public interest organisation in charge of the promotion of foreign trade and the attraction of foreign investments for Wallonia in Belgium. DGO6 has slightly stronger connections with the RFG reporting 92% of its links in the High and Medium bands as opposed to AWEX and AFMPS who reports 80% and 66% in these band
Appendix D – V-LINC Analysis Report Year 3 (2020)

V-LINC Analysis of BioWin’s Biomedical Health Cluster Ecosystem: Longitudinal Data & Perspectives from Year 3

Conor Harte, John Hobbs, Munster Technological University, Cork, Ireland.
E-mail: conor.m.harte@mycit.ie; john.hobbs@mtu.ie

Abstract

Since its creation in 2006, BioWin is recognised internationally as a leading cluster in the area of health biotechnology and medical technologies from its base in Wallonia (the southern region of Belgium). The depth of health science actors in Wallonia has created an ecosystem that promotes innovation and excellence, while allowing the region to develop unique and highly specialised capacities in health biotechnology and medical technologies. Included in these actors are 10 large companies in Biopharma, over two hundred and fifty highly specialised and innovative SMEs and 5 globally recognised universities.

V-LINC, a methodology which identifies, records and facilitates analysis of linkages that firms in clusters engage in, is applied to the BioWin Health Cluster as part of a three-year longitudinal study. Giuliani (2013, p. 1406), notes that “while several studies analyse the benefits and characteristics of regional cluster networks, very little is known about how such networks evolve over time and the extent to which their dynamics can affect development processes.” The goal is to analyse how BioWin’s members maintain and develop linkages and supply chain relations with its support. V-LINC was developed in Munster Technological University to enrich academic literature on clusters (Byrne, Hobbs, and Doran, 2018). V-LINC visualises information on the geographic footprint of cluster ecosystems, whilst measuring the perceived business impact of cluster linkages.

Understanding the linkages that firms in a cluster engage in, allows targeted policy recommendations to be developed to build on strengths and address cluster weaknesses. These strengths and weaknesses are highlighted and analysed in this report for 2020 (Year
3) and benchmarked against the data collected in 2018 (Year 1) and 2019 (Year 2). As the biotechnology and medical technologies sector in Wallonia develops and expands it is important that industry players, business support organisations and policy makers understand how the ecosystem operates internally along with the external relationships forged beyond the region, so that collaboratively, they can deliver growth and employment through supportive policy.

**Keywords:** V-LINC, industry cluster, ecosystem, BioWin, mapping.

**Introduction**

This report is a research collaboration between the Munster Technological University, BioWin Health Cluster of Wallonia and Service Public de Wallonie (SPW) who partnered to apply V-LINC to the biomedical health cluster in Wallonia. This research is part of a three-year longitudinal study of the BioWin cluster to ascertain how its members maintain and develop new linkages and supply chains with the support of the cluster. BioWin, among its many objectives, aims to train, attract and retain in Wallonia a motivated, innovative, excellent core of human capital, to support the improvement of collective infrastructures and technological platforms, whilst promoting the strengths of the Walloon region’s medical technologies internationally.

Companies specialising in bio-therapeutics avail of synergies created with local and neighbouring academic and research centres as well as utilising support services (includes expertise in bio-manufacturing of biologics) connected to BioWin. Wallonia as a region is at the forefront of clinical Research and Development in cell therapy. SPW actively promotes the Wallonia region in collaboration with the Wallonia Export and Foreign Investment Agency (AWEX). They work in synergy to continue to grow the high value sector - bio health.

The report begins by introducing V-LINC, a methodology that records, categorises and measures the business impact of linkages that cluster firms participate in, along with the facility to show linkages on geographic maps of appropriate scale. Linkages between
firms and other organisations are at the heart of how clusters function. Linkages are defined (Hobbs, 2010; p 221) as “relationships that enable exchange of goods, services, personnel, information, ideas, expertise, grants and other supports to business that occur between two or more parties, over a sustained time period.”

Next, the report comments on the scale of the BioWin health cluster in Wallonia, then reviews findings from V-LINC analysis on the linkages of a sample of firms in Wallonia. The analysis includes: the distribution of linkages by category, by geographic scope, and by their impact as reported by company employees who engage in the linkages. V-LINC maps illustrate the linkages at different geographic scopes. Arising from the analysis, an informed judgement is made about the extent of cluster activity in the health sector in Wallonia.

Finally, the report provides a longitudinal perspective comparing the results from the final year of interviews, 2020, to the previous two years data collected in 2018 and 2019. This analysis allows cluster impacts to be assessed over the three years of research. The report closes with recommendations on how to strengthen and support the BioWin Health Cluster in Belgium having investigated three years of data.

**V-LINC: Visualisation of Linkages in Networked Clusters**

V-LINC\(^{42}\) is a methodology for identifying, recording and analysing the linkages that firms in clusters engage in. It categorizes these linkages, and groups them by geographic scope: Local linkages, within Wallonia; National linkages, across Belgium (outside Wallonia); European linkages, outside Belgium; and International linkages, outside Europe. Furthermore, V-LINC records the business impact of linkages based on the perceptions of firm personnel who engage in the linkages with other companies and organisations. The data required for the V-LINC analysis is collected by structured interviews of company personnel. Likert scale questions are employed to gauge the business impact of individual linkages engaged in by respondent companies. V-LINC

\(^{42}\) The V-LINC methodology is outlined in Byrne, E., Hobbs, J., and Doran, J. (2018), further methodological detail is provided in Byrne, E. (2016) PhD thesis section 4.2.1 defines each of the linkage categories and outlines the perceived business impact bands used by V-LINC
maps give a visual representation of the relative reliance on local, national, European or international linkages of a company and when combined, of a cluster (Figure 2). V-LINC facilitates policy development at local and national levels, through the aggregation of data from a sample of firms. Confidentiality of firms’ linkages is maintained throughout.

V-LINC assigns company linkages to one of eight categories (Figure 1). Besides linkages along the supply chain, namely those which provide Inputs and Specialist Services to firms, and Output linkages which provide markets for goods produced, V-LINC adds five other categories of linkages: those with Industry Peers, with Industry Associations, with Research & Development partners, with Training partners and with Government Agencies. The linkage categories in V-LINC derive from Porter’s (1990, 1998a and 1998b) discourse on the interactions and relationships of companies in a cluster.

V-LINC responses collected through structured interviews combine to reveal the impact of business linkages as perceived by expert company personnel. Likert scale responses convert qualitative judgements into quantitative data which are subject to further analysis. The impact of the linkages is recorded and scored between 0 and 40, then arranged into four impact bands based on their importance: High (30 to 40), Medium (20 to 30), Low (10 to 20), or Tenuous (0 to 10). This enables one to answer the question: at which geographic level and linkage category do clusters’ most valuable linkages occur. The rationale for applying V-LINC to the BioWin Health Cluster in Wallonia is outlined in the next section.

![Figure 1: The Eight V-LINC linkage categories analysed for each firm](image-url)
Wallonia, with its young and ambitious population, boasts numerous colleges and universities held in high esteem globally. This diverse population is made up of many different cultures and languages. BioWin is at the forefront of promoting collaborative projects between industry and academia as well as research centres with the underlying aim of developing products and services for the global market (biowin, 2019).

The BioWin health cluster promotes its scientific excellence by having a presence at world renowned events and fairs for health and biotechnology. Another key component involves developing and consolidating partnerships with other clusters from around Europe and the rest of the world. To achieve scientific objectives an optimal environment must be created to allow these types of collaborations and exchanges to flourish as well as acquiring the adequate private and public funding.

BioWin have created and defined four strategic areas to support Wallonia’s health sector from an industrial and academic perspective. These areas include; helping foster the evolution in human and animal health R&D projects, promoting Wallonia’s world-class levels of expertise, bringing together and maintain a work force of highly qualified individuals and aiding the formation of collaborative technological infrastructures. BioWin’s Smart Specialisation strategy seeks to closely monitor technological developments, identify new/emerging areas of development and bring players together, to speed up innovation and enhance excellence (biowin, 2020). It has identified six key technological areas in which their members are active: bio-pharmacy, cell therapy, medical devices, bio-manufacturing, data science and radiation applications in healthcare (portail.wallonie.be, 2019).

Wallonia is at the heart of the biopharmaceutical sector, which is the main industrial activity in regard to driving economic growth in the region. The pharmaceutical industry employs 35,700 FTE in Belgium (direct jobs) of which 54% are working in Wallonia. The sector accounts for 27% of all regional exports. In the past 14 years, the BioWin cluster has been able to combine health innovation actors within the region and enhance the visibility of the biotech, pharma and medtech ecosystem at an international level. This in turn has led to growth in employment and the region’s industry (biowin, 2020).

BioWin connects its members to possible collaborators, via global networking events and working closely with the AWEX (Wallonia Foreign Trade and Investment Agency) and
the WBI (Wallonia Brussels International), as well as their own events which focus on different areas such as R&D, strategic or business partnerships and collaborations).

In this research the V-LINC analysis is applied to a sample of seventeen firms based in the Wallonia region, with a specific focus on SMEs whose market is not just targeted on the local/national region but on European and international markets alike. 17 online Zoom meetings (due to the COVID-19 global pandemic prohibiting face-to-face interviews) were held with personnel from these companies to gather information regarding their key relationships. These meetings uncovered 458 firm linkages (Table 1) in contrast with 404 firm linkages recorded in Year 1 and 459 linkages in Year 2. The term Respondent Firm Group (RFG) relates to the summation of data for the seventeen health cluster respondent firms.

V-LINC Analysis Results: BioWin Health Cluster, Wallonia

Table 1 lists the firms who participated in the Year 3 (2020) V-LINC analysis. Table 1 includes the percentage of linkages of each firm across the eight linkage categories along with the total number of linkages reported. It also distinguishes the total numbers of linkages per category for the cluster (sum of all respondents). Table 1 reports that the most frequent linkages are in Outputs, which account for 24% of all linkages reported; followed by Inputs at 18% and Government Agencies, 13%. The least frequent linkage categories are Training, and Industry Peers, both of which account for 4% of all linkages, respectively. This may indicate disconnection with firms in the same industry and perhaps due to firms’ employees being highly qualified the need for Training providers at present is limited. Firms may also believe it is most appropriate to train their own employees in house. For example, in the firm GSK, they now train their employees on site through the use of virtual reality and purpose-built sterile rooms and labs.
<table>
<thead>
<tr>
<th>Company</th>
<th>SIZE</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BioSourcing</td>
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<td>16%</td>
<td>11%</td>
<td>0%</td>
<td>16%</td>
<td>11%</td>
<td>26%</td>
<td>21%</td>
<td>0%</td>
<td>19</td>
</tr>
<tr>
<td>DNAlytics</td>
<td>Micro (&lt;10)</td>
<td>15%</td>
<td>12%</td>
<td>3%</td>
<td>12%</td>
<td>33%</td>
<td>18%</td>
<td>6%</td>
<td>0%</td>
<td>33</td>
</tr>
<tr>
<td>Immunexperts</td>
<td>Micro (&lt;10)</td>
<td>8%</td>
<td>19%</td>
<td>3%</td>
<td>19%</td>
<td>22%</td>
<td>11%</td>
<td>8%</td>
<td>8%</td>
<td>36</td>
</tr>
<tr>
<td>SynAbs SA</td>
<td>Micro (&lt;10)</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>4%</td>
<td>43%</td>
<td>7%</td>
<td>11%</td>
<td>4%</td>
<td>28</td>
</tr>
<tr>
<td>Aseptic Technologies</td>
<td>Small (&lt;50)</td>
<td>7%</td>
<td>13%</td>
<td>9%</td>
<td>22%</td>
<td>40%</td>
<td>0%</td>
<td>7%</td>
<td>2%</td>
<td>45</td>
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<tr>
<td>Caprion Biosciences</td>
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<td>0%</td>
<td>17%</td>
<td>4%</td>
<td>26%</td>
<td>17%</td>
<td>0%</td>
<td>33</td>
</tr>
<tr>
<td>Imcyse</td>
<td>Small (&lt;50)</td>
<td>22%</td>
<td>13%</td>
<td>0%</td>
<td>17%</td>
<td>4%</td>
<td>26%</td>
<td>17%</td>
<td>0%</td>
<td>23</td>
</tr>
<tr>
<td>JUMO</td>
<td>Small (&lt;50)</td>
<td>6%</td>
<td>19%</td>
<td>0%</td>
<td>31%</td>
<td>19%</td>
<td>13%</td>
<td>6%</td>
<td>6%</td>
<td>16</td>
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<tr>
<td>Pharmalex</td>
<td>Small (&lt;50)</td>
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<td>0%</td>
<td>47%</td>
<td>7%</td>
<td>13%</td>
<td>0%</td>
<td>15</td>
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<tr>
<td>Xpress Biologics</td>
<td>Small (&lt;50)</td>
<td>11%</td>
<td>5%</td>
<td>0%</td>
<td>26%</td>
<td>34%</td>
<td>11%</td>
<td>8%</td>
<td>5%</td>
<td>38</td>
</tr>
<tr>
<td>Bone Therapeutics</td>
<td>Medium (50-250)</td>
<td>19%</td>
<td>15%</td>
<td>0%</td>
<td>22%</td>
<td>0%</td>
<td>15%</td>
<td>30%</td>
<td>0%</td>
<td>27</td>
</tr>
<tr>
<td>Celyad</td>
<td>Medium (50-250)</td>
<td>17%</td>
<td>17%</td>
<td>0%</td>
<td>13%</td>
<td>0%</td>
<td>26%</td>
<td>17%</td>
<td>9%</td>
<td>23</td>
</tr>
<tr>
<td>MaSTherCell</td>
<td>Medium (50-250)</td>
<td>10%</td>
<td>10%</td>
<td>5%</td>
<td>24%</td>
<td>38%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>21</td>
</tr>
<tr>
<td>Univercells</td>
<td>Medium (50-250)</td>
<td>26%</td>
<td>11%</td>
<td>11%</td>
<td>7%</td>
<td>19%</td>
<td>11%</td>
<td>15%</td>
<td>0%</td>
<td>27</td>
</tr>
<tr>
<td>Eurogentec</td>
<td>Large (&gt;250)</td>
<td>9%</td>
<td>14%</td>
<td>0%</td>
<td>32%</td>
<td>23%</td>
<td>9%</td>
<td>9%</td>
<td>9%</td>
<td>22</td>
</tr>
<tr>
<td>GSK Vaccines</td>
<td>Large (&gt;250)</td>
<td>11%</td>
<td>28%</td>
<td>11%</td>
<td>17%</td>
<td>11%</td>
<td>17%</td>
<td>0%</td>
<td>6%</td>
<td>18</td>
</tr>
<tr>
<td>Novasep</td>
<td>Large (&gt;250)</td>
<td>12%</td>
<td>6%</td>
<td>12%</td>
<td>12%</td>
<td>27%</td>
<td>15%</td>
<td>6%</td>
<td>9%</td>
<td>33</td>
</tr>
<tr>
<td>RFG Average</td>
<td></td>
<td>13%</td>
<td>13%</td>
<td>4%</td>
<td>18%</td>
<td>24%</td>
<td>13%</td>
<td>12%</td>
<td>3%</td>
<td>19</td>
</tr>
<tr>
<td>Total(n)</td>
<td></td>
<td>60</td>
<td>57</td>
<td>20</td>
<td>84</td>
<td>112</td>
<td>54</td>
<td>53</td>
<td>18</td>
<td>458</td>
</tr>
<tr>
<td>Most Populous(Rank 1-8)</td>
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<td>3rd</td>
<td>4th</td>
<td>7th</td>
<td>2nd</td>
<td>1st</td>
<td>5th</td>
<td>6th</td>
<td>8th</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Distribution of Linkages by Category and by Firm

**Linkage categories by geographic Scope:** Geographic proximity of firms provides the opportunity for the development of local connections between firms or organisations. Face-to-face interactions play an integral role in cluster theory and are associated with producing higher growth and innovation in clusters. Porter (1998a, p 226) considers, “a cluster is a form of network that occurs within a geographical location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions.” Modern advances in communication and technology may have impacted this need for geographic proximity and allow connected firms to be more widely dispersed across a region, or even countries. Firms may source Inputs from several regions, engage in R&D with research organisations in foreign countries, and sell into multiple international markets. Therefore, it is important to look at the geographic scope of linkage categories, and their business impact over these different geographic scopes.

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Note to Table 2: The eight linkage categories are: Government agencies (GA); Industry association (IA); Industry peers (IP); Inputs (IN); Output (OU); Research & development (RD) Specialist service linkages (SS) and Training (TN).
Table 2 and Figure 2 display the linkages reported at each geographic level for each of the eight linkage categories. Table 2 distinguishes the dominant geographic scope for each category and when we focus on individual categories, it is apparent that 30% of Output linkages in this study are within Belgium (in Wallonia, Brussels and Flanders), whilst a further 37% serve the European market, and 33% are exported internationally. These results highlight the significance and reliance of the European and international markets for BioWin respondent firms.

It should be noted that this is not in line with the norm for SMEs, as smaller firms tend to be less inclined to export than larger firms do (Dana et. al., 1999a; 1999b). Hirsch and Adar (1974 p. 41) note that “large firms can afford to assume more risks than small ones; in addition, their risks from foreign operations are less than those of small firms because the large firms benefit from economies of scale in foreign marketing.” Only small firms that see early internationalisation as a requirement for survival will want to tackle the challenges and risks associated with international expansion (Baum et al., 2011). These smaller companies with less capability will follow a more risk averse internationalisation approach and will either expand at a more gradual rate or later in their respective life cycle (Johanson & Vahlne, 2009). Analysis of several hundred firms across Denmark, The Netherlands and Israel illustrated that “the size of firms is indeed positively correlated with the ratio of exports to sales” (Hirsch and Adar, 1974 p. 41).

The spread of Inputs is notable as every second supplier of the RFG is found at a European/international level. Specialist Service linkages (68%) are predominantly sourced from across Belgium. Firms record over two thirds of their Industry Peer linkages with other firms from Wallonia (60%) and Belgium (5%). Overall, local and national linkages, i.e. those within Wallonia and Belgium as a whole, make up 57% of all linkages.

<table>
<thead>
<tr>
<th>Geographic Scope</th>
<th>Local</th>
<th>National</th>
<th>European</th>
<th>International</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Agencies</td>
<td>37%</td>
<td>38%</td>
<td>12%</td>
<td>13%</td>
<td>60</td>
</tr>
<tr>
<td>Industry Association</td>
<td>40%</td>
<td>32%</td>
<td>11%</td>
<td>18%</td>
<td>57</td>
</tr>
<tr>
<td>Industry Peers</td>
<td>60%</td>
<td>5%</td>
<td>25%</td>
<td>10%</td>
<td>20</td>
</tr>
<tr>
<td>Input</td>
<td>17%</td>
<td>32%</td>
<td>42%</td>
<td>10%</td>
<td>84</td>
</tr>
<tr>
<td>Output</td>
<td>18%</td>
<td>12%</td>
<td>37%</td>
<td>33%</td>
<td>112</td>
</tr>
<tr>
<td>Research &amp; Dev.</td>
<td>37%</td>
<td>30%</td>
<td>26%</td>
<td>7%</td>
<td>54</td>
</tr>
<tr>
<td>Specialist Service</td>
<td>30%</td>
<td>36%</td>
<td>26%</td>
<td>8%</td>
<td>53</td>
</tr>
<tr>
<td>Training</td>
<td>78%</td>
<td>11%</td>
<td>11%</td>
<td>0%</td>
<td>18</td>
</tr>
<tr>
<td>Total (n)</td>
<td>141</td>
<td>120</td>
<td>124</td>
<td>73</td>
<td>458</td>
</tr>
</tbody>
</table>

Table 2: Distribution of Linkage Categories by Geographic Scope
The V-LINC maps in Figure 2 visualise respondent linkages across the Wallonia region, as well as in Belgium as a whole. The maps also clearly show connections across Europe and internationally with a strong focus on connections in the US. There are geographic pockets of Belgium that are important and heavily linked to the BioWin Health Cluster’s firms, namely Brussels, Ghent, Louvain-la-Neuve, Liege and Namur, which is in line with expectations by virtue of density, as four are in the top ten most populous cities in Belgium (Statista, 2020).

Porter (1998b) places great emphasis on support from organisations and businesses, within the cluster locality. The word local or locally appears in each element of his diamond of local industrial clustering. If local linkages are critical to the functioning of a cluster, Table 2 shows that local linkages make up 31% of all linkages reported in the study, the remaining 69% of linkages being distributed amongst national (26%), European (27%) and international (16%) linkages. The firms report a large proportion of Training (78%) and Industry Peers (60%) linkages within Wallonia highlighting the connection to the local area and concentration of activity in the bio-manufacturing sector.

**V-LINC Business Impact Findings**

Tables 3a to 3e show the percentage of linkages (by category) reported in each of the impact bands based on the perception of expert respondents involved with these linkages. Table 3a shows the combined impact results for all linkages. Tables 3b to 3e, reports the data by local, national, European and international scopes.
In Table 3a, when the proportions of linkages are analysed by band, Outputs 28% are rated by the RFG to be of highest impact, followed by Inputs (26%) and Specialist

<table>
<thead>
<tr>
<th>Business Impact</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &gt;30 to 40</td>
<td>17%</td>
<td>18%</td>
<td>15%</td>
<td>26%</td>
<td>28%</td>
<td>15%</td>
<td>21%</td>
<td>0%</td>
<td>95 (21%)</td>
</tr>
<tr>
<td>Medium &gt;20 to 30</td>
<td>62%</td>
<td>54%</td>
<td>70%</td>
<td>47%</td>
<td>60%</td>
<td>63%</td>
<td>62%</td>
<td>72%</td>
<td>268 (58%)</td>
</tr>
<tr>
<td>Low &gt;10 to 20</td>
<td>22%</td>
<td>28%</td>
<td>15%</td>
<td>27%</td>
<td>11%</td>
<td>20%</td>
<td>17%</td>
<td>28%</td>
<td>92 (20%)</td>
</tr>
<tr>
<td>Tenuous &gt;1 to 10</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>3 (1%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60 (13%)</strong></td>
<td><strong>57 (12%)</strong></td>
<td><strong>20 (4%)</strong></td>
<td><strong>84 (18%)</strong></td>
<td><strong>112 (24%)</strong></td>
<td><strong>54 (12%)</strong></td>
<td><strong>53 (11%)</strong></td>
<td><strong>18 (4%)</strong></td>
<td><strong>458</strong></td>
</tr>
</tbody>
</table>

Table 3a: Business Impact by Linkage Category

<table>
<thead>
<tr>
<th>Business Impact</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &gt;30 to 40</td>
<td>13%</td>
<td>17%</td>
<td>0%</td>
<td>29%</td>
<td>40%</td>
<td>20%</td>
<td>25%</td>
<td>0%</td>
<td>27 (20%)</td>
</tr>
<tr>
<td>Medium &gt;20 to 30</td>
<td>65%</td>
<td>50%</td>
<td>100%</td>
<td>52%</td>
<td>64%</td>
<td>50%</td>
<td>74%</td>
<td>71%</td>
<td>191 (60%)</td>
</tr>
<tr>
<td>Low &gt;10 to 20</td>
<td>22%</td>
<td>33%</td>
<td>0%</td>
<td>33%</td>
<td>14%</td>
<td>38%</td>
<td>11%</td>
<td>0%</td>
<td>30 (25%)</td>
</tr>
<tr>
<td>Tenuous &gt;1 to 10</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23 (19%)</strong></td>
<td><strong>18 (15%)</strong></td>
<td><strong>1 (1%)</strong></td>
<td><strong>27 (22%)</strong></td>
<td><strong>14 (12%)</strong></td>
<td><strong>16 (13%)</strong></td>
<td><strong>19 (16%)</strong></td>
<td><strong>2 (2%)</strong></td>
<td><strong>120</strong></td>
</tr>
</tbody>
</table>

Table 3b: Business Impact by Linkage Category - Local Linkages

<table>
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<tr>
<th>Business Impact</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &gt;30 to 40</td>
<td>14%</td>
<td>17%</td>
<td>60%</td>
<td>37%</td>
<td>20%</td>
<td>0%</td>
<td>21%</td>
<td>0%</td>
<td>29 (23%)</td>
</tr>
<tr>
<td>Medium &gt;20 to 30</td>
<td>57%</td>
<td>67%</td>
<td>40%</td>
<td>43%</td>
<td>65%</td>
<td>64%</td>
<td>36%</td>
<td>50%</td>
<td>67 (54%)</td>
</tr>
<tr>
<td>Low &gt;10 to 20</td>
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<td>50%</td>
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<td>7%</td>
<td>0%</td>
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<td>14 (19%)</td>
</tr>
<tr>
<td>Tenuous &gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>7%</td>
<td>0%</td>
<td>0%</td>
<td>3 (2%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7 (6%)</strong></td>
<td><strong>6 (5%)</strong></td>
<td><strong>5 (4%)</strong></td>
<td><strong>35 (28%)</strong></td>
<td><strong>41 (33%)</strong></td>
<td><strong>14 (11%)</strong></td>
<td><strong>14 (11%)</strong></td>
<td><strong>2 (2%)</strong></td>
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Table 3c: Business Impact by Linkage Category – National Linkages

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<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &gt;30 to 40</td>
<td>38%</td>
<td>20%</td>
<td>0%</td>
<td>13%</td>
<td>32%</td>
<td>0%</td>
<td>25%</td>
<td>0%</td>
<td>21 (29%)</td>
</tr>
<tr>
<td>Medium &gt;20 to 30</td>
<td>38%</td>
<td>50%</td>
<td>50%</td>
<td>63%</td>
<td>55%</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>38 (52%)</td>
</tr>
<tr>
<td>Low &gt;10 to 20</td>
<td>25%</td>
<td>30%</td>
<td>50%</td>
<td>25%</td>
<td>13%</td>
<td>50%</td>
<td>25%</td>
<td>0%</td>
<td>14 (19%)</td>
</tr>
<tr>
<td>Tenuous &gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8 (11%)</strong></td>
<td><strong>10 (14%)</strong></td>
<td><strong>2 (3%)</strong></td>
<td><strong>8 (11%)</strong></td>
<td><strong>37 (51%)</strong></td>
<td><strong>4 (5%)</strong></td>
<td><strong>4 (5%)</strong></td>
<td><strong>0 (0%)</strong></td>
<td><strong>73</strong></td>
</tr>
</tbody>
</table>

Table 3d: Business Impact by Linkage Category - European Linkages

<table>
<thead>
<tr>
<th>Business Impact</th>
<th>GA</th>
<th>IA</th>
<th>IP</th>
<th>IN</th>
<th>OU</th>
<th>RD</th>
<th>SS</th>
<th>TN</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &gt;30 to 40</td>
<td>17%</td>
<td>18%</td>
<td>15%</td>
<td>26%</td>
<td>28%</td>
<td>15%</td>
<td>21%</td>
<td>0%</td>
<td>95 (21%)</td>
</tr>
<tr>
<td>Medium &gt;20 to 30</td>
<td>62%</td>
<td>54%</td>
<td>70%</td>
<td>47%</td>
<td>60%</td>
<td>63%</td>
<td>62%</td>
<td>72%</td>
<td>268 (58%)</td>
</tr>
<tr>
<td>Low &gt;10 to 20</td>
<td>22%</td>
<td>28%</td>
<td>15%</td>
<td>27%</td>
<td>11%</td>
<td>20%</td>
<td>17%</td>
<td>28%</td>
<td>92 (20%)</td>
</tr>
<tr>
<td>Tenuous &gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>3 (1%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60 (13%)</strong></td>
<td><strong>57 (12%)</strong></td>
<td><strong>20 (4%)</strong></td>
<td><strong>84 (18%)</strong></td>
<td><strong>112 (24%)</strong></td>
<td><strong>54 (12%)</strong></td>
<td><strong>53 (11%)</strong></td>
<td><strong>18 (4%)</strong></td>
<td><strong>458</strong></td>
</tr>
</tbody>
</table>

Table 3e: Business Impact by Linkage Category – International Linkages

In Table 3a, when the proportions of linkages are analysed by band, Outputs 28% are rated by the RFG to be of highest impact, followed by Inputs (26%) and Specialist
Services (21%) respectively. It is obvious from Table 3a that the respondent companies are heavily connected by relationships that are valuable to the firms and via connections with various Industry Associations. In all eight of the linkage categories, most linkages are in the top two impact bands (e.g. High and Medium bands); overall 79% of all linkages reported were in these bands. Industry Association as well as Training linkages seem to be of least impact to the firms each with 28% of linkages found in the Low and Tenuous categories. It is also interesting to discuss the impact accorded to linkages at the differing levels of geographic scope, this is assessed in tables 3b to 3e, where the data is sorted and analysed across local, national, European and international scopes.

Table 3b focuses on the impact of 141 local linkages in Wallonia. This ‘local’ level is the most populace geographic scope (containing 31% of all linkages), 19% of which are reported to be in the High impact band. The most important linkage categories reported by the RFG in the High impact band locally are Output (40%), Input (29%) and Specialist Service (25%) linkages. It is important to qualify these results with the fact that 18% of Output (n=20) and 17% of Input (n=14) are reported at a local level which further displays the importance of the European and international markets for the RFG’s customers and suppliers alike. Specialist Service linkages are the only category to have all links valued in the High-Medium impact band at a local level.

On the opposite end of the business impact scale, there were zero Tenuous links reported locally. Thirty six percent of Input linkages are reported in the Low impact band with the next lowest scored category being Training at 29%. It is important to note that these Training linkages at a local level (n=14) account for 78% of the total Training linkages recorded by the RFGs.

Table 3c presents the impact data for 120 linkages that occur across Belgium (outside Wallonia), 15% of which are in the High impact quartile. The most important linkages at national level, (High impact), are Output (21%), Industry Association (17%) and Specialist Service linkages (16%), respectively. Government Agencies (n=23) and Specialist Services (n=19) report the majority of their linkages at a national level. These two categories account for 35% of all national linkages recorded. Outputs represent only 12% of all national linkages and record the fewest number of linkages across all of the four geographic scopes (n=14).
Approximately 84% of all the European linkages are reported across four categories: Input, Output, Research and Development and Specialist Services. Of all European linkages, almost a quarter (24%) are reported to be in the High impact band (29 of the 124). Industry Peer (60%) and Input (37%) linkages are reported to be the strongest connections at this geographic scope. It is important to note that 23% of all European linkages are in the Low and Tenuous impact bands. Research and Development and Output are the only categories to report linkages in the Tenuous category.

Table 3e reports the impact for the 73 international linkages for Year 2. These are viewed as important to the respondent firms with 29% of these linkages (n=21) reported in the High impact band and another 52% (n=38) in the Medium band. The Output category highlights that respondent’s customers are based across the globe, with 70% of all Output linkages reported across Europe and internationally (Table 2, 3d and 3e), which contradicts Hirsch and Adar (1974) argument that predominantly only larger firms risk exporting to foreign and global markets. It is important also to note that Research and Development, Specialist Services and Government Agencies also recorded the majority of their linkages in the High and Medium impact bands at an international level.

Table 4 displays the proportion of linkages reported in each of the impact bands for each geographic scope, to compare the overall impact of linkages across the four geographic scopes. Porter (2000) believes ‘once a cluster forms, the whole group of industries becomes mutually supporting. Benefits flow forward, backward, and horizontally,’ therefore, it is important to look closely at the impact of local linkages. Local linkages account for 141 of the 458 reported, 84% (n=118) of which are reported in the High to Medium impact band. Thus, the largest proportion of linkages are reported in the High and Medium impact band when compared with national (75%), European (77%) and international (81%) scopes respectively. European linkages scored the highest number (n=29) of the 124 linkages reported in the High impact band totalling 24%.

The respondent firms engage in more linkages across the local Wallonia region (n=141) than at any other geographic scope. Respondents seem less likely to engage in international linkages (nearly exactly half that of the Local linkages reported) which are at further distances (perhaps as these links are harder to form and maintain). However, it
has already been noted the importance of internationalisation to the RFG as 70% of all Outputs linkages are reported across Europe and further afield (Table 2, 3d and 3e).

Local, national and European linkages, each account for between 26-31% of all linkages recorded. This is interesting when compared to the importance Porter believes clusters place on local connections and proximities and the role it plays in firms’ competitiveness. It is imperative to note that the local region, when mentioned, refers to that of Wallonia and the national region refers to the rest of Belgium i.e. we discuss only two regions north and south.

<table>
<thead>
<tr>
<th>Geographic Scope</th>
<th>Local</th>
<th>National</th>
<th>European</th>
<th>International</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Impact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>&gt;30 to 40</td>
<td>18%</td>
<td>16%</td>
<td>24%</td>
<td>28%</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;20 to 30</td>
<td>65%</td>
<td>59%</td>
<td>54%</td>
<td>53%</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;10 to 20</td>
<td>16%</td>
<td>25%</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>Tenuous</td>
<td>&gt;0 to 10</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Percentage</td>
<td></td>
<td>31%</td>
<td>26%</td>
<td>27%</td>
<td>16%</td>
</tr>
<tr>
<td>Total (n)</td>
<td></td>
<td>141</td>
<td>120</td>
<td>124</td>
<td>73</td>
</tr>
</tbody>
</table>

Table 4: Impact by Geographic Scope of Linkages

**Key Connectors**

Figure 3 illustrates the key connectors in the BioWin Health Cluster, strong linkages exist with organisations linked to firms’ Output, Industry Associations, Government Agencies and Research and Development. However, the standout Industry Association - BioWin and Government Agencies - The Directorate General for Economy, Employment and Research (DGO6), The Walloon Export and Foreign Investment Agency (AWEX) and The Federal Agency for Medicines and Health Products (AFMPS) are the strongest linked organisations to the RFG. The key connectors are those organisations who connect the cluster, they are identified through the number of linkages they have with respondent firms and the business impact of those linkages to respondents is presented in Table 5.
Figure 3: Key Connectors BioWin Health Cluster

<table>
<thead>
<tr>
<th>Key Connectors</th>
<th>BioWin</th>
<th>DGO6</th>
<th>AWEX</th>
<th>AFMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &gt;30 to 40</td>
<td>18%</td>
<td>17%</td>
<td>0%</td>
<td>44%</td>
</tr>
<tr>
<td>Medium &gt;20 to 30</td>
<td>53%</td>
<td>75%</td>
<td>70%</td>
<td>44%</td>
</tr>
<tr>
<td>Low &gt;10 to 20</td>
<td>29%</td>
<td>8%</td>
<td>30%</td>
<td>12%</td>
</tr>
<tr>
<td>Tenuous &gt;1 to 10</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total (n)</td>
<td>17</td>
<td>12</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 5: Impact of Key Connectors within the BioWin Health Cluster

Each of the RFG reports an Industry Association connection with BioWin, which is natural as all the RFG are members of the cluster. However, this also provides an opportunity for feedback for the organisation from its members. Furthermore, these RFG report that 71% of the linkages to BioWin are reported in the High and Medium categories displaying the importance of the cluster to its members. DGO6, AFMPS and AWEX are heavily linked to the RFG, which highlights the importance of Government Agencies support to the firms within the BioWin Health Cluster. Directorate General for Economy, Employment and Research (DGO6) is responsible for policy-design and is the implementing body for regional research and innovation policy in Wallonia. Its mission is to implement and monitor the aid granted in the field of economic policy - including the support granted within the framework of EU programmes and encouraging the development of enterprises, especially SMEs.
The AFMPS is responsible for ensuring medicines and health products are of the highest quality stemming from ensuring companies adhere to having the best medical devices, accessories and raw materials for the preparation and production of drugs. Wallonia Foreign Trade and Investment Agency (AWEX) is a public interest organisation in charge of the promotion of foreign trade and the attraction of foreign investments for Wallonia in Belgium. DGO6 has slightly stronger connections with the RFG reporting 92% of its links in the High and Medium bands as opposed to AWEX and AFMPS who reports 70% and 88% in these bands respectively.
Appendix E – Non-Disclosure Agreement

THIS AGREEMENT is made on the ____ day of ____________ 20__.

BETWEEN

(1) [NAME AND ADDRESS OF DISCLOSER] (“Company”); and
(2) Cork Institute of Technology with an address at Bishopstown, Cork, Ireland (“Recipient”).

The parties to this Agreement may be referred to individually as “Party” and jointly as “Parties.”

RECITALS

A. The Company possesses Proprietary Information that it wants to protect;

B. The Company is willing to disclose to the Recipient certain Proprietary Information (as defined below) for the purpose of information exchange regarding mapping, visualising and analysing the strength of key relationships within the Company’s ecosystem. This information will be used to develop an in-depth understanding of the _________ sector in the __________ region, on the condition that the Recipient does not disclose the same to any third party nor make use of the information in any manner except as set out below.

AGREEMENT

The Parties agree as follows:

(1) “Proprietary Information” means any information including geographical and non-financial business data relating to the Company’s business relationships with third parties, as may be collected by the Recipient from the Company using eight different industry categories as described during a face to face interview with the Company.

(2) Proprietary Information covered under this agreement will pertain to all information collected by the CIT interviewer; 1) orally - during interview, or through follow up correspondence via, 2) post, 3) e-mail or 4) over the telephone.

(3) The Recipient may use the Propriety Information for the purposes of analysing and compiling data arising from it in anonymised form that may be reproduced for educational, research and/or policy informing purposes.

(4) The Recipient agrees not to otherwise use or disclose to any third party any Proprietary Information without the Discloser’s prior written authorisation except to the Recipient’s employees on a ‘need-to-know’ basis and who agree to abide by nondisclosure terms comparable to those in this Agreement. The Recipient will maintain the confidentiality of the Proprietary Information with at least the same degree
of care that it uses to protect its own confidential information, but no less than a reasonable degree of care under the circumstances.

(5) The Recipient will not be liable for the disclosure of any Proprietary Information that is otherwise: (a) rightfully in the public domain; (b) rightfully received from a third party; (c) rightfully known to the Recipient without any limitation on use or disclosure prior to its receipt from the Discloser; (d) independently developed by the employees of the Recipient; (e) generally made available to third parties by the Discloser without restriction on disclosure; or (f) disclosed on foot of an order of any court of competent jurisdiction or any regulatory, judicial, governmental or similar body or any taxation authority of competent jurisdiction.

(6) The Recipient will, upon receipt of a written request from the Discloser, make reasonable efforts to promptly destroy or return all of the Discloser’s Proprietary Information and copies (save for one copy for archival purposes) and immediately cease using the same.

(7) Neither Party has any obligation to disclose Proprietary Information to the other. Either Party may terminate this Agreement at any time without cause upon written notice to the other Party, provided that each Party’s obligations with respect to Proprietary Information disclosed during the term of this Agreement will survive any termination. The failure of a Party to enforce a right under this Agreement will not be deemed a waiver of any subsequent right.

(8) This Agreement shall be governed by and construed in accordance with the law of Ireland and the Parties hereby submit to the exclusive jurisdiction of the Irish courts.

COMPANY

Signed for and on behalf of _____________________ (‘’Company’’)

Signature: _______________________________________

Name: __________________________________________

Position: _________________________________________

Date: ____________________________________________

RECIPIENT

Signed for and on behalf of Cork Institute of Technology - Interviewer

Signature: _______________________________________

2
Name: Mr. Conor Harte

Position: PhD Student, V-LINC Research Group, Cork Institute of Technology, Rossa Avenue, Cork

Date_______________________________

RECIPIENT

Signed for and on behalf of Cork Institute of Technology – Head of V-LINC Research Group

Signature: __________________________

Name: Dr John Hobbs

Position: Senior Lecturer, Economics, Cork Institute of Technology, Rossa Avenue, Cork

Date: ___________________________