Suitable Financing: A High-Tech Semiconductor (Photonics) Start-up Context

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A High-Tech Semiconductor (Photonics) Start-up Context

SARKAR MAHBUB AKHTER
Suitable Financing: A High-Tech Semiconductor (Photonics) Start-up Context

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This Thesis is Submitted for the Partial fulfilment for the Degree of Masters of Business (M. Bus) Studies
Declaration

I, hereby declare that, this thesis is the individual and independent work of mine, conducted under the supervision of Dr. Angela Wright and is submitted for the partial fulfilment for the degree of Master of Business (M. Bus) at Cork Institute of Technology (CIT). No part of this research has been submitted in the past, or is being submitted for a degree or award in any other educational institute.

Signature: ________________________________
Sarkar Mahbub Akhter

Date: 28/10/2015
This thesis is dedicated in loving memory of my father who very sadly passed away during the course of my study.
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Appendix A:
Abstract

This research investigates the financing options available to a "High-Tech Start-up" when a technical person seeks to start a business from innovations emerging from his or her daily work. In seeking to understand the different factors which might influence the choice of a particular type of financial source, firstly a thorough literature survey has been performed. In the main part of the study, a qualitative research approach was considered to be the most appropriate one and as part of it, a number of interviews with entrepreneurs, CEOs and CTOs have been conducted. Findings from these people with financial experiences are studied, analyzed and compared, to select a suitable financing option for a photonics start-up originating from the work inside a research institute.

Considering the high amount of capital required to start a semiconductor start-up, private equity based Venture Capitalist (VC)s are thought to be the most appropriate funding source for such a type of high-tech start-up. This research explores the different aspects of VC funding and the creation of favorable environments to attract more VC investment in the area of semiconductor start-ups. It is found that, the VCs bring much more to the table than merely finance. The role of the VCs in the start-up extends way beyond the traditional financial aspect, with their experience and expertise in different areas, they become deeply involved with the managing and mentoring of the firms they finance. With all their positive influences, the VCs contribute significantly to the success of a high-tech start-up.

It is concluded that VCs are not the only solution for financing a high-tech start-up throughout all its stages of development. Also, the interaction between entrepreneurs and venture capitalists is not immune to conflicts; both sides need to promote mutual understanding in order to bring success to the "high tech start-up".
Chapter 1

Introduction

"It is almost always harder to raise capital than you thought it would be, and it always takes longer. So plan for that"

(Richard Harroch, Venture Capitalist and Author)

1.1 Introduction:

There are some fundamental differences between the world of science and technology and the business world. In the world of science and technology, everything occurs according to a theory or a formula following the rules and the boundary conditions, whereas the business world deals with people, processes, corporate behaviour and the culture. In order to get the maximum benefit from both worlds or in other words to make a technology based business to be successful, firstly these two sectors must have to be familiarized with each other properly and then have to accommodate each other complementarily. The process of taking an innovation from the laboratory to a viable business concept to the market - technology commercialization- is a very challenging task and presents a unique set of
challenges and opportunities. This value chain of the technology commercialization process is illustrated graphically by the following figure.

Fig1.1: From concept to a company (graphical demonstration).

There are two main ways to capture the value from the knowledge assets generated from years of intensive research and development work. One way is to partially or fully sell or license the technology to an established firm and can get economic benefits from that licensing or selling. The other is by spinning out a venture from the mother institute, where the technology was developed. This knowledge based and technology driven ventures are characterized as "high-tech start-ups" and represent an
important power in the economy as they create innovations and dynamics, economic flexibility, new jobs and incomes, sometimes even new markets.

The actual start-up of a business would include several complex, complicated and time consuming steps. The decision on how to transform the knowledge may depend on the strategic decision of the technology development team, capability and strength of the team, target market sectors and a few other factors. For that, it is essential that before launching any business, the engineers and scientist learn some business related skills and techniques. One of the main challenges of these growth oriented entrepreneurial ventures is to source and manage the different resources to make these firms successful. The access to different types of resources would affect the success of entrepreneurial start-up throughout its life cycle, specially firms at early stages of development. Any successful start-up would be able to leverage its currently available resources to attract alliance partners in order to access other necessary complementary resources.

A very successful “high tech start-up” is similar with making an “Oscar winning movie”. For an Oscar winning movie, firstly the story has to be excellent, then the acting of the characters has to be outstanding and the movie has to be directed by an expert and very talented director. A talented director would bring out the best from the actors and actresses and match the other resources as music directing, sound editing or tracking, movie script etc. to make the movie exceptionally good. Similarly, for a “high tech start-up”, the technology on offer has to be really very demanding (people are eagerly waiting for this), the product has to be very reliable and high quality and manufactured and maintained by sound engineers and technical people and the overall resource management has to be exceptionally good by a wise and clever entrepreneur and his team. This similarity is demonstrated in the Fig 1.2.
A successful company is like a movie that wins the OSCAR
(not a movie which is only a big commercial success)

Good story line  →  Great acting  →  Excellent directing

Strength of technology  Sound Engineers  Efficient business people

Fig 1.2: Requirements for a “high tech start-up” to be successful.

So, it is important to leverage all the entrepreneurial resources for making the start-up successful. Copper et al. (1994) studied the performance of start-ups in terms of survival, failure and success on the utilization of human and financial resources and found that based on these two resources it is possible to predict the performance of new ventures with some degree of confidence (Copper et al., 1994: 374). So, along with the human resources, the financial resources are the fundamental necessity for establishing any successful ventures. The decision on the amount of funding required, timing of the fund and how to acquire that funding are the strategic decisions that have to fit with the other driving forces of the entrepreneurship. Without adequate financial resources a new venture would not be able to maintain the other resources and would fail to exploit the business opportunity, no matter how wonderful the business idea is.

For any start-up, including the “high-tech start-ups” one of the most important matters to successfully source the finance. After spending a lot of effort both in terms of time and money in the research and development (R & D) phase, the venture has to spend even larger amounts of money when
they want to take it to the next level. The business needs to spend money for product development and modification, bearing the cost of the technical and administrative people. Engineers and technical people are the biggest resource of a high tech organization and at the same time can be the biggest source of expenditure. Funding will also influence the market entry and ongoing market development strategy. Every step of the business requires the company to spend serious amounts of money before seeing any return. The sourcing of finance would influence the business operations to a great extent. So, it is essential to know what type of funding options are available and how appropriate they are for a particular business. Also raising finance for the start-up will probably not be a once off process and may not be drown from the same source each time; there may be a few rounds of different types of funding. For any start-up, the finance sourcing option would depend on the size of the economy and the structure of its corporate sector in the country where it is originated (although there may be the option of generating finance globally) and any relevant policy frameworks. The funding issue may depend on the type of business model that the start-up adapts. It also has to be a well thought out process specifying when and how the money will be spent. After the initial hard work on sourcing the finance, if the business does not operate according to a solid plan, the pressure and the knock on effect on the acquired finance could increase at an alarming rate and this could also affect the business operation severely.

Typically, the entrepreneur would have many start-up expenses even before business operation can start. So, it is very important to estimate these expenses accurately and then to plan where the entrepreneur would get sufficient capital. A proper research is needed to estimate the capital and one has to be careful not to underestimate that amount. As most of the investment decisions have to be made based on the prediction of the various inputs, risk is an important factor in all financial decision making. So the
matter of risk versus reward issue plays a part when choosing a particular type of finance source. In general, when the stakes are high, the risk is also high and pursuing potentially higher returns means accepting higher levels of risk. Accepting investment from some sources may carry a certain amount of risk and can come with some pain, but that pain has to be forgotten to achieve a gain. The entrepreneur would also feel some pain losing the overall control after the introduction of finance providers in the business. In order to reach the financial objectives of the high tech start-up, the entrepreneur needs to choose the investment which is most suitable for his type of organization and has to strike the right balance between the potential risk and reward based on the financial objectives, financial situation and investment style. The risk may also be focusing the financing goals as without strong financial control, the start-ups often lose their foundation and may be left on shaky ground. Entrepreneurs should not focus just on the expected return without considering the associated risk with it and to look beyond the expected returns on a set of decisions and consider the variability induced by this outcome. It is worth remembering that the risk is also taken by the financial investors as they may never see the return at all. Decision to invest into a high tech start-up is very vulnerable, like stepping into an unknown territory. Pike and Neale (1993) observe that entrepreneurs on an average have nine failures for each major success, nine empty wells are drilled before having a successful digging, and getting it wrong is a part of getting it right (Pike and Neale, 1993: 174).

1.2 Aims and Objectives for the Research:

The aim of this research is to understand how a high-tech start-up deals with financing options in general. This research has two dimensions; firstly it
is aimed at studying the different financing options used by the start-ups in the high technology sector and secondly to recommend a suitable financing structure for a high-tech start-up based on photonics technology throughout its life cycle. Since the financing of high-tech start-ups in the semiconductor area are mostly funded by private equity providers, the issues relating to "Venture Capital" (VC) financing is analysed. The analysis of these two dimensions will be satisfied by addressing the following two research questions:

1. What are the available financing options for a high-tech start-up based on semiconductor technology (photonics) originating from a research institute?
2. What are the implications of introducing private equity based funding in the areas of high-tech start-ups?

Apparently, the Venture Capital (VC) investors are the most suitable financing source for a high tech start-up in the semiconductor sector. So, question 2 is particularly chosen with VC funding in mind.

The objective of the research is to find out:

How the VC funding option is considered to be the best suited funding option for a high-tech semiconductor based start-up.

1.3 Motivation for the Study:

Innovation and creativity are the most precious assets that people with a technical background (engineers and scientist) can bring to the high-tech environment. By its very nature, high tech enterprises need creative people with a strong technical background not only to manage the research and
development phase but also to play a significant role in other functions such as administration, management, manufacturing sales etc. As a consequence, the most capable and creative scientists and engineers often feel challenged to accept the responsibility to start, run and manage a high-tech business.

I am an engineer with an idea which can be the key to a new high tech company. Being an engineer and working in a research and development environment for the last 15 years has provided me with the opportunity to create something innovative and proud to be a part of it. Spending time with talented and creative individuals with an in-depth knowledge of the semiconductor industry motivated me to think about a photonics start-up. During my Ph.D. studies, I got the opportunity to work in a big EU project called AGETHA (Amber Green Emitters Targeting High-temperature Application) and saw the birth of Firecomms, a spin-off from that project. My experience as a Process Engineer for the last 12 years and the intense work with the application specialist in the photonics source area saw the birth and growth of InfiniLED, another successful high-tech spin-off from Tyndall. This time, I would like to take the challenge to see the successful launch of a new product called superluminescent diode (SLD) through another start-up. This SLD device has characteristics somewhere between a light emitting diode (LED) and a LASER.

1.4 Justification for the Research:

The challenge for an inventor or technology entrepreneur is to get a business out of the invention. Whether someone is an inventor in a laboratory or, a researcher in an institution, building a business though the creation of a start-up company based on a solid technology where the
technological product has both definite and futuristic indefinite demand is hard work, requiring a good team and a good corporate culture. The team needs to gather the human and financial resources, come out with a solid and achievable business plan and target to manoeuvre through the early stages to eventually become established and also to keep away from endeavours which may not be accepted in the market. The role of management is as important as the technology itself and so both of the roles need to be recognized and fully utilized.

The fact is that, business people may not always understand the business value of those remarkable ideas which come through the research laboratories. This has little to do with the science behind the idea. Similarly, the technology people should accept the fact that, the technological success does not automatically guarantee commercial success. Also the technologist should recognize that the product or service on offer has to have a real demand in the market eliminating the blind believe in their own opinion. The ability to recognize a great business opportunity and to bring together the resources to commercialize that opportunity is what every start-up requires. This will be a stiff learning curve where the chance of failure is very high.

So, a gap exists between the business opportunity and arrangements of the resources. The start-up is much like a giant jigsaw puzzle where some of the elements are: present market situation, competitive situation, product strategy, functional plan, financial plans etc. Among these elements the financial elements seem to be the crucial ones as the financing issues of a high tech firm can affect and influence all other sections of the organization. Issues relating to the capital structure decisions are particularly important as this issue primarily affects the young and small sized tech start-ups. Restricted access to finance is considered to be the main barrier for growth for high-tech start-ups. It is also important to know the different funding agencies and schemes offered both by the public and private sectors as well
as the finance patterns, the availability and the duration of each type of finance. Similarly it is necessary to know the alternative sources of finance at crucial times. The effective implementation of the financing resource is also crucial while it is available, as the start ups lack both dealing with the experience and expertise of running the business as well as maintaining the financing operations. It is simply remarkable to know that a company can be very profitable but still can go out of business if the financing issues are not properly dealt with. This shows the importance of the financing issue.

In the case of the photonics (semiconductor) industry, which is a very dynamic market and where much of the innovation is driven by the start-ups there is a definite need for a right “exit strategy” which would be required by a certain type of finance providers. The entrepreneur needs to show that the start-up seeking investment has a credible business opportunity and offers the potential for a significant return on investment (ROI). Tech entrepreneurs may focus too much on the technical aspects of the business and rather overlook the other essential requirements specially the financial issues. So, certainly there is a need for proper understanding about the financing options, financing structures and financial outcomes to make the start-up successful.

1.5 Design of the study:

Entrepreneurship for technical people as engineers and scientists is an important aspect beyond satisfying their own intellectual curiosity. It is like a vehicle which serves prosperity in the individuals, in the organization, in the region and the overall the nation where the financial matters are the engine of the vehicle.
This study is focused on the different types of financing options for a high tech start-up originating from a semiconductor R & D activity. The design of this study is cross-sectional: the research will be performed on a small number of high tech spin-off companies from the Tyndall National Institute in Cork. Over the years, Tyndall has successfully spun-out a number of high potential start-ups and provided support in terms of technology development and business development. The opinions from the entrepreneurs as well as the different Chief Executing Officers (CEOs) and Chief technical Officers (CTOs) on the financing issues will be analysed. The role of the support infrastructure and the formation of the proper team in terms of required qualifications and experience will be studied. A few similar high tech spin-offs from other universities and research institutes will be examined as well. Besides that an entrepreneur who had a failed high tech start-up will be examined. In depth analysis of both successful and failed spin-offs will be taken into consideration.

1.6 Thesis Outline:

The goal of this research was to study and evaluate the different issues for venture capital (VC) funding in a high tech photonics start-up originating from a research institute.

This chapter endeavours to introduce the areas of exploration that are pertinent to the current research. Chapter 2, gives an overview of the general literatures about entrepreneurship and also highlights the role of entrepreneurs in the areas of photonics technology. This chapter also discusses the different financial options available for high-tech start-up organizations and provides a very brief introduction about financing theories.
and its effects on the start-ups. Chapter 3, deals with the research methodology and provides the reason for choosing a particular research methodology for this study. In chapter 4, the opinions and quotations of different entrepreneurs, CEOs and CTOs are provided which were collected through interviews as a part of the study. The discussion and conclusions from the present work as well as the suggestions for future works are presented in Chapter 5. Based on the study a model for best practice for sourcing the finance for a high-tech start-up emerging from a semiconductor research and development institute is also given. Appendix A contains probing questions which were asked to get the opinion of different interviewees.
Chapter 2

Literature review

"Accessing capital to start a business can be a daunting process, especially for entrepreneurs who start out with a great idea, but have no real familiarity with the business world"

(Gavin Newsom, Lieutenant Governor of California)

2.1 Introduction:

The start-up or spin-off processes, is an important mechanism to commercialize technological innovations emerging from different research and development (R&D) facilities. The product or the system based on these technological innovations has to face stiff challenges from existing technologies and the firm has to possess the right combination of resources before stepping into the commercial world. One of the resources which are often the most essential for such technology commercialization is the financial resource. The start-up organization not only has to be concerned with finance from the very start, but also has to obtain the necessary finance at crucial times to support its growth.
This chapter is divided into two sections; section one, provides the views, opinions and some suggestions from theorists about the different issues relating to a high tech start-up; section two mainly discusses the different financing options for the technology based start-ups and their suitability for financing a high tech photonics start-up venture. This will help to develop a solid background for the study and to identify the right source for financing a high tech start up.

2.2 Definition of "High Tech Start-up":

Before going in-depth about the financing options of a high-tech start-up, let us first define what is a "high tech start up"?

Based on the direct research and development (R&D) intensity and R&D embodied in intermediate and investment goods, OECD (Organisation of Economic and Social Development) defines the high tech industry as a "very technology-intensive" industry (OECD, 2001). Many manufacturing activities could be considered as high-technology oriented but this definition is based on the direct R&D intensities and relatively recent R&D performance where the 'high-tech' industries can produce a variety of products ranging between 'low-tech' and 'high-tech' (OECD, 2001).

Lei et al. (2000) define technology and knowledge intensive industry as high-tech industry. The internationally accepted definition defines "high technology" as "the new state-of-the-art intellectual intensive technology" where the equivalencies for "high technology" are "advanced technology" and "leading technology". Lei et al. (2000) concludes that high-tech industries are those who produce product and service by using high
technologies and the various definitions for high-tech industry convey virtually the same meaning (Lei et al., 2000: 390).

Burgel et al. (2000) define "high-tech start-ups" as being a legally independent company which is less than ten years old, and which operates in high-technology sectors with technologically sophisticated products. For the definition, Burgel et al. (2000) study start-ups from selected service industries with large research and development (R&D) activities which may exhibit materially different characteristics (Burgel et al., 2000: 7). Hellmann and Puri (2000) describe the "high technology start-ups" as heterogeneous types of firms ranging from technology developers to technology adopters where the technology adopters use new technologies to enter the market, or, launch new ways to do business but not necessarily develop the new technology (Hellmann and Puri, 2000: 961).

Clarysse and Moray (2004) define the "high tech start-up" or 'new technology based firm' as a new entry formed by a staff member, student or a faculty member from a research based entity who left the organization to found the new company with a core technology or idea or still affiliated to the mother institute. Clarysse and Moray (2004) further mention that these start-ups would have marketable ideas in their research portfolio but would differ significantly in the extent to which they actively search for business opportunities and business development (Clarysse and Moray, 2004: 57-58). Park (2005) defines the "high-tech start-ups" as a firm that uses new innovating technology and invests in rapidly emerging or evolving technology as a key part of its product development, production or marketing strategy. Park cautions that in the high-tech sector, the survivals of the business, let alone the growth is dependent on finding and exploiting a reliable innovation strategy quickly, and before other firms enters the market (Park, 2005:741).
A most recent definition about the high tech sector came from Hathaway (2013) who studied the job creation issues in the high technology sector. According to the Hathaway, "high tech start-ups" are defined as a group of industries, working in the field of science, technology, engineering and mathematics and in the sector of Information and Communication Technology (ICT) which is generally growth oriented and acts differently from other business sectors across the economy (Hathaway, 2013). Similarly, Cannone and Ughetto (2014) define start-up companies working in the area of ICT and electronics sectors being the high-tech sector (Cannone and Ughetto, 2014: 280). Altena et al. (2014) also define the high tech sectors as industries working in the areas of ICT, life science and clean tech (Altena et al., 2014: 7).

2.3 Issues Relating to High Tech Start-ups:

Lei et al. (2000) outline that high-tech start-ups are an emerging power that plays an important role in a country's economic and social development and where constant innovation is the very vigour that supports these enterprises growth and development (Lei et al., 2000: 390). So it is important to learn the different issues relating to the high-tech start-up sector.

Kakati (2003) identified the criteria that influence the performance of high-tech new ventures by surveying more than twenty-five venture capitalists who experienced both failure and success in high-tech ventures. The venture capitalists identified six elements: entrepreneur quality, resource-based capability, competitive strategy, product characteristics, market characteristics and financial criteria for determining the venture's success or failure. The study by Kakati (2003) reveals that entrepreneur
quality, resource-based capability, and competitive strategy are the critical determinants of the firm’s viability and achievement where successful entrepreneurs develop multiple resource-based capabilities to backup multiple-strategies to push their products to market (2003: 455-456).

Chorev and Anderson (2006) establish a practical model for the factors which are important for success in the high-tech industry sector in Israel. In the model, the idea itself, the commitment of the core team, their expertise, general strategy and marketing strategies; customer relationships, management and R&D capacity are considered as critical factors. The less critical factors are found to be the type of funding, the networking, the economy, a complete product, organization, the general environment and politics. According to Chorev and Anderson (2006), although this model was based on the high tech industry data in Israel, this could be accepted globally (Chorev and Anderson, 2006: 172).

Chen et al. (2009) points out that technological capabilities, financial capital and networking capabilities that the venture possesses are associated with growth, which in turn affect the overall performance of the venture. In the research done by Chen et al. (2009), using data from nearly 250 high tech ventures, the above 3 elements are found to be the most relevant factor for the success of the start-up (Chen et al. 2009: 274). Also according to Adebanjo (2010), to a large extent, the success of businesses depends on having the right mix and balance of skills, specially for technologically-based entrepreneurial start-ups there is a need for a balance of technical and business skills to develop and support effective business strategies (Adebanjo, 2010: 166).

As it is found out that three issues are common to the different theories for all the high tech start-ups and these are: (i) Business Planning (ii) Market Research and (iii) Technology Support and Protection. These
above three issues are discussed next while the main issue (according to the author: “Finance”) which is the topic of the current research, is discussed in next section.

2.3.1 Business Planning:

Chwolka and Raith (2012) argue that although the value of business planning has been the subject of much controversy, proponents of planning regard the business plan as a crucial prerequisite for creating a successful new venture. Chwolka and Raith (2012) state that the enterprises, founded with a business plan, will reveal a better market performance than those started without one. Accordingly, the majority of empirical studies on this issue take a, comparative view of the relationship between planning and performance (Chwolka and Raith, 2012: 386).

Dellenbach and Woo (2010) emphasize the need to write an effective business plan for the high tech start up, defining the business plan as the roadmap for transforming the idea into a successful business (Fenwick & West LLP). According to Dellenbach and Woo (2010), the business plan is a good tool for focusing the team’s effort and to benchmark its progress. Going through the process of developing, the business plan will test the ideas against real world economics and thus trends and help to guide the business properly. Dellenbach and Woo advise to use the business plan effectively: to talk with the potential investors, employees and customers (https://www.fenwick.com). Zimmerer and Scarborough (2005) also advise for a solid successful business plan to have both a financial plan and a marketing plan. Like the financial plan, an effective marketing plan projects numbers and analyses from a different prospective; rather than focusing on
cash flow, net earnings, the marketing plan focuses on the customer’s needs and requirements (2005: 174). Lee et al. (2009) discuss a new approach to finding business opportunities based on technological assets and propose technology-driven road mapping processes (2009: 770). Shane and Delmar (2004) insist on writing business plans before undertaking marketing activities which should enhance venture’s organizing efforts (2004: 767).

Westhead and Wright (2013) advice to develop both formal and informal business plans which would set out the nature of the business, its intended market and customers and the resources it needs to achieve its goal of meeting a perceived market need. According to Westhead and Wright (2013), informal business plans are utilized as an operational guide for the start-ups development and the formal business plan is a key document for attracting the initial attention of a financier such as a bank, local enterprise development agency, business angel and venture capitalist (Westhead and Wright, 2013: 50).

2.3.2 Market Research:

Mariotti and Glackin (2012) highlight the importance of analysing the market and industry feasibility by stating that evaluating the targeted market and industry is essential for the start-up. Mariotti and Glackin (2012) state that the success or failure of the business depends largely on the market and industry in which they are to launch; just like a seed which will grow in fertile soil and wither away in barren earth. According to Mariotti and Glackin (2012), this segment of feasibility analysis examines the attractiveness of the product offered by the start-up and also provides opportunity to find a strategic and defensible niche (Mariotti and Glackin, 2012: 79).
Bekkers and Martinelli (2012) highlight the knowledge base of a firm in the context for the market of the technology. Bekkers and Martinelli (2012) suggest to quantify knowledge positions, and do this by focusing on markets where technology standards play a central role (Bekkers and Martinelli, 2012: 1192).

Haverila (2013) points to the need for high technology based companies to focus their attention on product and new product development related activities so that the final product offered to the market place is different from competitive product offerings and priced according to the performance differences. Haverila (2013) further emphasizes that the new product development related activities should be executed with an organization-wide adoption of the marketing concept and marketing information from personal sales efforts should be utilized (Haverila, 2013: 1).

Dohse and Vaona (2014) investigate the impact of input market thickness on the start-up activity and find that the case of high and low tech start-ups differ substantially. According to Dohse, and Vaona (2014), high tech start-up projects have rather different locational requirements and benefit strongly from a high regional density of R&D and highly qualified employees (Dohse, and Vaona, 2014: 427).

2.3.3 Technology Support and Protection:

Gaff (2015) cautioned that in the excitement of launching a start-up, certain issues can slip through the cracks, but the IP issues should not fall victim to that fate. Gaff advised to work with the lawyer from the start to ensure that the entrepreneur has covered the clearance issues and taken steps to address them, otherwise the entrepreneur might encounter an eleventh-hour
difficulty that derails the ability to market the new product as the organisation intended (Gaff, 2015: 7).

Linden from the European patent office (http://www.7pennies.com, 2002) places emphasizes on obtaining a patent on the technological innovation as it is important to protect the idea (Linden 2002). As a start-up company, the patent could be the business driver, the most important possession and a strategic weapon for the company. Linden expresses that faced by increased competition in a global market place the intellectual property right has become a business driver (Linden 2002). Zimmerer and Scarborough (2005) advice tech entrepreneurs that whenever they come up with an innovative idea for a product that has market potential, their immediate concern should be to protect it from unauthorized use (2005; 58). Barringer and Ireland (2006) also highlighted the need for patent as protecting patents grants the inventors the exclusive right to market their inventions. According to Barringer and Ireland (2006), if it were not for patent laws, inventors would have little incentive to invest time and money in new inventions. Patent right gives inventors and their financial backers the opportunity to recoup their costs and earn a profit in exchange for the risks and cost they incur during the invention process (2006: 282). Allen (2010) describes the patent as being the most powerful form of intellectual property (2010: 73).

2.4 Entrepreneur and Entrepreneurship:

Since the word start-up and entrepreneur are complementary to each other, it is worth to have a brief analysis of both the entrepreneur and entrepreneurship. According to Fu (2014), entrepreneurship is about
innovation, opportunity recognition and making the right decision. Entrepreneurs are able to create ventures to peruse profit opportunities and have the hidden power to make strategic decision for the business: which product to develop, which market to enter and which investment to make (Fu, 2014: 7-8).

Gaglio and Kertz (2001) define the opportunity identification process as one of the core intellectual questions in the domain of entrepreneurship. Gaglio and Kertz (2001) detailed a conceptual model based on a comprehensive and cognitive approach to the theory of entrepreneurial alertness and predicted that the early stage of the business start-up process deals with how opportunities are detected and acted upon (Gaglio and Kertz, 2001: 109). Eckhardt and Shane (2003) further explain the role of opportunities in the entrepreneurial domain. Eckhardt and Shane highlighted the importance of examining entrepreneurship through a disequilibrium framework that focuses on the existence and characteristics of entrepreneurial opportunities and their implications for understanding entrepreneurship (Eckhardt and Shane, 2003: 346). Sarason et al. (2006) describes how entrepreneurs interpret and influence the world through their discovery, evaluation, and exploitation of opportunities. According to Sarason et al. (2006), entrepreneurial opportunities do not exist independently of the entrepreneur and it would be more fruitful to focus on the recursive nature of entrepreneur-opportunity relationships through time and space, as longitudinal perspectives will reveal the complex dynamics of mutual interdependence between the agent and structure (Sarason et al., 2006: 303).

Ucbasaran et al. (2009) explores the links between entrepreneur's prior experience and their opportunity identification behaviour. Experienced entrepreneurs identified more opportunities and exploited more innovative opportunities with greater wealth creation potential (Ucbasaran et al. 2009: 22).
Soriano and Huarng (2013) observe that innovation and entrepreneurship generally go hand in hand. According to Soriano and Huarng, innovation is an exogenous variable and innovations by entrepreneurs tip the balance in the economy and lead to a process of "creative destruction" (Soriano and Huarng, 2013: 1969). Galino and Mendez (2014) analyse the relationships between entrepreneurship, innovation and economic growth, and show that the feedback affects this relationship. The analysis shows that several factors have positive impacts on innovation and entrepreneurship, including monetary policy and social climate. Additionally, when a feedback effect is at work: the economic activity promotes entrepreneurship and innovation activities which in turn enhance economic activity (Galino and Mendez, 2014: 828).

Wu and Huarn (2015) mention that both entrepreneurs and innovators are the people who introduce the new inventions into new productive activities. Reporting about the 2014 Global Entrepreneurship and Innovation in Management Conference (2014 GEIM), which represents an important contribution to the state-of-the-art research results in this area, Wu and Huarn (2015) observe how new theories and models emerge on both global entrepreneurship and innovation on the basis of empirical analyses (Wu and Huarn, 2015: 175).

2.4.1 Importance of Entrepreneurial Education:

Samsom (1990) states that, the process of technology commercialisation and innovation through a new venture is a phenomenon occurring routinely in the business environment. Samsom records that a scientist from a university, or from an independent institute or from a Government research and development (R&D) facility produces a scientific and technological
innovation, in the course of his/her everyday work. At some point, the scientific discovery is recognized to have sufficient application potential outside of the laboratory to justify an attempt at commercialization (Samsom, 1990: 3). Martin (1994) highlights that for a typical technological innovation a collaborated effort from a number of individual inventors is needed, but attributed the ultimate success to the sustained efforts of one or more inventors-entrepreneurs who pioneered the development of a new high technology industry (Martin, 1994: 5).

By tracking the activities and performance of the successful high-tech ventures, McMullan and Gillin (1998) highlight the need for entrepreneurship education for the technological start up entrepreneurs, and discusses the implementation of the designed program. According to McMullan and Gillin (1998), this type of programming helps people to launch meaningful entrepreneurial careers and at the same time provides Governments with an effective micro-economic response for job creation (1998: 276).

Mullins (2006) states that turning basic scientific research into new ventures is a challenging task. Mullins finds that the research scientists often lack the market and industry understanding to identify the commercial applications which may be present in the science and their principle interest often lies more in the knowledge itself than the commercial potential of the research work (Mullins, 2006: 213). This is further outlined by Kennedy (2006) who observes the existence of a language barrier between the inventor and the business community. Kennedy recommends that the inventors and tech entrepreneurs who are naturally expert in their chosen field, to speak in a common language which is understandable to the business people, defined as the “language of business” (Kennedy, 2006: 4).

Allen (2010) also notices that the transition from the technical disciplines to entrepreneurship would involve filling a challenging gap of
knowledge. Allen expresses that the scientists who cannot understand the way the entrepreneurs think would find it extremely difficult to employ the business tools required to commercialize their technology (2010: 3). Unlike scientist and engineers, the entrepreneurs are not bound by formulas, rules and linear patterns of thinking and the mindset of an entrepreneur is different in respect to uncertainty and ambiguity. On a positive note, Allen (2010) also mentions that many scientists and engineers are moving away from the belief that “it’s the technology that determines the business success” and are trying to understand and learn some essential entrepreneurial skills. Finally Allen pointed out

*By studying entrepreneurship, scientists and engineers will experience the opportunity to work through the complex business process involved in launching a new venture, which will help to install an entrepreneurial mind-set- a way of thinking that is opportunistic, embraces uncertainty, is creative, and capable of taking calculated risk* (Allen, 2010: 4).

### 2.4.2 Entrepreneurship in the Areas of Photonics:

According to PR photonics website, photonics is one of the key technologies that underpin the modern economy: it deals with the generation, manipulation and utilization of light using various semiconductor materials (www.rp-photonics.com). The impact of photonics is great on everyday life and on diverse industries such as information technology and communication technology, health care and life science and above all, the general lighting (http://www.rp-photonics.com). The United nations (UN) recognized the importance of raising global awareness about how light-based technologies promote sustainable development and provide solutions to global challenges in energy, education, agriculture and health and as a result, at the UN.
General assembly’s 68th session proclaimed 2015 as the “International Year of Light and Light-based Technologies” (http://www.light2015.org/).

Pennings (2013), General Manager and Principal of 7 Pennies Consulting, brands the photonic industry as a very dynamic market, where much of the innovation is driven by start-up companies. According to Pennings (2013) entrepreneurs are drivers of innovation and the economic society, and the photonics industry offers a myriad of opportunities (http://www.7pennies.com). But the situation about a decade ago was very different as outlined in the next paragraph.

Chang from Incubic Management LLC (http://www.photonics.com/) observed that during the telecom bubble of the 1990s, the photonics industry was euphoric, and it was easy to get funding to start companies. According to Chang, most bubble companies had capable technologies to improve some aspects of an existing product, but not enough business expertise. As a result by the early part of 2000, most of the 'bubble companies' had disappeared (http://www.photonics.com/). Milton Chang noticed that the number of photonics start-ups has subsided significantly since the heady days of the late '90s - not from a lack of people interested in starting companies, but from a lack of investor interest after having been burned by the telecom bubble. Milton Chang advised that for the good of the photonics industry, the engineers and entrepreneurs must get investors back by having a higher percentage successful start-up companies in this area (http://www.photonics.com/).

Thankfully the situation has changed recently which is reflected in the recent achievements of photonics on the highest possible stage of basic science as the Nobel Prizes for both physics and chemistry in 2014 were awarded to the most important developments in photonics. (http://www.PRphotonics.com). The Nobel Prize in Physics went for the
The invention of blue LEDs and for Chemistry for the development of super-resolved florescence microscopy (FM) (http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2014/). The discovery of the blue LED was rather applied than very basic but the Nobel jury emphasised the usefulness of the invention done by a small Japanese Company called 'Nichia Chemicals' to recognise developments that would deliver the greatest benefit to mankind (http://www.bbc.com/news/science-environment-29518521).

In order to stimulate and support innovative entrepreneurship in the domains of photonics, the organisation 'Photonics4life' which is supported and funded by EU's 7th Framework Programme, organizes intensive training on Entrepreneurship in Photonics (www.photonics4life.eu). This intensive course is targeted at researchers of universities and research institutes, young professionals, employees of photonics related companies, lawyers, business angels, consultants or anybody who is involved or interested in entrepreneurship in photonics. According to the Photonics4Life website:

*Photonics is a major enabling technology and will be a driver for innovations in a wide range of domains. Its core technologies, such as lasers, light emitting diodes, vision, displays, fibre optic cable, photovoltaic cells, translate in a wide range of industrial and consumer applications, of which several are in an explosive growth phase.*

(http://www.photonics4life.eu)

It is seen from the Boston University Photonics Centre website that it has started incubation of photonics technology companies in order to pioneer fundamental knowledge and innovative technology in the field of Photonics. In the year of 2013-2014 the photonics centre attracted $14.5M in new research grants and contracts along with prodigious honours and awards and generated more than 100 notable scholarly publications in the leading journals in the field of photonics (http://www.bu.edu).
The European Photonics Industry Consortium (EPIC) a non-profit organisation was formed in 2003 by five companies (Osram, Philips, AIXTRON, CDT and SEGAM) to serve the photonics community through a regular series of workshops, market studies and partnership (Photonics.com). In 2015, more than 180 companies, research organization, universities, and other industry stakeholders are members of the consortium who work together to execute the mission by proposing and implementing influential initiatives of significant impact on the industrial landscape (www.epic-assoc.com). Similarly, realizing the importance of photonics in Ireland, Science Foundation Ireland (SFI) invested €30million in the Irish Photonic Integration Centre (IPIC) to bring together over 100 researchers from four institutes to develop new light-enabled technologies (www.sfi.ie). Targeting the ICT and medical devices sectors, IPIC is working with 18 industry partners to develop the next generation of highly-compact and miniaturised photonic technologies. The centre’s work is focused on revolutionising the speed of data transfer through faster and more energy efficient devices and delivering new smart medical devices for improved diagnosis and treatment of disease (www.ipic.ie).

As a last word about demonstrating the importance of photonics technology, according to the "BIZ LED technology" website, many scientists believe that 21st century will depend on photonics just like 20th century depended on electronics. Growth in the photonics industry has commenced in the last decade. From a current global market of more than $300 billion, it is expected to grow to $600 billion by 2020 (http://bizled.co.in/photonics-will-technology-21st-century).
2.5 Sourcing and Management of Financial Resource:

Blundel and Lockett (2011) defined financial issues as a fundamental prerequisite for establishing successful new ventures. Without the financial resources, a new venture will not be able to maintain the other resources and would fail to exploit the business idea—no matter how good or attractive the idea is (Blundel and Lockett, 2011: 190). Tareq (2013) observes that restricted access to finance for the start-up firms is acting as a main barrier to growth. According to Tareq, the start-up firms not only need to successfully source the finance, but also need to efficiently manage and implement when these are made available (Tareq, 2013: 2).

Manigart and Struyf (1997) did an explorative study on the financing of nearly 20 high technology based startups and realized that besides the normal financing requirements that any new company faces, a high tech company needed additional money for its R&D in order to develop new products and markets. Manigart and Struyf (1997) found that the most important sources of finance for the start-ups are the entrepreneurs and the banks but the sources that provided the largest amount of funds are the venture capitalist companies and private investors whereas the role of Government and Universities are somewhat limited (Manigart and Struyf, 1997: 195).

2.5.1 Stages and Types of Financing:

According to the Lewis and Churchill growth model (1983) a business goes through different stages of growth and development. These stages involve conception or existence, survival, profitability or stabilization, profitability and growth, take-off, and maturity. The Churchill and Lewis growth model focuses on how the entrepreneur's role evolves with growth and what skills and resources (one of them is the financial resource) are required at each of these stages: this is illustrated in the Figure below.

![Business growth model by Lewis and Churchill (1983).](image)

Figure 2.1 Business growth model by Lewis and Churchill (1983).

Similarly, Prakke (1988) also showed that the new technology based firms evolve in different stages. Prakke (1988) distinguishes the following stages as research and development stage, start-up stage, risky growth, regular growth and maturity stage and showed the likely source of financing changes at different stages (1988: 75). The stage and the types of financing for a high tech start-up have been well articulated by Mayer (2004) where it is shown that the development involves several stages. The first stage is the
seed stage when the concept is still being proven and developed. The second stage is the start-up phase where the firm may be a year old or new and when products are further developed and initial marketing takes place. The third stage is the early development stage when the firm is expanding and producing, however the operation may be still unprofitable. It may consist of a few rounds of funding generation and the firm is often about five years old at this stage. During the fourth stage of expansion, the firm might go public in six months to a year (Mayer 2004: 37). Meyer anticipated different types of funding source at different stage of funding.

Adelman and Marks (2014) mentioned four different stages through which the firm goes from concept to maturity, which are seed/start up stage, early stage, expansion stage and the later stage (2014: 55).

2.5.2 Sources of Finance:

The following section describes the different sources of capital available for start-ups. After the initial description of the traditional financial sources, it will go to the specific preference of financiers which are more suitable for a high-tech start up.

2.5.2.1 Personal Financing:

Batey and Breen (1996) observed that a typical new venture begins with a good idea with its founder's money after the business entity is created where moving beyond this stage requires careful financing planning and
considerations. Batey and Breen (1996) also consider friends and families to be an initial source of financing but warn that their resources are usually outstripped quickly by the growing business's need for capital (Batey and Breen, 1996: 452). Berger and Udell (2006) also expressed a similar opinion about friends, family members and colleagues being the primary source of finance for the start-up specially in the initial stage. According to Berger and Udell (2006) these people act as a finance source in the form of interest free loans or may even donate to the start-ups with no formal bindings. As a result, this sort of financing is considered informal as there is no strict requirement for the availability of credit Berger and Udell, 2006: 2946). Nofsinger and Wang (2011) defined these important people as 'informal investor' who usually affiliates with the entrepreneur through various social networks as friends, colleagues and others (Nofsinger and Wang, 2011: 2283).

MacVicar (2010) suggests the entrepreneur to put some of the own money into the company if not for any other reason than to demonstrate the dedication of the entrepreneur. It also helps in terms of the more the company's stock the entrepreneur owns at the beginning, the more the entrepreneur will own later when the stock may be quite valuable. MacVicar defines the family and friends being the 'next best thing' for investing in terms of maintaining the control of the business (2010).

2.5.2.2. Bank Financing:

Traditionally banks are the main source of financing for most of the businesses. Shapiro (1990) mentioned different forms of credit available
from commercial banks and these are term loans, line of credit, bank overdrafts, revolving credit agreements, discounting etc. (1990: 265).

Berger and Udell (2006) proposed a complete framework of lending technologies classified as transactional lending and relationship lending, based on government policies and national financial structure. The different lending technologies are financial statement lending, small business credit scoring, asset base lending, factoring, fixed asset lending, leasing etc. (Berger and Udell, 2006: 2948). Elyasiani and Goldberg (2004) review the literature on relationship lending. According to Elyasiani and Goldberg (2004), the effect of relationship lending on firm value is examined in the context of the event studies investigating the impact of announcement of bank loans on stocks of the borrowing firms and the effects on funds availability, loan rates, and collateral requirements. The evidence indicates that relationships increase funds availability and reduce loan rates (Elyasiani and Goldberg, 2004: 315).

Timmons and Spinelli (2007) cautioned that start-ups would generally face more difficulty to source bank financing as they do not have assets or a track record of profitability or a positive cash flow. Timmons and Spinelli (2007) also mentioned that such debt for high tech start-ups can sometime depends on the business location. For example high tech start-ups located in the Silicon Valley would have relatively easy to debt capital once the entrepreneur is able to show a sound business plan (Timmons and Spinelli, 2007: 450). Hall (2004) also argues that banks are less willing to provide funds to start-ups, as these firms lack collateral and are more opaque. Asymmetric information regarding creditworthiness and a lack of tangible capital may arguably lead to stronger credit constraints for high-tech start-ups as opposed to low-tech start-ups (Hall, 2004: 8). Mann (2009) also reports that Start-ups with human capital embodied in the entrepreneur or
in intellectual property assets have a lower probability of using debt, given their greater asset specificity and lower collateral value.

Despite all these shortcoming specially for a start-up case, Blundel and Lockett (2011) define banks as a vital source of finance for both small business and new ventures where both national and international banks provide finance to the business (Blundel and Lockett, 2011: 196).

### 2.5.2.3 Equity Financing

Denis (2004) observes since high tech start-ups are typically not profitable at the initial stage and also lack tangible assets, debt financing is usually not an option and consequently, entrepreneurs tend to rely on sources of outside equity financing: angel investors and venture capital funds (2004: 304).

According to the business angel investor website (http://www.thebusinessangel.org/) both Angel Investors and Venture Capitalists will hold private equity from having made investments directly into private companies. However Business Angel Investors will be individuals, often successful business people, who are investing their own personal funds into a potentially rewarding business opportunity. Whereas Venture Capital is invested by firms or companies that use other people's money. They raise that money by offering investors a chance to take part in a fund that is then used to buy shares in a private company (www.thebusinessangel.org/difference-businessangel-enturecapital.html).

Metrick and Yasuda (2010) define venture capitalists as a financial intermediary, meaning that it takes the investors' capital and invests it directly in portfolio companies. Metrick and Yasuda (2010) point out that VCs
are often compared to—and confused with—angel investors. Angel investors, often just called angels, are similar to VCs in some ways but differ because angels use their own capital and, thus, do not satisfy the above characteristic (2010: 4).

2.5.2.3.1 Angel Investors:

Mason and Harrison (1995) encountered the shortage of long term investment finance particularly at the start-up and initial stage. According to Mason and Harrison (1995) the institutional venture capital industry has done very little to fill this 'equity gap' and has rather concentrated on making large investments in established companies and management/leverage buyouts. Mason and Harrison (1995) business angels (BAs) are private investors who show a proper attitude by providing risk capital to new and growing businesses in the early and development stage to which they have no family connection (1995: 170).

Elitzura and Gaviousb (2003) noticed that the number of wealthy individuals who are known as 'angels,' in start-up firms, especially in the high-tech sectors is quite significant and has increased a lot for the last few years. These angels do not make such investments as their primary business and so quite often they invest in the company at an earlier stage than venture capitalists (VCs) do (Elitzura and Gaviousb, 2003: 710).

Paul et al. (2007) examine the process that business angels undertake when they invest in new and small businesses. Gathering evidence from 30 interviews with business angels, Paul et al. (2007) presents an overarching model of the angel investment process and also identifies underlying factors that generate and sustain the investment process (Paul et al., 2007: 107).
Osnabrugge (2010) provides a detailed comparison of the investment criteria and procedures of business angels (BAs) and venture capitalists (VCs) across the full investment process and finds that the BAs and VCs behave quite differently in their investment processes on account of different structural and risk difference (Osnabrugge, 2010: 108).

Fairchild (2011) also noticed that despite the fact that venture capitalists usually do have higher value-creating abilities than the angel by providing managerial contributions towards the success of the venture, entrepreneurs often prefer to use angel-financing. According to Fairchild (2011), quantitative analysis suggests that angel-financing dominates venture capital financing globally, both in terms of the number of new firms receiving funding, and the value of financial investment (Fairchild, 2011: 371). Similarly Mason (2009) mentions that these private investors fill up the funding gaps especially for firms seeking finance in the high technology sector. But Mason (2009) noticed that because of the informal and private nature of the angel investors it is hard to measure the level of investment activity, the size of the market and track record over time (2009: 550).

2.5.2.3.2 Venture Capital:

Most of the entrepreneurs and business people mention the Venture capitalists as the main source of funding in the area of semiconductor start-ups. So it is worth looking at the history of the VC investments, the theoretical framework on which they operate and finally on the impact that the VCs bring in the areas of high-tech start-ups.
2.5.2.3.2.1 The Birth of Venture Capital:

Landstrom (2007) defines the Venture capital investment phenomenon as a very ancient activity with a tendency to invest in high risk projects examples of which go back as far as the Babylonian era. Landstrom (2007) argues that the development of industrial revolution during the nineteenth and twentieth century was influenced by private individuals (2007: 10).

Kortum and Lerner (1998) mention that the formal venture capital industry in the United States dates back to the formation of the first fund, American Research and Development, in 1946. In the years between the late 40's and early 70's, only a handful of venture funds were established and the flow of money into the new ventures did not exceed more than a few hundred million dollars. According to Kortum and Lerner (1998), the funds flowing into the venture capital industry increased dramatically in the later 70s with amendment to the "prudent man" rule governing pension fund investments into venture capital or other high-risk asset classes which saw an investment of $424 million in the year of 1978 in new venture capital funds (Kortum and Lerner, 1998: 5). In present days, according to the MoneyTree Report by PricewaterhouseCoopers LLP (PwC) and the National Venture Capital Association (NVCA), based on data from Thomson Reuters, Venture capitalists invested $48.3 billion in 4,356 deals in 2014 (http://nvca.org/pressreleases/).

McCahery and Renneboog (2003) state that Venture Capitalists are intermediaries that provide direct capital to the firms which are generally excluded from the corporate debt market and other private finance providers. So, the start-ups rely on VCs as one of their main sources of funding. McCahery and Renneboog (2003) also mention that Venture Capital has been a critical component in the innovation process in the USA over the
last two decades and been involved in generating patents and corporate R & D (McCahery and Renneboog, 2003: 1).

In another report, Kortum and Lerner(2003) state that the Israeli Government initiated the formation of the venture Capital funds in 1991 which saw the rise in investment by 20 times in 6 years with the burst of high-tech companies in both R & D and manufacturing facilities (Kortum and Lerner, 2003: 188). Kortum and Lerner(2003) also report that the Singapore Government aggressively promoted the VC investment in the mid-80s and saw the dramatic rise in the VC activity from $42 million in 1985 to $7.7 billion in 1996 Kortum and Lerner (2003: 188).

Landstrom (2007) reviews that for a long time VC was regarded as an “American phenomenon” and it was not until the late 1980s that a significant Venture Capital industry emerged in Europe. According to Landstrom (2007) this growth of VC industry in Europe was associated with the introduction of secondary markets in many European countries such as the Alternative Investment Market in UK, the Nouveau Marche in France and the Neuer Markt in Germany (Landstrom, 2007: 13). Hege et al. (2003) studied the contractual determinants of success of Venture Capital investments in the US and Europe and found that a possible interpretation of their finding is that US VCs have better screening skills (due to their greater experience) than European ones. According to Hege et al. (2003) the US based VCs are probably better at sorting out good projects from bad ones and once good projects have been identified, VCs are willing to finance intensively these projects in the initial stage and while relatively less financing is necessary in later stages (Hege et al., 2003: 21). In a report by Cumming et al. (2014), the scant development of the European VC market has in the recent past resulted in a series of policy initiatives in the EU directed aimed at level playing level fields (e.g. measures aimed at increasing stock market openness and/or labour market flexibility, tax incentives) in order to
stimulate the supply and the demand side of the VC market (Cumming et al., 2014: 1).

2.5.2.3.2.2 Capital Structure:

According to Zhu, a company’s capital structure is arguably one of its most important choices as it influences everything from the firm’s risk profile to how easy it is to get funding, to how expensive that funding will be and how to return the value to the investors and lenders (http://www.axial.net/forum/why-capital-structure-matters/). The basis of the modern thinking on the capital structure follows the Modigliani-Miller theorem which states that under ideal market conditions, it is irrelevant how the firm is financed. But the real world includes the taxation, bankruptcy costs, interests and so to address these imperfections following three theories, trade-off theory, the pecking order theory and agency theory are introduced relaxing the assumptions of Modigliani – Miller (M & M) model (2003: 297).

2.5.2.3.2.2.1 Trade-off Theory:

Trade-off theory allows the bankruptcy cost to exist and it states that there is an advantage to financing by debt and also there is a cost of financing with debt. Kraus and Litzenberger (1973) provide the classical version of the trade-off theory as a balance between the dead-weight costs of bankruptcy and borrowing and the tax saving benefits of debt. Recently Denis et al. (2014) describe the trade-off theories of capital structure as the way firms
choose levels of debt in order to balance the benefits from the interest tax
shield with the costs of future financial distress or of current financial
inflexibility (2014:78).

2.5.2.3.2.2.2 Pecking Order Theory:

The pecking Order theory of corporate finance was pioneered by Myers and
states that according to the pecking order theory the company priorities the
funding sources and the preference are based on the fact that the cost of the
financing increases with asymmetry information, which means one party has
more information that the other. As a result, when an organisation tries to
source new funding, new equity brings higher cost as many companies hold
certain information internally that as they do not want to share with outside
parties (Samoylova, 2014: 8). Gao and Zhu (2015) state that under the
pecking order theory, equity capital is the most information-sensitive
security whereas debt capital is much less sensitive to the adverse selection
problem. Consequently, outside investors would require a higher adverse
selection risk premium on equity than on debt and firms with intense
information asymmetry would borrow more and end up with high leverage

2.5.2.3.2.2.3 Agency Theory:

Jensen and Meckling (1976) present the first unified treatment of agency
theory which states that both the entrepreneur and the funding organisation
work for their self-interest and so conflicts of interest naturally arise. These conflicts are apparent when two individuals form an agency relationship, i.e. one individual (principal) engages another individual (agent) to perform some service on his/her behalf. A fundamental feature of this contract is the delegation of some decision-making authority to the agent. Agency theory is an economic framework employed to analyse these contracting relationships (Jensen and Meckling, 1976: 2).

Lindqvist and Mijovski (2012) state that the role and the goal of two different parties (the entrepreneur and the finance provider) throughout the funding process are crucial for the future of the venture. Lindqvist and Mijovski choose to examine this complex relationship in this context and conclude that the best relationship between these two parties can be outlined by the agency theory (Lindqvist and Mijovski, 2012: 42).

### 2.5.2.3.2 Impact of Venture Capital Investment:

Gompers and Lerner (2001) state that venture capitalists are an important intermediary in financial markets, providing substantial capital to start-ups which might have difficulty attracting finance. According to Gompers and Lerner (2001), these high tech start-ups have very few tangible assets and operate in a very changeable market with a high level of uncertainty. Venture Capital organisation finance these high risk but potentially high rewarding projects, purchasing equity or equity linked stakes while the firm is still privately held (Gompers and Lerner, 2001: 145).

Lockett *et al.* (2002) investigated the availability of venture capital as a catalyst for new or 'high' technology-based firms and found out VC firms' preferred to be involved in the later stages rather than the earliest (seed
and start-up) stages of the technology (Lockett et al., 2002: 1027-1028). To continue with that finding, Clarysse et al. (2007) carried out an elaborate study across seven high-tech regions in Europe and found that three different types of investors emerge: one section that focuses on the technology, another focuses on finance and the last section focuses on people. It was found that technology investors often employ investment managers with a technical background and technology investors use public money which is viewed as an attempt to overcome the problems associated with perceived market failure, which could easily happen in the early stage of the high-tech start-up sectors (Clarysse et al. 2007: 27).

Audretsch and Lehman (2004) examine whether debt and equity are complements or substitutes in financing young high-tech firms. Using a data set of firms listed in the Neuer Markt in Germany, Audretsch and Lehman (2004) demonstrate that venture backed firms differ from firms with other financial resources, especially debt and small and innovative firms are more likely to be financed by venture capitalists than banks (2004: 1). Audretsch and Lehman (2004) also find that the presence of the venture capitalists enhances the growth rate of the firms positively.

Barnes and Menzies (2005) recognise the complementary relationship between the entrepreneur and the VCs where the entrepreneurs need venture capital finance to grow their business and VCs need entrepreneurs to generate a return from the investment. According to Barnes and Menzies (2005), VCs are not the ultimate providers of capital as they do not sit at the beginning of the capital supply chain, instead VCs are hands-on intermediaries who provide an interface between the provider of the capital (pension funds, investment trusts etc.) and the entrepreneur who utilizes such capital to create a successful business. Barnes and Menzies (2005) point out:
VCs screen, monitor, advise and assist in investments; they manage information asymmetry and decrease agency costs, providing their investors with access to investment opportunities that they would not normally be equipped to undertake.

(Barnes and Menzies, 2005: 222)

Bettignies and Brander (2007) observed that although venture capitalists (VCs) make only a modest contribution to the overall supply of entrepreneurial finance, considerable attention has been focused on the role of venture capital in financing entrepreneurial activity as many now-prominent high tech corporations relied on venture capital finance during their early developments which include Microsoft and Intel. Filipov (2011) also states that some presently highly successful companies such as Apple Computers, Cisco Systems, Genentech, Intel, Microsoft, Netscape, and Sun Microsystems were initially financed by venture capital organisations (Filipov, 2011: 5).

Beuselinck and Manigart (2007) mention that private equity in the form of venture capital typically provide capital to the young and small high tech firms with no track record and no assets in place and thus fills the void between source of funds for innovation and traditional financial alternatives. This private equity combines the provision of finance with active governance and provides professional management skills and supportive guidance (Beuselinck and Manigart, 2007: 261).

Bilau and Couto (2010) mentioned that historically venture capitalists have been involved in the sectors which were very dynamic in terms of innovation. During the 80's Venture capitalists concentrated on computers and biotechnologies, internet technology and biotechnology during the 90's while during the 2000's the focus shifted to semiconductors, nanotechnology and bio medical devices (Bilau and Couto, 2010).
Popov and Roosenboom (2013) provide a comprehensive study of the effect of venture capital on new business creation. Using a comprehensive database of firms from 21 European countries over the period 1998–2008, Popov and Roosenboom (2013) find that venture capital investment has a positive effect on the rate of new business creation. This is especially true in countries with higher entry costs, higher level of protection of intellectual property rights, and lower taxes on capital gains. Popov and Roosenboom (2013) results suggest that, for such country and industry characteristics, venture capital is beneficial to bringing new ideas to the marketplace in the shape of new companies (Popov and Roosenboom, 2013: 4695).

But it is not all glowing about the involvement of VCs in the high-tech start-up sectors. Hiller et al., (2014) state some realities about the funding scopes from the Venture Capitalists. Hiller et al. (2014) find that the VCs carry out a thorough screening process before any investment is made and rely heavily on an informal network of lawyers, accountants, bankers as well as other VC to help to identify good investment opportunities (Hiller et al., 2014: 399). Hiller et al. (2014) also mention that the introduction of the VCs can be very costly: where in a typical deal VCs may demand as high as 40% equity in the company and frequently hold various important senior management positions to control and take priorities in the event of company liquidation or selling (Hiller et al., 2014: 399). Cohen (2012) who is an investment consultant also states that the introduction of VCs can be bad news for the start-up simply because the VCs can crave the control of the entrepreneur’s and also even be in at the position of firing the founder. Wadhwa (2006) mentions that the venture capitalists usually ask for onerous conditions as Anti-dilution protection (if the company's stock price goes down any time in the future, they get additional stock for free), dividends (in addition to stock, they get a guaranteed rate of return and gets both Liquidation preferences and Participating preferred). Wadhwa (2006)
also warns that the VCs routinely compete with each other for deals and sometimes the entrepreneur may find himself trapped into the tug of war.

2.5.2.3. Government Support:

Doutriaux (1991) mention that developing a strong high-technology base has been one of the goals of many Governments. To help these new firms grow and reach their full potential, different Governments have developed a full array of support mechanisms. Emerging high-tech firms have access to the various Government programmes designed for small businesses: special loans, reduced tax rates, shared-cost contributions, grants, export assistance, training programs, incubators and management assistance. They can also take advantage of most of the programs designed to encourage R&D and innovations: R&D grants and tax credits, and government programs for scientific and technical information, training, technology support (Doutriaux, 1991: 134-135).

In Ireland, Enterprise Ireland provides different types of funding schemes for harvesting the research and development and thus creation of jobs in the technological sector. Enterprise Ireland (EI) offers a range of supports to business tailored to suit the stage of development and the specific funding needs (http://www.enterprise-ireland.com/en/funding-supports/). One of them is the Commercialisation Fund Programme aiming to convert the outputs of state funded research into innovative new products, services and companies. The Programme supports researchers in Higher Education Institutions and Research Performing Organisations to undertake research that has the potential to result in the commercialisation of new innovations by way of licenses to improve the competitiveness of
Irish Industry or through the spin out of new start-up ventures (http://www.enterprise-ireland.com/en/Researchers/Research-Commercialisation-Supports/).

According to an Intratrade Ireland report the Irish Government recognises the importance of the venture activity by deploying capital efficiently to emerging technologies. This would result in creation of direct and indirect jobs and billions of euros in revenue and export. So, the Irish Government has been proactive and has committed through Enterprise Ireland, up to 175 million euro as a cornerstone investor to venture capital funds under the seed and venture capital scheme 2013-2018 (http://www.intertradeireland.com/media/intertradeirelandcom/microsites/equitynetwork/IVCAEISReport2012LRFINALApril2014.pdf).

2.5.3.4 Other Financial Sources:

Besides the traditional financial providers like Banks and private equity providers, there are a few innovative and modern ways to provide finance in the high-etch start-up sectors. A few such funding schemes specially used in financing the high tech start-ups are described below:

2.5.3.4.1 Crowdfunding:

Parker (2014) defines crowdfunding as a platform which enable members of the public to make small investments in ventures pitched by entrepreneurs which permits the investors to take small shareholdings in new start-ups
(Parker, 2014: 433). Similar opinion was also expressed by Schwienbacher and Larralde (2010) who describe Crowdfunding as a novel method of funding a variety of new ventures, allowing individual founders of for-profit, cultural, or social projects to request funding from many individuals, often in return for future products or equity. Crowdfunding projects can range greatly in both goal and magnitude, from small artistic projects to entrepreneurs seeking hundreds of thousands of dollars in seed capital as an alternative to traditional venture capital investment (Schwienbacher and Larralde, 2010: 3).

Stemler (2013) reports that on April 5, 2012, President Barack Obama signed into law the Jumpstart Our Business Start-ups (JOBS) Act, which dramatically changes the landscape for many companies raising capital. One of the most interesting sections of the Act is Title III, the CROWDFUND Act, which enables entrepreneurs and small business owners to sell limited amounts of equity in their companies to a large number of investors via social networks and various Internet platforms (Stemler, 2013: 270). Stemler (2013) further mentions that in the past 15 years, crowdfunding has become a popular source of capital formation for design, filmmaking, music, and photography projects via websites such as Kickstarter (www.kickstarter.com) and IndieGoGo (www.indiegogo.com). Through these sites, businesses or individuals who need financing for a project/venture publish an appeal for funds and typically offer a token reward (e.g., music CD, framed photo) to those who make contributions. Because small amounts of money from a large number of people can add up quickly, these sites have experienced tremendous success (Stemler, 2013: 271). Mollick (2014) expects that the Crowdfunding represents a potentially disruptive change in the way that new ventures are funded (Mollick, 2014: 14).
2.5.3.4.2: Trade Credit/Informal Lending/Market Finance:

Tareq (2013) defines 'trade credit' as being a relationship based source which might be used when the start-up is trying to move away from informal sources of financing to a more formal source of financing (Tareq, 2013: 7). Lin and Chou (2015) express 'Trade credit' as a financing instrument offered by suppliers to their customers, where the cost of trade credit depends on the credit terms. The supply of trade credit (i.e. accounts receivable), representing a means to promote firm sales, can be regarded as working capital financing to other firms, which may be small or face credit constrained. Casey and O'Toole (2014) examine that during the recent financial crisis (2008-2013), where bank lending has constrained, small- and medium-sized enterprises (SMEs) and start-ups were more likely to use or apply for alternative external finance including trade credit, informal lending, loans from other companies, market financing (issued debt or equity) and state grants (Casey and O'Toole, 2014: 176).

Popovic and Fahrni (2002) describe a funding scheme called 'co-operation finding' specially for a niche market for a small product, which does not afford a big amount of capital in a short timeframe. According to Popovic and Fahrni (2002), if time, establishment and confidence of clients are key success factors for the high-tech start-up company, fast venture capital is not favourable, instead the cooperation mechanism is to prefer. Interviewing a few high etch companies in Switzerland, Popovic and Fahrni find that almost all of the companies have a combination of several types of cooperation with another company (Popovic and Fahrni, 2002: 436).
2.5.3.4.3 Bootstrapping:

Ekanem (2005) finds that the investment decisions in many small firms are made by 'bootstrapping' techniques instead of formal methods suggested in the financial management literature. According to Ekanem (2005) bootstrapping represents an approach to decision-making that is grounded in the previous experience of key decision-makers and their organisations and the largely informal routines that they develop from this which brings knowledge, skills, values and attitudes together and provides owner-managers with an opportunity to evaluate outcomes based on previous experience (Ekanem 2005: 300).

Ebben and Johnson (2006) find bootstrapping process as a widely utilized strategic practice for small firms and regard it as an important topic in the entrepreneurship literature. Ebben and Johnson (2006) observe that small firms face constraints in obtaining financing from traditional outside parties due to information asymmetries and transaction costs and the small firms response these constraints via bootstrapping, or finding creative ways to avoid the need for external financing through reducing overall cost of operation, improving cash flow, or using financial sources internal to the company (Ebben and Johnson, 2006: 851). Very similar behaviour was observed by Nanka-Bruce (2009) who reveals that bootstrapping mechanisms are the most commonly employed by firms to sources the finance for small businesses, especially in the start-up phase when businesses are the riskiest. Nanka-Bruce (2009) finds that bank loans and professional venture capital are very difficult to access in the start-up phase leading to financing through bootstrapping, angel investments and public venture capital.
2.6 Summary:

The purpose of this study was to address different types of financing sources that are available for high-tech start-up firms. This chapter provides an overview of the general entrepreneurial issues before discussing the different finance options. The main findings from this chapter can be summarized in the following 3 points:

1. Most of the innovation and new technology introduction has been done by start-ups in the areas of Photonics. So, it is essential to learn about entrepreneurship and different aspects of it.

2. Financial resource is one of the most important resources for the start-ups and so it is very important to learn how to source and manage this resource which could be a make or break event for the start-up.

3. Different financing options have its own characteristics with both the good side and the bad side. For a high tech semiconductor ( photonics) start-up, the ultimate choice of funding provider is the private equity based venture capitalists (VCs). The VCs bring good management expertise along with the capital which could be an additional benefit for the ventures.
Chapter 3

Research Methodology

"All research is a practical activity requiring the exercise of judgment in context; it is not a matter of simply following methodological rules”

(Martyn Hammersley, Expert in Social Research)

3.1 Introduction:

After a detailed theoretical study about entrepreneurship and the different sources for financing a high tech start-up in the previous chapter, this chapter deals with the research methodology and has two main aims. Firstly to identify a suitable financing source for a high tech start-up originating from a semiconductor research institute and secondly to examine how well the private equity based funding, mainly the venture capitalist funding scheme, fits such a photonics start-up. To find out the answer, the primary research is done by a qualitative research method where a total of nine interviews were conducted with entrepreneurs, CEOs and CTOs who have spun-off high tech start-ups. Also an interview was conducted with the director of a well-known corporate finance firm who provides advice to the private equity investors to identify attractive investment opportunities.
3.2 Research Context:

Tyndall National Institute which is a part of University College Cork (UCC) is one of Europe’s leading research centres in Information and Communications Technology (ICT) research and development, and the largest facility of its type in the island of Ireland. Besides doing the basic and applied ground breaking research in the area of ICT, the goal of the institute is to create new start-up companies which is recognised as a key contributor to economic growth and development in this region. To meet this goal, the researchers need to realize the commercial potential of their research output and at the same time need to learn some of the specialized marketing and product development skills. Tyndall National Institute (TNI) has successfully spun-out a number of high potential start-up companies and licensed its technology to other external start-ups. The Tyndall Institute supports new start-up companies and offers on site facilities for entrepreneurs and researchers creating a start-up that utilises Tyndall technology or services. The overall context of the research is to develop a strategy to build a successful business from years of high quality research work and to exploit the knowledge through entrepreneurial activities.

3.3. Research Methods:

Before undertaking any research study, the researcher has an option to choose a suitable research methodology among a number of available scientific research methodologies. This approach would depend upon the subject matter of the research and also on the ability of the researcher to clearly identify which approach is the most appropriate method of enquiry.
Considering the advantage and disadvantage as well as the strength and limitation of each approach and the applicability of the particular method to answer the research questions, the researcher should adopt a method that clearly provides the answer. As mentioned by Silverman (2013), the methods cannot be always 'right' or 'wrong', only more or less appropriate and rational assessment of alternatives (Silverman, 2013: 6). Saunders et al. (2009) point out that 'method' refers to techniques and procedures used to obtain and analyse data and so includes questionnaires, observations and interviews for both quantitative (statistics) and qualitative analysis (non-statistics) techniques (2009: 414). The main characteristics and the suitability of these two research methods, the qualitative research method (QUAL) and the quantitative research method (QUAN) are discussed below.

### 3.3.1 Qualitative Method:

Kumar (2005) outlines that the research is classified as qualitative when the purpose of the study is mainly to describe a situation, event or problem and the information is gathered through the use of variables measured on a nominal or ordinary scale (Kumar, 2005: 12). So, this research method focuses upon behaviours, interactions, feelings to uncover the meaning embedded into the theme. In qualitative research, it is needed to go through the process of identifying the themes and describing the findings during the interview and observations rather than subjecting the data to statistical procedures. The qualitative method is particularly suited for studying a substantive area where most of the things are not exposed to describe the phenomena in detail and to explore the effects which are difficult to study by other research methods. The qualitative research method is used to
understand the processes, as why people make a specific type of decision. To derive the information, the qualitative research needs to be open-minded, curious and be attentive while listening the stories told by different people. The use of interviews will help the researcher to gather valid and reliable data that are relevant to the research questions and objectives. For this reason it is important to gather clear questions on the topic and to probe to ensure that the required information is extracted from the views and the experiences of the different interviewees.

Qualitative research allows the researcher to identify the issues from the perspective of the study and to understand the meaning. In the present study, the qualitative research was adapted to answer the question why a particular type of financing option is preferred by the entrepreneurs for funding high-tech start-ups. This research method also helps to understand the experience of introducing a private equity funding in the start-up.

3.3.2 Quantitative Method:

The Quantitative research method as the name implies, is a technique associated with gathering, analysing, interpreting and presenting the research finding through numerical information. In the quantitative research method, it uses numbers to try to understand the social behaviour. Hennink et al. (2011) states that the purpose of quantitative research is to quantify a research outcome and to measure and count the issues and generalise these findings to a broader population which is then extrapolated to the general population (Hennink et al., 2011: 16-17). In this research method, the researcher asks specific, narrow set of questions, collects quantifiable data from usually a large number of participants; analyses these numbers using
statistics; and conducts the inquiry in an unbiased, objective manner. The quantitative method is also classified as a structured method where everything that forms the research process is predetermined. The main purpose of this investigation is to quantify the event of variation in a particular situation of phenomenon. This can range from a simple count as the frequency or occurrences to more complex statistical modelling and data analysis. With the advance in computer based counting and sorting techniques along with the ability to reach a large number of populations around the globe through the internet, the quantitative research method is gaining popularity and the application of this research method is seen in many areas of science and technology.

3.3.3 Mixed Methods:

In the case of many in-depth investigations, the inconsistent patterns of data obtained by both qualitative and quantitative patterns separately may not match the overall average patterns of the results. So, a mixed research methodology appears as an alternative to the qualitative and quantitates method by providing the use of whatever methodological tools are required to answer the research question. So, as the name indicates, a mixed research method is designed for collecting, analysing, and “mixing” both quantitative and qualitative data and the method is a single study to understand a research problem rather than considering one methodology being intrinsically superior to the other. In the mixed method research, the information can be presented both in narrative and numerical formats. To utilize this design effectively, the researcher must have to understand both quantitative and qualitative research. As it is mentioned in the sage publication website
"Designing research studies is a challenging process in both quantitative and qualitative research. This process can become even more of a challenge when the researcher has decided to use a mixed methods approach due to the inherent complexity in mixed methods designs”

(Retrieved from www.sage.com)

3.4 Chosen Research Approach:

This research is using qualitative analysis to find answers to the research questions. Suitable approaches for qualitative research are the approaches which enable the collection of different opinions on research question through different interviews, participant observations or the analysis of the documents etc. Qualitative research is used to explore the options, motivations and underlying reasons. In qualitative research, it is possible to uncover a trend in a particular sector and to dig deeper into the problem and understand a phenomenon from a closer perspective using a limited number of samples. It can also bring out new aspects or findings. As Hamscher et al. (1995) the finds the use of qualitative research techniques in the areas of business, finance and economics. According to Hamscher et al. (1995) qualitative approach matches well with the simplifying decision rules and information format which filters and reformats the information presented to the decision makers, works like a screening tool that will substantially reduce the effort in complicated decision making processes (Hamscher et al., 1995: 102). So, this present research is designed using qualitative analysis to find out the answers to the research questions regarding the financial matters for a high-tech photonic start-up.
3.4.1 Semi-structured Interviews:

Semi-structured interviews are often used to collect qualitative data. A semi-structured interview is a verbal interview, where the interviewer has a predetermined structure. Rather than a rigorous set of questions for a well-structured interview, the semi-structured interview is often preceded by observation, informal and unstructured interviewing in order to allow the researchers to develop a keen understanding of the topic of interest necessary to developing relevant and meaningful semi-structured questions.

Longhurst (2009) describes the in-depth, semi-structured interview as a stand-alone method that can be used in conjunction with another method or several other methods (which is sometimes referred to ‘triangulation’) where the researcher needs to prepare questions, select the interviewees, contact potential participants, choose a location, carry out the interviews, and transcribe the data, all the while being cognizant of the ethical issues and power relations involved in the research work (Longhurst, 2009: 584).

In this research a semi structured in-depth interview method was adopted considering the complexity and the amplitude of the subject. The in-depth interview which can be considered as a conversation with a purpose was standardized and tailored for the study with strict questions directed to different interviewees. Key people for the interviews were identified as people having positions with the ability to influence the choice of financial resources, such as the founder of the company, the CEO or the CTO. The interviews were primarily used to seek the stories, opinions and experiences of the different parties: the entrepreneurs and the investors. The discussion in the answers is not limited, allowing the interviewee the freedom to openly express his or her opinion. The main goal was to keep the discussion on the research topic with the informal setting to achieve successful outcomes. The
main research questions were broken down step by step into more manageable questions to put forward in interviews. The stepwise breaking down of the research questions are associated with the type of information needed and process of deciding which questions to articulate. Among the questions, there was an introductory question about the business and this led into the key questions; the interview finished with a concluding question asking the view of the interviewee about that particular research topic. The semi-structured interviews were conducted with a number of high tech start-ups including 3 prominent start-ups from the Tyndall National Institute. These three start-ups are at 3 different states. The first one is just couple of months old, whereas the 2\textsuperscript{nd} one is about 5 years old, and the 3\textsuperscript{rd} one is about 10 years old and has generated venture capital funding on a couple of occasions. Recently, the 3\textsuperscript{rd} company has been successfully sold off to a reputed foreign owner and has extended its operating range across the whole world. Besides the Tyndall spin offs, a few other CEOs, CTOs and entrepreneurs known through personal connections were also interviewed. Initially they were asked politely for their opinion about the financing issues for their start-ups. Almost all of them immediately asked to see the questions and preferred to take time to answer the questions in written format to choose the words in the way they would measure the financing issues for a business. The analysis and the findings are based on the collected data from different interviews and are presented in chapter five.

Besides interviewing the entrepreneurs, it is also important to interview the investors as they are the ones who actually know what is going on in today's start-ups. Investors know more about start-up financing than most paid advisors as they have to go through a significant number of companies a year. By interviewing the investors it would be possible to understand their perceptions, attitudes and reasoning behind the investment decisions in their organisation. It would be particularly useful for determining
the opinions and attitudes of private equity investors and also understanding how their sense of social reality, and discovering the reasons for these opinions. Unfortunately, it was not possible to reach any of the VCs or the Angel Investors, but the director a corporate finance firm (who advises the equity providers and links them up with the entrepreneurs) was kind enough to answer a few questions regarding high-tech start-up financing after repeated requests.

3.5 Research Ethics:

This research involves a great deal of cooperation and coordination between the entrepreneurs and the finance providers of the business. So it is important to obey the ethical norm of the research to promote the values that are essential to collaborative work, such as trust, accountability, mutual respect, and also fairness among the parties. For a high technology based business other ethical norms as protecting the intellectual property interests while encouraging the collaborations, data sharing among the different bodies, non-disclosure agreements between the parties also need to be considered at the highest level. The funding providers especially the private equity providers may often work with other competing technologies and so the entrepreneurs are concerned that their ideas could not end up somewhere else due to accidental expose. The finance provider for the business whether it is the bank (although the bank would certainly ask for a security) or venture capitalist or the angel investors who works on good faith are more likely to fund the business if they can trust not only the ability but also the quality and the integrity of the entrepreneurs. So, both parties need to respect each other’s confidentiality and privacy requirements.
3.6 Limitations of the Study:

Financial matters are not only the most important but also the most sensitive matters for any business. As a result the organisations are interested to keep the financial details only to themselves and are very reluctant to disclose financial information. A business organisation expects that its data are well protected and not to be used in an inconsistent manner. The protection of financial status and financial sources is paramount for the business whether it is at a start-up stage, growth stage or even in a fully grown stage. Also the private equity providers do not want to be held liable for revealing information normally not available to the general public.

Initially a number of entrepreneurs and CEOs and CTOs were approached for the interview but only a few (nine in total) of them were agreed to conduct the interview. Certainly, people in the financial world have very limited time to spare!

3.7 Summary:

Chapter 3 discuss and describes the research design that was considered to be appropriate to address the research questions. This chapter also discuss the validity of selecting the proper questions for the interview process as a part of the particular research method. Also discusses about the ethical issues as well as the limitation of the research in the sensitive areas of finance. The following chapter includes the data from all the sources that was obtained for the research work.
Chapter 4

Research Findings

"85% of your financial success is due to your personality and ability to communicate, negotiate and lead. Shockingly, only 15% is due to technical knowledge”

(Keld Jensen, Expert on Negotiation and Leadership)

4.1 Introduction:

This chapter presents the main findings of the data collected through general discussion and in-depth interviews which were conducted as part of this study. The findings include the direct quotations from nine different interviewees in support of their opinions and observations, who contributed to the study. As most of the interviewees preferred to remain anonymous (except the CEO of NDevices, an electronics assembly start-up), no names were mentioned with the quotations. But the positions they hold in the organisation (CEO, CTO, COO) are mentioned alongside their quotations. After seeing what kind of an approach works best for funding a high-tech a start-up organisation from the entrepreneur’s point of view, it was clear to the author that in-depth interviews were the perfect approach for tackling this research problem. The findings from this study give valuable insight in
the financing issues for a "high tech start-up" originating from a research and development environment. These findings have also been related to the detailed theoretical study done in chapter 2.

4.2 Main Findings:

The following sections provide the different quotations collected from all the interviewees as a response to the different questions.

4.2.1 Recognizing the Business Opportunity:

The identification of the business opportunity is the first step towards starting any business. People with creative personalities and willing to take risk are more likely than others to identify entrepreneurial opportunities or to be entrepreneurs. The Entrepreneur's family background, personal characteristics as interests and hobbies and working environment also help to find the right business opportunities. This was highlighted by an interviewee:

*The business opportunity was spotted while developing the technology in the mother institute before spinning out. This happened through advertising general properties of the technology to the different end-users and subsequent engagement with potential customer.*

(Co-founder, Irish Tech Start-up)

Another interviewee who has a successful start-up which is a part of a large multinational company now, was encouraged to see the demand for
what he was developing during his Ph. D research. He was also introduced to the value and intellectual challenge of working in industry which gave him the inspiration to start his own company. This entrepreneur describes:

*The business opportunity first really presented itself when I was contacted by some industry partner looking to source some of the devices that I was working on. At the time this was very encouraging and it was certainly an important feature in helping to prepare a credible business plan. This initial industrial interest provided the motivation to look at other potential and perhaps less risky applications and markets as well as start the process of figuring out how a start-up company could deliver a product.*

(Founder, An Irish Tech Start-up)

Another entrepreneur spotted the commercial opportunity while working in the area of research and development. He realised that this research could cater to a niche market if he could control the economy of scale. According to this entrepreneur

*I was doing research on something very interesting where I saw that there could be a commercial opportunity to serve a niche market. For possible applications, I team up with another research group to target high volumes and to take the control of the economy of scale. The combination was attractive enough to award this team a few national and European grants. So we have good chances of soft money during the difficult start-up years and we have the possibility to grow into a mass market.*

(Entrepreneur of a High Tech Start-up in SWEDEN)

Another entrepreneur also recognised business potential while perusing his post-doctoral research.

*The technology was new and was developed during my Ph.D. which we found to have a good market demand. The scalability of the product and the easy access for the newcomers make it suitable for business opportunity.*

(CTO of Cloud based Software Start-up)
Similarly, another entrepreneur who is an engineer by profession spotted the business opportunity when he was asked by colleagues to make some custom electronics for them. This encouraged him to pursue it further. As he mentions:

*When I was asked by a colleague of mine to make some custom electronics for his project, I had an opportunity to look for best use of my skills and expertise. At the same time, I saw some technical opportunities for new electronic devices looking through different websites.*

(CEO of an Electronic Devices Start-up)

Another Engineer who had a good number of years of experience in a particular engineering field noticed that there is no uniform level of services to different sized industries. He points out:

*I had worked on a similar project before and I had garnered some experience and expertise in the area where my present venture operates. I found that most corporates are busy in serving the bigger customers and nobody was serving the smaller but growing industries. I noticed that incident and immediately realized the potential for a business to service the small players.*

(Co-founder of a Big Data Analytic Start-up)

According to another entrepreneur, the business opportunity came from his hobby.

*I saw a product opportunity within the area of my personal interest which I am conducting for more than 10 years. I recognized that there was an appetite for a particular device in that area which encouraged me to talk with the other people with the same hobby. I spent 6 months researching the market, travelling to trade shows and speaking to particular equipment manufacturers and formed the belief that there was market opportunity in that particular field around the globe which gave me the believe to have a start-up to serve that niche market.*

(Entrepreneur of a High-Tech Start-up)
Another Entrepreneur, who is now the CEO of a well-established high tech automation company based in Cork, which is a branch of a multinational, was advised to look for opportunities outside the workplace and to pursue a new challenge. As this person mentions:

*I had left a start-up of 6 years and was looking for a new start up role in Operations. I was working with the Irish Development Authority (IDA) clients showing them Cork ICT (Information and Communication Technologies) companies and I was offered to setup a European base for the present company in 1997.*

(CEO of a Local Brunch of a High Tech Automation Company)

4.2.2 Influencing Factors for Sourcing Finance:

This section links up the entrepreneurship with financing options. As expected, there are a number of factors that affect the entrepreneur’s choice of finance in both formal and informal ways. Also, for ‘high-tech start-ups’ these influencing factors differ significantly from those of start-ups in other business sectors. For any start-up, there are no on-going operations or track record making is difficult for finance providers to examine the situation and as a result their financing options may be very limited. This is observed by one interviewee. As he mentions:

*You will probably not have the option to pick and choose a finance provider in the seed stage for a start-up; most probably you have to go with what is available.*

(Co-founder, Tech Start-up)

According to another high-tech founder, the influence of the financing choice is a very complex issue and highly dependent upon the precise nature of the opportunity. As he describes
A software based start-up will have a different financing requirement compared to a hardware based product which may need several rounds of significant funding just to get it to a viable engineering stage. Whereas complex processes developed on generic capital intensive equipment may be better exploited through licensing and hence the financial requirements may be relatively modest and so the factors would be different.

(Founder, An Irish Tech Start-up)

On the other hand, another interview stated the “value proposition” of the business as the main factor for influencing the financial option for a high tech start-up. He feels that

Cost of R&D, product development and risks associated with it, profit margin from factory to retailer, management team and also the key people in the organization all these are variables for factors affecting financing choice.

(Entrepreneur of a High-Tech Start-up)

These words were almost repeated by an entrepreneur who had a start-up while doing his post-doctoral research. As he expressed

Main factors that influence the financing options are production cost, pricing, patents and competing technology that is currently available in the market.

(CTO of Cloud based Start-up, Providing Service to Livestock)

On the other hand, the CEO of an electronic devices start-up leaves these influential factors more up to the entrepreneur himself. As he mentions

Personal resources, personal connections to potential customers and availability of the crowdfunding opportunities are the main factors affecting the financial choice.

(CEO of an Electronic Devices Start-up)
A similar opinion was expressed by another entrepreneur who brought up his start-up from his research work. This entrepreneur relates the financing options onto the passion of the founder, the team formation and on the market demand. As he expresses:

*The market forces will dominate and the team must have to follow that. It is important that the team shows this agility and is prepared to switch focus to products the market wants. Once established you can sneak in new products.*

(Entrepreneur of a High Tech Start-up in Sweden)

This was supported by another entrepreneur. As that person states:

*Technology, market analysis, well defined customer needs and strong business plan are the main factors that affect the financial option of a start-up specially working in a high tech area.*

(CEO of a Local Branch of a High Tech Automation Company)

In relation to the financing options, another entrepreneur expresses a similar opinion:

*Valuation and term sheet are the main factors for the financing choice*

(Co-founder of a Big Data Analytic Start-up)

When someone from the investor side was asked about the factors affecting the financial options, that person left it in the hands of the management team to determine it. That person from an independent corporate finance firm mentions:

*I think the track record of the management team would play an important role in selecting the right financing choice. Also evidence of early revenue with the customer reference and preferably the recurrence of the revenue are important. Also the underlying technology sector would determine the right financing option.*

(Director of a Corporate Finance Firm in Ireland)
4.2.3 Barriers for Funding and Role of Government:

For survival, a high tech start-up would need a strong market demand, a sound business plan and an enthusiastic and efficient team to look after all the sides of the business including the most important matter of sourcing and managing financial resources from the very start. Usually this is a very difficult job as the entrepreneur finds a number of barriers while searching for financing his start-up. This section deals with the barriers that exist for a start-up to raise the capital and also highlight the needs for Government support for the business.

In addition to this general barrier between the financiers and the entrepreneurs, some barriers exist that are specific to combinations of entrepreneurial type and financier. This may be due to the valuation of high-tech firms in Ireland. As it emerged from the comments of one of the interviewees:

*The reduced number of funding options in Ireland means that the company valuation is expected to be lower than the US where there is greater competition amongst seed investors and the VCs.*

(Co-founder, Irish Tech Start-up)

About the support from the Government, this interviewee mentions the indirect support that the Government can provide in terms of setting up the right environment for VC investments:

*I know a few VCs came to Ireland and set-up their operation. So certainly Government is proving some support to them in terms of tax incentives or equity enhancement etc.*

(Co-founder, Irish Tech Start-up)
Similar opinion was also expressed by the CEO of a local branch of a large multination automation company about the limited number of finance providers in Ireland.

*Only a small number of financial institutes are willing to offer finance to high-tech start-ups*

(CEO of a Local Branch of a High Tech Automation Company)

Another entrepreneur is less concerned about this limitation, although he accepts there are a few hurdles to overcome. He focuses on ways to cross the barrier. He thinks:

*Government support is not must, but would certainly help to overcome the barrier. A good business plan and value proposition is the key to jump over the hurdles.*

(Entrepreneur of a High-Tech Start-up)

Similarly the entrepreneur in Sweden who founded his start-up while working as a professor in a University, does not talk about barriers, he talks more about the Government support to overcome the difficulties of managing finance. According to him, Government has a big part to play, to provide, manage and control the funding. As he prescribes:

*Government funding is always linked to some type of project, but the fund should be provided to develop the market and to develop the skills of the team to adapt to the market which is much more important. Government to establish incubator tiers where the start-up enter into the lowest tier and coach helps to analyse the market, to overcome the weaknesses in the team, to improve the technology that needs to develop, and to formulate milestones that need to be reached. The venture moves up in the tiers and at each level there is more money available to develop the business.*

(Entrepreneur of a high Tech Start-up in SWEDEN)
Another entrepreneur leaves the hurdles to the entrepreneur himself and his ability to fit himself in a team to develop and execute a plausible business plan with a genuine profit potential. What he thinks about raising funding for University based technology start-up is

There is a need for a technologist who is utterly committed to the project and who has the missionary zeal to get the project off the ground and to carry over. Government support is part of the mix, but without the drive and vision of the founder then nothing is going to happen.

(Founder, An Irish Tech Start-up)

The CEO of "Ndevices", an electronics start-up, pointed out a few things about the existing barriers and the potential ways to overcome these. He thinks

It is hard to get hold of the equipment and facilities needed for a start-up and the private investors and banks only look at nearly finished product. I think the Government support is highly desirable, but should be through an open, clear and transparent completion.

(CEO, Ndevices)

The entrepreneur with the big data company talks about the lack of strategy and poor financial planning as the main barriers for start-up financing. He particularly talks about the need to have proper exit strategy from the entrepreneur as the barrier for private equity funding. As he comments

High initial investment with no profit for at least one year along with expected high internal rate of return are the main financial barriers for funding high tech-start-ups. Government support is a great help specially in the early days.

(Co-founder of a Big Data Analytic Start-up)
Another entrepreneur also considers the strategic planning and lack of Government support as the main barriers for financing the start-up. As he describes

*Exclusive and long-term strategic partnerships are needed along with government or institutional supports in terms of incubation centre.*

(CTO of Cloud Based Start-up, Providing Service to Livestock)

When the director of a corporate finance firm was interviewed, he pointed out a few things about the existing barriers for financing a start-up firm in the high technology sector. He describes

*Quite often the entrepreneurs in the technology sector have unrealistic valuation exceptions. Also there are a large number of early stage companies with small number of investment funds and many firms are with too limited commercial traction before funding.*

(Director of a Corporate Finance Firm in Ireland)

About the Government support, the director of the corporate finance firm was very positive. As he expresses

*I think it as not a must have item but rather nice to have an item. I also think Irish Government plays a good support role through Enterprise Ireland on the Irish tech funding scene.*

(Director of a Corporate Finance Firm in Ireland)

### 4.2.4 Do Patents Attract Finance?

For a high tech start-up, the technology which is usually the result of a few years of intense research and development (R & D) work is the most important asset. This technology which works behind the offered product
sets apart the organization from the crowd and allows the venture to offer something unique to the customers. It is possible for the new venture to create a new market and even a new customer base. So it is important to protect the technology by patenting it and patents fulfil a fundamental role, allowing innovators to profit from their inventions. The patent situation in the firm may influence the entrepreneurial finance as the investors are usually interested in the firm's patent portfolio.

In relation to this patent issue, the CEO of a high tech start-up, who managed to sell his business to a large multinational, thinks that the patents are very important and emphasized the patent situation:

*Without a doubt, a strong patent portfolio is exceedingly valuable provided of course there is commercial merit to the technology. If I was looking at a financing opportunity, I would certainly like to see good, defensible patents in addition to an analysis of the patent landscape including patents of competing technologies.*

(Founder, An Irish Tech Start-up)

Another entrepreneur also agrees on the importance of having a good patent portfolio for the start-up. But he was a bit cautious about it.

*Yes, patents are important, but these should be seen only to provide basic idea protection. Initial stage patents can be done cheaply and give protection for even vague ideas, but for the later stage, it becomes expensive.*

(Entrepreneur of a High-Tech Start-up)

The CEO of the cloud based software service provider and the co-founder of a big data analytic also points to the importance of having a good patent portfolio. The co-founder believes that the patent situation helps in positively for obtaining finance. He thinks the patents act as a defence shield for the vulnerable investors.
Patents acts as collateral and provides the nervous investors some confidence about their investment.

(Co-founder of a Big Data Analytic Start-up)

Another interviewee believes that the patent situation not only attracts the investors but also provides some additional advantages. He explains:

The patent portfolio brings a mix of positive attributes, enhances the level of technology development in the organization and gives some bargaining power for asking for finance. It enhances the level of technology development and expertise at the management level.

(Co-founder, Irish Tech Start-up)

Similarly, the founder of a high tech semiconductor start-up from Sweden also emphasizes the need for a patent portfolio for a number of reasons apart from attracting investors. Patents give the start-up freedom to work on its own technology and if the venture can grow to serve the mass market, its effectiveness becomes even bigger. He puts a word of caution in his statement though:

A good intelligent property (IP) strategy is really important so you can operate well and not bankrupt the company. You need to know the IP market as well as the financial market so you can make the correct decisions. Doing a freedom to operate (FTO) investigation is as important as filing patents. This should be done early and it may turn out that you decide not to move forward with your business. An investor will look at your FTO and your patents to make sure you will be able to operate in a good way. It is also important to find a good patent attorney.

(Entrepreneur of a High Tech Start-up in SWEDEN)

The CEO of a local branch of a large multinational automation company was cautious about expressing the opinion on the patent issue. This person comments:
IP protection is important but if you do not have the cash flow to defend the patent then protection is pointless. Venture capitalists like their assets protected so it may be a deal breaker in VC.

(CEO of a Local Branch of a Multinational Automation Company)

On the contrary, the CEO of the electronic start-up had a completely different view about the value of patents. He does not think that patents are important for financing now-a-days. About patenting the technology he comments:

It is practically prohibitively expensive for start-ups. Patent system became overcomplicated, slow and inefficient.

(CEO, Ndevices)

The director of a corporate finance firm was not so certain about patents being an important element in attracting funding. He thinks that the importance of the patent depends on the sector. As he mentions

Patents are more important for medical technology and certain hardwire segments. Also the intellectual property needs to be balanced with the commercial traction as it would be more attractive to have a strong commercial traction and limited IP protection rather than limited IP protection and no commercial traction.

(Director of a Corporate Finance Firm in Ireland)

4.2.5 Ownership Issue with VC Involvement:

Usually the private equity providers, specially the venture capitalists (VC) are interested in the high tech start-ups because of the high growth prospect. These high risk investments might provide a high return. The likelihood of the VCs to get involved in the early stage financing of a high
tech start-up is likely and this may be a good thing for the organization. As an interviewee who co-founded a high tech start-up mentions:

> It is much better to involve the VCs in the development and growth stage of the organization. This is mainly for two reasons as you would have a decent valuation when good cash is brought in to the business and at the same time you would have the opportunity to explore and expand in new horizons.

(Co-founder, Irish Tech Start-up)

The CTO of a high tech start-up thinks the ownership issue to be a very complex one. He points out the importance to both parties; to the Entrepreneur and to the finance provider. The Entrepreneur must keep in mind that if he does not have the resources to put money into the company then inevitably the founders will get diluted if further funding rounds are required. As he mentioned:

> The key issue is that the founders have realistic expectation of what may happen if revenue targets are missed and technology speed bumps slow the process and growth of the company.

(CTO of a High-Tech Start-up).

The entrepreneur of the electronic start-up agrees that the ownership issue becomes critical when external investors are involved. His opinion about this theme is:

> Yes, certainly. The private equity investors feel very vulnerable when dealing with high-tech. It is very hard to judge the technology status for non-specialist. Also, the core value (IP, software, technologies) can easily be taken away and then show-up in another place.

(Co-founder, Irish Tech Start-up)

Another interviewee who realized the business opportunity through his hobby agrees strongly with this.

> Yes. VCs buy shares of ownership in return for investment into the company. The more ownership they can get for their investment, the
happier they are! Too many split ownership of the venture before their investment will make the VCs worried. Generally if this happens, they would offer you the terms and you either accept them or not.

(Founder, Irish Tech Start-up)

On the other hand, the founder of the big data analytic start-up does not see any clash about the control issue when the venture capitalists are involved. As he expresses his opinion in relation to the involvement of the venture capitalist and the ownership issue:

No, not as such – instead it is more about how much they want to control the downside and how much they want to share the upside.

(Co-founder of a Big Data Analytic Start-up)

The Entrepreneur who brought up his business from his University professorship in Sweden agrees that the ownership issue is likely to give rise conflict with the inclusion of private equity in the start-up. But he suggested building a solid and stable relationship between the two parties.

The VC wants to be in control of the board so that they can make essentially any decision they want even with a quarter of the whole ownership. It is therefore important that the relationship is built on trust and that the company’s goals are aligned with the VC’s goals. Financially it will matter if the company is sold at some stage, but after several rounds of investment the company should be worth quite a lot as well.

(Entrepreneur of a High Tech Start-up in SWEDEN)

Another interviewee leaves the ownership issue to the long term planning of the entrepreneur and to his vision. This interviewee suggested to be positive about this ownership issue

50% of 10M is better than 100% of 5M – the company has more experience and mentors available in a VC – who can also share the stress at critical times

(CEO of a Local Branch of a Multinational Automation Company)
When the director of a corporate finance firm was asked about the ownership issue relating to the introduction of private equity investors, he was not very concerned about this. He describes:

*It is worth mentioning that the VCs are professional investors and they are typically very exit-focused and will make decisions based on expected return on investment. Often this covers ownership issues such as a potential sale of a company.*

(Director of a Corporate Finance Firm in Ireland)

**4.2.6 Are the VC backed Firms More Successful?**

There are many reports that VC funded firms are more successful as these firms grow faster, patent more, have higher productivity and are more likely to go public than non-VC-backed ones (Davila *et al.*, 2003; Florin, 2005, and Chemmanur *et al.*, 2011). But there remains a question: is the superior performance of VC-backed firms related to the VC funding received or to value-adding activities from the VC investors? It is also important to keep in mind that the VCs are likely to have picked "likely Winners" when they made their investment decision. So, it is important to understand the impact of the VC backed high tech start-ups to increase the dynamic efficiency of the economic system. At the same time, it is needed to analyse the business environment so that the VC investors can successfully develop and exit entrepreneurial firms, set-up and further developed incentive schemes to enhance this type of investment.

For the success of the VC backed firms, the entrepreneur from Sweden leaves it into the hands of the VC, Entrepreneur and the relationship between them. For the success of the start-up, the entrepreneur has to be
clear on his goal, has to form a team with right skills and combination and to choose the right VC. He suggests

\textit{Find a good VC or several good VCs for the company and build a relationship with them. Get them involved and interested in the company. Get them committed to an investment by setting up attractive milestones for the company. Once these are reached the investment procedure should start. Building a relationship such as this is good because the VC understands that you have a goal and interested in building long term value and moving into new markets and moving up in the value chain gradually. At the same time, making a really good strategy for the company is also good and getting everyone to commit to the strategy is important.}

(Entrepreneur of a High Tech Start-up in SWEDEN)

The entrepreneur of the electronic start-up explains why the VC backed firms are more successful:

a) \textit{The VCs arrived because they thought that the idea was considered to be worth investing by the experienced investors.}

b) \textit{Having significant capital resources obviously increases chances for success.}

(CEO, Ndevices)

The co-founder of the big data analytics start-up sees the positive influence of the VCs on the organization. According to him, the involvement of the VCs into the business means having prospects of growth and sustainability. He states:

\textit{VC backed firms do get some guidance and mentoring which if aligned with the entrepreneur’s interests can be an added catalyst. This way the VC is able to exit and return capital to investors who then decide whether to re-commit capital or not.}

(Founder of a Big Data Analytic Start-up)

The CTO of the cloud based high tech Start-up relates the type of technology on offer with the performance of the VC backed firms. This CTO first distinguishes the technology to be either a continuous or incremental
improvement of the product offering referred as evolutionary or a radical or completely novel offering referred as revolutionary.

In my opinion VC backed firms are more successful than non-VC firms, if the technology to offer is not revolutionary. If the technology to offer is evolutionary than the revolutionary, VC backed firm has high changes of success.

(The CTO of Cloud Based High Tech Start-up)

The CEO of a local branch of a multinational automation company finds the involvement of VC’s in the start-up as a positive sign and thinks that the firm has now more chance to be a successful venture. This person expresses:

VC backed organizations require a strong business plan, makes the company more robust and risks are clearer. The VCs mainly interested to invest in safe bets with large returns, so certainly more chance to be successful.

(CEO of a Local Branch of a Multinational Automation Company)

A few interviewees who had not got VC financing in their start-up yet, but would highly welcome it, have also expected the expectations that VC financing would have a positive influence on the start-up. As one of them states:

I can’t be sure. But to get VC funding you probably need a better business plan and opportunity. Also once a VC is in, you have someone with deep pockets that has a motivation to keep you going: - less chance of failure!

(Co-founder, Irish Tech Start-up)

The director of a corporate finance firm does not think that the introduction of the VCs would automatically bring success to the firm,
although he agrees that it would bring some positive vibe to the venture. As he states:

Success is not a function of the investors rather than the company itself and the management. But VC backed firms may be more successful as they have more access to capital and are typically more proactive in driving the growth.

(The director of a corporate finance firm in Ireland)

4.2.7 How to Attract more VCs in High Tech Start-ups?

It has been reported that in recent days, there has been a lagging of VCs in semiconductor industry which is mainly due to the severe losses of investors in the “dot-com bubbles” in late nineties. The VC can be considered as an industry which evolves over time while also co-evolving with the technology sector. It is needed to focus on the dynamic processes that enabled the VC industry and high-tech cluster development. Most of the VC development and policy literature emphasizes capital market structure and regulation and the limited partnership (LP) structure and contracts as the main factors in enabling VC development. The entrepreneur of the electronic start-up stressed the importance of eco system around the VC industry. As he mentions:

I think presence of human resources and high-tech infrastructure (strong universities, measurement labs, printed circuit board (PCB) manufacturing /soldering) are needed along with the VC industry.

(CEO, Ndevices)

Whereas another interviewee proposed to concentrate more on what is present at this moment. As he states:
The private equity investors will most probably follow the returns. So a few successful ones and they will be all in!

(Co-founder, Irish Tech Start-up)

The comments from another interviewee, who is working as a CTO in a cloud based start-up highlights the need for a start-up eco system for attracting more VCs in the area of high tech start-ups. He prescribes:

*High-tech start-ups require a platform or incubator centre to attract VCs. Incubator centre must be supported by government agencies. Government agencies can act a bridge between the high tech start-ups and VCs. In this regards in Ireland, Enterprise Ireland can play a vital role for attracting VCs.*

(The CTO of Cloud Based High Tech Start-up)

A similar opinion about attracting more VCs in the area of high-tech start-ups was also expressed by the founder of a big data analytic start-up. He mentions that to attract more VC we need to:

*Create an eco-system for VCs, providing good tax incentives and reducing restrictions on individuals investing in early-stage ventures.*

(Founder of a Big Data Analytic Start-up)

The CTO of another high tech start up leaves the job of attracting more VCs into the High tech start-ups onto the hands of a dedicated team. This interviewee with a technical background emphasizes particularly on the need for people with good business knowledge in the team.

*VCs will only invest if they see the potential for a large up-side; they don’t invest for technology’s sake. Hence VCs are only going to be attracted by commercially interesting opportunities undertaken by a passionate and balanced team. It is a cliché but the reality is success breeds success and hence the best method of attracting VC’s is to achieve a stellar success.*

(Founder of a High Tech Start-up)
The interviewee, who brought up his start-up from his hobby, also expressed a similar opinion about attracting the VCs into the high tech start-up sector. Besides the business minded people, this interviewee also points out the need for cutting edge, really needed technological solutions to solve the current day problems, and then he expects that there would be no shortage of investments.

*It is not a question of how to attract more VCs in high tech start-ups. VC's are there and constantly look for the entrepreneurs with profitable business ideas. Entrepreneurs are also there in abundance. What are hard to come by are good high tech ideas and good entrepreneurs. Without the profitable high tech business ideas VCs are likely to invest in other areas or investment opportunities (property, funds, non-high tech businesses).*

(Founder of a High-Tech Start-up)

The Entrepreneur of the high-tech start up in Sweden suggested to get an incubation system for the high-tech start-up and also suggests to involve Government at every stage of the start-up

*I think the government need to shoulder a role here. They can release money to VCs targeted for high tech start-ups. Get VCs as well as government money involved in the incubators. Today the incubators normally have good relationships with VCs but it is not enough. If you have tiers in the incubator a VC can directly see if your company is ready for an investment in their fund or not. The goals for the company are also clearer and a relationship with the VC can be built quicker where milestones are made at an early stage.*

(Founder of a High Tech Start-up in Sweden)

The CEO of the local branch of the multinational automation company suggests that the entrepreneurs of high potential high tech start-ups should keep a good relationship with the VC networks. As she states

*Having feasibility and Research done by capable innovative people who has capability to identify and build knowledge intensive companies*
based on promising technology and on successful business plans. I also think it is important to be at the right place at the right time with a solid researched business plan and use the business network for advice. Lots of Mentors and support. Do not be afraid to ask – be brave.

(The CEO of a Local Branch of a Multinational Automation Company)

For attracting more VC investment in the area of high-tech start-ups, the director of a corporate finance firm has the following to says

i. VCs are attracted to good companies, companies with sound business plan and good execution of that plan. Good companies will attract VC even from outside of Ireland.

ii. Needs to put greater emphasis on university spin-outs.

iii. Encourage investment in business generally, rather than investment in assets (i.e. property).

(The Director of a Corporate Finance Firm)

4.2.8 Other Financing Options besides Private Equity Funding:

The co-existence of alternative sources of finance for a high tech start-up is evaluated in this section. Financial capital is one of the necessary resources required for enterprises to form and to operate successfully. Financial decisions and the selection of the right type of finance at start-up have been shown to have important implications for the operations of the business, risk of failure, firm performance, and the potential of the business to expand. Most of the high tech semiconductor start-ups are financed by Venture Capitalists and Angel investors mainly because of their high initial costs. Also the private equity investors are attracted by the high growth prospect of the
high tech company. But the failing of the dot com bubble has made the investors much more selective and has forced the entrepreneurs to look also at other options.

The entrepreneur of the electronic start-up who actually funded his company by crowd funding thinks that the crowd funding is one of the alternative funding options alongside the private equity investors. As he mentions:

*I think crowdfunding is an obvious answer of these days. Websites like kickstarter, indigogo helped to launch my business.*

(CEO, Ndevices)

The entrepreneur who developed his business from his hobby was more philosophical about the different funding options. He thinks that the funding option depends on the total investment required to make the business self-sustainable. As he expresses:

*I would say anything greater than 500k is likely going to be VC. Anything less, you can approach banks, credit unions, the government, business angels, private individuals, regional enterprise associations. Government is always looking for business ideas that are create export revenue and generate employment, so ask the Government as well.*

(Founder, Irish Tech Start-up)

The option of crowd funding came up with a few other options from the co-founder of a high tech start-up.

*Crowd funding: Mostly for smaller value opportunities although it has been some big ones.*

*Bank: Certainly not in Ireland, although BOI has got a start-up financing option. Certainly in some countries as US (the Silicon Valley Bank), Germany.*
Trade credit: I think this is a last resort as it is expensive.

Customer PO: Best sort of financing (but brings its own headaches in terms of deliverables and expectations).

(Co-founder, Irish Tech Start-up)

The CTO of the cloud based high tech start-up who is providing a livestock service also mentions crowd funding. Besides the financing supports, he mentions other supports which would complement to the financial supports. As he states:

Government funding, crowd funding such as kick starter funding, creation of business incubator centres is essential for high-tech start-ups.

(CTO of Cloud based Start-up Providing Service to Livestock)

The founder of the big data analytic start-up also comes up with the solution of crowd funding for high -tech start-ups. According to him, the alternative sources are

Crowd funding, business Angels, Govt. Coupons

(Founder of the Big Data Analytic Start-up)

Crowd funding also came from the entrepreneur who developed his business from his professorship. He also advices to be creative to bring funding into the business

Get the customer interested in your technology and form a relationship with this customer from the very start. Be careful about not to be locked on with only one customer though, a regular investment may work but make sure you can sell to others as well.

(Entrepreneur of a High Tech Start-up in SWEDEN)
The CEO of the local branch of a large multinational automation company also mentions the option of engaging the customers for funding a section of the business.

*Get the customers and business partners to finance your business as much as you can.*

(CEO of a Local Branch of a Large Multinational)

Another interviewee who has a very successful high-tech start-up leaves the alternative financing sources to the specifics of the opportunity. The recommendation for the entrepreneurs from the CTO was to investigate the possibility of boot-strapping a company if at all possible.

*What I would recommend is that entrepreneurs investigate, i.e. is there an opportunity to generate revenue while the principle product is under development. What needs to be avoided is prematurely raising money; the closer the founders can get their product to the market prior to raising significant funds the better; ideally they should be raising money when the project is almost a dead certainty, i.e. customers are desperate to place PO's; there is an undeniable market pull for the product.*

(Founder of a High-Tech Start-up)

Whereas the director of a corporate finance firm mention about the following alternating financing options for high tech start-ups.

i. Corporate partners (through equity investment, investment-in-kind, or pre-funding early sales).

ii. Funding through sales.

iii. State support mechanism.

(The Director of a Corporate Finance Firm)
4.3 Summary:

The above section describes the insights and remarks received from different interviewees as part of the study. All the interviewees are involved in a business start-up in the areas of high technology but in different sectors. Also, they are from different backgrounds and have different levels of experience and most have them have very high educational qualifications. The interviewees were encouraged to talk comprehensively about their journey towards the start-up and also raising any other topics which they wished to. They key findings from these interviews and the discussion about the different themes about financing and conclusions are presented in the next chapter.
Main Findings, Recommendations and Conclusion

"Smart tech investors think about future product roadmap, market size and market growth rate and talent and skill of the team. Essentially you are valuing things that have not yet happened, and the likelihood of the CEO and team being able to make them happen. Finance people find this appalling, but investors who do this well are likely to be successful”

(Marc Andreessen, an Entrepreneur, Investor and Engineer)

5.1 Introduction:

This chapter contains the conclusion part of the current research where the objective of the research was to evaluate the Venture Capital (VC) funding option for a high-tech semiconductor start-up. It contains the discussion of the main research findings and summarizes the key results in table format. Recommendations for sourcing suitable funding at the appropriate time for the high-tech start-ups have also been made. Finally, the future areas of research in terms of VC funding in high-tech start-up are also prescribed in this chapter.
5.2 Main Findings:

The following sections provide the discussions generated from the interviews with the entrepreneurs, CEOs and CTOs.

5.2.1 Recognizing the Business Opportunity:

An entrepreneur's creative and open mind-set looks for opportunities, identifies problems and comes up with potential solutions. The entrepreneur brings an idea to an actual venture with the recognition of the opportunity; going through the entrepreneurial process. As part of the process, the entrepreneur needs to gather all his/her resources including the financial resources. In the world of high tech start-ups, the entrepreneur needs to raise the necessary funding to turn the vision outlined into the reality.

In the case of a high tech start-up the 'opportunity' may emerge as an imprecisely defined market needs, or from the inventions for which no market has yet been defined, or ideas for products and services. It is realised that the entrepreneur's family background, level of education, even his interests and hobbies play a critical role in identifying a business opportunity. Also the entrepreneur’s attitude towards something new and creative; his or her independence, proactiveness, innovation propensity, networking abilities are considered as key qualities for recognising the business opportunity.

As it emerged from the response of different interviewees that the entrepreneur's knowledge in any particular field certainly opens his or her eyes to recognise an opportunity and gives that person the strength and
capability to nurture and bring it up further. Many of the interviewees had the highest level of education in the areas of science, technology and engineering which focus mainly on technical problem solving skills. This definitely arms them with many essential tools to explore the opportunity. This particular technical knowledge of the entrepreneur, works as a competitive advantage in most high-tech start-ups in terms of product development, product modification and management approach. “The technology was new and was developed during my Ph.D. which we found to have a good market demand” (Chapter 4: 63). The ideas which they develop during the study in their specific fields may develop into great opportunities which may not be perfect at the beginning or in the middle or even at the end but their ability to see the imperfection should not blind them to the larger possibilities.

It is believed that the creation of a successful business follows a successful opportunity development process. While many entrepreneurs may be able to recognise an opportunity, it is also possible to develop and create opportunities. Careful investigation of market needs and the ability to spot suboptimal deployment of resources may help an entrepreneur begin to develop an opportunity. The development process may be cyclic and may evolve at different stages which lead to further opportunities. So, it would provide a means of prescribing or evaluating solutions and answers to applied problems as well as responding to new problems that have no previously identified solutions.

So, innovative people will look around and would find business opportunities which are worth screening for further investigation and pursuing. The entrepreneur has to be passionate, enthusiastic and motivated as well as not afraid of failure. They have to have faith in the technology and have to be optimistic along with an eagerness to commit their own time and
resources. Only then the entrepreneur will be able to bring success from his realized opportunities.

5.2.2 Influencing Factors for Sourcing Finance:

A clear understanding of the financial requirements is a must for all the start-ups specially in early stages. When the start-up starts to deal with the finance, it becomes crucial to pick the right type of source, right amount and also for the proper time duration as it could have a detrimental effect on the whole business.

The start-up may not have a choice of financing option; it may hugely depend on the entrepreneur’s or founder’s personal resources and his personal connection to different level of investors. But the good thing is that, as the business develops it is easier to persuade outsiders to invest in the business. During the interviews with different entrepreneurs, CEOs and CTOs, it became clear that the affecting factors for financing a high tech start-up is a complex one and there is no unique answer for that. The financing requirements in terms of the amounts needed among different high tech industry sectors are different and so are the financing factors.

High-tech start-ups are often the results of a high intensity research and development (R & D) effort by scientists and engineers spanning a few years. The cost of R & D along with the product development cost would be one of the influential factors for the choice of financing. Due to the nature of the rapid movement of the new and emerging technology usually offered by the high tech start-ups, it is classified as a high risk sector. For these high tech sectors which may provide a high growth prospect despite having a high failure possibility, the general options may be further limited and the
only financing option may be through equity financing and thus by sharing a slice of any future profits. For the private equity investors, the most important factors would be how the business is valued, governed and how in case of failure it can be liquidated. Also a strong business plan showing a clear marketing route and high profit margin would certainly help to attract more investors in any sector including the high-tech sectors. “Technology, market analysis, well defined customer needs and strong business plan are the main factors that affect the financial option” (Chapter 4: 67). A start-up with strong technological capabilities, a strong market pull and the ability of the start-up to adopt and meet the customer and market needs would also affect the financing choice of the firm.

So, it is important to understand the different factors that can influence financing options for start-up companies which determine the operation of their venture. Selecting the right type of investors for the type of start-up is also very important. As a general note, after evaluating opportunities for raising investment capital both inside and outside of the organisation as well as inside and outside the country and avoiding common mistakes and maintaining a positive fair balance sheet, the high tech start-ups are expected to manage funding for both on-going operation and future expansion. At the same time it is necessary to identify and to eliminate the factors (such as unrealistic value proposition, no clear business strategy) which would reduce the adverse effects.

5.2.3 Barriers for Funding and Government Support:

Certainly access to capital is labelled as the biggest barrier for the survival and growth of a high tech start-up especially in its early stage. Successfully
obtaining funding is partly a result of good planning for the business development from the entrepreneur and a matter of satisfying the investor’s faith and expectations in terms of returning the value of the investment. The entrepreneur needs to understand the factors which motivate the investors and arrange to satisfy those conditions to have improved chances of achieving a successful outcome.

With the bursting of the “dotcom” bubble in the early 2000’s along with the recent worldwide “credit crunch” during 2007-2009 which is considered by many economists to be the worst financial crisis since the “Great Depression” of the 1930s, the financing of high-tech start-up has suffered badly. This issue has severely affected not only the creation and the survival of high tech start-ups but also their ability to obtain external financing. Financial institutions in vulnerable countries have been struggling to keep their finances in order amidst the financial turmoil in the banking sector and the near-bankruptcy of some countries.

All the interviewees had different opinions on the existing barriers to the funding of their start-ups. Many of them are concerned about getting a poor valuation of their firms due to the small market in Ireland. But the valuation also has to be realistic as pointed out the by the director of the corporate finance firm. “Quite often the entrepreneurs in the technology sector have unrealistic valuation exceptions” (Chapter 4: 71). In the case of heavy investment (specially in the case of semiconductor start-ups) coupled with a very limited return during the early years of operation with the lack of a proper exit strategy is considered as a barrier for funding.

Some interviewees talk more about overcoming the barriers than about the existence of the barrier. A credible business plan would certainly help to overcome the barrier as many interviewees argued to have a flexible and realistic business plan to show the investors good solid reasons why the
assumptions and plans made are likely to be valid. Strategic partnership with other business start-ups is also thought to be a way to overcome the funding barrier. According to an interviewee, the key to successfully obtaining investment for a high-tech start-up will be to have a thoroughly good business plan that demonstrates a sensible and well researched business opportunity. The enthusiasm and the commitment of the entrepreneur will also help to get over the funding barrier.

Although the entrepreneurs and CEOs and CTOs were a little divided about the existing barriers for funding, all of them recognised the value of direct or indirect Government support, specially in the early days. Governments have connections to the different industries and markets and also have the power to allocate resources using public funding schemes. So, the Government can help the development of start-ups by providing funding, export assistance, supports to develop competitiveness, incentives to stimulate in-company R&D, assistance with R&D collaboration, and connections and introductions to customers at both national and international level.

All the entrepreneurs asked for Government support through a clear, open and transparent process. In Ireland, the Government provides support to high tech start-ups through Enterprise Ireland (EI). Very recently EI introduced a high potential start-up program called 'New Frontiers' which is Enterprise Ireland’s national entrepreneur development programme for innovative, early-stage start-ups (http://www.enterprise-ireland.com/en/Start-a-Business-in-Ireland/ Supports -for-High-Potential-Start-Ups.html).

The lack of access to affordable finance has been made identified as the dominant, persistent, barrier to establishing a start-up in the high technology sector and it puts emphasis on the need for strong policy support
from the Government. The Government can offer a comprehensive package of practical and financial supports to the start-ups through its extensive network of contacts in business and enterprise can provide access to a full suite of mentoring programmes and even help to get further investment.

5.2.4. Do Patents Attract Finance?

A better understanding of the role of patents in venture capital financing is desirable from both a theoretical and a practical perspective. Usually for high tech start-ups, the intellectual property in the form of patents provides a basic shield for the investors who place their resources as risk. According to the world intellectual property organization (WIPO),

*Patents are the integral part of the value creation in a technology based enterprise. It is a crucial element in obtaining venture capital and the threat of an expensive lawsuit which may be sufficient to reduce the probability of venture capital financing*

(www.wipo.int/sme/en/docs/.../venture_capital_investments.pdf)

During the interview with CEOs, CTOs and entrepreneurs of different start-ups working in different sectors of high-technology industry, stressed the importance of patents in securing finance. Most CTOs and entrepreneurs stressed the importance of having a strong patent portfolio for a high-tech company. Patents suggest that the start-up has a unique technology which may have a significant market value. According to them, patents are the things that separate a venture from the other crowd, prevent the competitor to access the venture’s property and works as a safe-guard for the investment. A patent constitutes a legal right to exclude others from using an invention and also shows the quality of the product of the firm. Patents can be measured as a quality of the invention or innovation and some
investors, especially the VC with unique and critical expertise in the areas of emerging technologies and market will be able to add more incremental value to the technology. Faced with high uncertainty and limited information in assessing new high-tech ventures, VCs usually rely on those characteristics of the start-up that are observable such as the patent portfolio. The VCs will assess the inherent value of these observable characteristics, and in addition will likely take them as a basis for drawing conclusions about unobservable characteristics of the firm.

Some interviewees were very cautious about the patent situation as it can also drain a huge amount of money although it provides the start-up with the support for developing its own technology and produce the stuff that the venture wants to produce. The wider the cover in terms of region, the more expensive it becomes. "A good intellectual property (IP) strategy is really important so you can operate well and not bankrupt the company" (Chapter 4: 73). Also it is important to realize that customers usually do not want to see whether you have a patent or not as long as they can use the technology or the product. Probably that is the reason that the CEO of Ndevices was not so concerned about having patents. As he works on the component level with standard electronic devices available on the market from different suppliers, it was not a concern for him.

Hoenen et al. (2014) show that the effect of patents on venture capital financing is stronger especially in early stage funding rounds, when the venture team has no initial public offering (IPO) experience. Hoenen et al. (2014) interpret these findings as evidence of a signalling effect of patents (Hoenen et al., 2014: 982). A study by Hsu and Ziedonis (2013) based on 370 start-ups in the semiconductor industry yields similar results, as the number of patent applications a start-up holds is shown to drive its financial evaluation by VCs, especially in early funding rounds (Hsu and Ziedonis, 2013: 761).
The patenting of technological innovation reduces information asymmetry and the risk of adverse selection by venture capital investors, contributes to the firm's competitiveness and increases the firm's intangible value. But, the preparation of patent applications requires effort and time, since applicants have to follow strict guidelines and need to include technical information in a very structured manner. The start-up needs to quickly assess the strengths and weaknesses of the invention and of the technology employed by the start-up. The patents convey important information about the company and they require considerable attention in due diligence processes. While preparing a patent application is costly and requires some disclosure of private information to the public, ventures should not underestimate the signalling value of patents as they help in acquiring funding and may also help keeping investors patient and enthusiastic about the venture.

5.2.5 Ownership Issue with VC Involvement:

When venture capitalists (VC) and business angel (BA) are involved in start-ups, they usually invest a big chunk of their own financial resource. To minimize the financial risk, these finance providers often gain the operating control and to do so they usually acquire a significant portion of the company ownership. As a result the private equity providers get significant control over company decisions and so the overall control of the organisation may become a critical issue. The investors require such a high degree of control in order to mitigate the risk associated specially with the high-technology sector as there is always a risk about the technology becoming obsolete or being replaced by a lower cost alternative. Also usually the VCs and entrepreneurs are two different types of people with probably different
types of personality, background and philosophy. So, in the entrepreneurial
culture where independence and control is valued greatly, this may not fit
well with the equity based capital providers.

It is found out from different interviewees during this study that as
investors VCs accept more risk and partner more closely with the
entrepreneurs than other equity investors, the control of the ownership issue
can be viewed differently. Some interviewees argue that the skill set and
domain expertise of venture capitalists help the entrepreneurs to bring
breakthrough ideas and technologies to the market and as these are
beneficial for the venture, the ownership issue should not come in the way.
The ownership issue can come into the play while the venture is successful
as well as when the venture is struggling. General human behaviour is that
we all want to share the success but usually do not want to share the failure!

If the ownership issue turns sour it may ruin the company by making
the wrong decisions. VCs are generally exit focus and want a quick return on
their investment (ROI) which may put pressure on the company. Sometimes
the VC might build an organizational structure much larger than is needed.
Whereas the founders may have a more altruistic view and they want to do
what is best for the company (and the society) which may not at all involve
a quick exit. So again the ownership issue comes into the lime light.

So, some interviewee advised both the venture capitalist and the
entrepreneur to negotiate the terms and conditions of the investment in
detail and well in advance to avoid any future conflict about this ownership
issue. Both parties have to have realistic expectations and be prepared for
the adverse situation, if it happens to happen. The interviewees suggest to
play a complementary role to both the VCs and the entrepreneurs.

Some interviewees were not so much concerned about this issue as
they think that VCs are there to control the down side. As long as they are
assured of a good return on their investment within an acceptable timeframe, the ownership issue would not affect. "VCs are professional investors and they are typically very exit-focused" (Chapter 4: 77). It is often believed that entrepreneurs who are overly concerned about the control of their start-up may need to find a path to success other than venture capital.

5.2.6 Are the VC backed Firms More Successful?

When the venture capitalists are involved, they take the responsibility beyond raising the capital, they nurture the entrepreneurs. The nurturing process takes the form of management support, recruitment as well as contact with important customers and vendors. So, they bring both financial and operational experience with them and an important asset of management know how in a start-up environment. As a result, the flat and horizontal small start-ups could have the benefit of some very experienced top management talent.

All the interviewees agree that the introduction of VCs is generally good news and the firm has a larger chance to become a successful organization. "The VCs arrived because they thought that the idea was considered to be worth investing" (Chapter 4: 78). VCs are very experienced people who always carefully select the ventures that they want to invest in after some very critical assessments. They also examine the business plan in detail for any potential flaws in the business. In the case of high technology industries, product development is often an extremely time consuming and money spending process. With the huge buffer in terms of financial resource and management expertise, the organization can improve the product...
development process as well as the product portfolio and has the option to explore new frontiers. The VC investment is a ‘signal’ for the quality of portfolio companies and so with the involvement of VCs in the start-up, the other parties would give instant credibility to the entrepreneurs and the new venture and even dealing with traditional conservative financial institutes as banks may become easier. VC investors can identify firms with hidden value and provide them with the necessary financing and at the same time actively monitor portfolio companies and perform a valuable coaching function.

Although the interaction between the entrepreneurs and VCs is not without friction, the common objectives are the promotion of understanding between these two parties. The objective of the VCs is to invest large amount of money and to protect their investment while the objective of the entrepreneurs is to use this money in the best possible way to generate wealth for both parties. As Kay says

"The Venture capital industry has played an important role not only in the financing but also in the management of creativity over the last 30 years”.

Kay (1990: 164)

So, although some interviewee was a bit sceptical about relating success with the money, there is no doubt that money and strong management are the two most influential materials for success. Most high tech start-ups from the Silicon Valley region as well as other high tech start-ups as Intel, Apple, Microsoft were financed by venture capitalists. As Florida and Kenny (1988) contend, VCs provide much more than money: VCs provide a fruitful climate for innovation and entrepreneurship by linkage and networking which are also important factors for success (Florida and Kenny, 1988: 301).
Venture capitalists make high-risk investments and expect some of them to fail. So, despite having high failure rate (one or two may be highly successful among 10 investments while 3 or 4 may bring some success and 3 to 4 may be a complete failure), the big successes are good enough to cover the failures. Also, failure is not always a bad thing, if it happens quicker, so that the entrepreneurs and the finance providers can engage themselves to a separate start-up with the knowledge with "what not to do". Also, the failures of start-ups would release people with improved skills and time to either establish another start-up or join an already existing start-up.

5.2.7 How to Attract More VCs in High Tech Start-ups:

To attract more VCs in the area of high-tech start-ups it is needed to study the nature of investment that venture capitalists usually decide on. The venture capital investment criteria are based on the potential of the company to grow fast within a limited time period with the resources it poses. The ventures with a tendency of providing great returns with a successful "exit strategy" within a desired time period of investment are the ideal opportunity for venture capitalists. The start-up company which is based on innovative structure and a well-designed and tested business model supported by a strong management team attracts the venture capitalists. The VCs ensure stocks follow the desired venture capital investment criteria to make mature investment in stocks to get high returns.

It is found out from the different interviewees that, the investment system in the high-tech sectors needs to show some success after the collapse of the "dot.com" bubble during the late nineties. This will help to restore faith in the high-technology sector. Some of the interviewees see it
in the other way that there are many investors but not enough cutting edge technology offers. While both sides may have a point in some respect, it is more important to have a sound system for investment allowing the technology oriented venture capitalists to expand their investments and increase the scope of the venture capital activity. "VCs are only going to be attracted by commercially interesting opportunities undertaken by a passionate and balanced team" (Chapter 4: 81).

The issue of the start-up eco system specially in the areas of high technology sector has surfaced several times during the interview. An effective investments climate depends upon a lot of interactions, networking and linkage among the different parties. Providing incentives like the reduction in capital gain tax rate, availability of pension funds will attract more capital to the industry. But simply making the venture capital funds available will not automatically generate the conditions under which high technology entrepreneurship will flourish. Besides the financial resources, the start-ups need support organizations like incubators, accelerators, co-working spaces etc. Also the eco system needs research organizations, service provider organizations like legal, financial services and large corporations and above all highly qualified and well trained engineers and technology graduates and even postgraduates from the Universities. These organisations are often considered the breeding ground for future entrepreneurs and regularly provide new ideas and new ventures from the existing operations. All of these form together a "start-up ecosystem" which is linked together by shared activities, events and interactions. Resources like skill, time and money flow through the ecosystem and their interaction play a key role in the movement of these resources to create a newer successful start-up and strengthen the already existing ones. The Government and the state organisation have a very important role to play in making the ecosystem successful.
The start-up ecosystems would help the business incubation and commercialization, strategic planning, and economic sustainability and would advance the technology led economic development practices at local, regional, national, and international levels. It is often believed that the tremendous success of "Silicon Valley" which can be considered as the birthplace of the high-tech start-up is due to the excellent ecosystem.

5.2.8 Other Funding Options besides Private Equity Funding

For high-tech start-ups funding could be the single most important issue, as important as the technology on offer and even in some cases more important than that. The entrepreneur needs to carefully analyse the situation, thoroughly examine the different options before making the right choice. Also it is very much possible that the entrepreneur may not have the option to choose and may have to go along with whichever source is willing to provide him the necessary financial resource for the survival and growth of the start-up. The type of business even in the areas of high-tech industry also has an effect on sourcing alternative finance providers. Since most of the semiconductor business involving device fabrication, characterisation and packaging which requires the use of high expertise as well as expensive equipment, the initial lay-out and operating costs becomes very high compared to other high-tech industry such as software development or electronics assembly business.

The traditional funding providers such as banks and building societies do not invest in the high tech sector simply due to the high risk involved and so the private equity investors may be the only remaining option. Despite these limitations, the very rapid advance of the information and
communication technology has opened the door to the global community for more options across the world.

As it came out from almost all the interviewees that in today's business world crowd-funding is a great way to get access to start-up capital without incurring a massive debt obligation. "I think crowdfunding is an obvious answer of these days" (Chapter 4: 84). Crowdfunding is easily accessible, low cost and has a convenient e-commerce platform. The way it works is that the entrepreneur pitches the concept to a crowd of investors on a website dedicated for this purpose such as Kick-starter and Indiegogo. And after the initial judgement, crowdfunders would validate the concept and interact with the entrepreneurs in exchange for perks. The prospect of good financial returns, the ease of the investment process and control over where the money goes, are the main features that trigger investments. The CEO of Ndevices started his company by crowdfunding and found that a growing number of companies are seeking crowdfunding investment along with other forms of finance such as VC funds and Angel funding.

Besides Crowdfunding bootstrapping was also mentioned by several interviewees. Some innovative funding mechanisms as "Customer POs" and "trade credits" were also suggested by some CEOs and CTOs. The advantage of these alternative funding schemes is that the profit of the business is not divided or shared and so the control of the business remains with the founders. A long-term working relationship with the customers is certainly beneficial and may hold the company’s finance on solid ground.

Along with the financial supports, the other forms of supports in terms of infrastructure for business mainly in terms of "business incubation" came from different interviewees. At a minimum free office space, phones, internet etc. would cost a 'parent' organization virtually nothing. If the entrepreneur is provided with these basic supports he may spend more time
in sourcing the all-important finance for growth and further development. Also having a good team with a good CEO and good board members is important. Also the timing of the finance came into the discussion and it was advised that the prototypes could be built from non-formal finance sources whereas main finance should be invested when the product is market ready. Business grants from Government through different agencies also came into consideration as Government is always looking for business ideas that can create export, revenue and employment.
Table 5.1 Summary of the Key Research Findings

<table>
<thead>
<tr>
<th>Theme</th>
<th>Research Findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business-opportunity</td>
<td>Business opportunity may arise from entrepreneur's family background, hobbies, general interests etc. Many technical people have spotted the opportunity through higher education (Ph.D. and Post-doc research).</td>
<td>Open-minded, curious and enthusiastic people are more likely to spot the business opportunity.</td>
</tr>
<tr>
<td>Factors for Funding</td>
<td>The factors depend upon the funding amount, timing of the fund including the payback time and the capital structure of the organisation.</td>
<td>In different high-tech start-ups, these factors are sector dependent.</td>
</tr>
<tr>
<td>Funding barriers</td>
<td>Improper valuation and lack of track record, limited numbers of funding providers are considered as the main barrier for funding.</td>
<td>Government support at any stage is highly desirable.</td>
</tr>
<tr>
<td>Patent Issues</td>
<td>Certainly patents help to attract finance. In general VCs are very interested in a good patent portfolio before providing the funding.</td>
<td>In most cases, patents work as a safe-guard for the VC investments.</td>
</tr>
<tr>
<td>Ownership Issues</td>
<td>This one can be a critical topic as usually the entrepreneurs and the funding providers are people with two different types of aims and objectives.</td>
<td>Both parties just have to learn how to live together in harmony and to support and complement each other.</td>
</tr>
<tr>
<td>Success factors</td>
<td>Success can be claimed by many factors, but in general the VC backed ventures are more successful than the non-VC organisations.</td>
<td>VCs know that not all of their investments in different businesses will be successful, but those which they expect to be would cover the cost of the unsuccessful ones.</td>
</tr>
<tr>
<td>Attract more VCs</td>
<td>A start-up ecosystem is needed, part of which could be educational and research institutes, funding providers, support organisations (lawyers, accountants).</td>
<td>Recent success seems to have overcome the burst of the dotcom bubble in 90s.</td>
</tr>
<tr>
<td>Other finance options</td>
<td>Crowd funding, bootstrapping, customer purchase order (PO's) could be a partial alternative for the private equity based finance providers.</td>
<td>Needs to be innovative and creative in sourcing and managing finance. Other sources may be used during the early stages.</td>
</tr>
</tbody>
</table>
5.4 Recommendation for Start-ups for Sourcing Finance:

There is a high demand for financial capital for high tech start-ups due to the very fast shifting of technology. Specially for the entrepreneurs of high-tech start-ups when they are searching for investment at an early development stage while there is still considerable technological risk. Although in general investors are risk takers, very few of them may be willing to finance ventures with such a high technological risk. Traditional finance providers such as banks or lending institutes are generally more interested in well established businesses where they are more secured in terms of their return on the investment.

So, it is advised to do a proper market research before coming out of the womb of the mother organization. The development of the prototype, the necessary modifications of the product to show superior performance should be done a part of a routine exercise, preferably by research projects before spinning out into the real world. Also needs to demand for some initial support from the mother organization not necessarily in the form of financial support. Some timely support in the form of incubation to provide office spaces, telephones, internets would help the new venture to form a reasonably strong infrastructure for survival with minimum effort and expense from the mother organization.

In terms of sourcing the finance, it is suggested to raise the capital when the product is market ready. Although probably no company has gone out of business for having too much capital, it is better to have the finance when it is much clearer where the money would be properly invested and utilized. It is suggested to have a realistic business plan as well as financing plan with achievable milestones. One should always need to keep in mind
the basic financing rules (such as "Cash is the King"). Also it is largely advised to protect the key asset in terms of patents and technical know-hows and to build a patent portfolio which in term helps to secure finance for the future as well as put the organization on a comparatively solid ground.

At the initial stage, it is important to have one or two key customers who really want to buy the product. This initial customer would also help to determine the initial product market fit by acting as a major source of information and may also help the start-up by providing some funding at the early stage. Also needs to keep an eye on different Government and state supports available for the start-ups. Due to the high initial costs, the use of recently developed crowdfunding or bootstrapping funding mechanism may not be very suitable for the financing the whole venture but may be suitable for a partial funding. A gradual investment through different capital increases might be better than a large investment at the very start.

Besides family and friends, it is worth finding a business angel with a motivation aligned to the company. Some business angels are very technology focused and may also have a passion for that particular technology and even may have expertise in that area. This would certainly help the start-up both in terms of financing, monitoring and mentoring. In some cases the angel investors and the VCs can work together effectively and efficiently. Eventually when the VCs are introduced, it is better to be introduced in the development and growth stage. This will help to explore and exploit the previously not travelled territory and at the same time would obtain a decent valuation of the company. If the start-up is lucky enough to have the option to choose a VC from the several, it is advised to look at the track record in the field and find similar investments and also the size so that they would be able to join and drive any further rounds. Careful negotiation with the VCs in terms of equity sharing must be sorted out and needs to form a strong team complementing with each other expertise.
It is important for both the entrepreneurs and the finance providers to think more in the terms of what they might offer to each other rather than what they can extract from each other. In an ideal case for a high-tech start-up, the entrepreneurs should focus mainly on product development, product modification and market adaption so that they can sell themselves as an attractive investment opportunity for the investors. On the finance providers side they consider that the entrepreneurs should know what kind of deal they should expect from a certain finance provider and not to concentrate on the offer in terms of knowledge, network or experience. The finance providers may be sometime unable to position themselves well towards the entrepreneurs. Usually, the financers get more proposals than they can handle at a time and so it is quite time consuming to select the right one for the investment. It is suggested that the entrepreneur may better wait until the last possible moment, may need to abandon or modify some terms of the contract, and may need to change and alter the plan to get a better deal from the finance providers.

The entrepreneurs constantly need to look for new ways to gain a competitive advantage over the competitors in terms of product range, business process and service which would certainly help to provide confidence to the finance providers.

5.5 Future Research Areas:

In the case of semiconductor based start-ups, private equity based Venture Capitalists and Angel investors are the two most common finance providers. This research on what we need to know about venture capital financing is just a tip of the iceberg in the complex and complicated world of start-up financing. The amount of literature available on Venture Capital financing is
enormous. There are several academic journals devoted solely to VCs and there are numerous books on VC investing. This research is an attempt to find out a few issues about VC financing. Whenever the opportunity arises, a few more key issues could be further explored.

1. The Venture Capital industry is well established in the USA and a large number of VC based very successful high-tech start-ups as INTEL, Google, Apple etc. are noticed. On the other hand, in Europe, the VC involvement in high-tech start-ups seems to be a very recent event and is a small scale activity. It would be very useful to learn how to replicate the same success in Europe using the VC financing in the high-tech sectors as in the USA.

2. The second area for further research could be about the venture capitalists decision making policy and about the model of their investment. The VC decision-making process and the criteria used to evaluate potential deals would help to create a right environment for large investment. It would be worth knowing how decision-making criteria change at different stages of the VC evaluation process, or whether and how they change over time as VCs learn more about the business.

3. The third area for further research might be about the relationship between the Government backed VCs and the private VC industry. Arguably, a Government lead and sponsored venture capitals would be more beneficial compared to private venture capitalists. So, it would be worth examining and knowing what value added benefits and facilities the Government venture capital funds can provide compared with independent venture capital funds.
5.6 Conclusion:

As the technology advances, new products and new markets will develop and generally, the start-ups will pioneer in these areas. But, high-tech start-up’s journey towards financing is always expected to be a very challenging and difficult. So, the entrepreneur needs to be well prepared and keep a fighting spirit needed for sourcing the finance.

In this study a number of entrepreneurs and technology developers were interviewed and questioned in order to investigate the financing issues relating to a high-tech start-up. In the case of high-tech start-ups in the area of semiconductor, there is not enough evidence for an organic growth as far too large investments are needed to reach a critical mass and stagger forward doing small scales. Also besides the high capital requirement, the economics of manufacturing semiconductor donot offer a very attractive risk-reward profile for the traditional finance providers such as banks and other lending institutes. So, although the venture capital is not absolutely necessary to facilitate the entrepreneurs in the areas of semiconductor, the VCs are probably the most suited funding providers in such cases. VCs are typically looking for investments that can provide them a few folds return on their investments. So, for entrepreneurs, venture capitalists provide an opportunity to raise capital, often accompanied with industry experience and a referral network in return of some degree of ownership and control over the organisation.

The performance and pros and cons of the VC investing have been analysed and it considered that a well-developed venture capital network can provide tremendous support both in terms of capital and catalysts and lower the barriers for entering in the high technology sector. The VCs use both their experience and their contacts to reduce many of the information
and opportunity costs associated with the new business formation. This in turn facilitates the development of entrepreneurial network sharing information, making deals and mobilizing resources and stimulates even more business formation.

Also the entrepreneur has to be more innovative towards utilizing the expertise and the financial wealth from the VCs and showing the promise of return more values for the VC investments. The entrepreneurs need to avoid the areas where the technology is maturing and there are fewer opportunities, as well as the lower margins and lower exit prices for the investors. To secure the strong financial backing from the VC and the angel investors, the entrepreneurs need to look for differentiated technologies that solve high-value problems in semiconductor manufacturing, or that bring semiconductor technology to disruptive applications in exciting fields as in the medical and environmental sectors (such as use of low energy and environmental friendly general lighting).

In a complex high tech industry like the semiconductor industry, it is not easy to pin-point the best practices to attract investment from venture capitalists. An effort has been made to gather a significant amount of information from different successful high tech start-ups to obtain an insight in the challenges of venture capital financing. It is concluded from this study that by assembling a brilliant team of both technical and non-technical people, sourcing sufficient finance at different stages of the start-up, obtaining strong guidance from the VCs and without ever losing the passion, an enthusiastic entrepreneur would be able to create a successful “high tech start up”.
References


Allen, K 2010, Entrepreneurship for Scientist and Engineers, Pearson New Jersey, US.


Davila, A, Foster, G and Gupta, M 2003, 'Venture capital financing and the growth of start up firms', *Journal of Business Venturing*, vol. 18, no. 6, pp. 689–708.


Hsu, D and Ziedonis, R 2013,' Resources as dual sources of advantage: implications for valuing entrepreneurial-firm patents', Strategic Management Journal, vol. 34. no.7, pp. 761-781


Landstrom, H (ed.) 2007, 'Pioneers in venture capital research' in Handbook of Research on Venture Capital, Edward Elgar, USA.


Mariotti, S. and Glackin, C 2012, Entrepreneurship and Small Business management, Prentice Hall, USA.


Silverman, D 2013, Doing qualitative research, fourth edition, SAGE publications Ltd, LONDON, UK.


Web References


http://www.photonics4life.eu/P4L/Event/Intensive-training-on-Entrepreneurship-in-Photonics


http://www.light2015.org/Home.html


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http://www.sagepub.com/upm-data/35066_Chapter3.pdf


www.rp-photonics.com/

Appendix A

Questions on start-up financing

1. What was the motivation behind your start-up? How did you recognize the business opportunity?

2. Which factors do you think influence the financing options for a high tech start-up?

3. What are the barriers for funding a high tech start-up? Do you think that Govt. support is a must for the high tech start-ups?

4. In your opinion do you think that the patent issue influences the financing options?

5. Do you think that the ownership issue becomes critical when VCs are involved?

6. Do you think that VC backed firms are more successful than the non-VC firms? If so, what do you think the reason for that?

7. According to you how can we attract more VCs in high tech start-ups?

8. What are the other funding options should the entrepreneurs of high tech start-up look for?