Technology Based-Entrepreneurship: Measurement Technology Perspective

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ABSTRACT

Currently, there are several papers on the New Technology Based Firms (NTBFs) yet the case studies of measurement technology appear to not be available. This work aims to present the entrepreneurial processes of Finnish measurement technology firms. Eight interviews were conducted with the key players of the industry. Successfully, the outcomes of the study revealed that there are five interconnected and interactive phases for new technology commercialization; they are not static and they are continuous in a circular mode. Likewise, there are two facilitators – networking and market potential which serve as linked pins for the identified stages. Furthermore, financing, research and development (R&D), government supports and the entrepreneurship issues were found to be highly relevant for NTBFs. Most importantly, this study presents a new model, which can be adopted by technology entrepreneurs for their invention valorizations.

Keywords: *Measurement Technology, Technology application, Team building, Business Model, Global market entry, Networking, Marketing Intelligence*

1 INTRODUCTION

Entrepreneurship is a power house of innovation; it links with the commercialization of research results and technological innovations. These three concepts are essential for the creation and maintenance of wealth, even at a national level (Hindle & Yenchen, 2004). Additionally, Mirjam vaa Praag & Versloot (2007) conclude that entrepreneurs play important roles in the economy; increase of employment and commercialization of high-quality innovations are among their contributions. In view of this, Hindle & Yenchen (2004) argue that "…accumulated tacit knowledge and culture of the entrepreneur are the resources essential to create wealth from research commercialization leading to technological innovation and the creation of New Technology Based Firms" (p.793). This is supported by Dahlstrand (2007) that technology-based entrepreneurship is a reflection and a small component of the general entrepreneurship. It is a regional and industrial based entrepreneurship; it improves creation of entrepreneurs in the regions by improving and sustaining the regional intellectual capabilities. Its results comprises of increase of spin-offs and better utilization of new innovations.

Furthermore, Markman, Siegel & Wright (2008) contribute by stating that the commercialization of researches is an ecosystem in which leads to establishment of new firms. It is argued that this situation is facilitated by the trends of key legislation such as Organization for Economic Co-operation and Development (OECD) 2003 and the increase of public-private research partnership such as Science parks and government programmes supporting new business creations (Markman et al cited Phan et al., 2005). More so, it is claimed that "Studying research and technology commercialization is especially important because such analysis provides important evidence for policymakers and managers. Indeed, the topic has moved beyond a niche field and is now a scholarly subject matter that is published in premier academic journals" Markman et al (2008; 3).

Therefore, it seems relevant and important to elucidate the entrepreneurial processes or activities of NTBFs using measurement technology companies as case studies because it is well known that many inventions are generated yearly and many patents are registered annually but converting these innovations to usable items,

purposely to satisfy certain needs, is tedious and cumbersome. Many scholars have highlighted the processes; many scientists have shared their experiences yet it is worth knowing how these can be utilized in the sector of measurement technology. Therefore, this paper tried to answer the question of "How does a new measurement technology turn into a final product?" More so, this paper is divided into two parts – theoretical review and empirical study. The first part comprised this section, introduction (which explains the scope of the research and the empirical conditions of the study) and the literature reviews of NTBFs, measurement technology and the business model. The second part consists of research methodology, results and discussions, and conclusion, which presents a model to be used by CEMIS and any interested organization for creating NTBFs.

1.1 Scope of the Study

This study assumed that "Idea" which is represented by "X" is a starting point when a discovery is detected in the research findings and it is patented, while "Final/End product" denoted by "Y" is the destination when the users benefit from the idea. This passage involves entrepreneurial efforts and the successfulness of the entire processes depends on the attitude of the technologists. Although these processes are existing, yet it is noted that they may be different from one sector to other and it seems that there is no case study of measurement technology; even, sometimes the existing procedures are regarded as secrets among the successful entrepreneurial scientists. Hence, it is worth knowing and understanding how these activities are taken place in the measurement technology. Hence, to support and to contribute to the commercialization of research results, Center for Measurement and Information Systems (CEMIS) embarked on this study to derive a probable model that may serve as a guide for the experts of measurement technology and related industries. Nonetheless, the following figure depicts the scope of this study:

From the figure, the factors – technology potentials (especially its applications), business model, and globalization – were tried to be investigated especially on how they could affect the smooth processes of new technology commercialization. These issues were fully investigated and their outcomes were presented in the third section of this study. Meanwhile, it sounds reasonable to state the circumstances that made this study worth doing; the conditions are explained in the following subsection.

1.2 Empirical and Current Situations

Dr. Per Eri ksson, the Director General of the Swedish Agency for Innovation System (VINNOVA) stated in the VINNOVA forum preface that "University professors can teach at the universities, and at the same time be successful business people, enabling the university to contribute to the development of its region through clusters of growing science-based new companies" VINNOVA (2003; 10). This is confirmed by Dahlstrand (2007) who suggests that Nordic-like countries and innovative nations should welcome with warm hands the entrepreneurialism for better utilization of their research works. Recently, the Finnish National Broadcasting Corporation, Yle, says "…

some 150,000 jobs need to be created in Finland to ensure the welfare of its citizens. For this, the country needs new ideas, innovations, and, most importantly, new entrepreneurs" Yle News (2011).

In addition to above and more recently, the Finnish Funding Agency for Technology and Innovation (popular known as "TEKES" in Finland) categorically called for papers of the research institutes and universities for the commercialization of their findings (TEKES, August 18th, 2011). It was stated that about four million euro assigned for this. Therefore, it can be agreed that there is a need to pay attention to commercialization of research results and their entrepreneurs. Nevertheless, the following sections handle the theoretical frameworks on the NTBFs, the measurement technology and the business model.

2 LITERATURE REVIEW

Brockhaus (2004) suggested that the quality of empirical studies will be improved if the previous literary works are critically reviewed. Therefore, this sub-part focuses on the previous works with emphasis on the main issues of NTBFs formation and development.

2.1 New Technology Based Firms

NTBF is a company formation which emerges from a discovery. The discovery comprises either an invention or innovation that probably developed by researchers; it is can be described as a commercialization of research findings (Colombo & Piva, 2012; Freitas et al, 2012; Mets, 2009; Hindle & Yencken, 2004; Yli-Renko & Autio,

1998). Due to the involvement of research, the importance of tertiary institutions (especially universities, polytechnics and colleges) and other research institutes are high. Therefore, the common form of NTBF is spin-off (Freitas et al, 2012; Tahvanainen, 2011; Mets 2009). Similarly, this kind of business establishment is science and technology oriented (Colombo & Piva 2012, Meyer, 2003; Rickne, 2006; Witt & Zellner, 2005); it is combination of entrepreneurship and research activities (Meyer, 2003; Witt & Zellner, 2005). Thus, it involves knowledge or it bases on the knowledge capacities (Baptista & Preto, 2009; Witt & Zellner, 2005).

Subsequently, there are many terms using for NTBF depending on the perspectives of the scholars and their field; for instance, it is known as "Academic Start-up" (Colombo & Piva 2012), Academic Spin-off (Freitas et al 2012), "University Industry Technology Transfer- UITT" (Tahvanainen, 2011), Research-Based Spin-Offs – RBSOs (Mets 2009), NTBF (Mets, 2009; Hindle & Yencken, 2004 and Yli-Renko & Autio,1998), Science-Based Firm (Meyer, 2003; Rickne, 2006 and Miettinen 2006 cited Tidd et al., 2000 and Baldwin & Gellatly, 2004), Knowledge-Based Entrepreneurship/ Technology-oriented Start-up Firm, (Witt & Zellner, 2005), Research-Based Ventures (Meyer, 2003), Technology-Based Small Firms (Revest & Sapio, 2010), and Knowledge-Based Start-ups (Baptista & Preto, 2009). Henceforth, NTBF will be used throughout this paper.

Emphasizing on the importance of NTBF, Gibson & Naquin (2011) argue that developing of human capacity on commercialization of research results improves regional economies; such development serves as an investment. The technology knowledge transfer revamps economy stresses via human networks. Additionally, countries need result valorizations these days if such nation wants to be sustained in the global market; thus, there is high need for knowledge cluster if the research results are to be sold as products in the market (Suvinen, Konttinen & Nieminen, 2008). Building or pioneering a technology is not only functional but it is essential for social benefits (Banerjee & Cole, 2011). Baptista & Preto (2009) say:

"Start-ups in knowledge-based sectors have greater effects on subsequent employment growth than other start-ups, regardless of the type of region where these start-ups occur… knowledge based start-ups have a greater potential to induce change in markets, bringing about both negative selection effects and positive spillover effects on overall employment." (p. 439)

Furthermore, "Science-based firms play a significant role, capturing the promises of scientific knowledge, realizing the industrial potential and reaping some of the economic returns" (Rickne 2006; 393). Specifically, Finland needs more commercialized inventions in order to keep the pace in the global competition; biotechnology is one of the industries that the Finland has to work on (Tahvanainen (2011). However, the commercialization can only be attained by entrepreneurship (Witt & Zellner, 2005). Two ways to transfer innovation for commercial purpose are – start new firms and run them by former scientists (academic entrepreneurs) or use incumbent/existing companies with good R&D (Witt & Zellner, 2005). Furthermore, the training and development of academic entrepreneurial skills and behavioral pattern can facilitate the NTBFs; likewise, the business networks play important role (Colombo & Piva, 2012; Meyer, 2003). The NTBFs are often possessing growth and simultaneously consisting of risks; thus commitment is the main drive for their successes. Entrepreneurship encourages and gives the strength to attain the success (Hindle & Yencken, 2004).

Therefore, the government supports are vital to the success of research commercialization; such aids enable to promote institutional change, the basic infrastructure, build new infrastructure, promote learning and development of new initiatives, and aid some specific projects. Additionally, training and coaching academic entrepreneurs are among the government activities (Rasmussen et al, 2006). The positive attitude of regional governmental policies may lead to good outcome of entrepreneurial activities and firms (Audretsch et al., 2011; Parrilli & Elola, 2011). "Public policy can shape the competitiveness of regions by providing both the infrastructure that enables young firms to absorb necessary resources as well as the right incentives for entrepreneurs and researchers" notes by Audretsch et al (2011; 13).

Moreover, the government grants appear to be ease solution for financial bottlenecks for NTBFs. Even, after the establishment, the grants still assist the NTBF to sustain and to handle cashless situations. Therefore, NTBF seems to be dependent on the government supports (Elston & Audretsch, 2009). Nevertheless, these are examples of the governmental supports in the Nordic area: the Norwegian "FORNY" (Mets, 2009) and Finnish "TULI", "INTRO" and "LIKSA" (Rasmussen et al, 2006). Still, the government needs to exert more efforts on the entrepreneurship for potential business start-up owners or increase its support for entrepreneurial efforts of the academia because this will result to increase in new firm formations (Mets, 2010). The following framework provides basis for the argument:

However, it is noted that some government initiatives are not well defined and such supports are aided with local or regional initiatives. Likewise, it is noted that government are more focused on the commercializing project than any other invention valorization and this is due to proof of funding required by the government agents for proper accountability (Rasmussen et al, 2006). Similarly, the NTBFs still suffer because the government fails to identify the high quality firms from the common or normal businesses; thereby the funds are not tailored to the right channel. In the same vein, the failure of understanding different regional needs for industrial and development growth is hampering the better developments of NTBFs (Tahvanainen, 2011).

As it can be noted from the above figure, research commercialization requires efforts of the research institutes, companies and government; these actors are now playing active roles in the research commercialization because of essentiality of innovation in the society (Mets, 2009 & 2010). They include government agents, universities/polytechnics, research centers, technology parks, private firms and others that are playing significant roles for making inventions available at market (Suvinen et al 2008). Their relationship in this sense is called 'Triple Helix "or otherwise known as University-Industry-Government- UIG" (Mets, 2010; Meyer, 2003) or University/industry technology transfer – UITT (Siegel et al, 2004). Institutional connection is one of distinguished features of NTBFs (Freitas et al, 2012)

On the NTBF formation, the strategic choices may have either positive or negative impacts on the establishment of NTBFs; the choices include: nature of knowledge in use, appropriateness of the conditions, location and other non-technological materials and selling or licensing of invention (Oscarina Conceiçãoa, Margarida Fontesb and Teresa Calapezc in Mets, 2010). The following figure depicts the NTBFs processes:

Establishing of a NTBF comprises many activities; organizational and managerial issues are worth understanding (Siegel et al, 2004) because there is a difference between of being a successful academic and of being an achieving entrepreneur (Suvinen et al, 2008). NTBFs should center on the product effectiveness, the market entry and sustenance and the financing. More so, the availability of funds, the entrepreneurial skill, the motivation, the aspiration, the human resources and the collaboration with other companies are common factors contributing the growth of NTBFs even right from the inception (Heinonen, 2009). The below figure expatiates the possible activity to be undergone while commercializing an invention:

The afore-stated processes break into two and the focus is on the two extreme ends – academic research and commercial application (Rasmussen et al, 2006). This is shown in the next figure:

The gap between the ends is termed "Valley of death"; this is a trap for many inventions and that is reason many research results, despite their high market potentials, cannot achieve market success because it is often difficult for the researches to successfully pass the "valley". However, with the university roles (including research centers) and the industrial efforts and interest, the gap can be filled and this leads to networking and cooperation (Rasmussen et al, 2006). It is presented in the below figure:

The collaboration can be attained by "Intermediary model" and this is termed "Broker". The common agents for Finnish brokerage are TEKES (Tuli and Venture Cup), Finnish Foundation for Inventions (Innovation Manager), SITRA (Introduction to Initial Investment Market-INTRO & Funding for Business Idea Development - LIKSA), Academy of Finland, Science Parks, Universities/Polytechnic Innovation centers and VTT. They are otherwise known as Knowledge-Intensive Business Service Companies (KIBS) (Suvinen et al 2008). The good relationship among the players of University/Industry Technology Transfer (UITT) is necessary to enable smooth technology transfer; thereby networking plays important roles. The informal rapport seems better than contractual relationship if the transfer has to be successful (Siegel et al, 2004). Thus, there is a need for a cluster to handle the commercialization processes (Suvinen, et al 2008). "Start-up support in science-based technologies should include help with access to and integration in an established business network" (Meyer, 2003; 113). The networking is an important role for development and growing of NTBFs (Yli-Renko & Autio, 1998). Parrilli & Elola (2011) state it categorically that:

"…the importance of collaboration and exchange across specific and knowledgeable actors of the innovation system; it is not the traditional experiential exchange of tacit knowledge across small firms alone; rather, it is the exchange of formal scientific knowledge and competences among agents of the (regional, national and sometimes even international) innovation system that matters, which could be strengthened through appropriate actions and incentives." (p. 9).

More so, the technology based, firm with strong innovation and R&D activities, seems to have better competitiveness; such company can continue to be progressive especially if it has strong technological and

innovation alliances (Parrilli & Elola, 2011). This is a result of clusters which have impact on the NTBFs; they create access to resources for the developing and growing of NTBFs. Either they are near or far; they facilitate development via resources (Maine et al, 2008). The networking, especially technology related social capitals, seems to assist the NTBFs to perform better. It is highly essential where the field of NTBFs is comprised of high diversified technological inputs, high need for technological relation and the level of technological transfer (Rickne, 2006). Furthermore, the following table shows the importance and evolution of networking in the establishment of NTBF enterprises:

Despite the importance of NTBFs, the government supports and the collaboration efforts, NBTFs are having problems due to the lack of business experience and marketing related information; though the entrepreneurs may

measurement technologies. The measurement appliances depend on their needy purposes but they are usually needed. Surprisingly, quality of measured valued is determined by the effectiveness of the measurement device (MEFOS). Consequently, there is a need for inspection; the inspections needs are often change. Thus, there is need for standard instrument to handle the situations. The good measurement devices provide the means to locate the problem; thereby reducing costs like time and money and improve the benefits (GE Company, 2007). Furthermore, the importance of measurement technology appears to go across the many activities, for instance, if materials, as an industrial input, fail or possess problems, this can have bad results on the company products and its company itself; therefore there are need for proper assessing and processing of materials in terms of safety, longevity, and reliability. These can be attained via the measurement technology. More so, there are increases in demand for micros devices or products; these require the strong measurement systems and methods (Helmut Fischer GmbH, 2010).

Therefore, there is a need for constant advancements in the field; the research in the wireless measurement technology has been increased because there is need for speedy data transfer, less-power consumption, and instant communication of the results. Hence, this leads to innovation of the industry. One of its inventions is a device developed for commercial purposes; it is called Wearable Wireless Biopotential Measurement Device. Its prototype was made and tested; the project was sponsored by Academy of Finland (Vehkaoja & Lekkala, 2004). The Wearable Wireless Biopotential Measurement Device is described below:

"The device utilizes 868 MHz ISM license free frequency band. Very low noise and good interference rejection is achieved using three electrode differential amplifier design and wireless signal transfer. The device has a possibility of calculating heart rate when ECG signal is measured, and transmitting only the heart rate value while conserving power" (p. 2177)

Similarly, locating of a moveable object with a concise measurement was a problem before but the obstacle was solved with the help of Local Position Measurement; the 3-D device had ability to operate in the 5.8-GHz and it could be used in the industrial arena. It could also able to do 1000 measurements within seconds with adequate and sufficient accuracies. Its prototype showed positive results. This device was highly needed in the industrial–scientific–medical (ISM) due to wide area, even it could be used in sport especially to position and control the car and carts (Stelzer, Pourvoyeur & Fischer, 2004). Additionally and electrically, a synchronized phasor measurement technology was developed to monitor electrical power generating plants; its primary function was to ensure system stability and reduces stresses. It could also help in understanding the dynamics of the system, and help in improving the reliability of operating system. It was tested at Southern California Edison in the USA; its results were favorable (Ballance et al, 2003)

In addition, to diagnose a prostate cancer (CaP) was a problem due to its tedious diagnosis processes; fortunately a Bayesian Multi-Resolution (BBMR) system was developed purpose to identify regions of CaP on the digital biopsy slides. The prototype testing of the tool revealed that the roots and different groups of Cap and these results made way for easy management of the disease. The automated cancer detector made on the basis of measurement technology (Doyle et al, 2010). Surprisingly, the impacts of measurement still go to traffic improvement. Dr Rudolf Dieterle. the Director of Federal Road Office in Switzerland, says:

"Measuring devices used to monitor speed, red lights and other physical quantities must exhibit high dependability to achieve credibility. If they were not dependable, they would become an object of criticism themselves and the checks would lose their effect. Police, courts of law and naturally road users, too, must be able to 100 % rely on the measured values."(METAS 2010; 2)

Likewise, Dr Christian Bock, the Director of METAS states "Our society relies on dependable measuring instruments and measurement results. They form the necessary basis for activities within our legal, economic and

social systems." (p. 3). Thus, measurement devices are paramount technology in the road safety; they provide accuracy, certainty and stability. With the better performances of these tools, the security and safety of traffic are (METAS, 2010). Therefore, the creation of NTBFs in the field of measurement technology seems to be important in the society and the commercialization of research results from the research institutes and the academic institutions appears to be one of right options for both regional and national growth.

2.3 Business Model

The question of why the business model appears to be important needs to be answered. There are three factors that are affecting businesses across the globe – rapid changes, high competition and high complexity. Their impacts are the stresses on the companies; almost everyday, the news presents the striving firms. The giant companies are shaking while SME are trying to survive. Many supporting organizations like World Trade Centre and World Banks try to calm the situation, yet the condition seem to be fiercer. What appears to be one of best solution is innovation, the creative destruction. Surprisingly, innovation cannot happen successfully without a business model (Morris, 2003). The business environments are changing rapidly and the changes are not permanent. Therefore, there is a need for a framework that enables the firms to attend to the changes as well as manage its knowledge. A good business model will aid the firms, operating in innovative industries, to keep their core competencies and survive the business world challenges, even grow simultaneously (Malhotra, 2000). Therefore, a business model innovation is an important tool for NTBFs because this will enable them to make profit from the technological advancements (Malhotra, 2000; Morris, 2003; Zott et al, 2010), even it is one of features differentiating NTBFs from others (Freitas et al, 2012). Hence, creating a business model is essential for a new firm, yet it is difficult to design. The business model comprises the interconnected and interdependent activities; these activities are performed by the firm and its supply chain partners (Zott & Amit, 2009). The center of activities is to create and capture values for the consumers (Chesbrough, 2007; Zott & Amit (2009). In designing this kind of model, two paramount issues have to be considered: element and theme. The design elements are foundations of the activities; they determine the activity system. They include content, structure and governance. Summarily, the design elements are just based on the identification and analysis of each activity of all players in the supply chain while focusing on the profit and customers' satisfaction. Hence, they are exemplified as "what to do", "how to do" and "who to do" (Zott & Amit, 2009).

"Today, innovation must include business models, rather than just technology and R&D… business models matter. A better business model often will beat a better idea or technology" (Chesbrough, 2007; 12). Therefore, the definition of business model can be derived from its functions because each of its functions may generate value for the company; it works as value proposition, market targeting, value chain defining, revenue generating, value networking, and competition strategizing (Chesbrough, 2007).

Furthermore, the business model gives a business a chance to be successful; a case of Apple is a clear example of designing and redesigning of a business model. A successful business is supposed to have these elements: Customer Value Proposition, Profit Formula, Key Resources and Key processes. Customer value proposition is a "job" to do for customers while the profit formula is a" job" to do for the company in order to be existing as a company. Moreover, profit formula has sub-elements which include revenue model, cost structure, marginal model and resource velocity; these have to be well analyzed. More so, the key resources comprise all properties of the company that are using for production (manufacturing of products or rendering of services). Similarly, the key processes are the steps or activities to be done purposely to ensure that the "job" for the customers and the company are achieved. When all these are well panned and determined to be attained, a new firm can be said that it possess a good business model (Johnson, Christensen, & Kagermann, 2008). Nonetheless, this section ends the first part of this paper, meanwhile the next section paper starts the empirical part of the study.

3 RESEARCH METHODOLOGY

A qualitative research method seems to be relevant to this study because "…qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2000; 3). Additionally, the qualitative research is done in a natural environment and it permits sound interpretation and application of the research results (Denzin & Lincoln, 2000). A planned and a well-executed empirical study with a purpose of deriving a resourceful meaning can be done successfully with the qualitative method. However, to ensure the scientific processes of the method, the

researchers should try to: simplify the main issue for the participants, explain the phenomenon in relation with experiences of the participants, indicate the activities of the steps, present the when, where and how the activities are done, discuss the entry mode to the participants and comment on the ethical issues (Creswell, 2003 & 2009). Due to scope and purpose of this study, the qualitative research method was employed and to achieve the scientific process of the method, the following table shows the details of the participants.

As it is explained by Glaser & Strauss (1999; 45) who state:
"Theoretical sampling is the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges. This process of data collection is controlled by the emerging theory. . . . The [researcher! may begin the research with a partial framework of "local" concepts, designating a few principal or gross features of the structure and processes in the situations that he will study"

Therefore, the participants were selected based on their contribution to the company formation and development, working and/or invention experiences, level of education and most importantly, their research commercialization expertise. They are grouped into three - habitual or serial entrepreneurs, young entrepreneurs and the consultants (both private and public). The habitual founders (three in number in this study) have had companies before, they are currently running firms and they still appear to have motivation to establish more technology based firms in the future. The new entrepreneurs are at their start-up phase; there are two in number. The last group comprised of three consultants; there are two interviewees who had worked with many companies before joining the government owned company; they represent public consultants and they are working in the two core sections for NTBFs development in the government owned company (Finnish Research Center). The last participant is a private consultant who specialized in the management consulting for research results commercialization.

The interview was used as a research method; it was a semi-structured type. There were seven face-to-face and one telephone interviews. In the all cases, two digital recorders were used and there were at least two researchers presented in the each case. Despite its semi-structure, the main issues of the research were concentrated and almost the same questions were asked though in few cases, there were confirmatory questions to cross check the previous respondents and to verify the theses of previous scholars. The recorded interviews were transcribed and the needed information was extracted. Nevertheless, the following section presents the research findings and its discussions.

4 RESULTS AND DISCUSSIONS

The findings are derived from the data analysis (after transcribing and data summarization) and it is elaborated in the first section of this section. In the same vein, the discussions are drawn from the research results and the literature review; it is a comparison of literary works and new findings.

4.1 Results

Based on the aforementioned groups, the data analyses were done in relation to the main focus of the study. Thus, the serial entrepreneurs were firstly analyzed and the others followed. From the data analyses, the outcomes are the discovery potentials which seem to be the first and foremost stage of technology entrepreneurship; it is explained that wide-range application is crucial because "one-way" application is no more profitable in the business world nowadays. The emphasis is on the multi-usage of the inventions and easy extension of core technology for future changes or demands. From the experience, participants claimed that this can be achieved from three perspectives – market drives, entrepreneurial motives and attitude of researcher. The market drives described as a situation where the corporations contacted the tertiary institutions and research centers to, probably via research projects, to find solutions for their need. The research findings of this end appear to be useful for industrial purposes and they may be applied to many companies in the same industry or related industries. The interviewees cited examples from their experience. However, it is emphasized that wide usage of the technology is the main discovery potentials of technology based entrepreneurship, at least, in case of measurement technology.

Furthermore, the experienced technology entrepreneurs stated that entrepreneurial motive is another way of achieving discovery potential. It is elucidated that the motive is primarily associated to personal interest and personality of researcher or technologist. According to the serial entrepreneurs, in this circumstance, the technology entrepreneur sees what people do not see and makes move to utilize the opportunity. It is explained that this is common in the first NTBF start-ups which is metaphorically mentioned as "entrepreneurial attempts"

and it is seemed to be natural motivation. The last perspective is an extension of second perceptive by emphasizing on the personality; it is when the personality of discoverer, usually engineers or scientists, plays important roles than any related factors. The habitual entrepreneurs pinpointed that if the inventor is either naturally entrepreneurial oriented or experienced entrepreneur, the chance to get a useful innovation and to commercialize it appears to be high. Confirmedly, the second group of the participants expressed their views in the same way and it was evident that they were naturally motivated to see their "creations" being used and to satisfy industrial problems. The third group shared their same view and cited many cases as their supports. Hence, these perspectives are the means to attain the first stage of technology based entrepreneurship. It is solemnly agreed by the respondents that it is the most difficult stage in the NTBFs development. And, it was recommended that advisory roles of the research institutes and government agents may easy the problem.

The second stage, according to this study, is team building; this is explained to be combination of different people with the different expertise. The participants stated that a recipe for a good team includes a person who knows the technology deeply (both how it works and how it cannot work), economist/businessman/entrepreneur, marketer, researcher/inventor and others. It is advised that the team should be open-minded; cooperation should be welcomed, tolerance should be encouraged, mission should be focused and the information sharing should be highly achievable. It is mentioned authoritatively by the serial entrepreneurs that failure to develop a sound team is like a failure from inception.

The third phase is business model designing; the participants did not specifically state a model but they did suggest that a model should include both major and minor revenue generations. According to them, this can be attained by wide range application of the technology and developing of more services for each application. Cost reduction and core competency sustenance and maintenance are also stated to be among significant elements to be considered while designing a good business model for NTBFs. They gave examples of profit chain generation like "core value" of the chain or the main technology satisfaction or solution, and the service packages. Likewise, the partnerships with both suppliers and consumers through strategic alliances of supply chain players, spending mainly on the business, and small personal salaries, are the examples of the cost reduction. More so, going international and continuous innovation of the technology via R&D are the main points for sustaining the firm competitive advantages.

From the immediate stage, the two stages were stated and explained that are really necessary for NTBFs – supply chain building and global market entry. The participants said that the key supply chain players should be identified, contacted and linked; with this action, the formation and running of the new firm is seemed to be well planned. For the global market entry, the interviewees advised that home market is often small for new inventions and even, having a patent right does not disturb the perpetrators to steal the ideas, reframe them and sell them. Thus, it is suggested that going international from the beginning is one of best ways to curb these violators and to grow NTBFs. The participants completely agreed that going across the boarders was supposed to be one of the first priorities of an inventor (or the company). It was synthesized that home market is relatively small for NTBFs because the main innovation appears to be new and probably difficult to present its usage, its impacts and all other necessary aspects of it; thus these require a broad trial area before it can be warmly welcomed by the users. More so, the respondents confirmed that the local market seemed to not be sufficient for development and growth of the company; thus it is good for its founding team to bear this in its mind to be global right from the company inception. Meanwhile, it is cautioned that the technology entrepreneurs should not go global too early and too late and the type of supply chain alliances to be made should be well examined legally, culturally and economically.

It was learned from the responses that networking is not only important but also it is highly needed for technology entrepreneurs. The respondents stated that this could be started, even, from the family. Personal connections via workplaces, classmates, and acquaintances play useful roles in the NTBFs development. Furthermore, it was recommended that the potential technology entrepreneurs should endeavor to attend exhibitions, fairs, conferences, workshops and seminars; it was urged that possible team mates could be found and potential buyers could be reached. It was illustrated, in one of the case study firms, the company started as one of results of university-business connections through a seminar and its prototypes development and testing were successful to due to this network. It was claimed that networking is one of the sources of referencing marketing which is very important for NBTFs.

During the discussions of networking, the issue of marketing intelligence for NTBFs was raised; the participants confirmed that once a discovery is made, the marketing information becomes a serious task. It is explained that marketing information is not only to be done by "hope market" but "all hope markets" should be proposed, examined and tried. It is advised that buying marketing intelligence service or consultancy can be of help. At

this stage, there was a question on the relationship among the suggested phases; the participants professionally confirmed that all these stages are interconnected or intertwined and interactive. For instance, marketing information is essential for research project or technology adventure, and this cannot be attained without a networking. Likewise, networking starts from school and business lives. Similarly, the technology application is achieved from the marketing information and this leads to team building that emanates from the existing connections. From there, a business model is designed based on the available business links and marketing intelligence. Furthermore, supply chain is built on these interrelated webs and going international is based the same webs. Therefore, all the stages are interconnected and the marketing information and networking link everything together. In the center of these activities is research which produces the inventions. The participants, especially serial entrepreneurs, expatiated that these processes were common and they used them in more than two of their start-ups. Thus, it is professed to be highly useful for potential technology entrepreneurs.

Furthermore, the issue of finance is a paramount topic in the NTBFs, therefore, participants of this study made it clear that personal savings and low remunerations were the best method to finance NTBFs and they did not support early invitation of venture capitalism; one of the reasons why firm G failed to survive lonely was early venture capital. The consulting group and firm F advised that venture capitalism is good when the NTBFs have firmly established and started growing. Likewise, all the respondents agreed that government supports especially financial aids played reasonable roles in the initial and growth stage of NTBFs yet it was lamented that most of these supports were not smoothly directed to right end and they are even now less available. It was urged that these government helps are crucial for more births of NTBFs. Henceforth, R&D confirmed to necessary for NTBFs though it is advised to not be too much in the early life of the company due to its capital intensiveness. However, it is explained that NBTFs need this and it has to be written, even in the business plan.

Last but not the least, entrepreneurship was identified to be highly necessary for NTBFs. Firmly, the participants stated that the technology entrepreneurs need business related knowledge especially entrepreneurial and marketing skills. Although, it was clarified that personal attitude might have influence on the entrepreneurial interest, yet it was urged that having such knowledge usually assist the successfulness of the NTBFs. Furthermore, the interviewees pinpointed the importance of the facilitating environment; it was explained that this enables and encourages more young people to try the entrepreneurial career. The business incubation, describing as a facilitator, was directed to the companies to encourage intrapreneurship in the firms; it was encouraged that this might motivate the new staff to try their entrepreneurship as well as using the employer as a backbone in their trial effort.

On the importance of measurement technology, it was mentioned that measurement technology is no more a mere sector due to "internet age" the society finds itself. It was confirmed that this sector support numerous companies and it reduced few of the world threats – global warming and medical problems – by providing accurate measurement devices and development of detecting and controlling instruments for these threats. Now, the next subsection presents a brief discussion.

4.2 Discussion

The claims of Tahvanainen (2011), Mets (2009), Hindle & Yencken (2004), Yli-Renko & Autio (1998), Meyer (2003), Rickne (2006), Miettinen (2006), Witt & Zellner (2005), Revest & Sapio (2010), Colombo & Piva (2012), Baptista & Preto (2009) and Freitas et al (2012) appear to be right especially from the measurement technology perceptive because NTBFs originate from a research and it can be a spin off especially from the tertiary institutions or research centers (Freitas et al., 2012; Mets, 2009; Tahvanainen 2011); this is happened to all measurement companies that partook in the study. The CEOs, team leader and the business development manager appeared to be inventors in one company or the other. These people confirmed that most of their main products started during the university days. One of them said:
"*The big hard step is to recognize an invention, for example, in the "XXX" case, the core technology was published in the scientific papers, so we did not recognize that there was something like invention made, so I think… university has made many mistakes publishing something before recognizing that this is a realistic invention… So, recognizing your invention, if possible, do not publish if you are in the university, find people who have different expertise than you*."

As it is explained in the literary works especially Siegel et al (2004) who argued that form a NTBF is tedious and thus requires a lot of efforts and trials; it was even emphasized by Suvinen et al (2008) a successful academia might be a successful entrepreneur, therefore the putting both heads together seems to be difficult. This is strongly abided with by the participants and this is reason they pinpointed and insisted on the good

teaming. It is said by all participants that the poor the team formation might lead to or give high the chances of failure of NTBFs. One of the interviewees vividly analyzed that:
"*Normally, when we have an engineer, he is like another engineer. I think if you an engineer, you should find an economist who understands that one plus one is not one but one plus one is two. So, have people with different background … engineering, accounting, managing, marketing, ideally if it could be possible IPR, maybe you have someone with some money, so the more the people you find in the start phase who are not greedy the better you are because when you start borrowing money after starting a company, is too expensive…more so, if you need a legal, having a legal student when you're starting a company would be a real ideal if he's capable, he's learning his job and the company saves money. If have somebody who can, accounting actually I don't recommend, if you have person with CEO capabilities, relationship, excellent… So, do not look for the same people but different people*."

Furthermore, Meyer (2003) and Witt & Zellner (2005) state that technology entrepreneurs can have a breakthrough if they could combine the academics and entrepreneurship together which it could start from the research results. Colombo & Piva (2012) found that specialization skills empower technology entrepreneurs who have high level of education than their counterparts though lack of managerial skills may impede their NTBFs successfulness. These relate the arguments of the participants that extremeness of either academic (researches) or entrepreneurship (businesses) may lead to death of NTBFs.

Morris (2003) and Colombo & Piva (2012) claimed that a good business model is a significant success factor for NTBFs; the outcome of this study conformed to it. The participants, whose their businesses were successful, expatiated that they were able to identify the chains of income generation via their model and simultaneously they were able to minimize their costs. On the hand, the failed firm (G) lamented that poor business model was the among the business storms that cracked the company. Besides, the business model is a perquisite for NTBFs formation (Malhotra, 2000 and Zott et al, 2010) and this is has to be well designed considering all activities of the firm (Chesbrough, 2007; Johnson et al., 2008 and Zott & Amit, 2009). This statement is the same with experiences of the successful measurement technology firms in this study; therefore, it can be agreed that business model designing is an important stage of NTBFs starting-up.

Heinonen (2009) and Rasmussen et al (2006) emphasized on the collaborations with both upstream and downstream of supply chain. Empirically, the participants of this study told that good liaisons would bring referencing marketing and thus, this would lead to successfulness of the NTBFs. One of them stated:
"*Networking is a key thing…, finding a good network of suppliers and the research partners or R&D partners, that is the key thing because that enables you to do things simultaneously, in parallel, instead of serials, if you try do everything in house…you have to do things in serials one after the other…*"

Likewise, globalization is explained to be included in the business plan of NTBFs; it argued Elston & Audretsch (2009), Rasmussen et al (2006), Siegel et al (2004) and Tahvanainen(2011) that local market may not sufficient. This is confirmed by the participant though it is cautioned to not too wide, too early and no too late. The following excerpt presents of the responses:
"*…basic technology development in the beginning and then start looking for the applications and look for that, so called, key low applications as soon as possible…Then, select the market where you want to focus on first and do not try to be too global, that is also difficult; so the market for you want to be and then focus on that and try to penetrate there first*."

The roles of networking and marketing intelligence are proved to be right in the context of measurement technology NTBFs. The claims of Elston & Audretsch (2009), Rickne (2006), Maine et al (2008), Parrilli & Elola (2011), Rasmussen et al (2006) and Yli-Renko & Autio (1998) seem to be right because from the following short analysis of essence of networking by one of the serial entrepreneurs in this study reveals that that networks is a facilitator for NTBFs development.

"*What happened, for example to XXX, was that we started it in 1994 and we had a clear deadline for the product to be ready, it was September 1995… It was European Aerosol meeting, it was holding in Helsinki. It was easy, basically it was easy for us to bring the product to the conference and exhibit it. And it was a clear deadline, without that deadline, I think, the company would be dead… That was our ultimatum deadline... in the conference, we met our first potential distributor, from the UK, who approached us, actually there were 2 companies approached us willing to be our distributors. We also gave scientific presentation in the conference. The real breakthrough was that one student from Tampere University of Technology, had been studying in Japan and the people from Japan contacted him that they heard about a company, XXX in Finland and they*

would like to distribute the company products. It was easier and trustful connection, and basically the real sales started in Japan. I think, we sold more than 40 units in Japan in a couple of year which boomed …"

To buttress the functions of these tool link pins – networking and marketing intelligence, one of the young technology entrepreneurs shared his experience that:
"…because this project has been done in co-operation with YYY and ZZZ, the ZZZ is the printing house in Europe. So it is already done in the, how to say, co-operation with the end-user. We have been doing done the development in Germany with the end user, that is our marketing point… now we are started using the social media networks and then we are using, of course, the fairs and then all these networks… are very important. ... We have …something like 200 potential customers. And now, how to say, marketing plan is that we will get contacts through the fairs already, these customers. But if not, then we can, how to say, have the names from the YYY and from other partners and then contact them directly and then starting... because it's a new concept also for the customer so that we are starting with measurement service so that going there and showing how it works. That's the basic idea…"

Therefore, the findings of this study appear to be on line with the existing literary works; hence the next section is the concluding part.

5 CONCLUSIONS

From the results and discussions, it can be concluded that a NTBF in a measurement technology industry can be started from the new technology potentials and wide usage of the technology. Thereafter, the inventor or technology entrepreneur forms a team; there are supposed to combination of inventor/innovator, entrepreneur, marketer, manager, leader, investor and any other possible business skilled people in the team. The team is expected to design a good business model for the new firm. The model is recommended to be comprehensive in which all sources of income should be well elaborated and its costs should be well enumerated; most importantly its plans and implementation should be realistic and achievable. Afterwards, the new company advised to build a standard supply chain from the upstream to downstream; this helps the NTBFs to survive, grow and sustain its existence. Furthermore, internationalization, even from the start, aids the NTBFs to survive due to the fact that home market may either not welcome the technology or insufficient for the innovation.

Notably, these stages are interactive and interrelated; they can move clockwise or otherwise and the research result is its center heart. Additionally, lubricants for the phase interactions are the networking and the marketing information. Pictorially, the following picture shows the conclusion:

Furthermore, NTBF formation is a stage when the company starts operation, the products begins to be sold and the services is ready to be offered. Of course, the firm development as well as product development is a continuous activity; thus NTBF formation is not the final stage and this model can assist potential technology entrepreneurs. More so, the issues of financing, R&D), government supports and the entrepreneurship found to be highly relevant for NTBFs; hence the technology entrepreneurs should try to attention them.

However, this study tried to reach reasonable number of population of measurement technology industry in Finland (at least 50% of the firms were analyzed) through the participants of the study yet it will be good to see the NTBF formation, using measurement technology firms, from other countries; possibly factors like national culture and policy may be presented either they affect the technology entrepreneurial activities or not. More so, the provided model in this paper needs to be tested by measurement technology experts or researchers, probably, their findings may give modifications to it. Furthermore, the model can be tried on the other technology based industries.

Finally, it is hoped that the identified key phases of the NTBFs can be critically examined by the fellow researchers to know the extent in which they are related to specific measurement devices and to probably pinpoint their sub-phases.

Acknowledgment

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measurement technology start-ups and to increase internationalization of Finnish measurement and information system firms. It concentrates on the mining, the renewable chemical, industry, vehicle information systems, sports and well-being, and game and simulation technology industries.

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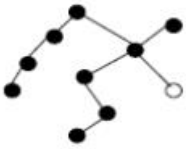
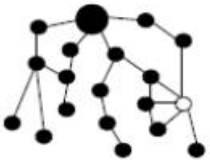
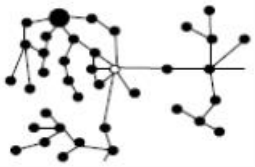
Table 1: *Systemic Evolution Model of New Technology-Based Firm (Revised)*

	1. New technology-based firm is founded • a new, technology-based firm is founded as a spin-off or as a private venture to exploit new technological solutions
	2. New, technology-based firm is linked to network or chain • new, technology-based firm develops initial customer and other connections • some of these connections become intensive • new, technology-based firm starts to become embedded in an innovation network or a manufacturing chain
	3. Cluster develops • positive externalities develop in the network; development and growth starts to feed itself • many new, technology-based firms are founded • locomotive effect takes place • locking-in into paradigmatic technological stage • firm is manufacturing and or technologically embedded
	4. New, technology-based firm is able to link into other networks and clusters • new, technology-based firm has developed firm-specific distinctive competencies • new, technology-based firm has reached critical mass • it is possible for the firm to link into other networks and clusters and become less dependent on the initial cluster

Source: Yli-Renko & Autio (1998, p. 258) The Network Embeddedness of New Technology-Based Firms: Developing A Systemic Evolution Mode, Small Business Economics 11: 253–267

Table 2: *The Details of the Participants*

Firm	Main Business	Position of Participant	Level of Education
A	Measurement Technology	CEO	PhD
B	Measurement Technology	CEO	PhD
C	Measurement Technology	CEO	PhD
D	Management Consultancy	CEO	PhD
E	IPR Management	IPR Manager	MSc
F	Venture Capitalism	CEO	MSc
G	Measurement Technology	Team Leader	PhD
H	Measurement Technology	Sales & Business Development Manager	MSc

Figure 1: *The Scope of this Study*

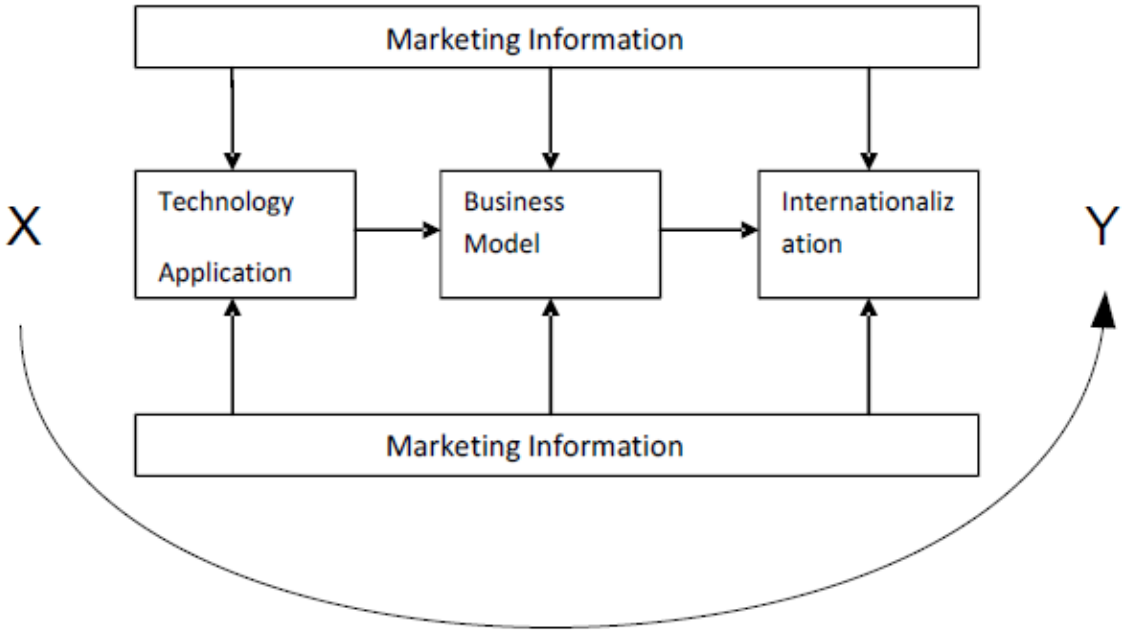
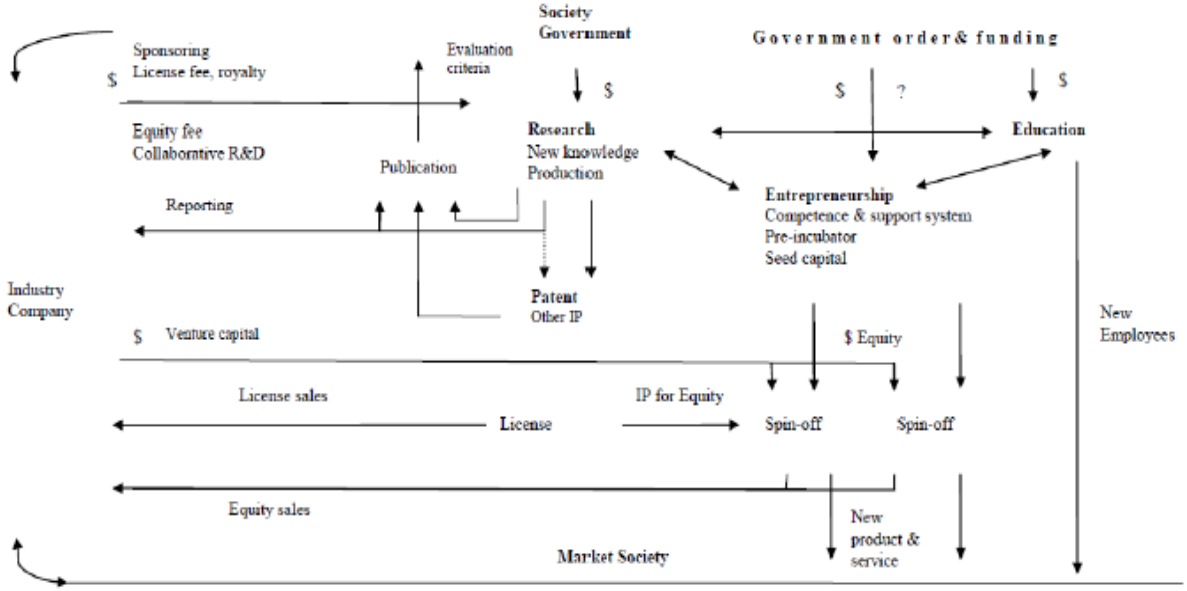
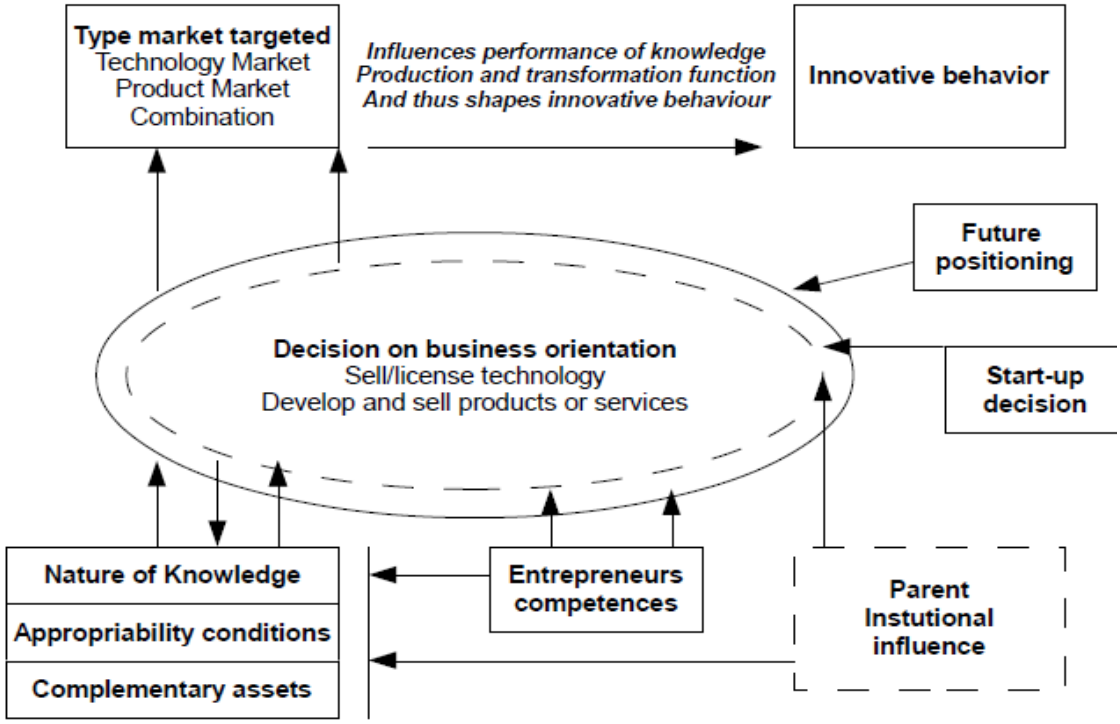


Figure 2: *University Base Model in the University-Industry-Government Framework (Revised)*



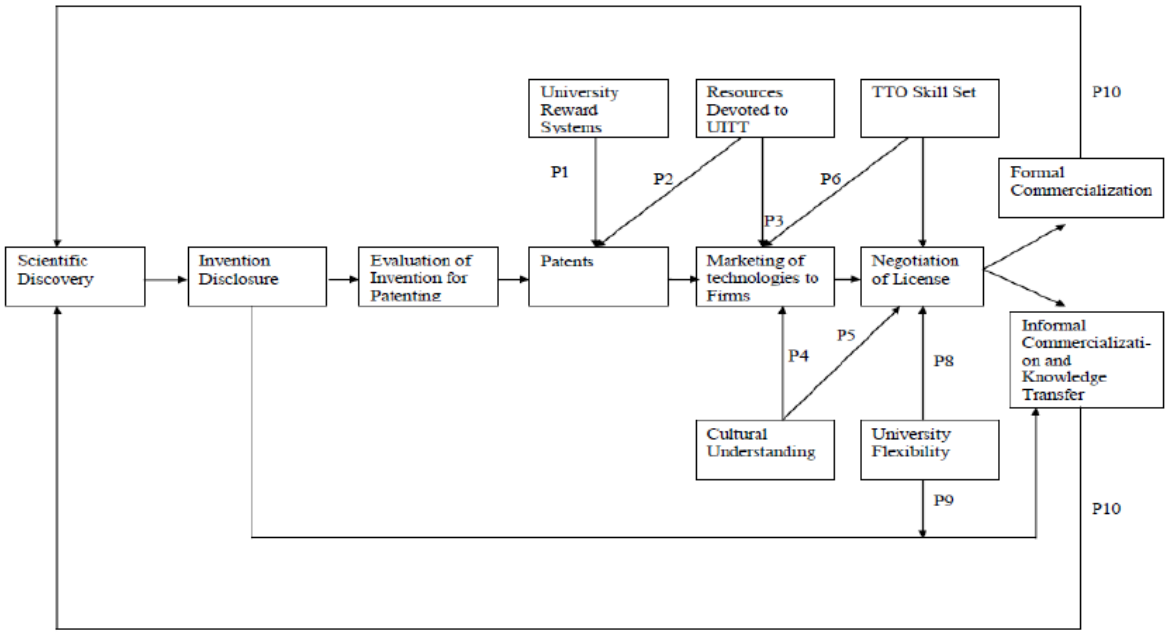
Source: Mets (2010, p. 83) Entrepreneurial Business Model for Classical Research University, Commerce of Engineering Decisions. ISSN 1392 – 2785

Figure 3: *RBSO's Decision on Commercialization (Revised)*



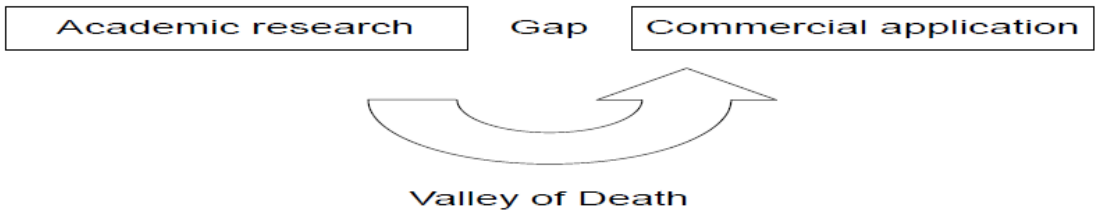
Source: Mets (2009, p. 74) From the University Environment to Academic Entrepreneurship European Council for Small Business and Entrepreneurship. Finland: Turku

Figure 4: *Organizational and Managerial issues in the University/Industry Technology Transfer Process (Revised)*



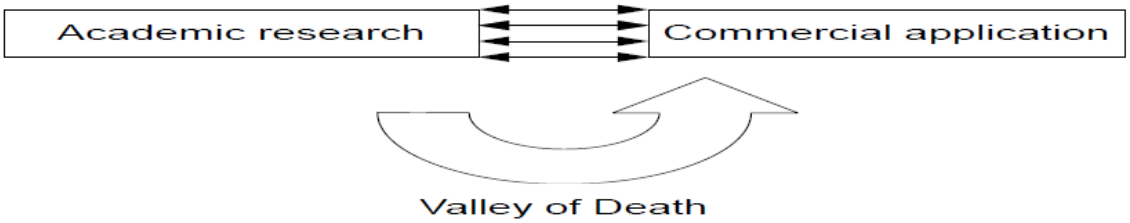
Source: Siegel et al (2004, p. 138) Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies, Journal of Engineering Technology Management, 21. p. 115–142

Figure 5: *The Gap between Academic Research and Commercial Application (Revised)*



Source: Rasmussen et al (2006, p. 10) Government Initiatives to support the Commercialization of Research: An International Benchmarking Study. Bodo Norway: Norwegian Research Council

Figure 6: *Networking and Cooperation (Revised)*



Source: Rasmussen et al (2006, p. 12) Government Initiatives to support the Commercialization of Research: An International Benchmarking Study. Bodo Norway: Norwegian Research Council

Figure 7: *Key Phases of Technology Based Entrepreneurship in the Measurement Technology Firm*