MASTER THESIS

PATENT SITUATIONAL AWARENESS: DEVELOPMENT OF A MODEL & MEASUREMENT INSTRUMENT

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Patent Situational Awareness: Development of a Model and Measurement Instrument

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Preface

This research project is the conclusion of my double degree master program Business Administration / Innovation Management & Entrepreneurship at the University of Twente and Technical University of Berlin. In the search of a master thesis assignment, I heard of the possibility to do a thesis on the area of intellectual property, more specifically that of patents. After contacting Dr. A.H. van Reekum, it was decided to attempt to investigate patent awareness and freedom to operate. This subject is relatively new in management literature and is thus more exploratory of nature. This allows for a contribution to future research and contemporary management literature. I hope I have done exactly that with this report.

This report would not have been established without the help of a great many people. First of all, I would like to thank my main supervisor, Dr. A.H. van Reekum for his time and effort in supervision and his enthusiasm in discussing the subject. Second, I would like to thank my second supervisor Dr. T. de Schryver for his accurate feedback and help in completing this research project. I would also like to thank Sjoerd Postma, Hendrik de Lange, Willemyn Slikker and the other two interview participants who want to remain anonymous. Furthermore, my thanks go out to all the respondents that have completed my questionnaire, without them this research project could not be completed. Last, but not least, I would like to thank my family and friends for supporting and motivating me throughout this final research project. Their support has been invaluable.

Tom ten Vregelaar

Enschede,
April 2015

Management Summary

This study aims to gain insight into patent situational awareness and patent litigation risk. The objective is to develop a model and measurement method for patent situational awareness. The report starts out with the general aim of patents and the patent system. It discusses what patents are and how they can be used. Afterwards, a suitable framework is searched for to create a conceptual model. This framework is found in the situational awareness model by Endsley (1995), which discusses the identification, comprehension and projection of elements in the environment. Furthermore, it discusses external elements which may influence the overall awareness. This model is taken as a basis and adapted to an organizational context of new product development. Here, different variables and factors are identified on the basis of patent functions and processes. This has resulted into a conceptual model which includes the variables firm size, propensity to patent, patenting experience, patent situational awareness, patent infringement risk and technology adoption decision.

One objective of this research project is to examine the established conceptual model empirically. To do so, a mixed method approach has been adopted. This means that data is gathered from two sources. First, a survey is created and evaluated on the basis of literary insight and interviews. This survey was distributed among 50 technological firms. Of this sample size, 21 firms responded leading to a response rate of 42%. After administering the survey, it has been evaluated once more to develop recommendations for future research. The second source of information is that of interviews with technological firms. Three interviews have been held with representatives of technological firms to examine the way in which they deal with patent information in the new product development process. These interviews provide more in-depth information and allow for the incorporation of contextual information.

The descriptive results from the questionnaire provide interesting and valuable data on patent situational awareness within companies. Scales were adopted that could later be used to develop overall scores for the variables. Results showed that firms score moderately on patent situational awareness. This is further supported by information from the interviews, which shows that firms only occasionally conduct patent information searches. This often depends on the newness of a technology. Furthermore, many of the small and medium sized firms do not employ someone that is specifically assigned responsibility of managing patents or patent information. These firms also often do not have an established patent policy.

After gathering the descriptive results, a reliability analysis has been conducted. All variables were deemed reliable, which means they can be used for regression analysis to evaluate the conceptual model. Not all the relationships from the model were confirmed. Patenting experience was found to significantly influence patent situational awareness, while firm size also shows a significant relation to patent situational awareness. While theorized, sector propensity to patent did not show a significant relation to patent situational awareness in this study. Furthermore, patent situational awareness showed a significant relationship to both patent infringement risk and technology adoption decision, but a mediation effect between patent situational awareness, patent infringement risk and technology adoption decision was not confirmed.

Due to the fact that this research project has been set up as a pilot study, evaluating both the model and the measurement method is important. Therefore, not only the evaluation of the model, but the functional feedback on the measurement instrument is important as well. Functional recommendations to improve the questionnaire items were:

- Alter the items on licensing to account for the fact that licensing is hardly employed by small and medium sized firms. It would be better to examine the considerations for licensing.
- Include items that test general knowledge about patents and intellectual property to further evaluate participant background and knowledge.
- Include items about contractual agreements firms make when collaborating with other parties in the development of technologies.
- Remove items that look somewhat similar as to reduce confusion with respondents when they are filling out the instrument

Not only functional recommendations to the measurement instrument can be made, but general recommendations for future research as well. These general recommendations are:

- Increase generalizability by increasing the sample size and choosing an even more specific target group. This means selecting respondents that fulfill a specific profile. This allows for more established results for a certain type of organization. The current set up works well for a pilot study, but does not deliver well-generalizable results, due to the variety of respondents and lower sample size.
- Use more than one respondent per organization for the questionnaire. This will lead to more valid results and reduces mono-method bias.
- Increase the validity of questionnaire items. This recommendation is closely related to the functional recommendation of altering the survey instrument. Changing some survey items will require new theoretical evaluation.
- Change several response scales as not to include a “Neutral” response category. This increases the validity of responses and reduces the amount of safe answers from respondents that are not fully knowledgeable or sure of their answer.
- Further examine sectorial and national differences. Different legislation may increase or decrease the importance of patent situational awareness and is thus interesting to examine in the future.

Patent awareness and freedom to operate is a subject that is not much discussed in management literature. This research was therefore exploratory of nature and provided initial insight into patent awareness and patent infringement risk. It has provided an evaluation of the established model and resulted in a measurement item and recommendations for future research. In these results lies the value of this study.

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Chapter 1: Introduction

In this chapter, an introduction to the research problem is given, after which the research question will be formulated. Similarly, an outline of the research project as well as the general structure of this report will be discussed.

1.1 Research Gap

Until recently, the academic literature on intellectual property (IP) was limited in scope and quantity and mostly legal of nature. Over recent years, IP has gained more publicity and developed into an important asset for the modern knowledge economy. This rise is popularity is reflected in the growing body of management literature with IP as its focus (Hanel, 2006). Numerous studies have been conducted on IP strategy and industry propensity (Levin et al, 1987; Arundel & Kabla, 1998; Cohen et al, 2000). These studies have shown varying perspectives on the usefulness of IP across different industries. For example, in the pharmaceuticals and medical equipment industry, patenting is more of a central vehicle (effective for more than 50% of product innovations) than in the electronic components industry (effective for 21% of product innovations). Across all industries, patents are being seen as a less effective means of appropriating from an invention than lead time, secrecy, complementary manufacturing and complementary assets. Nonetheless, the study by Cohen et al. (2000) reported that patents are seen as more effective than other legal IP mechanisms. As of 2012, WIPO reports an estimate of 8.66 million patents in use, an increase of 7,9% over 2011 (WIPO, 2013). These patents give the proprietor of a patent the exclusive right to exclude other parties from using the invention for the period of time during which the invention is covered by the patent. That means that for every patent proprietor, there can be several non-proprietors that are possibly infringing on a patent. While there is a part of the total body of patents granted that is not upheld or will not be enforced, non-proprietors do face possible litigation when they infringe on more important and valuable patents. For firms, the effects of litigation, particularly technology start-ups, can be disastrous and can often lead to bankruptcy. Chien (2012) looked into the negative effects of "Patent Assertion Entities" (PAE or "trolls") and found that High-Tech small firms (HTSF) are vulnerable targets for litigation, where the costly effects of a lawsuit have significant impact on the operational performance. Therefore, it is of pivotal interest for technology companies to reduce the risk of infringing patents, thereby effectively reducing the risk of litigation and the consequences thereof. IP literature however, is largely focused on the perspective of the proprietor, dealing with IP strategies and possible courses of action should other companies infringe. The perspective of the non-proprietor and how to reduce the risk of litigation is far less represented.

"Freedom to Operate" (FTO) is a concept in IP management that is well known for large technology venturing firms, but it is almost non-existent in the scholarly world. FTO is the ability to proceed with the research, development and/or commercial production of a new product or process with a minimal risk of infringing the unlicensed IPR or tangible property rights (TPR) of third parties. FTO is meant to determine whether a particular action in commercializing a technology can be done without infringing valid intellectual property rights (IPR). FTO is determined by conducting a specific patent search activity, often called a "FTO opinion". It requires sufficient resources and routines in the use of patent information. Due to the nature of FTO, as well as the general lack of awareness of the concept as well as IP in general, it is often overlooked by HTSF (Kern & van Reekum, 2012). However, as Chien (2012) reported, is it these firms in particular that are vulnerable and could be put in a completely disadvantageous position. Often, these firms lack the knowledge and capacity for

identifying intellectual proprietors before adopting any new-to-the-firm technology for use in products to be made and sold (Blackburn, 2003). Turning to available literature is of no help, because the concept is virtually non-existent. The practice of FTO is mainly one that is established at large firms, who have both knowledge of patents and sufficient resources. Small firms often either lack resources or general awareness of patents and their functions. Investigating the relationship between patent awareness and patent infringement risk in new product development will give insight into the role general patent awareness plays in evaluating risks in the new product development process. Assessing these risks is not only important for large firms, but small firms, specifically HTSF, as well. A clear relationship can lead to recommendations that help to reduce risk of litigation, thereby providing direct practical as well as scientific relevance to the field of IP management. Therefore, the goal of this research is:

- *To develop a model and measurement method for the role which patent awareness plays in the new product development process*

1.2 Research Question

Based on the research goal above, a central research question, as well as several sub-questions have been formulated. The answers to these questions combined support in reaching the main goal of the research process. The central research question summarizes the goal of the entire research process into a single question. The central research question for this research is:

- *Does patent awareness lead to lower patent infringement risk in the new product development process?*

This central research question is exploratory. The decision whether to adopt a technology or not in the new product development process is often surrounded by uncertainty. In order to measure patent awareness, a validated measurement instrument has to be developed. This project thus investigates the role of patent awareness and how it can be translated into a measurement instrument. In order to answer this question, as well as gain detailed insight into the workings of the variables, several sub questions have been formulated. These questions will help in answering the central research question. The sub questions are:

- *What is the function of patents?*

  Before turning to patent awareness, a clear understanding of patents and their functions are necessary. Interesting to research is why patents were developed as in instrument and how they are currently being used. This will be discussed in the literature review.

- *How do patents influence businesses?*

  After discussing the function of patents, a clear picture of why patents are important for businesses has to be made. A clear conceptualization of pro's and con's is necessary. This will be discussed in the literature review.

- *How can patent awareness be defined?*

  It is important to distinguish the most important aspects of patent awareness, so that a conceptual model can be developed. This will be discussed in the literature review.

- *Which factors influence and are influenced by patent awareness?*

  Besides patent awareness, it is important to identify contextual factors which may influence proposed relationships. This will be discussed in the literature review.

- *How can the key concepts be measured?*

  In this study an attempt at developing a conceptual model will be made. It is important to explain and argue how the variables are transferrable into measurable items. This will be discussed in the methodology chapter.

- *What is the role of patent awareness in the new product development process?*

  When the empirical study is done, conclusions have to be drawn from the data that is gathered. The results must be displayed clearly and the proposed relationships must be discussed. This will be discussed in the results chapter.

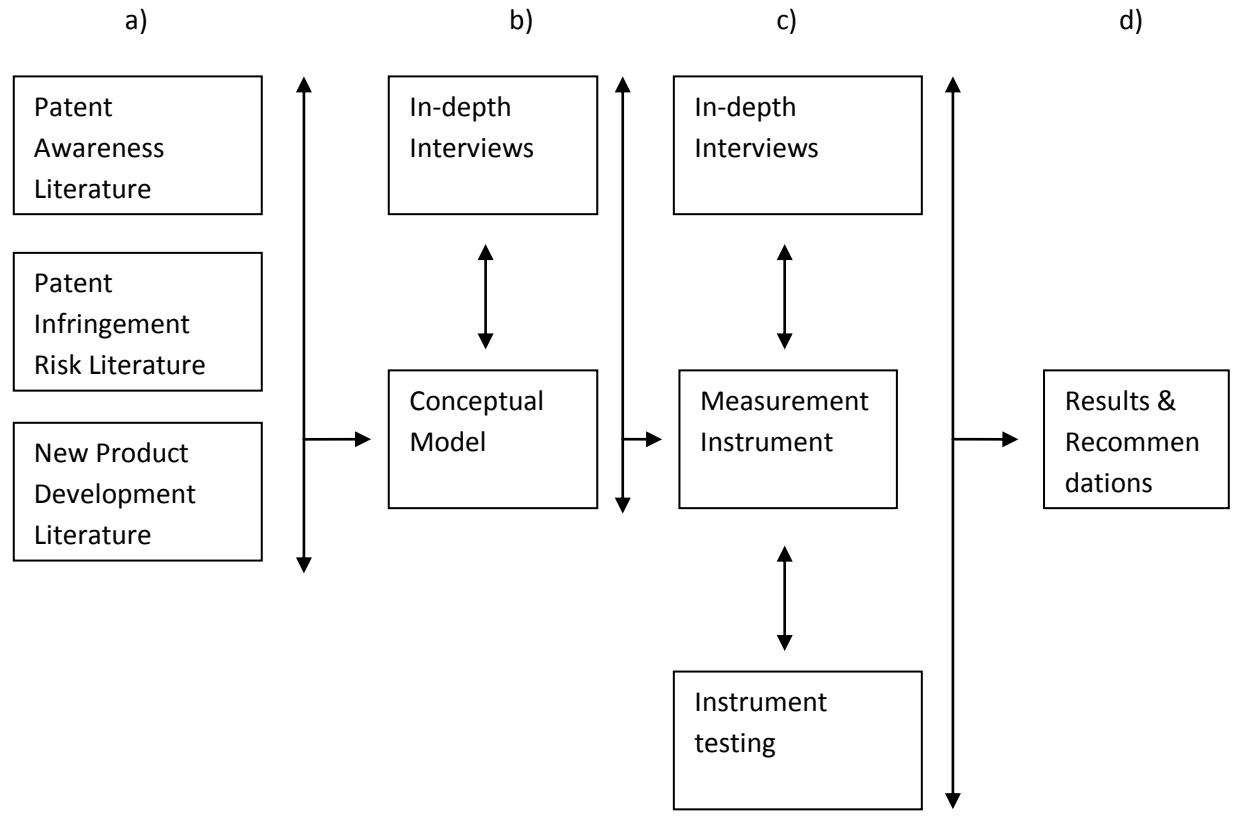
- *What are the most significant recommendations for future research?*

  Once the empirical data has been analyzed, hopefully recommendations can be made to further improve the model and measurement method so that it can be used in future research.

1.3 Research model

The goal of this research is to gain insight into the role patent awareness plays in the technology adoption process. Therefore, the assignment is to develop a conceptual model and measurement instrument for the relationship between patent awareness and patent infringement risk in new product development. In order to give an overview of the necessary steps to be taken, a research model has been developed. This research model can be found in figure 1, after which it will be discussed in further detail.

Figure 1: Research Model:



The proposed research model has been divided into four sections: a); b); c) and d). These sections distinguish separate steps in the entirety of the research. In section a), literature on patent awareness, patent infringement risk and new product development will be assessed. Literature on patent infringement risk will provide a background as to what the nature of the IPR instruments is as well as provide a legal perspective on possible risks of infringement. Literature on new product development will provide a background as to which factors are important in this process and how organizations structure it. The literature review will serve to provide a model on patent awareness that needs to be translated into a new product development perspective. These different perspectives will be used to develop the final conceptual framework in section b). Here, interviews with representatives from different organizations will be held in order to evaluate the established model from a practical point of view. Using literature on measurement instrument development, a suitable instrument will be developed in section c). The focus here is on developing a rigid and working instrument that can be used for further research with large sample sizes. Here, in-depth interviews will be held to evaluate the measurement instrument. In section d), the results from section c) will be analyzed and discussed. Similarities between the proposed framework and pilot

survey results will serve as a justification of the model, while differences between the two will be examined. Descriptive results and interview data will be compared and will be used to further evaluate the model. Furthermore, important issues for further research will be discussed. In chapter 3, a more detailed justification for the methodological choices in this research paper can be found.

1.4 Structure

In the table below, the structure of this thesis is presented.

Table 1: Thesis Structure

Structure	Content	Structure	Content
Chapter 1	Introduction Research Gap Research Question Research Model	Chapter 4	Results Conceptual Model Evaluation Survey Instrument Evaluation Descriptive Results
Chapter 2	Theory Intellectual Property Patents Patents as a legal –instrument Patent Awareness New Product Development Conceptual Model	Chapter 5	Conclusion, Discussion & Recommendations Conclusion Discussion Recommendations
Chapter 3	Methodology Research Design Design Science Survey Theory Survey Construction Interview Data Collection Target Group & Sample Validity Data Analysis		

Chapter 2: Theory

In this chapter, literature concerning intellectual property, patents, risk and technology adoption will be discussed. The reasoning that is used for this paper is deductive (Babbie, 1995), that is to say that we work from the more general to the more specific. Therefore, concerning patent awareness, applicable theories must be found that can then be applied to a more specific context. The theory, or also called systematic generalization, of the concepts in this paper will be based on existing literature.

2.1 Intellectual Property

In order to develop a conceptual model for the role of patent awareness in the technology adoption process, one must first have a clear conceptualization of what intellectual property rights, in particular what patents are and what they are meant to do. In this paragraph the principles of intellectual property rights and patents are discussed.

The notion of intellectual property needs to be seen within an entire system of innovation policy. Following research by Solow (1956) and Arrow (1962) it has been widely acknowledged that innovation is the principle engine for economic growth. Innovation is thus a main subject of countries and policy makers. The research by Solow and Arrow showed that in unregulated markets, innovation is typically inefficient. While markets in reality are almost never unregulated and fully competitive, the same reasons, also called market failures, form a condition for public innovation policy (Takalo, 2013). According to Takalo (2013), innovation policy measures can be classified in two categories. They can shift the risk-reward balance of innovation for companies, thereby providing incentives to innovate ex ante, or they can speed up the diffusion of innovation ex post. Intellectual property rights in their basis are an ex ante measure to provide incentives for innovation.

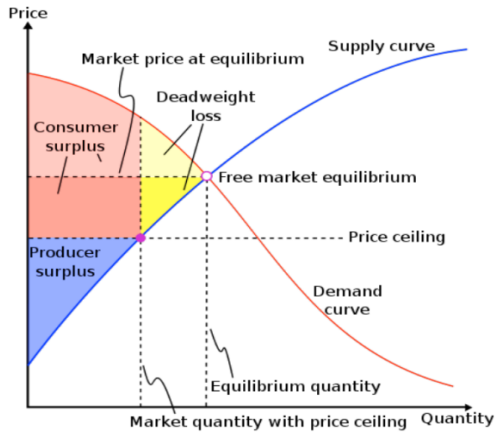
The question that arises is: "Where do these market failures originate from?" According to Takalo (2013), economic science has identified two broad areas of market failure, financial market imperfections and externalities. Financial market imperfections originate from the fact that R&D activities are in nature risky, human capital intensive and involve soft information (Takalo, 2013). This riskiness of R&D project leads to a situation in which outside investors find it hard to verify their returns. This leads to inefficient allocation of capital. The second area of market failure, externalities, arises when firms cannot fully take into account the effect of R&D investments beyond their profit. These externalities exist in various forms, like knowledge spillovers or imitation by other firms. R&D activities generate particularly large externalities, because new knowledge, technologies and creative works have the properties of public goods. This means that they are intangible, non-rivalry, non-depletable, impossible to dispossess and irreversible to transfer. At the same time, this new knowledge is often very expensive to produce and without the possibility of reaping the benefits, firms are unwilling to invest resources. It is for exactly this reason that intellectual property rights (IPR) were established. They provide an ex ante incentive for firms to innovate, as they turn the intangible aspect of public goods into a tangible product that is easier to commercialize.

The basis economic function of IPR is that by giving firms an exclusive right to exploitation, firms can charge a higher price than they would otherwise be able to. It provides legal protection for firms to exert this exclusive right. These legal instruments thus change public goods into a property, albeit

temporarily. The working of IPR can also be explained by basic supply and demand curves. IPR reduce supply, allowing producers to charge higher prices, creating more profit, thus solving some of the ex ante problems of innovation. There is a downside to this however, which is that there is a societal "deadweight" loss.

This societal deadweight loss comes from the fact a temporarily monopoly position is created, resulting in higher prices. In a free market, equilibrium would be achieved at a lower price but higher demand, resulting in higher overall welfare. Intellectual property is thus a system to stimulate innovation, but comes at the price of lower (temporary) societal welfare benefits. Within the IPR system of innovation policy, there are several instruments. These instruments all have their own characteristics and are used for different purposes. In this report, the focus lies solely on patents.

Figure 2: Supply & Demand Curves, adapted *from Samuelson & Nordhaus (2001).*



2.2 Patents

Patents are the most well known and spoken about instrument of intellectual property rights. Patents in the modern sense were already used as early as the year 1331, when in England, letters patents were being used to provide the recipient with a monopoly to produce particular goods or provide particular services (Wyndham Hume, 1896). While patent laws in countries differ, in most countries these exclusive rights entail the right to prevent others from making, using, selling or distributing the patented technological invention without permission for a certain amount of time. A patent thus gives not a right to use an invention, but rather gives the right to prevent others from using that invention. The patent holder thus creates a profitable situation in which he alone can exploit his innovation. Patents create a temporary societal cost (deadweight loss) at a trade-off for innovation stimulation. The set length characteristic of patents determines when the invention and knowledge becomes a public good, which allows society to benefit in its fullest.

On a corporate level, patents are used for a multitude of reasons and functions. Van Reekum & Kern (2012) distinguishes eight patent functions, which are either inherent or attributed functions. Inherent functions are those that are intended by the designers of the patent system. Attributed functions are those functions, outside of inherent functions, that are assigned by managers for corporate purposes. Inherent functions and attributed functions for patents are closely related, in that each inherent function has a corresponding attributed function, both which are based on the perspective of the beholder. This can result in opposites, as is the case with protection and liability, or it can be more complementary, as with incentive and asset. When discussing patent functions, one must keep in mind that these functions are closely related, and the main function to the observer can change depending on his position, or in other words, whether or not he is the patent holder. The patent functions are:

Table 2: Patent Functions

Inherent	Attributed
Incentive	Asset
Appropriation	Portfolio Component
Protection	Liability
Dissemination	Performance Indicator

Incentive

The incentive function of patents represents patens as input motivator for risky R&D investments. Patents serve as a basis for many businesses, in which many of the R&D investments have been incentivized by patents. Patent hold the promise of regaining and profiting from the initial risky investment in R&D endeavors.

Asset

The asset function of patents represents the patent as a financially valuated means of producing gains to the owner. It is the other side of the coin compared to the incentive function. Patents can be bought and sold to other firms, or can be used in license deals to allow other firms usage of the patented technology. Estimating potential profits for patents is difficult; therefore firms do not always activate their patents from a financial perspective.

Appropriation

The appropriation function of patents represents the patent as a mechanism of providing ownership over an investment or idea. By gaining a patent, a technology becomes proprietary, often enabling successful commercialization.

Portfolio Component

The portfolio component of patents is an extension of the appropriation function and represents the activity of synchronizing a set of patents and technologies with corporate strategy. There portfolio therefore serves as a basis for future endeavors and gains. Active management of a portfolio can lead to selling or out-licensing patents for those inventions that are of less strategic interest to the firm.

Protection

The protection function of patent represents the legal aspect of excluding others from using a proprietary technology. This function is therefore closely connected to the appropriation function. Unlike common thought, protection is not automatic, but it depends on the efforts of the firm. Firms require both internal and external intelligence in identifying possible infringement and screening for appropriable information. The protection function of patents focuses on:

- Prevention (Detecting possible infringement)
- Negotiation (Investigating and settling outside of court)
- Litigation (initiating and pursuing legal proceedings in court of law)

Liability

The liability function of patents represents the legal prevention of patent infringement. It is closely connected to the protection function and often results in either excluding a competitor firm from using an invention or agreeing upon a license construction. The liability function can be seen from two sides, either that of preventing other firms from infringing or prevention of own infringement of another firm's patents.

Dissemination

The dissemination function of patents represents patents as a source of information. This function of patents is connected to the mandatory publication of the inventive step of the invention. Firms can analyze patents for inspiration for new ideas, or use the information provided to make alterations and "invent around" the patent so they can use it for commercialization. The dissemination function of patents is central in this research project, as identifying and assessing relevant patents (and thus use patents as a source of information) is central for patent awareness.

Performance Indicator

The performance indicator function of patents represents patents as a means of assessing the firm's technological performance. It is closely related to the dissemination function of patents. It can be used to build a positive image for a firm and can attract potential investors.

Patents are requested by application at a patent office. In order to acquire a patent, full public disclosure of how to make and use the invention, often called the inventive step, is required. This creates a risk for companies in which competitors can build on the knowledge that was created. A patent can include one or more claims that define the scope of protection that a patent offers. After examination, the application is either accepted or refused, resulting in a grant and issued patent or a rejection. For an invention to be patentable, patent law requires that it must (European Patent Convention, Article 52):

- Be patentable subject-matter, i.e. a technological invention.
- Be novel
- Require an inventive step
- Have an industrial application

Because patents are granted by national patent offices, they are territorial by nature. Companies seeking protection in several countries will also need to apply for a patent in all of those countries. While there is a trend and movement towards a more centralized system, applying is currently still necessary in separate countries. There are currently systems in place to increase harmonization;

however they do not posses any direct legal effect. Examples of these are the Paris Convention for the Protection of Industrial Property and the Patent Cooperation Treaty. A more detailed analysis of patents as a legal instrument and their benefits and risks will be provided in chapter 2.3.

2.3 Patents as a legal instrument

In chapter 2.1 and 2.2, the basics of intellectual property and patents have been discussed. Different functions of patens have been identified. Among these functions were appropriation, protection and liability. These functions are closely related and deal with gaining a patent on an invention, which can then be used to protect an invention and thus prevent others from using that invention. When infringement has been detected, firms often proceed with negotiations and either settle out of court or initiate a litigation procedure. Here, a more detailed analysis of the legal aspects of patents will be given, after which the different options upon infringement will be discussed.

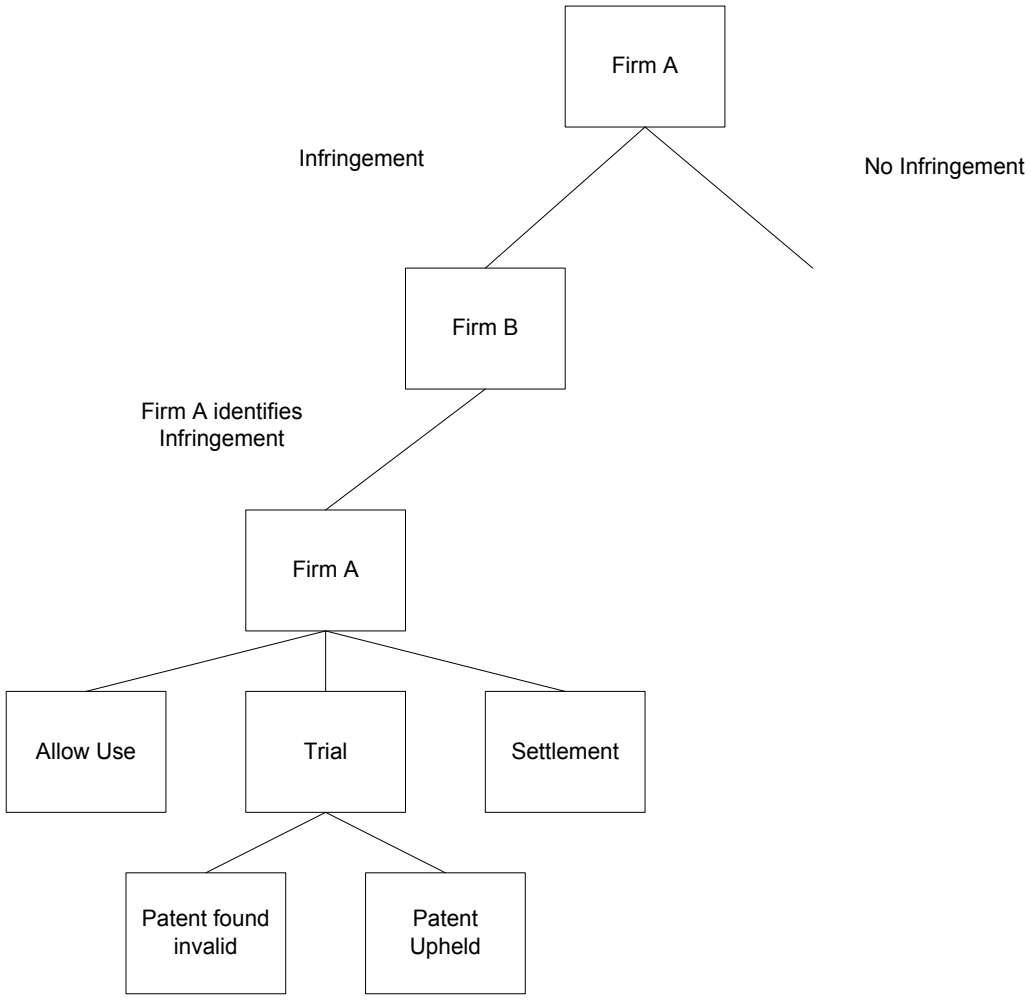
The possession of a patent can (at least in principle) allow an inventor to appropriate the benefits generated from their invention (Kitch, 1977). The protection offered by a patent would provide limited value if it did not protect the inventor against mere variations to the original idea. It is for this reason that the concept of “patent scope” has been established (Kitch, 1977). According to Merges & Nelson (1994) a patent application, besides the previously discussed requirements, is composed of two components. The first is the disclosure of the inventive step, which describes the techno-economic problem faced and the “precise characterization of the ‘best mode’ of solving the problem” (Merges & Nelson, 1994). The second is a set of claims, which specify variations or possible improvements that could be made to the patented invention to adapt it for different purposes (Walker, 1995). The positioning of the patent claims in the inventive space can vary. They can refer to marginal variations or more diverse variations (Novelli, 2014). These variations thus provide exclusion rights to patentees. “Patent scope”, also called “Patent Breadth” or “Patent Width” refers to the level of leniency used by the regulator in granting exclusion rights to patentees (e.g. Denicolo, 1996; Merges & Nelson, 1994). A larger patent scope therefore means that more variations of the original inventive step have been covert in the patent, providing more exclusion rights to the patentee. A large patent scope can provide both benefits and drawbacks. A high amount of claims can act as a deterrent to other firms from building on the knowledge underlying the patent, as it corresponds to an increased probability that a new invention in that area might infringe at least one of the patent claims (Kitch, 1977; Merges & Nelson, 1994). On the other hand, if those claims are spread out across multiple technological domains (or technological classes), firms are often not able to focus their attention to all of them, thereby failing to pursue developments for all of the claims (Merges & Nelson, 1994; Ocasio, 1997).

One of the inherent functions of patents is that it provides protection of an invention for the patentee. This protection is not automatic, but requires external intelligence. Possible infringement needs to be identified. Infringement occurs when a firm employs commercial activities using a technology that is already claimed in a patent. If firm A holds a patent and identifies firm B infringing, there are three overall paths that can be taken. The first is a straightforward “allowance”, thereby effectively letting firm B use the patented technology. The second is settling out of court, thereby entering negotiations and agreeing upon an amount for damages incurred and/or establishing a license deal. The third is going to trial, in which the patent can be upheld and firm B has to pay for

damages and is excluded from using the invention, or in which the patent is found invalid and firm B is free to use the technology. An overview of the process can be found in figure 3.
The possibility of a patent being invalid is especially interesting. Patent invalidity means a patent office has granted a patent, but that it can still be declared invalid if at least one of the requirements for patents has not sufficiently been met. If infringement leads to a trial, defense will often call for either non-infringement or patent invalidity (Ford, 2013). Patent invalidity is judged on the official requirements, which are that an invention should be novel, require an inventive step, have an industrial application and be patentable subject-matter. When one of these requirements are found to have not been met in hindsight, a patent can be declared invalid. A recent example of a patent that was found to be invalid is that of Apple's "Bounce Back" patent. This patent was found to be invalid, because it was predated by a patent granted to AOL.

Overall, trial is a very costly procedure that often both patentee and infringer want to avoid. Settlement out of court is therefore an option that is often used, but can still lead to potential bankruptcy for small firms. Especially small firms, which often lack resources and experience, would thus do wise to avoid the risks of litigation.

Figure 3: Possible reactions to Infringement



2.4 Patent Awareness

Over the years, patents have gained more attention from both management scholars and firms. The patent functions discussed in chapter 2.2 show that there are many possibly valuable aspects, as well as risks for firms that deal with patents. In order to use patents as an instrument to its fullest, one requires awareness and understanding of the patent system. Pitkethly (2012) studied IP awareness in the UK and found that especially small firms are effectively unaware of the IP system. This means that small firms forgo opportunities by searching patent literature (Graham et al, 2009). At the same time, they may also be at risk of infringing on already patented technologies. Although the survey was large scale, Pitkethly used a rather straightforward concept of IP awareness. The main issues he addressed were (Pitkethly, 2012):

- IP knowledge and understanding
- IP management practices
- Awareness and use of IP information and advice

While the operationalization Pitkethly used is valuable for assessing whether firms know what patents are and how they function, it is less interesting from a management perspective, because it does not deal with the external intelligence as was discussed in the protection function of patents. Gathering and using information so that it can be used to a firm's advantage can be seen as a contextual situation in which awareness and intelligence is required to achieve optimal results. Instead of focusing solely on "knowledge of IP instruments and usage thereof", taking a broader approach to patent awareness is therefore chosen. Pithkethly can thus be used as a basis for some items, but a deeper conceptualization of patent awareness is necessary.

2.4.1 Situational Awareness

The approach to patent awareness taken in this report is based on the "Situational Awareness Model" (Endsley, 1995), which can be found in figure 4. The model has been previously applied to patent awareness by Dexter Nijmanting (2012) in his Bachelor's thesis at the University of Twente. The model used in this report will show similarities in some areas, but will also be adjusted to the specific research objective.

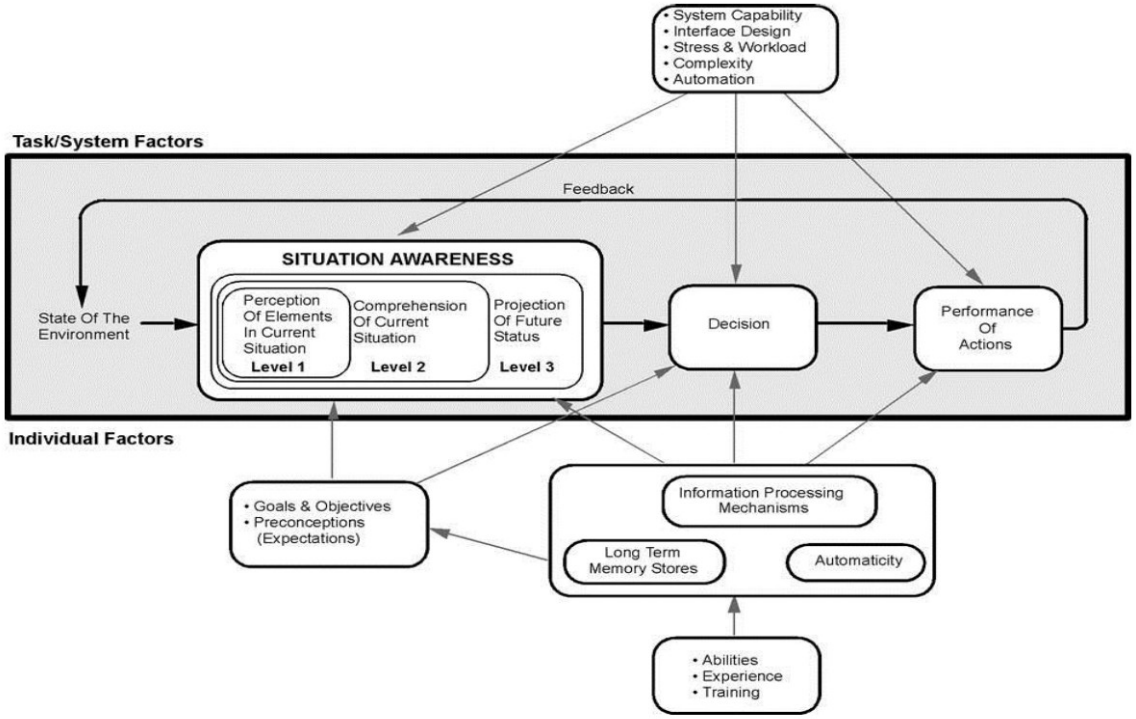
Endsley (1995) defines situational awareness as: "The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". This definition consists of three hierarchical phases which will be described in more detail. It is important to separate situational awareness (SA) from situational assessment, which is the process of achieving, acquiring or maintaining SA.

The first phase of situational awareness is that of "Perception of Elements in Current Situation". Central in this phase is to perceive the status, attributes and dynamics of relevant elements in the environment (Endsley, 1995). In terms of IP and patents, one could say that perception and identification of relevant technologies and patents is critical in this phase.

The second phase of situational awareness is that of "Comprehension of Current Situation". Here, a synthesis is made of elements gathered in the first phase (Endsley, 1995). Phase two goes further in the sense that it is aimed at not only identification of relevant elements, but also understanding of

those elements. Here, the decision maker forms a holistic picture of the environment. In terms of IP and patents, the decision maker must comprehend the scope and thereby the strengths and weaknesses of the claims in patents that are identified in phase one.

Figure 4: A Model for Situational Awareness in Dynamic Decision Making (Endsley, 1995)



The third phase of situational awareness is that of "Projection of Future Status". Central in this phase is the ability to project future actions of the elements in the environment (Endsley, 1995). To achieve this, a thorough identification and comprehension of the elements and dynamics in the system is required. In terms of IP and patents, this relates to tying the correct conclusions to possible actions. Litigation is more likely to occur if a patent is particularly strong and valuable to a competitor's commercial activity. Likewise, if the claims in a patent are ill-defined, there might be a possibility to invent around the patented technology.

The overall situational awareness is influenced by the goals, objectives and expectancies of the decision maker. Furthermore, not everybody is able to acquire the same level of SA, due to the fact that information processing mechanisms (i.e. innate abilities, experience and training) influence the ability to gather and analyze information, but also make the correct decision. Once a decision has been made, performance can be judged in comparison to previously set expectations. The new situation can then be seen as the overall input for the model, resulting in a SA cycle.

When comparing this model to the concepts measured by Pithkethly (2012), there are distinct differences. Pithkethly only focuses on a momentarily assessment of a firm's knowledge of IP and its IP practices, thereby not assessing contextual elements and environmental influences. The situational awareness model specifically tries to deal with environmental intelligence by clearly

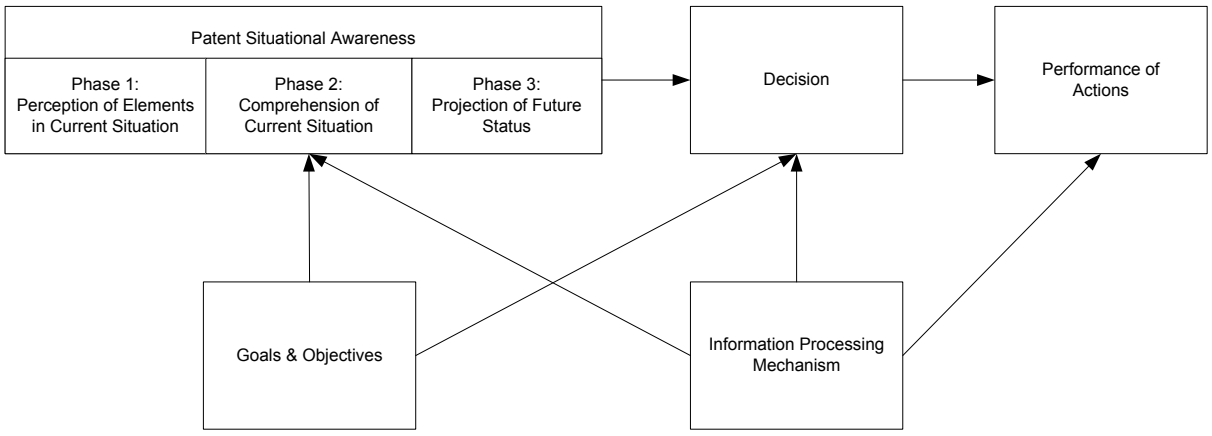
introducing phases in which elements in the environment must be perceived and understood, as well as projected into the future. It allows for awareness to be seen as a process as well, rather than a static outcome or score.

2.4.2 Conclusion

Using the model of situational awareness as a basis for patent awareness, we can identify several important elements. The relationship between analyzing and comprehending the environment and making the correct decision based on that information is important with regard to technology adoption. It is in that process that situational awareness can effectively make or break a firm's future endeavors. The definition for patent situational awareness in this research project is adapted from Endsley. Patent Situational Awareness is: *"The perception of relevant patents, not owned by you, in the environment within a volume of time and space, the comprehension of their meaning, and the project of their future status and consequences in the future".* Using this definition, we rise above the general notion of knowledge of the patent system, and move towards a notion that entails identification and understanding of relevant environmental factors. Overall, from the initial model for SA by Endsley (1995), we can identify several elements that can be used for a model for patent awareness. These elements can be found in figure 5. The elements of stress and workload have been exempted from the model, because the area of interest in this research lies more on firm or person characteristics than on psychological state of mind. The elements that are important for patent awareness are:

- Perception of Elements in Current Situation
- Comprehension of Current Situation
- Projection of Future Status
- Goals & Objectives
- Decision
- Information Processing Mechanism
- Performance of Action

Figure 5: Preliminary model for Patent Situational Awareness, derived from Endsley (1995):



2.5 New Product Development

In Chapter 2.4, the Situational Awareness model and its possible application to patent awareness has been discussed. Patent situational awareness has been defined as "*"The perception of relevant patents in the environment, not owned by you, within a volume of time and space, the comprehension of their meaning, and the project of their future status and consequences in the future".* To make further use of this definition, a specific time and space in which patent awareness is especially applicable must be found. In a business context, patent information is often being used in technology adoption decisions. Technology adoption can either be in-house development or external technologies. Technology adoption will be viewed from a "New Product Development" or "NPD" perspective, in which firms aim to develop new products, using new or existing technologies. Within the NPD process, important concepts are the "Innovation funnel" and "Stage Gate model". A detailed description of these concepts can be found in the appendix. These concepts are aimed at structuring the new product development process, in order to make well considered product development decisions. Final product decisions are mainly based on economic prospects. Under a rational frame of product development, the decision to adopt new technologies or projects is determined by the costs and expected returns to be generated by the investments (Attewell, 1992). When technology is first discovered, the novelty of the innovation makes it difficult for the firm to estimate its cost and benefits, because its usage is surrounded by uncertainty and imperfect information (Jensen, 1982). In technology development, uncertainty is often very high initially (Cooper, 2006). As the innovation process progresses, clarity often increases and companies can better select ideas worth pursuing. The high uncertainty of projects can be labeled as risky. This is especially true for smaller firms, which have a smaller portfolio of projects. Large firms often have a large portfolio of projects in which they can balance risky projects with less risky projects. Smaller, entrepreneurial firms often bet on a single project. The risk and possible consequences for these firms are therefore graver than those for large firms. Identifying risk and establishing freedom to operate is thus important during that phase. The success of a product innovation is determined by the interplay of external influences and internal circumstances (Keizer et al, 2002). To increase the chances of successful product commercialization, internal activities during the NPD process must be aimed at reducing the uncertainty associated with the innovation. Out of the different areas in which risks might be identified, IP is one that is important to firms, because its consequences can be severe. As discussed in chapter 2.3, litigation can often result in bankruptcy. Increasing better identification and assessment of risks, thereby establishing freedom to operate on the area of IP can thus help firms increase the chance of successful product commercialization. It is for this reason that the new product development process was taken as a context for patent situational awareness.

2.6 Conceptual Model

In chapter 2.4, the model for situational awareness as proposed by Endsley (1995) has been discussed. The definition for SA as proposed by Endsley is: *"The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future".* In Chapter 2.5, a specific context, that of the NPD process, has been identified in which situational awareness and in particular patent awareness is of utmost importance. The objective for the NPD process is that of risk reduction and profit maximization by successfully launching new products. Several elements from the original model by Endsley that are applicable to patent awareness have been identified in a preliminary model in figure 5. These elements will be used as a basis for forming the final conceptual model. The elements from Endsley's model, as well as additions to it, will be discussed separately. These elements will form the final conceptual model for patent situational awareness in new product development from the perspective on the non-proprietor.

2.6.1 Perception of elements in current situation

In Strategic Literature, the importance of effectively adapting to the external environment is widely accepted (e.g. Andrews, 1970). A firm's competitive position, financial success and even survival depends on its ability to scan, understand and adapt to environmental conditions (Daft et al., 1988). The external environment can serve as a great source of strategic information. The element of perception in the SA model entails identification of elements in the environment. It does not yet include interpretation of those elements. Environmental scanning is defined as *"Systematic, formal searching, using formal methodologies for obtaining information for a specific purpose."* (Choo, 1998).

For patent awareness in the NPD process, identification of relevant elements in the environment entails scanning the environment for relevant patents that may be infringed when adopting potential new-to-the-firm technologies. Not only the patents itself, but also the owner of those patents can be important. Identification of these patents can originate from different sources, in which two stand out which are most used:

- Usage of patent databases
- Consultation of external IP experts

Within the framework of this research, evaluation of the perception and usage of these instruments is required. Testing will mainly be done on the existence of usage of the instruments, instead of the actual differences in which they can be used. In the context of this research project, perception of elements in elements in current situation is defined as: "*"Systematic, formal searching and identification of patent information, using formal methodologies for obtaining information for a specific purpose."*

2.6.2 Comprehension of current situation

Perhaps the most important aspect of the SA model, comprehension of the current situations entails an understanding of the elements that have been identified in the previous phase. Whereas identification of relevant patents that other companies hold is important, it is the eventual understanding of them that drives future decisions. This aspect is closely related to the dissemination function of patents, in which patents serve as a source of information. Understanding the identified

patents is closely connected to the overall workings of patents in general. Like previously discussed, several important aspects can be identified:

- Patent Scope
- Technological Domains Covered
- Patent Impact (i.e. Citation Count)
- Patent owner's competitive position

In this phase, the emphasis is on deriving important (strategic) information from the patents that have been identified is the previous phase. It is thus important that the information is interpretable and that there is a fit between information gathered in the previous phase and the goals for which it is used. Thorough identification and understanding of patent strength and ownership as well as possible alternatives reduces uncertainty and thereby liability risk. In this research project, comprehension of current situation is defined as: *"The ability to understand and derive information from patent information sources".*

2.6.3 Projection of future state

In the previous phases, possible patents have been identified and evaluated on strength and scope through environmental scanning. This functions as the first step of dealing with environmental uncertainty (Daft et al., 1988). In this phase, the emphasis lies on investigation of the identified patents, their possible consequences for the organization and the most suitable responses. The planning school of strategic management emphasizes the importance of systematic analysis and integrative planning. Rational investigation of information and its integration in the organization's existing operations is a central theme (Ansoff, 1979). The central themes in the planning school of strategic management thus correspond with the "projection of future state" phase in the situational awareness model. The process of projecting a future state heavily depends on the environmental scanning conducted in the previous two phases. Nonetheless, actual situational awareness comes from transforming the information from environmental scanning into future possible scenarios. In the NPD process, especially when there are multiple technological options, it is important to ask the "what if?" question. Correctly assessing the likelihood of litigation can be the difference between success and bankruptcy. Correctly using patent information searches, may lead to spotting early infringement (Sandal & Kumar, 2011). Market intelligence is necessary to correctly assess possible competitor reactions to infringement. Company track records on litigation can serve as a basis of predicting the likelihood of legal action. Furthermore, examining patent information can lead to new technological insight for future products. Assessment of the technological domains covered may lead to the conclusion that a patent grant might have been invalid. Projection of the future state does not only entail the patent and the owner thereof, but it requires foresight into environmental dynamics which may transform the business context. Not only does this require detailed information, but a holistic view of the environment and its opportunities as well. One could say that full situational awareness can only be achieved if successful environmental scanning, through perception of elements and comprehension thereof, is combined with the assessment of the projection of future state. Only if all three elements are present can one speak of full situational awareness. In this research project, projection of future state is defined as: *"The evaluation of plausible alternative futures and their consequences for the organization".*

2.6.4 Decision

The decision element that is used in the model of SA is rather straightforward when applied to the role of patent awareness in the NPD process. Based on the input from patent awareness, the decision to adopt certain technologies into a product can be either yes or no. A negative projection of future state should thus lead to a no, and a positive projection of future state should lead to a yes. Interesting is the possibility of a third and a fourth option, that of requesting a license or inventing around a patent. By agreeing to a license deal, the firm receives permission to use a technology in return for a fee. A license can very often be a good solution, especially if estimated future profits far exceed the license fee. Inventing around a patent is possible when firms decide that the claims covered in a patent can be circumvented by making technological changes to technologies, therefore altering the main technology into one which does not fall under the claims of the existing patent.

In chapter 2.4, the NPD process has been discussed. Many firms combine the innovation funnel and stage gate concepts as to control the development process and aim for optimal results. A critical aspect of that NPD process is controlling for possible risk and uncertainty that may arise in adopting a technology for future commercial use. For the final conceptual model, a variable must therefore be present that encompasses the risk in this NPD process. Wood and Scheer (1996) argue that evaluation of an offering may be a function of perceived benefits, costs and risk. In light of this research project, that focuses on IP and technology adoption in the NPD process, perceived risk is of interest because it is connected to the liability function of IP. Perceived risk therefore serves as a variable that is influenced by situational awareness and influences the final decision to adopt a technology. It is defined as the magnitude of adverse consequences felt by the decision makers in the event of a wrong choice, and the level of uncertainty surrounding a decision (Kohli, 1983). Patent infringement risk has therefore been added in the final model as a mediating variable between patent situational awareness and the decision variable. Litigation risk is defined as *"The risk that legal action might be taken against to company in the near future"*.

2.6.5 Performance of Action

The performance of action for patent awareness in the NPD process is the effective reduction of uncertainty, leading to better decisions, thereby reducing risk of litigation. One could say that a well informed decision to take a risk is better than a blind bet on a fruitful ending. Especially for small firms, which often already focus on a single project, reducing the risk is of utmost importance for survival. For these firms, establishing freedom to operate can be life-saving. It does not guarantee success, but it does increase the chances of it happening. To increase the validity of the final model and avoid feedback relationships that are difficult to measure, performance of action has been exempted from the final model.

2.6.6 Information Processing Mechanism

In the model of situational awareness, the information processing mechanisms entail the enabling firm factors that influence the overall awareness, decision and performance evaluation of the entire process. For the model for the role of patent awareness in the NPD process, the information processing mechanisms can be seen as firm-level factors, which may strengthen or reduce the effects of patent awareness on litigation risk. These factors are especially interesting, because they can provide additional insight into relationships, showing which factors play a more important role than

others. From literature as well as logical reasoning, three important factors can be identified that might influence the strength of the effect of patent awareness. These factors are:

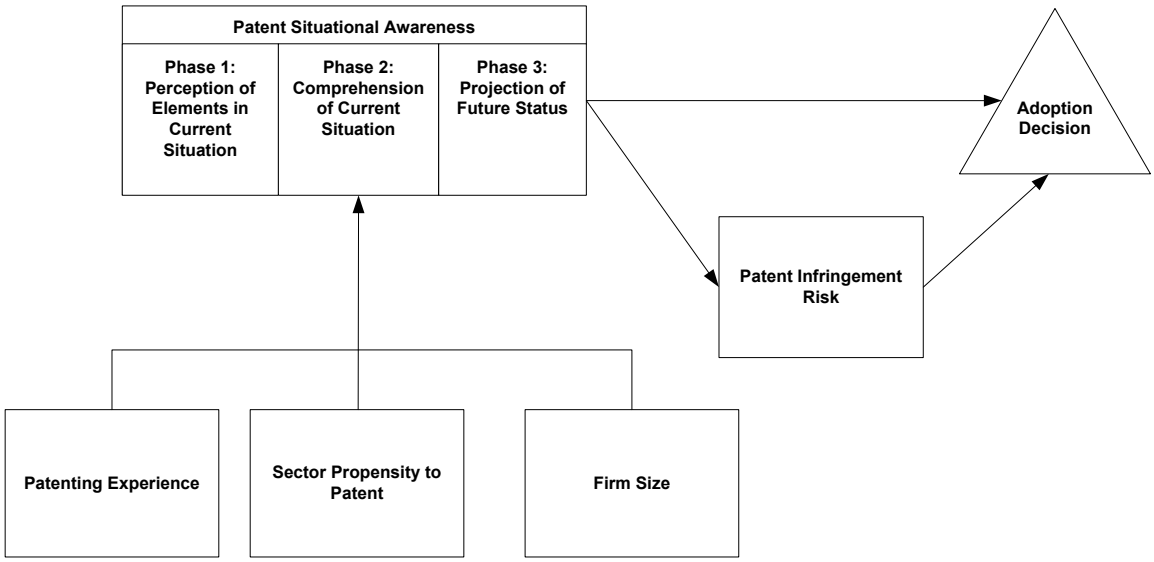
- Experience (Ericsson & Lehmann, 1996)
- Firm size (Pitkethly, 2012)
- Sector Propensity to Patent (Levin et al., 1987; Arundel, 1998))

The choice for these variables has been made, mainly because they show in both literature and business practice cases to greatly influence the awareness role. First of all, patent experience allows one to better understand the elements identified in the environment, mainly because it allows comparison to earlier occasions. Patenting experience can be defined as: *"Previous practical contact and observation of patents".* This can lead to better judgement calls, increasing the validity of the decision. Ericsson & Lehmann (1996) showed that extended engagement in domain-related activities is required to attain expert performance in that domain. Second, firm size is added as literature and business cases show that larger firms often employ processes that reduce uncertainty in the technology adoption process and business processes in general. Small firms often do not possess these capabilities (Blackburn, 2003). Pitkethly (2012) also found that small firms often lack capabilities on the area of IP that large firms do possess. Furthermore, with firm size often comes an increase is possible financial resource allocation, which increases the scope in which environmental scanning can be executed. Conducting a thorough environmental scanning process, perhaps including external advisors and experts, reduces uncertainty, but comes at the price of higher costs. A larger firm size will therefore likely increase the effect of patent situational awareness on better evaluating possible litigation risks. Furthermore, firm size is likely to influence overall governance practices due to resource availability and increased exposure. Firm size can be defined as: *"The size of a firm in terms of annual turnover and headcount"*. Levin et al. (1987) showed that different industries have different propensities to patent. This means that patents are seen as more important in some industries than others. Therefore, in industries in which the importance of patents is higher, patent situational awareness will be of more importance than in industries were patent importance is low. Industry propensity to patent in this research project is defined as: *"The importance of patenting instruments within an industry".* Patent propensity is often defined as the percentage of patented innovations to total innovations.

2.6.8 Final Conceptual Model

By using the initial model of situational awareness, identification of several important elements for the model for patent awareness was possible. This model serves as a theoretical basis, because it included not only knowledge of IP concepts, but identification, understanding and acting upon gained contextual information as well. Litigation risk has been added as a variable which is influenced by patent situational awareness and mediates the relationship between patent situational awareness and the adoption decision. Furthermore, the identified variables of patenting experience, sector propensity to patent and firm size have been added to the model. Important to note is that these variables are largely connected to the event that is new product development and technology adoption. This has to be taken into consideration in designing a measurement method. This will be further discussed in the methodology chapter. The context of new product development has been identified as a time and space in which patent situational awareness is especially important. The final conceptual model can be found in figure 6.

Figure 6: Final Conceptual Model for Patent Situational Awareness.



Chapter 3: Methodology

In this chapter, the methodological underpinnings of this research will be discussed. First, a discussion of the research design as well as an outline of data collection methods will be given. Second, the variables that have been identified in chapter 2 will be operationalized so they can later be used in survey research. In this research project, the focus lies on establishing a measurement instrument, not on testing relationships within the model.

3.1 Research design

The objective of this research project determines for a large part the research design. Revisiting the first chapter, the main objectives of this research project were:

- Develop a model for the role which patent awareness fulfills in the new product development process. The basic assumption is that firms that have higher patent awareness are able to reduce risk due to better identification and evaluation of external elements.
- Develop a measurement method for a model for patent situational awareness in the new product development process. The measurement instrument must attempt to assess patent situational awareness is a systematic and reliable manner.
- Due to the fact that this is a pilot study, results must lead to recommendations on the model and measurement instrument, possibly refining the instrument once results have been analyzed and the working of the model has been discussed.

In chapter 2, through the process of a literature study, relevant variables for patent situational awareness have been established and defined. Articles were selected by use of keywords and combinations thereof, i.e. patent awareness, patent litigation, technology adoption, litigation risk. From the total number of articles, a further selection has been made based on journals, titles, abstracts and content. Intellectual property related articles were mostly pusblished in innovation oriented journals like Technovation and Research Policy. By combining literature from different fields of expertise (i.e. marketing, psychology, law and technology management) the final conceptual model and the relationships therein have been established. This leads to the thought that patent situational awareness allows for a reduction of patent infringement risk early in the new product development process.

3.2 Mixed Methods Research

In chapter 2, the final conceptual model for patent situational awareness has been established. This led to several variables that need to be measured. An emphasis has been placed on the context in which patent awareness is especially important, that of the new product development process. This context also has consequences for the data collection method, because one has to account for the objective reality in which an innovating or technology adopting firm is present. This objective reality is difficult to measure in a survey, because a quantitative research often reasons from a singular reality. Qualitative research, using interviews, allows one to account for the views of participants, and can thus more correctly account for the objective reality of the participant. This leads to data that is more biased (and thus not as hard as with quantitative research), but that can still be very useful for exploratory research.

The exploratory nature of this research project has been previously highlighted. The focus in this project is the establishment of a model and measurement method. Variables have been established that require transformation into items that allow them to be measured, such that quantifiable data can be generated. Some aspects however, like the previously discussed objective reality of a participant and discussion of an event, can better be measured in an interview, using open questions. Furthermore, a pilot study allows discussion of the model and questions used. Therefore, in light of the nature of this project, a mixed methods research approach is particularly applicable. Creswell & Plano Clark (2006) define mixed mehods research as follows:

Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone.

Adopting a mixed method approach, both the established conceptual model and survey instrument can be evaluated. This allows for valuable recommendations for future research. The survey and interview process will be discussed separately.

3.3 Design Science

Design science focuses on human-made objects and processes designed to provide solutions for identified problems. It is concerned, “not with how things are, but how things might be” (Simon, 1996). Design science differs from human and natural sciences in that it focuses on building and evaluating artefacts, instead of searching for universal truth and prediction or understanding of phenomena in specific situations. For a master student that has to write a master thesis, using the design science approach is applicable in a design study, where a certain artefact or end product has to be developed and tested as a solution to a specific, contextual problem.

Hevner et al. (2004) developed a model in order to provide clear and consistent definitions of ontologies, boundaries and guidelines for using design science in projects. He distinguishes three cycles: the “rigor-“, “relevance-“and “design cycle”.

The “relevance cycle” provides a contextual situation in which a problem or opportunity is identified. This context also provides certain requirement which a solution will have to fulfil. There are different stakeholders involved in this cycle.

The “rigor cycle” is concerned with drawing information from the existing knowledge base. Often, reviewing literature and previously developed artefacts will be necessary to gain a clear and scientific overview of existing knowledge.

The “design cycle” is most central in the design science method, in that it links both the other cycles and uses their input in the design process. Contextual data and requirements are evaluated against scientific literature to come up with a solution for the initial problem. More so than the other cycles, the design cycle is an iterative process, in which implementation of the artefact and testing whether

it fulfils requirements is necessary. The “design cycle” is the core of design science research and it links the other cycles together. Input from both the “rigor-“ and “relevance cycle” is being used to design a specific problem solution. Evaluation of the solution must be done in a safe/testing environment before the solution is put to use in the real world. One must not expect perfect initial results as this cycle is often highly iterative and will require evaluation rounds before a satisfactory result is achieved.

Development of a measurement method can be seen as a design science problem. The established model for patent situational awareness has been developed on a literature basis. It provides the contextual variables that need to be measured. The solution to measuring these variables lies in the establishment of a suitable survey instrument. In order to develop a suitable instrument, relevant theory on survey development is necessary. Combining the theoretical aspects of survey development with the established model leads to the development of an artefact, the measurement instrument. The evaluation, which is critical in design science research, will be done by conducting a pilot survey, thereby effectively testing the measurement instrument.

3.4 Survey Theory

The use of a survey and subsequent statistical analysis is a quantitative research method that is mainly used in social sciences. According to Babbie (1995) survey research can be used for both explorative as well as causal research. Surveys are being used to make statistical inference about the population being studied and are thus aimed at providing generalizable results. A survey always contains a sample, method of data collection and statistical analysis. The method of data collection is aimed at the questions asked in the survey. Questions can be both open and closed, and can contain nominal answers as well as ordinal scales. The validity of a survey and subsequent statistical analysis depends on both sample selection, survey design in terms of questions and collection method in terms of contacting respondents.

As has been discussed in previous chapters, the main aim of this research project is to design a survey that can be used in future research to further test hypotheses. Due to the exploratory nature and limited time-frame of this research project, the decision for a pilot study has been made. A pilot study is a preliminary study used to gather information prior to conducting a survey on a large scale. A pilot study can be used to pre-test a particular research instrument. By conducting a pilot study, the efficiency of future research can be determined and any possible difficulties can be smoothed out before administering the main survey. Babbie (1995) gives several basic recommendations for designing a survey:

- Questions must not contain several components
- Questions must be clear and concise
- Respondents must be willing to answer the questions
- Questions must be relevant for the research project
- Questions that can be seen as negative must be avoided
- Questions must lie within the area of comprehension of the respondents

The recommendations by Babbie are helpful but do not yet provide clear direction on how to actually develop a survey. Especially when considering self-administered questionnaires, the design must be adequate so that respondents understand the questions and do not abandon the questionnaire. A self-administered questionnaire is a survey that collects data without the use of a telephone or in-person interviewer. It can either be a paper or web-based instrument. Watt (1997) concluded that Internet surveys provide considerable cost savings when compared to other survey methods. The lower overall cost of Internet surveys results from lower cost of delivery, lower cost in personnel time, and lower cost to convert data into a format that statistical programs can analyze. The development costs for all survey types are about the same. Furthermore, it guarantees fast response (Weible & Wallace, 1998) by allowing immediate delivery of the instrument (Litvin & Kar, 2001). Interviewer administered surveys on the other hand, may be subject to more cognitive processing, more thoughtfulness, and less satisficing than self-administered modes (de Leeuw, 2005).

To ensure respondent participation, it is important to provide a context as well as an urgency to take part in the questionnaire. This often entails explicating why the research objective is important. Furthermore, it is important to note how the date will be used and whether responses are anonymous. Providing this context can be done in an introductory text or front cover.

In terms of moving from theoretical concept towards survey questions Fiske (1971) describes a procedure in which an explicit conceptual specification must lead to a well-defined construct that poses a clear target for operationalization and permits-multi component operationalization. Fiske states that is is important to delineate the core of the construct, the unique aspect or quality to which the construct refers. This may lead to a construct that is too broad, which will require the use of subconstructs. Once these constructs have been defined, the measurement instrument can be constructed. Fiske recommends explicit decisions about measurement scales.

Later research by Sartori (1984) stresses the fact that conceptualization is mediated by language, which makes it important to study the semantic structure of our statements. Semantic analysis of survey questions helps to disentangle different meanings and recognize ambiguity in our constructs. For example, a semantic analysis of the Dutch word “geluk” combines the English words “happy” and “lucky”. This language difference can lead to mistranslation in question (Hox, 1997). Schaeffer (2003) agrees on the importance of language and lays a foundation for the science of asking questions. She structures her work around two types of inquiries: questions about events or behaviours and questions that ask for evaluations or attitudes. She discusses several issues bipolar versus unipolar scales, number of categories and question testing. This work can serve as assistance in formulating survey questions.

Once the survey has been administered, statistical analysis can be used to determine whether measures of a construct are consistent with a researcher’s view of the nature of that construct. It is an important process to test for construct validity, especially when considering future research.

3.5 Survey Construction

The goal of this research project was to establish a model and measurement method for patent situational awareness in the new product development process. In chapter 2, relevant literature has been discussed and the final model, based on the model by Endsley (1995), has been established. Due to the exploratory nature of this research project, previously tested measurements and survey

designs are not available for all variables. It is for that reason that this project will focus on development of a pilot survey, together with interviews, which can be used to test the validity of measurements. In order to create translate the variables as defined in chapter 2 into measurable constructs, they will have to be operationalized. Operationalization will be discussed separately per variable, with a methodological justification and discussion of the items and scales used in the final survey. Furthermore, Dillman (2003) argues that survey context is presented through visual cues. Tourangeau (2007) further supports this idea and emphasizes the need for clear formatting in survey design, noting that using different colors in formatting may increase responses and participant focus. The full survey with questions and scales can be found in appendix IV.

3.5.1 Firm size

The variable firm size is probably the most straightforward variable to measure, as it can easily be defined within certain thresholds. In order to define whether firms fall into the micro, small, medium or large category, usage of the thresholds as established by the European Commission (2005) is possible. Instead of translating these thresholds directly into item scales, questions ask for a numeric answer. This is done to avoid common method bias in the overall survey construction. Switching between ordinal scales and numeric answer keeps the respondent more focused and thus allows for better data. Two items have been established, the first measures the number of employees, the second measures annual turnover. The values are later translated to the different firm size categories which can be used for statistical analysis. A summarized overview of the items can be found in table 3.

Table 3: Operationalization Firm Size

Variable	Item	Scale	Reference in literature
Firm Size	Employee count	Numeric	European Commision (2005)
	Annual Turnover in Euros	Numeric	European Commision (2005)

3.5.2 Sector Propensity to Patent

The variable Sector Propensity to patent deals with the importance of patenting in a certain industry. Measuring the importance of patenting in an industry would pose difficult to do reliably without committing to a full scale research project on that aspect alone. Nonetheless, a lot of previous research has been done on sector propensity to patent (i.e. Arundel, 1998). Therefore, the participants can state in which industry they are active in a single questionnaire item, after which the propensity to patent score can be added from secondary data according to said industry. Therefore, item construction for sector propensity to patent is very straightforward.

Table 4: Operationalization Sector Propensity to Patent

Variable	Item	Scale	Reference in literature
Sector Propensity to Patent	Active Industry	Nominal	Arundel (1998)

3.5.3 Patenting Experience

In order to measure Patenting Experience, six items were used. Items from Pitkethly (2012) were taken as a basis. In his research, Pitkethly used a dichotomous scale and then differentiated between firm sizes. In this research project, we want to go beyond a mere yes or no answer for some items, and have thus adapted the items to use seven point Likert scales. By using a seven point Likert (1932) scale, measurement of different degrees of opinion is possible. Dillman (2000) and Babbie (1995) argue that ambiguous questions must be avoided. An attempt has therefore been made to make item scales as clear as possible, leaving no room for participant's own interpretation. Items were aimed at previous involvement in licensing in or out technologies, as well as the existence of an IP policy. A summarized overview of the items can be found in table 5.

Table 5: Operationalization Patenting Experience

Variable	Item	Scale	Reference in literature
Patenting Experience	Frequency patent application	Ordinal (Five Point Scale, never-weekly)	Pithkethly (2012)
	Number of patents held	Numeric	Pithkethly (2012)
	License in frequency	Ordinal (Five Point Scale, never-weekly)	Self established
	License out frequency	Ordinal (Five Point Scale, never-weekly)	Self established
	Responsibility IPR function	Ordinal (Five Point Scale, strongly disagree – strongly agree)	Pithkethly (2012)
	Assessment IP worth	Ordinal (Five Point Scale, strongly disagree – strongly agree)	Pithkethly (2012)
	Existence overall IP policy	Ordinal (Five Point Scale, strongly disagree – strongly agree)	Pithkethly (2012)

3.5.4 Patent Awareness

In chapter 2, the patent situational awareness variable has been discussed. This variable was found to consist of three stages, which together form patent situational awareness. To operationalize patent situational awareness and thus make it measurable, questions will need to be formulated based on the different phases that have been discussed. The variable patent situational awareness will therefore consist of several items.

The first phase of patent situational awareness is that of perception of elements in current situation. Here, the questions used by Nijmanting (2012) are used as a basis. The first question is asked as a

general question whether firms actually use patent information for research purposes. This question uses a dichotomous scale (Yes or No). If the answer is no, further questions on the use of patent information can be skipped. The following questions that were asked inquire on the frequency of patent database searches, patent information searches, consultation of IP experts and consultation of researchers.

The second phase of patent situational awareness is comprehension of current situation. These questions were based on Nijmanting (2012) and McGahan & Silverman (2006). Questions were aimed at the fit and interpretability of information provided from patent searches, as well as the way in which patent information is used. Scales for the first two questions were ordinal five point scales, ranging from not at all useful to very useful. The last question uses a nominal scale, in which four answers are possible. These answers can later be translated to a score for statistical analysis.

The third phase of patent situational awareness is projection of future state. Like with previous items, questions were derived from literary insights. In chapter 2, the importance of assessing future status has been discussed. Questions were thus aimed at assessing the development of future scenarios, possibility of licensing deals and assessing the likelihood of litigation. Finding appropriate items for this construct was difficult, as this aspect of patent awareness is not yet well documented. Items were thus adapted from different sources (i.e. Sandal & Kumar, 2011) who discuss similar topics in a slightly different manner. The items use a five point Likert (1932) scale, which provide reliable results and allow different degrees of opinion, rather than a simple yes or no. A summarized overview of the items can be found in table 6.

Table 6: Operationalization patent situational awareness

Variable	**Item**	**Sub-Item**	**Scale**	**Reference in literature**
Patent Situational Awareness	Perception of Elements	Use of patent information	Dichotomous (Yes – No)	Nijmanting (2012)
		Frequency Consultation Patent Database	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Nijmanting (2012)
		Databases used	Nominal (Espacenet, Google patent etc.)	Self established
		Frequency Consultation of Patenting Experts	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Pithkethly (2012)
Variable	**Item**	**Sub-Item**	**Scale**	**Reference in literature**
Patent Situational Awareness	Comprehension of Current Situation	Usage of patent information	Nominal (four categories)	McGahan & Silverman (2006)
		Usefulness of information own search	Ordinal (Five point scale, not at all useful – very useful)	Nijmanting (2012)
		Usefulness of information own	Ordinal (Five point scale, not at all useful – very	Nijmanting (2012)

		search	useful)	
Variable	**Item**	**Sub-Item**	**Scale**	**Reference in literature**
Patent Situational Awareness	Projection of future state	Assess likelihood of litigation	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Sandal & Kumar (2011)
		Develop future scenarios	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Nijmanting (2012)
		Possibility licensing deals	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Lin, Chen & Wu (2006)

3.5.5 Patent Infringement Risk

Patent infringement risk is the most difficult variable to create items for. First of all, because it is not yet a widely discussed aspect of academic literature, no existing items and scales are available. Second, risk is difficult to measure on its own, mostly because it is surrounded by terms are probably and chance. Nonetheless, an attempt will be made here to measure infringement risk by discussion ownership of technologies currently employed by firms. This variable faces validity issues, because risk may always be present even if participants do not see it. Following that thought, they may not effectively estimate their own risk without an amount of bias. Questions for patent infringement risk are largely self-established due to the fact that no existing items and scales are available. Concepts from patent literature are considered when developing questions, and attempts have been made to develop questions that are as clear and unambiguous as possible. Three items have been established, that all try to measure the patent infringement risk as perceived by the participant. A summarized overview of the items can be found in table 7.

Table 7: Operationalization Patent Infringement Risk

Variable	**Item**	**Scale**	**Reference in literature**
Patent Infringement Risk	Risk reduction is worth cost patent search	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Self-established
	Unlikely to face litigation	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Self-established
	Evaluate financial consequences litigation	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Self-established

3.5.6 Adoption Decision

The adoption decision variable is, like patent infringement risk, a difficult variable to create items for. It is not yet a widely discussed aspect of academic literature in combination with patent information searches, therefore no existing items and scales are available. Nonetheless, an attempt will be made here to quantify the adoption decision variable. Typical adoption decision variables are very context specific, aimed at evaluating the intention to adopt a specific technology. In this research project this is not possible, due to the fact that a more general attitude towards new product development is chosen. Therefore, questions for technology adoption are largely self-established due to the fact that

no existing items and scales are available. Three items have been established, that all try to measure the patent infringement risk as perceived by the participant. A summarized overview of the items can be found in table 8.

Table 8: Operationalization Technology adoption

Variable	Item	Scale	Reference in literature
Technology Adoption	No infringement	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Self-established
	License deals in place	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Self-established
	No products for which IP is not owned	Ordinal (Five point scale, Strongly disagree – Strongly agree)	Self-established

3.6 Interview

Patent awareness has been previously tied to the event of new product development and technology adoption. A survey has been developed that allows for measurement of variables that are quantifiable, but as previously discussed, using a survey only allows the viewpoint of a singular reality. This does deliver hard data, but does not account for the objective reality an innovator might be in. There can be distinct differences in the processes firms employ to reduce uncertainty and assist decision making. It is for this reason that a multi method approach was chosen, in which interviews are combined and compared to questionnaire results. Using this approach, interview participants can be asked and probed about their general new product development processes and the manner in which they accumulate and use information in that process. This approach focuses more on the process and the decisions made within it. This leads to a relatively unstructured interview process, in which the general themes and introductory questions are established, but further details are not yet set. This allows the researcher to explore topics, probe on topics which need further clarification or explanation and allows for the incorporation of more subjective, contextual information. This information can later be analyzed and compared to the data provided by the questionnaire, assessing whether the data complements or contradicts each other and in which way. This allows for a more balanced view of patent awareness in the new product development process.

3.6.1 Interview Design

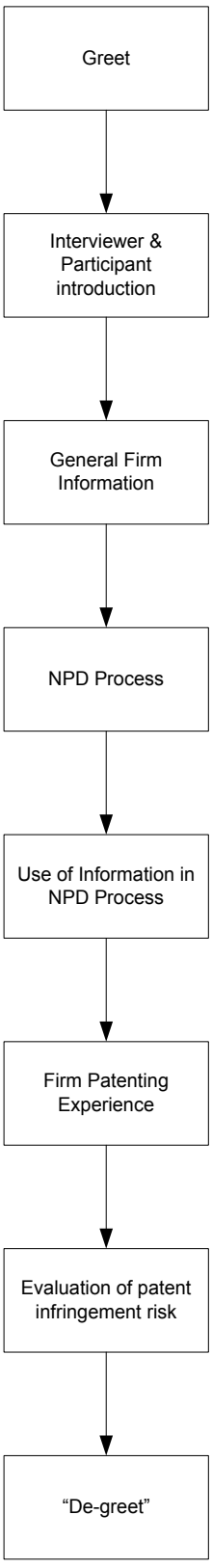
In-depth interviews are different from surveys and structured interviews in the sense that they are less rigid and more open to discussion. Answers can be flexible and thus questions and reactions are often not entirely prepared in advance. Nonetheless, thoroughly designing the interview is important, so that data accuracy increases and the interview does not venture into areas that hold no relevance for the research question. In an ideal interview, the participant does most of the talking, while the interviewer takes notes and guides the conversation in the direction it needs to go (Babbie, 1995).

In order to design a good interview, there need to be overarching themes present upon which the interview will be built. This is called thematizing. These themes must be introduced to the participant, as well as the overall working of the interview. That means that asking participants for the allowance of tape recording is necessary, as well as explaining that the interviewer will take occasional notes. The main themes for this interview originate from the conceptual model that has been developed in chapter 2. The main interview themes will thus be:

- Establish participant background in area of research
- General Introduction to the firm and industry
- New Product Development Process
- Use of (patent) information in NPD process
- Firm patenting experience
- Evaluation of patent infringement risk

Creswell (2002) stresses the importance of keeping questions open-ended and unstructured, as to avoid yes or no answers and allow for richer data. Furthermore, interviewers should ask single and clear questions, while using few in number. Using the themes stated above, a general outline for the interview and question scheme has been developed. Using this process, an investigation of the conceptual model can be made and in-depth, valuable data for this research project can be gathered. It is important to note that for each theme, the main questions have been developed. Probing and follow-up questions have been partly established, because they will depend on answers given by participants. These can be found in Appendix VI. An overview of the interview process, with established questions can be found in figure 7.

Figure 7: Interview Scheme



- Informal process, no questions yet asked. Warm-up introductory talk.

- Please, could you tell me something about your background?
- Could you tell me something about your responsibilities and experience with the company?

- Can you elaborate on the industry the firm is active in?
- Can you give some details about the products your firm is producing?

- Could you describe in as much detail as possible how your firm tries to structure the NPD process?

- Could you elaborate on the use of information in designing new products? Where does information come from and how is it used?

- Could you share some details about how and how often your firm deals with patents? Are there any license deals in place?

- Do you feel that your firm actively tries to avoid infringement by arranging licensing deals?
- Can you tell me how your firm evaluates whether a technology is free to use?

- Informal process, no question asked. Cool-down talk and thanking participant for cooperation.

3.7 Data collection

As was discussed in this chapter, a choice has been made for a mixed method approach. An interview scheme and survey have been developed, which will be administered separately. Firstly, open interviews will be held with companies, in which in-depth and contextual data can be gathered in order to evaluate the established conceptual model. This will be done in face-to-face interviews with representatives of medium sized technology oriented firms. Participants must have knowledge of their firm, NPD process and usage of patent information. They are likely to hold roles of project managers, product managers, CEO's and R&D personnel. As previously mentioned, data will be administered anonymously if firms wish it so. Company names and personal names need not be mentioned, and thus responses cannot be traced back to companies.

Secondly, survey data will be gathered through the use of an online survey instrument. Established questions will be added, after which the instrument will be spread via email to suitable respondents. For the survey to provide any valuable data, the instrument has to be validated. As was previously mentioned, the initial survey has been developed on the basis of literary insight. There are a few self-developed items in the survey that may or may not be applicable. Therefore, in order to evaluate the survey instrument, a choice has been made to conduct a survey evaluation phase. The purpose of this phase is to evaluate the established initial survey instrument on the areas of theory, methodology and practical insights. In order to do so, comments from experts on these areas will be sought in order to evaluate the established initial survey instrument. Results from the evaluation of the survey instrument and the adjustments made to the initial survey instrument will be discussed in chapter 4.

After the evaluation, the survey instrument was distributed to selected firms by email. The survey was administered by using an online survey software tool. Firms were selected based on their technological profile. Only those firms that were likely to deal with patents have been contacted. In the email, a password was included as to protect the survey instrument for uninvited participants. The survey has been administered for two and a half weeks. Selected firms were sent a reminder to fill in the survey instrument after one and a half weeks as to improve response rate. In order to increase motivation with respondents, they could leave their email address at the end of the survey if they wanted to receive a small report on their patent situational awareness score.

3.8 Target Group & Sample

The target group, or unit of analysis, is the group about which statements are made. As described in earlier chapters of this research paper, the aim is to investigate the role of patent awareness in the new product development process. It has been previously stated that small firms are especially vulnerable to litigation risks, and thus investigating small firms is definitely important. However, in order to make a comparison between small and large firms, it is interesting to collect data on both parties. This is also important in light of a pilot study, which can show for which firms a survey instrument is particularly applicable. In terms of industry firms are active in, a variation of industries is something that can provide contextual data, serving as a justification of the established model. Therefore, like with firm size, it is interesting to collect data on firms from different industries. Because this is a pilot study, the sample size will probably not be large enough to make thorough generalizations, but it is possible to pave the way for future research.

In an ideal situation, data is gathered from several individuals within a single firm. These individuals would possess different knowledge, allowing for a more balanced picture to be established and richer data to be collected. However, for a study of this magnitude and time-frame, creating such a sample group, in which multiple respondents within a single firm participate, is near impossible to achieve. Therefore, data collection is aimed at technological firms. Only firms who are very likely to deal with patents must be selected as to provide accurate data. Data will be administered anonymously as to not scare possible participants that confidential data is leaked.

As stated earlier, firms were selected on the basis of their technological profile. Only firms that are likely to deal with patents were approached for survey participation. In total, 50 firms were approached for survey participation. Firms that were selected are active in different industries. In table 9, an overview of different industries and their frequency in the sample can be found. When analyzing results, it is important to check whether responses accurately represent the sample.

Table 9: Sectors represented in sample

Function	Frequency
Precision Instruments	13
Medical Devices	12
Electrical Equipment	9
Machinery	7
Chemicals	3
Fabricated Metal Products	3
Food & Beverages	2
Rubber & plastic products	1

3.9 Validity

Validity is the extent to which a concept, conclusion or measurement is well-founded and corresponds accurately to the real world. Different categories of validity exist, and in every category there are threats that can reduce validity of the research project. The different validity categories are (Shadish, Cook & Campbell, 2002):

- Statistical Conclusion Validity
- Internal Validity
- External Validity
- Construct Validity

For each category, threats that may be applicable to this research project and measures to counter them will be discussed.

3.9.1 Statistical Conclusion Validity

Statistical Conclusion Validity concerns the degree to which conclusions among variables based on the data are correct. This can mean that two general errors can occur, either you measure correlation where none exists, or no correlation is measured where one does exist. This can lead to low statistical power and thus is a threat to research projects. In this research project, no hypotheses

are being tested. Nonetheless, when designing a survey instrument, it is important to keep statistical conclusion validity in mind. This research project was concerned with the establishment of a conceptual model and measurement instrument for patent situational awareness. Because of this reason, a somewhat small sample size was used on the basis of a pilot study. This decreases statistical power and can thus lead to inaccurate outcomes. Therefore, when measures are deemed reliable and statistical analysis can be done in this research project, it is important to keep the low statistical power in mind. Administering a full scale survey may lead to different results.

3.9.2 Internal Validity

Internal validity refers to the extent to which a causal conclusion is justified. Causality is based on three criteria:

- Temporal Precedence
- Covariation
- Nonspuriousness

Threats to internal validity thus arise when one or more of the above criteria are not sufficiently met. This can originate from, among others, failing to control for extraneous variables or ambiguous temporal precedence. In this research project, nonspuriousness is especially important due to the fact that a conceptual model is established. This conceptual model must include the relevant variables, which means there should be no other variables that influence the dependent variable. The conceptual model has been based on literature and has been evaluated in interviews with industry experts that have practical experience. This has been done to increase internal validity and reduce the chance of omitting important variables.

3.9.3 External Validity

External validity refers to the extent to which results can be generalized to other situations and other people. Threats to external validity thus mean that the results of the study are less transferable to other situations. In many research projects, there is a trade-off between internal and external validity. Often, measures that increase internal validity are detrimental to external validity. In this research project, external validity is not a priority due to the fact that the focus lies on testing the measurement instrument and providing direction for future research. This has led to a diversified target group with organizations originating from different industries. While this is worthwhile for pilot study purposes and provides insight into the working of patent situational awareness, it reduces external validity. For future research and more generalizable results, statistical analysis will have to be done on a larger scale and using a more homogenous target group in terms of size and industry.

3.9.4 Construct Validity

Construct validity refers to the extent to which a test measures what it claims, or purports, to be measuring. It thus deals with whether the operational definition of a variable actually reflects the true theoretical meaning of a concept. Construct validity is extremely important in this research project, due to the fact that the goal of this project is to develop and instrument to effectively measure the established constructs. Threats to construct validity can originate from not defining the construct well enough, to biases that originate from the researchers themselves. Furthermore, the way in which the researchers operationalize their constructs directly influences the measurement

and results. Construct validity can therefore also be referred to as a "labeling" issue. The main question for construct validity is: "Are you actually measuring what you want to measure?" A pilot study to test a measurement instrument is aimed at controlling for construct validity. That way, improvements to the measurement instrument can be made before it is used in a large scale research project. To control for construct validity in this research project, careful operationalization of constructs and well-considered questionnaire items are necessary. Construction of the survey instrument items has been done on the basis of available literature. The variables that have been established in the conceptual model have been defined and operationalized. Interviews with experts are used as a means of evaluating operationalization, from a theoretical, methodological and practical point of view. These evaluations increase the content, construct and face validity of the established measures and thus increase the validity of this research project in general.

A difficult threat to construct validity is that of common method bias. Common method bias refers to the fact that the variance in methods as questionnaires is measured not due to the constructs, but due to the measurement method. In order to reduce common method bias, the survey instrument was designed as to not have similar answer scales for all the items. Nonetheless, some items do require the same scales and other measures have to be used to reduce common method bias. One measure used is requiring respondents to click through to a new page in the survey software tool for each variable. Using this method, respondents are not exposed to long lists of similar item scales. This increases the chances that respondents are actively and objectively filling in the items, thereby reducing common method bias.

3.10 Data Analysis

As has been mentioned before, data in this research project comes from two sources: Questionnaire data and interview notes. Interview responses concerning the assessment of questionnaire items have been noted, and interviews with organizations have been recorded where possible. Nonetheless, they will be used to give recommendations for future research. Data from the survey instrument was gathered via the online software tool and captured in an "Excel" file, after which they were transferred into an "SPSS Statistical Software" dataset. In this dataset, answer scales have been transformed into numbers as to increase statistical power. Results will be presented in chapter 4. Using the SPSS software, the following methods are applicable:

- Examination of respondent characteristics. Identification of respondent experience with the company as well as company characteristics have been examined.
- Descriptive results of the survey items have been established. Furthermore, items are tested for reliability to see if they can be used for regression analysis.
- Regression analysis will be used for measures that are deemed reliable. To do so, a mean score for each variable will be established.

Chapter 4: Analysis

In this chapter, the results of the interviews aimed at conceptual model evaluation, the survey evaluation phase and survey descriptive results will be presented. The first paragraph will discuss the evaluation of the conceptual model and interviews with organizations concerning the use of patent information in new product development. The second paragraph will discuss the evaluation of the survey instrument and the changes it has provided. Lastly, the results of the survey will be presented and discussed.

4.1 Conceptual Model Evaluation

In previous chapter, the pilot study nature of this research project has been stressed. Considering the exploratory aspects of this topic, it is important to use more than one method to gather data. For this reason, a mixed method approach was chosen. In order to gain more in-depth information into how companies deal with patent information in the new product development process, interviews have been held with high-tech firms. The interviews were based on the established interview scheme and were aimed at evaluating the proposed conceptual model. Interviews lasted around 45 minutes. Full transcripts of the interviews can be found in the appendix. The most important findings are described here.

Three interviews have been held as means of gathering more in-depth information about the way firms deal with patents and how they use patent information in their product development process. The answers given shed light on the attitude towards using patent information and can help evaluate the established conceptual model. Comparing the three interviews, several things are clearly visible. All three firms have structured their new product development process, be it in their own way. They all deal with patents regularly and are aware of possible infringement and the risk it may pose to their organization. While the participants were not specifically schooled in patent literature, they seemed very well knowledgeable about the workings of the patent system. Two of them mentioned that the knowledge comes with experience, further adding to the notion that patenting experience is an important factor. Nonetheless, remarkable is the overall standing of all three participants with respect to licensing, clearly stating that licensing is not something they or their company considers. This is in stark contrast to patent literature and the concept of more open innovation and product development processes. All firms actively evaluate patent infringement when developing new product, but do so in relation to the newness of the technologies used. When they consider technologies as important to the future of the firm, they are more likely to investigate patent information and evaluate infringement risk. Furthermore, two of the participants stated that patenting is more important in some industries than others. As these firms employ no personnel that is specifically assigned to management of intellectual property, patent information searches are responsibility of the engineers themselves. Only when firms want to do their own patent applications or when they want to investigate possible blocking patents in more detail do they contact a patent attorney. Only one of three firms mentioned to have been involved in an actual case, one that was ultimately settled out of court. Overall, it seems likely that these firms hold patents, but are not likely to enforce them. Conclusively, it can be said that all three interview participants' responses validate the conceptual model. They are all actively trying to control infringement risk and are making product development decisions based on patent information, especially for important projects. Their knowledge comes from experience, thereby justifying the patenting experience variable in the

conceptual model. Furthermore, industry patent propensity does seem to influence the patent information search activities as theorized in the model. Therefore, taking the perspective of practice and real world application, the theorized conceptual model is justified.

4.2 Survey Instrument Evaluation

As previously discussed in the methodology chapter, an evaluation phase for the survey instrument was held in order to administer a survey instrument that was evaluated on the area of theory, methodology and practical relevance beforehand. In order to do so, experts on these areas have been contacted and asked to comment on the initial survey instrument (appendix III). Experts who were contacted and were willing to cooperate in the evaluation of the survey instrument were:

- Dr. A.H. van Reekum, assistant professor at the University of Twente. His main research interest is technology and innovation management, focused on intellectual property rights. Dr. van Reekum evaluated the initial survey from a theoretical perspective.

- Dr. T. de Schryver, assistant professor at the University of Twente. Dr. de Schryver is information specialist at the University of Twente and has thorough experience in data gathering and analysis. Dr. de Schryver evaluated the initial survey from a methodological perspective.

- Ir. H.C. de Lange, owner of “Octrooifabriek B.V.”. Mr. de Lange has multiple years of experience as a patent attorney, having recently founded his own office after working for a large established office for several years. Mr. de Lange evaluated the initial survey instrument from an industry / practical perspective.

- Ing. Willemyn Slikker, patent attorney at Arnold & Siedsma. Ms. Slikker has several years of experience as a patent attorney, evaluating patent applications and patent deals. Ms. Slikker evaluated the survey instrument from an industry / practical perspective.

Important to note is that due to different backgrounds of these experts, comments on the initial instruments varied. All comments have been taken into consideration and have led to several adjustments to the initial survey instrument. Comments were mainly aimed at word choice, which was either ambiguous or unnecessary in some cases. Examples of these are the use of words like “general”, “interpretablility”. In the initial survey, the technology adoption event was omitted due to possible difficulties in measurement. After theoretical evaluation, this has been reconsidered and added in the second version of the survey instrument. Methodological consideration led to the insights that some terms may be too specific and thus require additional information or definition in an introductory text. Furthermore, there were instances in which an objective and subjective scale was used in conjunction, which leads to measurement errors. These scales have been changed for the second survey version. In order to avoid common response bias, attempts have been made to set up the survey instrument in such a way that participants remain focused. Therefore, consecutive scales required participants to click through to a next page. Evaluation from an industry / practical perspective led to the insights that it is important to ask whether firms find patent analysis worthwhile and a good investment. Furthermore, dedicated IP personnel and IP policies are very much a hit or miss scenario and fully depend on the company in question. All in all, small changes to

questions or wording have been applied, leading to an overall evaluated and hopefully better survey instrument. The second survey version can be found in appendix IV.

Due to time constraints, the interview with Ing. Willemyn Slikker was conducted after administering the survey instrument. Her comments have thus not led to changes in the survey that was sent to organizations. Nonetheless, her comments can be used in the recommendations section of the next chapter to make adjustments to the survey instrument for future research. Ms. Slikker evaluated the survey from her practical experience and knowledge of the patent system, Questions were evaluated individually, identifying possible improvements where possible. The most important results of the interview can be found below.

- Some of the scales use a yearly – monthly – weekly frequency, which is not bad, but can possibly be improved. Instead of asking respondents to choose from a scale, one can ask for the yearly amount of patent applications. This is more direct and helps to stop the respondent from doubting between yearly and monthly.
- The survey item is particularly useful for small and medium sized firms. Large firms have a variety of practices they employ and often have established patent management practices. Furthermore, very large technological firms often employ their own patent attorneys and are therefore not very likely to still often contact an intermediary. This may distort the outcome.
- Respondents are asked for the amount of patents they hold. Here, a distinction could be made between patents and patent families. Due to the fact that patents need to be applied for in separate countries, a single patent family can hold several patents, which could inflate the number of patents.
- The frequency of license deals is asked for in the survey instrument. More often than not, licensing is something that is done reactively after infringement has been established and legal actions have been taken. As a settlement deal, a license deal can then possibly be established.
- Besides asking whether firms make use of intermediaries for patent information search activities, it would be interesting to ask if there are any other reasons for contacting patent attorneys.
- It would be beneficial to include a test question / case, which could be used to evaluate the participant's knowledge and background on the area of IP.
- One important topic that is not really discussed in the questionnaire is that of contractual agreements. More specifically, when parties collaborate, there are usually contractual agreements about who will own intellectual property that results from that cooperation. This is often an important aspect for engineering firms.
- There are some instances in which words can be added / removed or changed, in order to reduce ambiguousness. For example: "held" can be replaced by "owned" in item 24. Sometimes, freedom to operate as a context can be added to a question to make it more clear what is specifically asked from the participant.

4.3 Descriptive Results

This section will discuss the results of the administered survey. Due to the exploratory nature of this study, these results are important regardless of correlation and regression. These results can shine light on the working of patent situational awareness in new product development and can possibly give important outcomes as to where future research should focus on or account for. This means that, even though outcomes may show not to be internally consistent, they still provide important information regarding the patent situational awareness of firms. The survey results will be discussed in different sections, starting with overall respondent characteristics as was asked in the general information section of the survey.

4.3.1. Respondent Characteristics

In a previous chapter, survey methodology was discussed. It was stated here that the survey was sent via email to 50 organizations. After the two week survey administration period, a total of 21 completed questionnaires were received. This leads to a response rate of $\left(\frac{21}{50}\right) \times 100\% = 42\%$.Considering the difficulty of finding the correct respondents within firms and the administration method via email, a response rate of 42% is adequate (Hamilton, 2003).

While a response rate of 42% is adequate, the sample size is somewhat small in order to make clear generalizations possible. Due to low statistical power, finding correlations between the variables is difficult. However, as stated before, the main purpose of this research project is to gain first insight into the role of patent awareness in new product development. The exploratory nature of this project allows us to evaluate the research method and provide direction for future research. It can therefore still provide noteworthy results, despite lower statistical power.

Before looking at the results, it is important to discuss who has completed the questionnaires. Both small and large firms have participated in the survey, and individuals who hold different positions have completed the survey. Individual names and company names have been omitted due to anonymity guarantees. Overall speaking, the survey has proved to find its way to suitable individuals. One can expect knowledge about the new product development process and use of patent information judging from the functions they hold. The only function that might provide less reliable results is that of the graduate intern. Upon inquiry, it was said that he was specifically focusing on intellectual property, and should therefore be able to provide reliable answers. The functions held by the respondents can be found in table 10.

Table 10: Respondent Functions

Function	Frequency
R&D Manager	3
Patent Manager	3
Managing Director	3
Chief Technology Officer (CTO)	2
Product Manager	2
R&D Engineer	2
Sales Representative	1
Business Development Manager	1
Graduate Intern	1
Manager Innovations & Technology	1

Senior Groupleader	1
Research Director	1

Furthermore, respondents were not only asked for their functions, but also their experience at the company in years. The lowest company tenure was 1 year, while the highest was 30 years. Overall, the average respondent tenure was 12,47 year, with a standard deviation of 9,3 years. Respondents were asked to fill in the core business, which allows for a rather diverse sample. All the answers given by respondents can be classified in different sectors based on Arundel (1998) with corresponding patent propensity. The different sectors represented in the survey can be found in table 11.

Table 11: Sectors represented in responses

Function	Frequency	Patent Propensity Rate
Medical Devices	5	74,0 %
Electrical Equipment	5	43,0 %
Precision Instruments	5	52,6 %
Machinery	4	53,9 %
Food & Beverages	1	25,3 %
Fabricated Metal Products	1	29,2 %

Looking at the sectors represented in the responses and the overall target group as discussed in chapter 2, we see a large overlap. The medical devices, electrical equipment and precision instruments industries are well represented, as they were in the overall targeted group of 50 firms. Unfortunately, the chemicals industry and rubber and plastic products industry have generated no responses. Nonetheless, the distribution of the other industry frequency is representative for the overall target group.

It is of course hard to exclusively categorize organizations into a single sector, as they can sometimes overlap, especially in larger organizations. Nonetheless, the attempt has been made here in order to assess patent awareness in comparison to patent propensity rate. The patent propensity rate was taken from Arundel (1998), and will be evaluated in comparison to other results later on. Looking at firm size, there were two items which were used to measure this item. Both employee count and annual turnover were used to distinguish between small, medium and large firms. The firms sizes based on these measures can be found below.

Figure 8: Firms size distribution based on number of employees

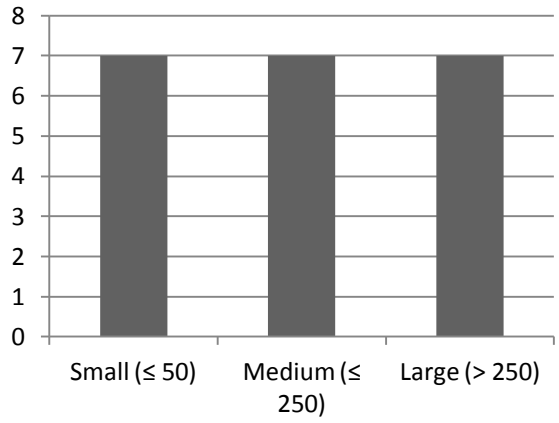
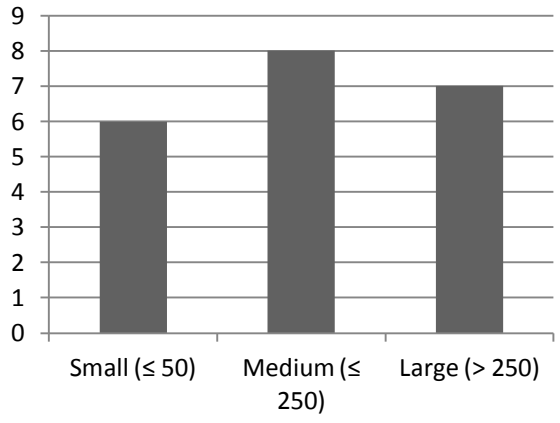


Figure 9: Firm size distribution based on annual turnover



Overall speaking, all firm sizes are represented. This is a difference between two measures due to the cut-off point for annual turnover. Upon reviewing the numbers, this particular firm has significantly less personnel than the cut-off point of 50, while having only a slightly higher annual turnover. For that reason, this firm has been considered to fall in the small category, as it more closely resembles a small firm.

4.3.2 Patenting experience

One variable that the survey tried to measure was patenting experience. Patenting experience is seen as previous practical contact and observations of patents. There were several items used in order to attempt to measure patenting experience. A majority of the firms responded that they applied for patents on self-developed technologies yearly, while only a small group of firms either never apply for patents or monthly or even weekly. Notable is that a large majority of respondents chose the "yearly" answer category, indicating that for future research, scales may need to split up the yearly category in two or more options as to improve response validity.

Table 12: Application frequency for patents on self-developed technologies

	Never	**Less than yearly**	**Yearly**	**Monthly**	**Weekly**
How often does your firm apply for patents on self-developed technologies?	14,3 %	23,8 %	47,6 %	4,8 %	9,5 %

A second item dealt with the current size of the patent portfolio. Respondents were asked for the amount of patents currently held by the company. Results were quite uniform, except for two obvious outliers (portfolio sizes of 7500 en 1000 respectively) generated by the largest firms in the sample. When excluding these two numbers, the average portfolio size is 33, which is a representative number for the sample.

When looking at the responses for licensing, both licensing in and out, there are striking results. While licensing is a well established theoretical concept, especially considering more open forms of innovation and permeable innovation processes, it is hardly done in practice, especially by small firms. The firms that do license are the firms with the largest patent portfolios. Due to the fact that licensing is conducted in such a low degree, this item will require alteration for future research. As it is now, too many respondents choose similar answers. Nonetheless, from an exploratory point of view, these answers are striking and interesting.

Table 13: License-In & License-Out frequency

	Never	**Less than yearly**	**Yearly**	**Monthly**	**Weekly**
How often does your firm license in patented technologies?	42,9 %	52,4 %	4,8 %	0 %	0 %
How often does your firm license out patented technologies?	66,7 %	19 %	9,5 %	4,8 %	0 %

Other items measured whether the company has an active patent policy, whether they try to assess the value of their patents and whether there is someone specifically assigned to manage patent information. Looking at these results, it can be seen that there are a lot of firms where responsibility for patent related processes is not specifically assigned to someone. Furthermore, these items score higher for firms that are larger in size and in an industry which is more focused on patents, that of medical devices.

Table 14: Results Patent responsibility, Patent Value and Patent policy

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Our company employs someone specifically assigned for responsibility of managing patents and patent information.	4,8 %	42,9 %	9,5 %	23,8 %	19 %
Our company tries to assess the value of patents being held.	4,8 %	23, 8 %	28,6 %	28,6 %	14,3 %
Our company has an overall patent policy that our employees are aware off.	4,8 %	23,8 %	33,3 %	28,6 %	9,5 %

Analyzing the reliability of the patent experience variable results in a Cronbach's alpha of 0.89. In this analysis, the patent portfolio size is left out, because it cannot effectively be included in the Cronbach's alpha measurement. Cronbach's alpha is a statistical reliability measure and thus refers to whether or not you get the same results if you use a tool to measure more than once (Bernard, 2000). Cronbach's alpha is a number between 0 and 1, in which a minimum of 0.7 is often considered in social sciences. Despite that the 0.89 number is good, reliability does not guarantee whether the validity of the measurement.

4.3.3 Patent Situational Awareness

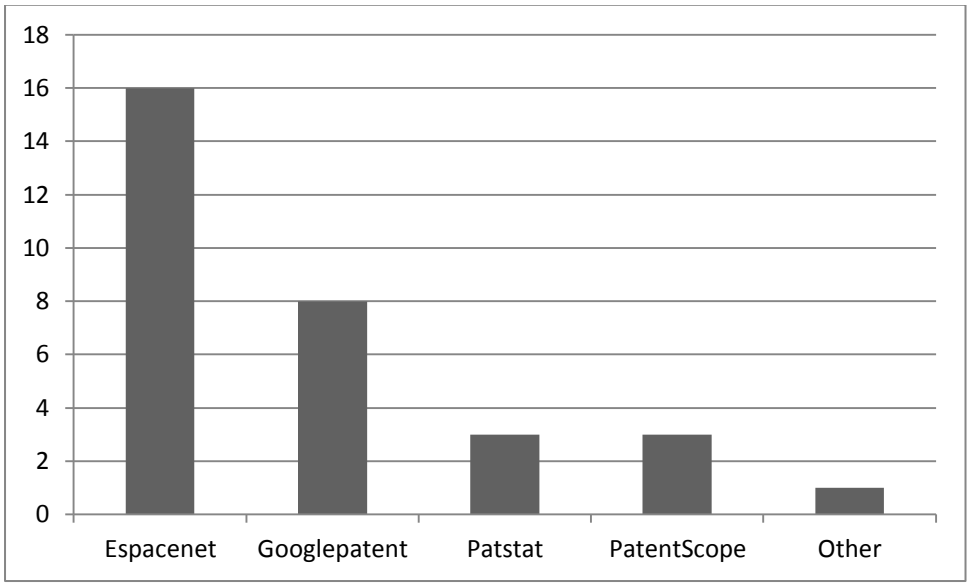
Here, the items which are meant to measure patent situational awareness will be discussed. All firms in the sample responded that they use patent information in new product development. Because there is no variance here, this measure will later on be left out when evaluating reliability. When investigating how often employees search for information in patent databases, the majority responded that they do so yearly. While it does show that patent database search is not done on a very regular basis, for future research it might be wise to create an answer category that further differentiates between yearly and monthly. Nonetheless, based on respondent characteristics, who held functions closely related to product development, one can assume that the judgements are correct and patent database search is not that established a process. Comparing results from different variables, one can see that especially firms that have some specifically assigned for managing patents employ database searches more often.

Table 15: Frequency patent database search

	Never	Less than yearly	Yearly	Monthly	Weekly
How often does your firm apply for patents on self-developed technologies?	0 %	14,3 %	57,1 %	19,0 %	9,5 %

While the previous item measured the frequency of patent database searches, the following item measured which database(s) was/were being used. The results show a clear favorite, followed only by an occasional use of different databases. Respondents could choose more than one answer. Most respondents only use Espacenet, sometimes in combination with Google Patent. Other databases are notably less used. The results can be found in figure 10.

Figure 10: Databases in use



Interesting was to research whether firms were often using an intermediary (e.g. patent attorney) to help in patent related questions or processes. Results were illustrative, as some firms responded never using an intermediary in patent information search activities. Firms that do make use of intermediaries do so yearly, while the larger firms employ them more often.

Table 16: Frequency use of Intermediary

	Never	Less than yearly	Yearly	Monthly	Weekly
How often does your firm consults an agent (intermediary) to assist in patent information search activities?	33,3 %	19 %	38,1 %	4,8 %	4,8 %

The reason as to employ patent information search activities was measured by an item that discusses the extent of information used following a patent information search. Responses were relatively equally divided among the categories. Because all firms conducted patent search activities, the option that no information was used was not selected by respondents. Interesting to see is that the firms with larger patent portfolios all score the highest possible score, using information to evaluate the value of a patent, as input for own product, but also to assess the strategy of competitors. This score is less represented for smaller firms.

Table 17: Extent to which patent information is used

	Not at all	**To evaluate the strength and value of patents**	**To evaluate the strength and value of patents, but also as input for ideas and/or own research**	**To evaluate the strength and value of patents, but also as input for ideas and/or own research and assess strategy of competitors**
To what extent is information from patents / patent databases used by your company?	0 %	38,1 %	38,1 %	23,8 %

For all firms that employ patent information searches, it is interesting to see how useful they find the information they obtain. Usefulness of information was evaluated for both own searches and searches conducted by an intermediary or agent on behalf of the company. Most firms are either somewhat indifferent towards the information gained by patent information searches or find it useful. There are but two firms that are explicitly stating that they do not find the information useful. Important to note is that many respondents have chosen neutral as their response. This will be discussed later in this report in the discussion section. The results can be found in table 18.

Table 18: Usefulness of patent information

	Not at all useful	**Not useful**	**Neutral**	**Useful**	**Very useful**
How do you grade the usefulness of information of patent documents you are supplied with when a patent search has been conducted by your company?	4,8 %	4,8 %	38,1 %	52,4 %	0 %
How do you grade the usefulness of information of patent documents you are supplied with when a patent search has been conducted by an agent on behalf of your company?	0 %	9,5 %	38,1 %	47,6 %	4,8 %

Final items for patent awareness were aimed at evaluating future scenarios. It is interesting to see that these results are somewhat on the lower side that other items. Perhaps this is because firms find it difficult to gather any real data from patent information search activities. In previous items respondents stated that they do find information useful, but these items somewhat seem to lessen that view. Information is being used to develop future course of action, but evaluating litigation seems more difficult. Nonetheless, the results once again show that licensing is not widely adopted.

Table 19: Assessing litigation, developing future course of action and evaluate license deals

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Our firm assesses the likelihood of future litigation based on the information provided by patent information searches	4,8 %	23,8 %	33,3 %	28,6 %	9,5 %
Our firm develops future courses of action based on the information provided by patent information searches	0 %	23,8 %	19 %	52,4 %	4,8 %
Our company evaluates the possibility of license deals based on the information provided by patent information searches	9,5 %	33,3 %	28,6 %	19,0 %	9,5 %

Cronbach's alpha for the patent situational awareness items is 0.886. This is a fairly high number that shows that the measurement is reliable. Like previously stated, a Cronbach's alpha higher than 0.7 is deemed acceptable. This reliability score of the patent situational awareness items allow for a preliminary regression analysis in a later stage.

4.3.4 Patent Infringement Risk

Patent infringement risk was measured by three items. The first measured whether firms find infringement risk reduction valuable and worth the cost, the second measured their perceived likeliness of infringing any patents, while the third measured whether firms evaluate the financial consequences that infringement may have on their firm. Interesting, but perhaps not fully surprising is the fact that a large portion of the firms does is not fully positive they are not infringing any patents. This can be related to the neglect of patent search activities some firms showed in earlier items. The same argument can be made for the worth of patent search activities, where some firms show that they do not find the results worth the cost. Other firms, especially those that are larger, are more positive about patent information search activities. The results from the different items can be found in table 20.

Table 20: Worth patent information search, likeliness of litigation and evaluation of financial consequences

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Patent infringement risk reduction is worth the cost of a patent information search	0 %	9,5 %	33,3 %	33,3 %	23,8 %
It is unlikely that we face litigation for cases related to patents held by others	0 %	23,8 %	38,1 %	33,3 %	4,8 %
We evaluate the financial consequences that litigation cases can have on our business	4,8 %	33,3 %	19 %	28,6 %	14,3 %

Cronbach's alpha for the patent infringement risk items is 0.73. This Cronbach's alpha score is on the lower side, but is still an acceptable score in terms of reliability. The score cannot be improved by omitting any items and is thus the highest score attainable for this variable.

4.3.5 Technology Adoption Decision

The technology adoption decision was measured by three items. The items were aimed at measuring whether firms are willing to commercialize products or technologies for which they do not own patents or licenses. Results show that firms take a somewhat safe approach when adopting technologies or commercializing products, showing that they largely agree on not selling product for which they do not own the appropriate rights. Interesting is to see that most firms score on the higher end here, whereas when evaluating whether they assess the likelihood of litigation the score was lower. This may indicate that there is a slight bias present and some firms might not be fully able to answer these questions truthfully. Nonetheless, the results are interesting, because it shows a slight contradiction indicating that firms may not be as aware as they might think. The results for the items can be found in table 21.

Table 21: Selling without rights, license arranged and no infringement

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
We do not sell products for which we do not own the appropriate patents or license	0 %	4,8 %	33,3 %	52,4 %	9,5 %
When we sell products that include technologies we do not own ourselves, we always have appropriate license deals arranged	4,8 %	9,5 %	38,1 %	33,3 %	14,3 %

When selling new products, we make sure we do not infringe on patents held by others	0 %	4,8 %	23,8 %	47,6 %	23,8 %

Cronbach's alpha for the technology adoption decision items is 0.772. Like patent infringement risk, this is on the lower side of acceptable reliability scores. The score cannot be further improved by omitting any items.

4.3.6 Comparing scores & Regression analysis

This research project was conceptualized as a pilot study and thus not aimed at testing hypotheses. Nonetheless, if reliability scores are high enough, testing for correlation is useful, because it sheds light on future relationships that are important to investigate. Furthermore, it allows statistical investigation of the established conceptual model. The reliability scores for the items were all deemed acceptable, and thus can be used to test for correlation. These scores can be found in table 222. Propensity to patent does not have a cronbach's alpha score due to the fact that it was measured by a single item. Due to the fact that for the separate variables the same Likert-scale was used, the scores allow for easy aggregation into a mean score that can be used for further analysis. Firm size and industry propensity to patent has been previously established. For the variables patenting experience, patent situational awareness, patent infringement risk and technology adoption decision, mean scores have to be calculated. Propensity to patent has been measured on a different scale compared to the other variables (score between 0 and 1). The results can be found in table 22.

Table 22: Average mean scores and standard deviation per variable

Variable	**Mean Score**	**Standard Deviation**	**Cronbach's Alpha**
Propensity to Patent	0,53	0,14	-
Patenting Experience	2,56	0,83	0,89
Patent Situational Awareness	3,04	0,80	0,886
Patent Infringement Risk	3,35	0,82	0,73
Technology Adoption Decision	3,67	0,72	0,772

Like previously stated, it is important to generate feedback for future research. In the established conceptual model, firm size was expected to influence the patent situational awareness score as such that larger firms are more likely to score higher on patent situational awareness. In order to evaluate this relationship, the firms have been previously classified as small, medium-sized or large. The mean scores for patent situational awareness examined by firm size can be found in table 23.

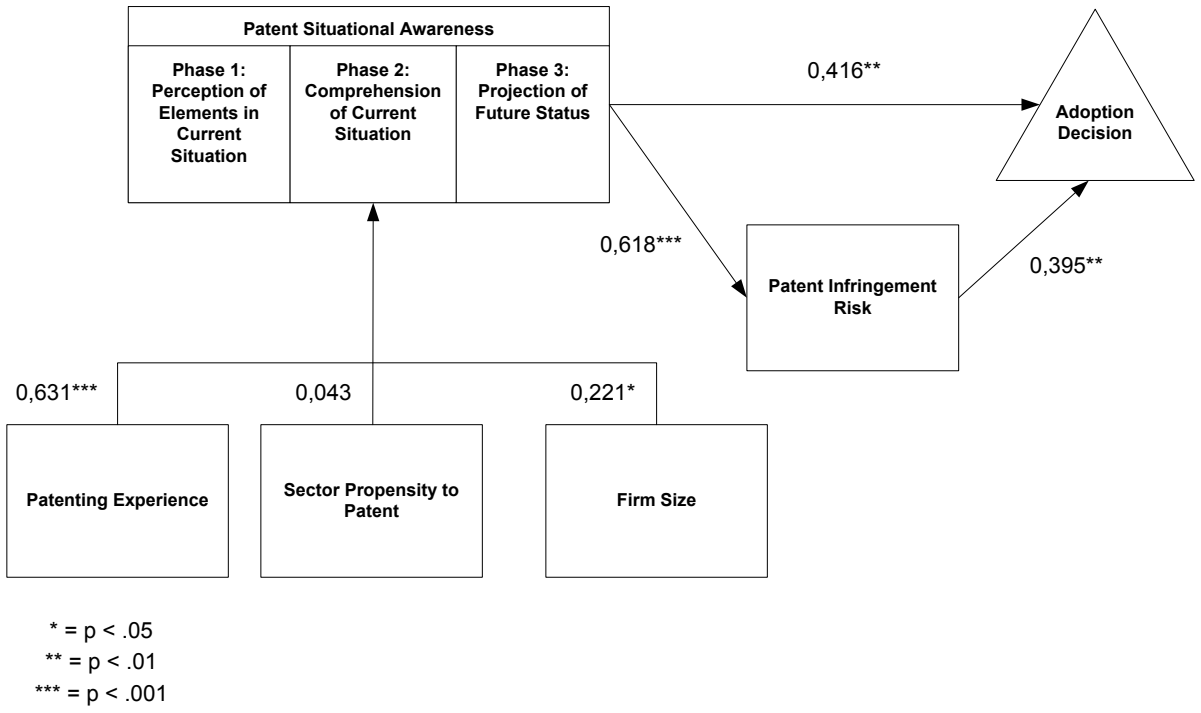
Table 23: Mean scores for Patent Awareness by firm size

Firm Size	Patent Situation Awareness	Standard Deviation
Small	2,71	0,66
Medium	2,81	0,77
Large	3,62	0,74

The comparison of mean scores according to firm size shows interesting results. Small and medium sized firm score a 2,71 and 2,81 on a scale of 5 respectively, showing that there is definitely room for improvement in patent situational awareness. Large firms on the other hand score remarkably higher, with a score of 3,62, indicating that large firms have more established mechanisms and more actively try to identify and comprehend patent information and more actively try to predict the future based on that information.

In order to more statistically test the relationships from the conceptual model, regression analysis was performed to see if there are any significant relationships. Outcomes have to be interpreted with caution due to somewhat low statistical power originating from the smaller sample size used in this pilot study. An overview of the observed relations can be found in figure 11.

Figure 11: Conceptual model with observed relations



The depicted model shows the conceptual model that was established in chapter 2 with corresponding results from regression analysis. Patenting experience was found to explain a significant amount of variance in patent situational awareness ($F(1,19) = 32,47$, $p < .001$, $R^2 = .631$, $R_{adjusted} = .28$). Sector propensity to patent on the other hand, did not show significant results and

thus does not explain as large a variance in patent situational awareness ($F(1,19) = 0{,}86$, $p > 0{,}05$, $R^2 = .043$, $R_{adjusted} = -.007$). Results for firm size did show significance, albeit less significant than patenting experience ($F(1,19) = 5{,}40$, $p < .05$, $R^2 = .221$, $R_{adjusted} = .18$). Further analysis was done on the relationship between patent situational awareness, patent infringement risk and adoption decision. First of all, there is a significant relationship between patent situational awareness and adoption decision ($F(1,19) = 13{,}52$, $p < .01$, $R^2 = .416$, $R_{adjusted} = .385$). Second, Patent situational awareness explained a large amount of variety in reduction of patent infringement risk ($F(1,19) = 30{,}76$, $p < .001$, $R^2 = .618$, $R_{adjusted} = .598$). Third, reduction of patent infringement risk also showed a significant relation to the adoption decision variable ($F(1,19) = 12{,}40$, $p < .01$, $R^2 = .395$, $R_{adjusted} = .363$). Due to these three results, a test for mediation can be run in which the relationship between patent situational awareness and adoption decision is analyzed while controlling for patent infringement risk. Surprisingly enough, when conducting this analysis no significant relationship between the variables remains. This leads to the conclusion that a mediation effect cannot be established, possibly due to the fact that the original relationships between the variables were not strongly significant enough to begin with. Nonetheless, it is an interesting result of the analysis that can be further examined in future research.

4.3.7 Survey Comments

Respondents that participated in the survey were asked to comment on the survey after completing it, explaining what they found difficult or unclear. These comments do not change the results of the survey, but they do help in improving the survey instrument for future research purposes. Comments on the survey varied and often involved the perspective of the participant. The most important comments from respondents that can help build a better instrument are listed below.

- Include the option to not answer a question. This can help if a respondent does not know the answer or if the question is not applicable to the firm the respondent represents.
- Processes within firms can vary greatly and therefore strongly (dis)agreeing with a statement is difficult. This can results in a sometimes safely chosen answer somewhere in the middle of the scale.
- A few questions look somewhat alike and thus generate the same response if respondents are not fully concentrated.
- For multinationals, business practices can vary greatly between business units, making it hard to answer for an entire firm. Contacting representatives from separate business units would be a solution to this problem.
- The survey instrument requires vey specific knowledge, which can make it difficult for the respondents to objectively answer each question.

5. Conclusion, Discussion & Recommendations

The main conclusions of this research project are presented in this chapter. Afterwards, a discussion of results and recommendations for future research will be presented. The conclusions are presented in relation to the established conceptual model. Here, the findings from both the interview and questionnaire will be analyzed. The discussion will discuss the weaknesses of this research project, and the recommendation will focus on the improvement of theoretical concepts and methods.

5.1 Conclusion

A literature study has been employed, which has lead to the establishment of a conceptual model for patent situational awareness that includes several variables. Due to the fact that this research project was exploratory of nature and set up as a pilot study, the main focus was on evaluating the established model, establishing a measurement instrument and providing direction for future research. Focus did not lie on testing relationships. However, if opportunity presented itself, relationships were to be tested to gain preliminary insight into the relationships.

An attempt has been made to evaluate the model by conducting interviews and establishing and testing a survey instrument. Before administrating the survey instrument, it has been evaluated in a by experts with methodological, theoretical and practical experience. This has lead to a well-considered instrument that was administered. This instrument was distributed among 50 organizations, of which 21 completed the questionnaire, leading to a response rate of 42%. The questionnaire responses were analyzed using SPSS statistical software and together with the interviews, provide insight into the role of patent situational awareness in the new product development process. Survey variables showed adequate Cronbach's Alpha scores, and could therefore be used for test for relationships. After administrating the survey, another evaluative interview was held in order to possibly improve the survey for future research purposes.

Both the survey results and interviews show that firms try to investigate whether technologies are free to use. Survey results showed a moderate score for patent situational awareness, showing that they do employ patent information searches, but not to full force. This is supported by the findings from the interviews, which shows that employing a patent information search is very much dependent on the technology at hand. This means that it is up to the judgement of the firm whether or not to conduct an information search. The interview participants noted that when technologies are state of the art, they are more likely to do extensive research.

An important part of patent literature is that of licenses and licensing arrangements. These deals focus on the allowed usage of patented technology by a non-proprietor for a fee. Considering open innovation and open development processes, one would expect licensing to be fairly common in technological firms. It is therefore interesting to see that very few firms consider licensing to be effective. Survey results show that only a small percentage of firms either license in or out, and this happened to be the largest firm in the sample. Interview participants stated that they do not employ licensing deals, even going as far as stating that licensing is bothersome and not worth the effort. This is a surprising result and may be interesting to further examine in the future.

A high percentage of firms stated that they employ an intermediary for patent search activities yearly, showing that they do occasionally require a professional opinion. This was further supported

by responses from the interview participants, stating that whenever they find patented technologies that block or are extremely similar to the technology a firm wants to use, a professional opinion from a patent attorney is sought to make a better evaluation of the actions to take. All interview participants stated that their firms have a specific patent attorney they contact regularly.

The survey attempted to measure patenting experience and found this to significantly influence patent awareness, as was established in the conceptual model. Most firms apply for patents yearly, which corresponds with the actual size of their patent portfolio's. Only the larger firms apply for patents more often, which is to be expected. Their patent portfolios are larger following from that process. Striking is the fact that many of the smaller firms respond that they do not employ someone specifically assigned for management of patent information and that they do not have an overall policy of patenting. The interview participants also stated that they do not assign responsibility of patent related tasks to a specific person, mainly due to the fact that this is too expensive. Within these organizations, engineers were always responsible for patent information searches. One could argue that this is an important factor in reducing overall patent awareness within smaller organizations, because an established policy would set clear rules and guidelines upon how to deal with patent information. Nonetheless, it is a striking result and shows the contrast between small and large firms.

Firm size was established as a variable in the conceptual model, because it was argued from a practical point of view that large firms have more resources to employ specific patent search activities. Furthermore, large firms often have a more thorough and documented structure of business processes. This idea was supported by survey results, which showed a significant relationship between firm size and patent situational awareness. There was no large difference between small and medium sized firms, in which patent and intellectual property related processes are often responsibility of management. Large firms on the other hand more often showed an established patent policy and personnel assigned for responsibility of patent processes. These firms do not have to pay expensive fees to third parties when they want to do an extensive patent information search and can thus employ these searches more often in their product development process.

In the conceptual model, a third variable that influenced patent situational awareness was that of industry propensity to patent. It was argued that the importance of patenting within an industry influences patent situational awareness, because it can increase or lessen the pressure on firms to actively evaluate patent information. This idea was somewhat supported from interview responses, stating that patenting was extremely important in the medical industry and they thus had to conduct patent information searches there more often. Surprisingly, this variable did not show a significant relationship after statistically analyzing survey data. Possible reasons for this will be discussed in the next section.

The relationship between patent awareness and patent infringement risk was found to be significant, showing that higher patent awareness leads to a reduction in patent infringement risk. This can be seen as a clear answer to the research question, however results cannot be completely generalized due to low statistical power. Nonetheless, it shows that the conceptual model was accurate in predicting this relationship. This is further supporting by interview responses, stating that they employ their patent information searches specifically to investigate whether infringement is any real

danger they have to account for. Like previously stated, this is closely tied to the state of the art, and thus becomes more important when technologies are newer.

The last variable that was conceptualized was the adoption decision variable. Both patent infringement risk and patent situational awareness showed a weak significant relationship with the adoption decision, showing that the information from patent information search activities is being used to evaluate adoption decisions. However, when testing for mediation, no significant relationships remained. Possible reasons for this finding will be discussed in the next section. However, this shows that the established conceptual model is not yet fully accurate.

In summary, the most significant conclusions of this study are:

- A model and measurement instrument for patent situational awareness and patent infringement risk has been developed on the basis of literary insights.
- An empirical study has been conducted to evaluate the model and the measurement instrument. Two patent attorneys and three firm representatives were interviewed and 21 firms completed the survey instrument.
- From a literary and practical point of view, questions were deemed relevant and interesting. Both patent attorneys stated the questions to be relevant and to be interested in results. They did provide a few nuances to questions that can be used for future research.
- Survey items were reliable enough to be used for further statistical analysis and have been used to test for regression among the variables. Results from the survey and interviews provide insight into patent situational awareness in firms, how firms deal with patent information and their standings on infringement risk.
- Regression results show that patent situational awareness reduces patent infringement risk as was established in the conceptual model. Not all established relationships were confirmed, as there was no mediation effect established and sector propensity to patent showed no significant relationship.

5.2 Discussion

This discussion will focus on the model and method used in this research project. This research project employed a mixed-methods research approach, using both a survey and interviews. Reasons for this approach were two-fold. First, the interviews could be used to evaluate the established conceptual model to gain a more in-depth look into how firms deal with patent information, which is valuable because of the exploratory nature of this research project. Second, expert interviews help evaluate the established survey instrument before administering it. Finally, because dealing with patent information in new product development can also be seen as a process, it can be difficult to evaluate the model on survey data alone. The answers from interview participants can thus add nuances to concepts or provide a more detailed answer and thus helps reduce the mono-method bias.

The interviews were valuable in examining the use of patent information search activities and the reasons to do so. Furthermore, they provided feedback on the established conceptual model and measurement instrument which helps to improve it. In a previous chapter, design science has been discussed. Here, it was argued that developing a survey instrument is very much a design science problem. One aspect of designing an instrument is testing it in the field. For this reason, it was

important to actually administer the survey. Feedback from interviews tends to be focused on the questions at hand, modifying them ever so slightly. Testing the survey in the field can show whether or not questions are relevant, based on the answers given by respondents. The comments made after administrating the survey will be used to give recommendations for future research. By combining data from both survey and interviews, generalized considerations can be made about methodology. These considerations are:

- Generalizability is an issue. One aspect of this research project which was discussed previously is that of a pilot study. A pilot study is particularly meant to evaluate the model and research method, and less so to test the relationships. This means that the established relationships and corresponding number are not fully generalizable due to low statistical power. Furthermore, because of a diverse sample, it is hard to make clear statements about firms outside of the sample. Nonetheless, this has provided insight into the concept of patent situational awareness.
- The specification and selection of questionnaire items can be improved. Based on comments given from survey respondents and post-survey evaluation, there were a few items which looked similar for respondents. For some items, wording could be improved to make questions more clear and specific. Comments on similar items in a survey may indicate that some items are redundant and could thus be improved. Similar items may distort the reliability scores that have been established.
- Using single respondents limits validity. Using a single respondent for an organization may lead to safe choices and many “Stuck in the middle” answers. This was also explained by a comment from an employee at a multi-national. He stated, sometimes it was hard to fill out the survey in a multi-national context, due to the fact that processes may vary within business units. Using multiple respondents within an organization may increase validity and reduce mono-method bias.
- Quite a few respondents answered “Neutral”, which is detrimental to measurement and validity. This can be largely explained by the lack of knowledge many people have concerning intellectual property. Often, they are not fully aware of or have not established clear practices concerning patent management, and thus choose “Neutral” as a safe answer category. For future research, it would be valuable to change the “Neutral” answer category as to improve response data.
- While theorized, industry propensity to patent did not show a significant relationship with patent situational awareness based on survey data. However, interview participants did mention clear differences in importance for different industries. The fact that this relationship is not found can likely be explained by the fact that research by Arundel (1998) was taken as a basis for the industry propensity to patent analysis. Over the years, many industries may have changed in structure and as such, patenting may have become more or less important. This may distort the outcome of the analysis. Furthermore, analysis was based on a single item. In future research, using multiple items for industry propensity to patent may be advisable.
- In the conceptual model, a mediating effect for patent infringement risk was theorized. This mediating effect was not confirmed after statistical analysis. This can possibly be caused by the fact that the main relationships between the variables were not so strongly significant. When controlling for both patent awareness and patent infringement risk, this causes them

to no longer be significant. This can also be caused by low statistical power, originating from the smaller sample sized used in this pilot study. This can lead to not observing a relationship, while in reality there may be one. A different explanation can lie in the difficulty of measuring a concept like technology adoption, mainly due to the fact that it is very event oriented. It would be interesting to see how patent infringement risk and patent situational awareness would relate to technology adoption when adopting a more process oriented view.

- National differences are not accounted for. The survey and interviews are administered in a single country, thereby not discussing differences between countries. Differences could be caused by laws & regulation, cultural factors, innovation policies etc. It would be interesting to see whether there are any real differences between countries.

The above statements are general issues that reflect on the research project as a whole. Specific recommendations to improve the survey instrument will be reported in the next paragraph.

5.3 Recommendations

This study was aimed at examining patent situational awareness and patent infringement risk within organizations. Due to the fact that this is a pilot study, recommendations focus on improvements that can be made both to the model and to the measurement instrument. The recommendations follow logically from previous analysis and discussion. The generalized statements mentioned in earlier paragraphs can be translated in the following recommendations for future research:

- Further examine the technology adoption variable. It would be possible to further investigate the strategy of inventing around the blocking patent. Based on interview information, inventing around a patent is done far more than agreeing to a license deal. Examining this might change the conceptual model, but may better represent reality, especially for small and medium sized firms.
- Further test the relationships in the conceptual model. To make a more thorough evaluation of the relationships within the conceptual model, a larger sample size is required. The reliability of the items in the measurement instrument was adequate, but a few changes are necessary to further increase the accurateness of the measurement instrument. Some items need small adaptations, while some items may be changed to a larger degree (i.e. items on licensing).
- Account for the generalization of results. Like with further testing of the relationships within the established conceptual model, generalization of results requires a larger sample size. Doing so will increase statistical power. Further improvements to generalizability can be made by using a more focused sample and target population.
- Use multiple respondents when administering the questionnaire items. Multiple respondents reduce mono-method bias and allows respondents to answer more specifically related to their department or function. This also increases the usefulness of the survey instrument for large organizations, as their processes may vary more than small organizations.
- Increase the validity of questionnaire items. Overall, the questionnaire items were deemed reliable, but respondents reacted that some items looked similar. This may indicate that there are a few redundant items, or items that may not have their intented function. One example of this is the items that measure licensing. These items are just slightly different in their direction, and when licensing hardly employed, it may distort the validity of the

measurement. A remedy for this would be to employ more follow-up interviews, but this would significantly increase the time required.

- Further assess sectorial / national varieties. An attempt to assess sectorial differences has already been made by included the propensity to patent variable. Unfortunately, this relationship was not found significant. Nonetheless, a different assessment could be made by administering the survey within different target populations, comparing the results of the measurement. The same could be done for national varieties.

The above mentioned recommendations are aimed at future research in general. Recommendations concerning the survey instrument that followed from statistical analysis and interview results are also to be made. These recommendations are:

- Use the notion patent families instead of patents. One patent family can hold several patents. Asking respondents for patents can sometimes distort the picture, especially for multi-national firms.
- Instead of asking on a subjective scale, ask for direct yearly frequencies that can later be categorized. This allows for richer and more accurate data collection.
- Adapt the items concerned with licensing. Licensing frequencies are low for small and medium sized firms, therefore examining the considerations these firms employ may be more relevant than the licensing process itself.
- Adapt the response scales that include “Neutral” items. The “Neutral” answer category is too often seen as a safe choice when respondents are not fully knowledgeable or unsure of their answer. Changing this response category may improve validity.
- Examine the reason why firms employ intermediaries to conduct a patent search activity. From practical experience of patent attorneys, the reasons for contacting them can be diverse.
- Include items that deal with contractual agreements regarding patents that flow from cooperation of several parties. This concept resulted from the interviews in which contractual agreements were discussed. Often, this is an issue for small and medium sized firms and can lead to serious damages if not properly arranged.
- Include items that test overall knowledge of intellectual property and patents. This can be done in the general part of the survey and may help to evaluate general IP knowledge as well as participant background.

In the appendix, a first attempt has been made to incorporate some of these recommendations, especially regarding restructuring of sentences and wording. Completely changing items however will require new theoretical evaluation and design of specific measurement scales. Establishing these items lies outside the reach of this research project. Overall, this project has examined patent situational awareness and patent infringement risk and has provided first insight into this problem from a business perspective. Furthermore, recommendations for future research have been established. It is here in which lies the value of this research project.

List of abbreviations

HTSF	-	High-Tech Small Firms
IP	-	Intellectual Property
IPR	-	Intellectual Property Rights
NPD	-	New Product Development
PAE	-	Patent Assertion Entity
SA	-	Situational Awareness
TPR	-	Tangible Property Rights

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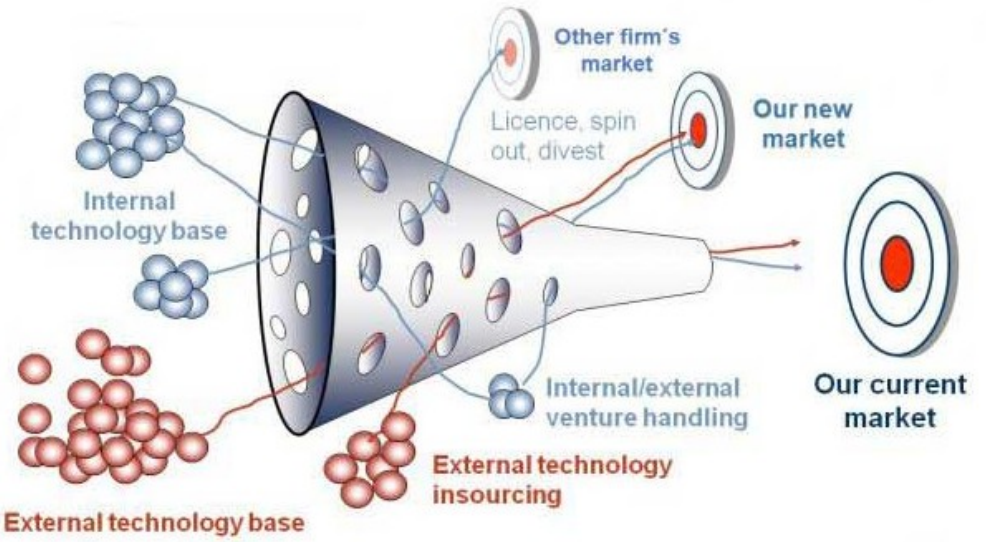
Appendix I: New Product Development Concepts

New product development is the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale (Krishnan & Ulrich, 2001). In an attempt to structure the process of opportunity recognition to product launch, many firms employ the stage-gate model (i.e. Unilever; Keizer et al, 2001), often in combination with the concept of an innovation funnel. Using these concepts, firms evaluate opportunities and decide upon whether or not to develop or adopt technologies and products.

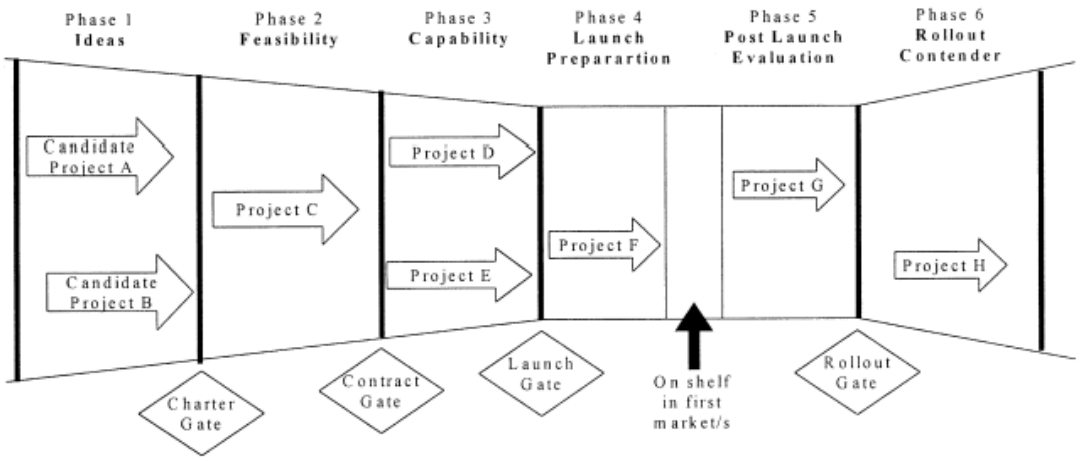
The innovation funnel is a concept from innovation management that describes the process of idea generation until commercialization. While the concept of the innovation funnel used to be rather closed off, over recent years a shift has been made towards a more "open" innovation funnel concept (Chesbrough, 2004). This means that the innovation funnel is more permeable to factors originating from the external environment. Nonetheless, the end state of the funnel is a product that can meet a market need in an economical, manufacturable form. Overall, the innovation funnel starts off broad, in which many ideas must be generated and evaluated for feasibility. The ideas use the existing technology base as input. These technology bases can be both internal and external. This thus means that technologies that are being used in the innovation funnel process can be proprietary or non-proprietary. The multitude of ideas generated must be narrowed down to a number which will be developed for testing. From the multitude of ideas, only a few are applicable to the current market. Some ideas may be used to enter new markets, while other ideas leave the innovation funnel early in order to create a license deal or establish a new firm. Out of the few ideas remaining, the best idea is chosen en consequently commercialized. Successfully managing the innovation funnel poses challenges for firms. The first of those challenges is to provide a wide enough mouth for the funnel so that sufficient ideas, be it of internal or external origin, are generated and communicated. A second challenge is to quickly narrow those ideas down to useful ideas that are worthwhile to develop prototypes for. A third important challenge is to spread resources efficiently during the innovation process.

Figure: Open innovation funnel, taken from Chesbrough (2004).



Many firms seek to structure the innovation funnel process by adding the concept of a stage-gate model. The stage-gate model (Cooper, 1990) sees product innovation as a process that can be managed. The process can divided into a number of stages, where between each stage there is quality control checkpoint, or gate. For each gate, there are specified quality criteria to decide whether a idea will continue on to the next stage. The stages are where developments take place, the gates ensure that the quality is sufficient. Typically, each stage is more expensive than the stage preceding it. Often, gates are managed by multidisciplinary managers or senior employees that assess the project, resulting in a "Go/Kill/Hold/Recycle" decision. Often, the stage gate and innovation funnel need to be adapted to company-specific criteria.

Figure: Unilever's Innovation Funnel combined with a Stage Gate approach, taken from Keizer et al. (2002)



Appendix II: Interview transcripts

Interview 1

The first interview was held with Sjoerd Postma, Senior Groupleader at Demcon. Demcon is situated in Enschede and is a high-end technology supplier. The interview lasted around 45 minutes and was recorded following approval from mr. Postma. An overview of the most important answers given by mr. Postma can be found below.

Could you tell me something about your responsibilities and experience with the company?

My name is Sjoerd Postma, and my current position is Senior Groupleader at Demcon. This means I'm in charge of the engineering groups here at Demcon. I've held this position for three years now. Before that, I was active as an engineer at Demcon. In total, I've now worked at Demcon for 12 years.

My own background comes from a study Applied Physics at the University of Twente, after which I've gained my Phd in Mechanical Engineering. I then started working for Demcon as an engineer, which was 12 years ago. The group I'm currently leading is the mechatronics group, which largely consists of academic personnel. Overall, Demcon is definitely a firm that employs many academics. We currently employ 200 people, of which around 50% holds an engineering position. Of that 50% an estimated 80% has an academic background.

Can you elaborate on the industry the firm is active in?

Demcon is an engineering firm and technology supplier. We create new systems, which contain new technologies. We have a very broad expertise, and tackle technological projects and questions on various areas. This means that we serve many different markets. Our organizational structure, which is relatively flat, allows us to be very flexible in serving these markets. Nonetheless, our overall focus areas are twofold, that of high-tech systems and medical devices. High-tech systems is focused on high-tech machines and machine modules, while medical devices solely focuses on a medical market.

Could you describe in as much detail as possible how your firm tries to structure the NPD process?

We have definitely structured our new product development process. We are even obligated to do so due to the fact that we have medical certification. If you want to develop medical devices, structuring the development process is mandatory, because you have to be able to document and show different steps in the process to get products admitted.

We develop according to the V-model, which provides guidance and planning for the realization of projects. The model consists of different phases, which all require documentation on the work that has been done. The V-model starts with establishing requirements, your concept and concept considerations. These ideas are then engineered into a prototype, which is ultimately tested, debugged and integrated. The last step in this process is verifying whether a product fulfills the requirements that have been set initially. This development process is employed for all engineering projects here at Demcon. The V-model comes from the shape of the letter V, which can be seen as the developmental path of a project. Drawing an imaginary line in the centre, a left-hand and right-hand side can be created. On the left-hand side, design and requirements are established, which correspond with a design or test step on the right hand side. Applying the V-model to a project can

be done several times, in the sense that a large project can include the development of separate products or modules which are each developed according to their own V-model process.

Furthermore, when developing new products, we always employ multi-disciplinary teams. This means that, from very early on in the process, employees with different areas of expertise will be involved as to quickly assess the possibilities and limits of a project.

Could you elaborate on the use of information in designing new products?

Demcon projects always originate from the market, from customers. This means that there is always a certain wish or direction present. We do not develop products in the sense of penetrating new markets for ourselves. We do have an interest in a few firms that do have their own products, but Demcon itself always starts operating from the specifications delivered by customers. Mechatronics is a very central aspect of most projects at Demcon, and we require personnel to think on different physical levels, i.e. chemistry, mechanical engineering, etc. This means that integrating knowledge, but keeping an overview as well is extremely important. Most of the knowledge used in this process comes from an educational background and experience in engineering. Our projects are mostly state-of-the-art, especially in the high-tech systems market. In the medical devices market, this is mostly the case as well, but it also sometimes includes some reengineering of older concepts as well. Nonetheless, our organization is very much based on a learning-by-doing concept, and much knowledge is thus anchored in experience. Due to the fact that we employ many academics, there are always people that keep up with new academic literature on their field of expertise. Sometimes, we can integrate this knowledge in projects, but that is largely dependent on the customers' systems and wishes. Furthermore, when designing a solution, our engineers set out on their own search of information that can be used for solutions. This can come from academic journals, but also from other products, third parties or events.

Could you share some details about how and how often your firm deals with patents?

We are mainly active in a high-tech systems and medical devices markets. Both markets are, according to our experience, relatively patent intensive. Especially the medical devices industry, in which strict regulations play a large role, patents are being used a lot. Due to the fact that we develop solutions for our customers, we also gain insight into patented technologies used by them. When we develop solutions, and we do achieve patentable results, we are contractually obligated to transfer the property rights to the customers. This is almost always the case in the medical devices industry, in which new technical solutions are almost always patented. We thus do not apply for patents for ourselves, but we do support that process if customers want it so. We thus do not hold any patents ourselves as Demcon.

Can you tell me how your firm evaluates whether a technology is free to use?

When developing new solutions for customers, our engineers themselves and the customers are responsible for the identification of relevant patents in the environment. Examining the strength of a patent is done by our engineers, and in some cases in cooperation with a third party, a patent attorney firm. Especially in the medical devices market, we often examine the products of our customers' competitors, effectively reverse-engineering these solutions. When we see something that isn't standard, we start our search whether or not there are patents involved. We then examine

the extent of the conflict with the identified patents. Judging the extent of the conflict rests upon the shoulders of our engineers. When there is a conflict, we always try to circumvent the patent, adopting an invent-around strategy. Once again, judging whether this is possible is done by our engineers, sometimes with involvement of a third party. As far as I know, we have not been involved in any conflict by following this strategy. Nonetheless, if there is a conflict, the customer that initiated the project is responsible for the further handling of the conflict. We have an advisory role on the patented technologies, but the final implementation decision lies with the customer.

Interview 2

The second interview was held with a representative of a precision equipment manufacturing firm. The interview lasted around one hour, in which answers were administered by taking notes. For confidentiality reasons, the participant did not allow recording of the interview, and wanted to stay anonymous in both firm and personal information.

Could you tell me something about your responsibilities and experience with the company?

I currently hold a project management function at the company, overseeing the engineering work that is done on a particular product that we produce. I've been involved in work on this particular product since I've started here, which was after I graduated from my electrical engineering study back in 2004. Our firm currently employs around 300 people here on location, and employs a total of around 500 people worldwide. The organization has a solid technological basis and most people that we employ have a technical background.

Can you elaborate on the industry the firm is active in?

Like we've discussed, the products we sell are highly technical of nature. We serve a variety of markets that all demand a particular variation of our product. Our main business is producing general purpose instruments, which are used in many different markets to different degrees in accordance to legislative requirement. All these markets have different demands and legislation to account for, which is why there are some markets we do not serve at the moment. An example of this is the medical devices markets, in which the legislative requirements are very high and the investment in both time and financials are too high at the moment. In order to do so we would require high commitments from customers beforehand, which we currently do not have for that particular industry. Overall speaking, we serve a multitude of markets with different variations of our product.

Could you describe in as much detail as possible how your firm tries to structure the NPD process?

We have definitely structured our development process in order to guide projects from beginning to end in a successful manner. Structuring of this process has not been done on the basis of any theoretical model as far as I know, but is based on the standard product development process. For us, it starts with a market assessment, researching which requirements need to be fulfilled. Once this has been completed, a proof of principle can be made in which we quickly test whether any solution we thought of is possible. When a proof of principle turns out well, a fully working prototype is developed, which has to be tested for the requirements that have previously been established. For a typical engineering firm that develops specific customer solutions on a project basis, work usually stops when the product is tested and can be successfully built. For us, this is somewhat different as we require products to be scaleable. One can imagine that producing a thousands of products brings

with it different questions and problems. For us to successfully launch new products, these problems have to be solved, which often involves cooperating and negotiating with suppliers. When all this has been successfully completed, the last phase of our development process is concerned with the release of the product and accompanied details and information.

Overall speaking, we use multidisciplinary teams in our engineering departments from early on in the process. That means that personnel with different areas of expertise are involved in a single project and collaborate intensively. For us, it is harder to do so in the same manner with the sales department, because we mainly work on a technology push basis.

Could you elaborate on the use of information in designing new products?

Our firm mainly works on a technology push basis, which means that we develop technologies in-house on our own initiative when we see opportunities. We do see possibilities in the variety of markets we serve, and there are customers that are looking for particular solutions. However, investments in these projects are often costly, while only serving a narrow market. These projects would require commitment upfront from our customers, which they most of the times can't give. The market pull information streams are definitely there, but we do not always act upon it. Overall speaking, we push on products on the market.

A different information stream we have is that of research projects we have in collaboration with Phd. Candidates at universities. These projects often deliver new insights or technologies, and it is up to us to incorporate these technologies into products. This can prove to be difficult, as not all technologies are commercially viable. Nonetheless, these projects do sometimes deliver interesting results and can be a valuable stream of information.

Could you share some details about how and how often your firm deals with patents?

Due to the fact that we are a high-tech manufacturing firm, we come into contact with patents fairly often. This contact can be from a proprietor or non-proprietor perspective. In terms of the proprietor perspective, we currently own upwards of 10 patents. When something is worthwhile and patentable, we make sure we do so. For this, we have a single person that is responsible for managing patents, who is in periodic contact with a patent attorney. When we hire engineering firms or collaborate with other firms in the development process in any way, we make sure we have contractual agreements on the ownership of intellectual property rights that result from the cooperation. This means that if the majority of the investment is ours, so is the intellectual property that flows from it.

Can you tell me how your firm evaluates whether a technology is free to use?

We definitely investigate patent information actively when developing new products, especially products that incorporate more new technologies than others. We do not stare blindly at the results of these searches as we believe that patents can sometimes be used to lead competitors astray. We therefore do not try to deduct a competitor's strategy from the patents they hold for example. Nonetheless, sometimes these searches show that technologies show some close resemblance and require further investigation to make sure we do not infringe upon the patent. This is especially the case if we know that a patent holder has a certain reputation of enforcing patents aggressively. We then ask our patent attorney for a professional opinion, as he is more adept at researching the

legislative boundaries of a certain patent. Where possible, we always try to circumvent existing patents. As far as I know, we haven't had any clash with competitors so far concerning patented technologies. In terms of either licensing in or out, we have not established any deals. We believe this is a hassle and difficult to arrange or monetize on. Furthermore, we would rather keep the technology in-house.

Interview 3

The third interview was held with a representative from a firm that develops and sells sensor technology. For confidentiality reasons, the firm and representative will not be named in the overview of the interview. The interview lasted about 45 minutes.

Could you tell me something about your responsibilities and experience with the company?

I've been with the company for 11 years now and hold a management position in our R&D department. I've started as an engineer after graduating and have slowly moved into the position I currently hold. I've been active as a manager R&D for about 3 years now. In my position, I'm responsible for managing the different projects that our engineers are working on. In my opinion this requires a good sense of overview, but vast technological knowledge as well.My background comes from Electrical Engineering, a field of study which is highly represented in our firm. We employ around 70 people, of which a large portion has a technical background.

Can you elaborate on the industry the firm is active in?

We are active in the sensor technology market, operating at the cutting edge of the state of the art in sensor technology. The environment we are active in is very dynamic, which keeps things very exciting. Our products are used for a variety of applications, but are mainly used for industrial applications. They are used in a wide range of markets, from robotics to medical devices and others. We operate on the both a standardized solution basis, as well as engineer specific solutions to fulfill certain requirements that are set by customers. When standardized solutions are not applicable, we always heavily cooperate with customers in order to develop the best possible solution.

Could you describe in as much detail as possible how your firm tries to structure the NPD process?

For us, the development of a new product is a complex process that often involves contributions from several disciplines. For this reason, we employ people from different background that work together in order to design the best possible solutions. The more complex the new product becomes, the more important having multidisciplinary teams is. Our new product development projects are all managed by a project manager, who controls on three aspects: Financials, delivery time and performance. Due to the fact that we are in basis an engineering firm, it is important not to overly focus on performance and over-engineer a product. We always have to keep in mind that a product has to remain commercially viable. As far as further structuring goes, it is dependent on the type of project. For in-house development of projects that are started without a specific relation in mind and thus generate a more general product, we try to gather ideas internally. We actually encourage personnel to come up with ideas that may improve our existing products or develop entirely new applications. At first, this idea generation was slow, but I believe that we have improved that over the years and developed a healthy process. Deducting good and viable ideas is always a difficult task, in which we try to remain open minded. Nonetheless, only a few ideas ever make it to

commercialization. When a customer approaches us and shows commitment towards a certain technology or requirement, we can of course facilitate the development. Actual development is done on the basis of different stages, which revolve around the typical product development issues. The first is always generating requirements which the new product or technology should fulfill. After this, we start by developing a prototype to test the feasibility of the product. When a working prototype has been develop and tested, we evaluate whether we have to capability to generate larger volumes. When this is possible, actual commercialization can be approved. All these different stages are separated by milestones and meetings in which we discuss whether or not we continue the project. We have had cases in which we concluded that the product was not viable too late before and with this structure we hope to prevent those situations from happening.

Could you elaborate on the use of information in designing new products?

I believe we have a really talented team capable of engineering great solutions. Their knowledge comes from their educational background and their enthusiasm for their job. Because we are operating at a state of the art level, much of the new knowledge is publicized in research journals. In fact, we have contributed to several articles ourselves. Responsibility for keeping up with knowledge lies with our personnel, and this has thus far not created any problems. Further information is something we get from the field, we actively try to judge market sentiments and evaluate new possibilities. Cooperation with third parties is another stream of information, which can come from either different firms or universities and research projects. Lastly, while not always possible, we sometimes reverse-engineer the products of our competitors to see if there are any interesting technologies or applications we have not thought of.

Could you share some details about how and how often your firm deals with patents?

Patenting ideas is an extremely widespread practice in our industry. Due to the fact that technologies and solutions are often very promising, most firms jump at the chance to patent their idea. We thus come across patents often and own several ourselves. Basically, for every new solution we develop we evaluate whether it is patentable. Often this is not the case, because it's just minor adjustments to existing products, but for big new projects patents can definitely be a result. We believe that patents can be beneficial to the organization, not just for the added protection it gives a technology, but for marketing purposes as well. Our experience is that especially American customers react more positively when technologies are patented and thus protected. We have issued a claim only once, which resulted in us reaching a settlement with the infringing party in the form of a financial compensation. The whole process of fighting infringement is rather cumbersome and takes up a lot of time and energy.

Can you tell me how your firm evaluates whether a technology is free to use?

For most projects, we try to investigate whether there are any patents blocking our development of a product or technology. Generally, this is done on a two-step basis. The first step is our own assessment of patents in the environment, using search databases to check for closely related technologies. We do not employ anyone specifically assigned for managing patent information, so this process is subject to our engineers' judgement. When blocking patents are found, we always first try to assess the strength of the patent in question and challenge ourselves to circumvent the patent by reengineering our solution. When the project is extremely important or we are unsure whether

infringement is actually the case, we contact a patent attorney to give their opinion. Thus far, this process has always worked well for us. We do not have the financial capabilities to have a patent attorney examine all our developments, so we try to focus on the most important projects.

Appendix III: Initial survey before evaluation

Survey:

Patent Situational Awareness

University of Twente

Thank you for participating in this survey. This questionnaire is aimed at gathering data concerning patent situational awareness and patent infringement risk concerning new product development. This area of research is relatively new and a significant contribution to academic literature is possible. With this survey, we hope to gain insight into the patent situational awareness of firms and how this translates to risk. This survey will be administered anonymously. Minimal organizational background information is required, but names and titles need not be mentioned. The initial question will focus on general firm information, while later questions focus more specifically on IP aspects. The survey segments are separated by color. Please, when filling out this questionnaire, answer the questions as truthfully as possible.

General Information

1. How many employees (FTE) does your firm employ?

…… FTE

2. What is the estimated annual turnover of your company?

…… Euro

3. In which industry is your company active?

……

Patenting Experience

4. How often does your firm license in intellectual property from other parties (to allow your company to use intellectual property owned or controlled by others)?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

5. How often does your firm license out intellectual property to other parties (to allow your company to use intellectual property owned or controlled by others)?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

6. How often does your firm apply for patents on self-developed technologies?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

Considering your company, please state whether the following statements are true or false:

	False	**True**
7. In my company there is at least one person specifically assigned for responsibility of managing IPR.	o	o
8. Our company tries to assess the worth of our IP.	o	o
9. Our company has an overall IP policy	o	o

Patent Situational Awareness

Perception of elements

10. Does your firm ever use patent literature in conducting research?

o Yes	o No

11. How often does your firm search for information in Patent Databases (e.g. Espacenet)?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

12. Please, qualify your frequency of searching for patent information?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

13. How often does your firm consult a private domain patent datasearch company about technologies? (e.g. a patent attorney)

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

14. How often does your firm consult researchers and/or scientific personnel for information about technologies?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

Comprehension of Current Situation

15. To what extent is information used from patents/patent databases used by your organization?

o	Not at all
o	To evaluate the strength and value of patents (e.g. citation count)
o	To evaluate the strength of patents, but also as input for ideas and/or own research

o	To evaluate the strength of patents, for use as input for ideas and/or own research and to assess the strategy of competitors

16. How do you generally grade the fit of information of patent documents you are supplied with when a patent search has been conducted?

o Not at all useful	o Not useful	o Neutral	o Useful	o Very useful

17. How would you grade the interpretability of information in patent documents you are supplied with when a patent search has been conducted?

o Not at all useful	o Not useful	o Neutral	o Useful	o Very useful

Projection of future state

Considering your company, please state your level of agreement with the following statements:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
18. Our firm assesses the likelihood of future litigation based on the information provided by patent information searches.	o	o	o	o	o
19. Our firm develops future courses of action based on the information provided by patent information searches.	o	o	o	o	o
20. Our company evaluates the possibility of license deals based on the information provided by patent information searches.	o	o	o	o	o

Patenting Experience

21. How often does your firm license in intellectual property from other parties (to allow your company to use intellectual property owned or controlled by others)?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

22. How often does your firm license out intellectual property to other parties (to allow your company to use intellectual property owned or controlled by others)?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

23. How often does your firm apply for patents on self-developed technologies?

o Never	o Rarely	o Yearly	o Several times a year	o Monthly	o Several times a month	o Weekly

Considering your company, please state whether the following statements are true or false:

	False	**True**
24. In my company there is at least one person specifically assigned for responsibility of managing IPR.	o	o
25. Our company tries to assess the worth of our IP.	o	o
26. Our company has an overall IP policy.	o	o

Patent Infringement Risk

Considering your company, please state your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
27. When marketing new products, we do not infringe on patent held by others.	o	o	o	o	o
28. It is unlikely that we face litigation for cases related to intellectual property rights.	o	o	o	o	o
29. When we market products that include technologies we do not own ourselves, we always have appropriate license deals arranged.	o	o	o	o	o
30. We do not market products for which we do not own intellectual property rights.	o	o	o	o	o

Thank you for completing this questionnaire.

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Appendix IV: Survey after evaluation

Survey:

Patent Situational Awareness

University of Twente

Thank you for participating in this survey. This questionnaire is aimed at gathering data about patent situational awareness and patent infringement risk concerning new product development. With this survey, we hope to gain insight into patent situational awareness of firms and how this translates to risks when adopting new technologies. We want to investigate whether firms actively use patent literature when researching new technologies. This area of research is relatively new and a significant contribution to academic literature is possible with your help. In order to achieve accurate results, questions must be answered truthfully. Therefore, when filling out the questionnaire, please answer questions as truthfully as possible.

This survey will be administered anonymously. You are not required to fill in your or your company name. In order to complete this survey, organizational knowledge about new product development and the use of intellectual property is required. The initial question will focus on general firm information, while later questions focus more specifically on IP aspects. The survey segments are separated by color. For every section, possible unclear words are defined in the section introduction. If you wish to receive a small rapport on your patent awareness score, please leave your email address at the end of the survey.

General Information

In this section of the questionnaire, a typology of the company and the participant will be established. Questions are aimed at establishing participant background information and establishing firm size as well as the industry the firm is active in. This information is required to evaluate whether firm size or the industry in which a firm is active influences the use of patent information.

1. What function do you currently hold at your company?

…….

2. How many years of experience do you have at your company?

…….Years

3. How many employees (FTE) does your firm employ?

…… FTE

4. What is the estimated annual turnover of your company?

…… Euro

5. In which industry is your company active?

……

Patenting Experience

In this section of the questionnaire, questions are aimed at gathering information on previous experience of the area of patenting. Patenting experience is expected to influence the accuracy of patent searches, allowing for better results when conducting patent searches.

Definitions:

License in – The process of obtaining a license/contract/permission so that patented technologies owned by other firms can be used without risk of legal consequences.

License out – The process of giving out a license/contract/permission so that patented technologies owned by your firm can be used by others without risk of legal consequences.

Apply for a patent - The process of filing a patent applications in the hope of obtaining a patent.

6. How often does your firm apply for patents on self-developed technologies?

o Never	o Less than yearly	o Yearly	o Monthly	o Weekly

7. How many patents does your company hold?

……

8. How often does your firm license in patented technologies from other parties (to allow your company to use patented technologies owned or controlled by others)?

o Never	o Less than yearly	o Yearly	o Monthly	o Weekly

9. How often does your firm license out patented technologies to other parties (to allow others to use intellectual property owned or controlled by you)?

o Never	o Less than yearly	o Yearly	o Monthly	o Weekly

State your level of agreement with the following statements:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
10. Our company employs someone specifically assigned for responsibility of managing patents and patent information	o	o	o	o	o
11. Our company tries to assess the value of patents being held	o	o	o	o	o
12. Our company has an overall patent policy that our employees are aware of	o	o	o	o	o

Patent Situational Awareness

In this section of the questionnaire, questions are aimed at gathering information on the frequency of patent searches, where information is being searched and to what extent it used and found useful. This information is important, because it shows in which way firms use patent information.

Definitions:

Infringement - Violation of patent right

Litigation - Legal procedure following from infringement

Perception of elements

13. Does your company ever use information obtained from a patent information search in new product development?

o Yes	o No

14. How often do employees in your firm search for information in Patent Databases (e.g. Espacenet)?

o Never	o Less than yearly	o Yearly	o Monthly	o Weekly

15. Which of the following databases do employees of your company use?

Database	Yes	No
Espacenet	o	o
Patstat	o	o
Patentscope	o	o
Google Patent	o	o
Other	o	o

16. How often does your firm consult an agent (intermediary) to assist in patent information search activities? (e.g. a patent attorney)

o Never	o Less than yearly	o Yearly	o Monthly	o Weekly

Comprehension of Current Situation

17. To what extent is information from patents/patent databases used by your organization?

o	Not at all
o	To evaluate the strength and value of patents (e.g. citation count)
o	To evaluate the strength of patents, but also as input for ideas and/or own research
o	To evaluate the strength of patents, for use as input for ideas and/or own research and to assess the strategy of competitors

18. How do you grade the usefulness of information of patent documents you are supplied with when a patent search has been conducted by your company?

o Not at all useful	o Not useful	o Neutral	o Useful	o Very useful

19. How would you grade the usefulness of information in patent documents you are supplied with when a patent search has been conducted by an agent on behalf of your company?

o Not at all useful	o Not useful	o Neutral	o Useful	o Very useful

Projection of future state

Considering your company, please state your level of agreement with the following statements:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
20. Our firm assesses the likelihood of future litigation based on the information provided by patent information searches.	o	o	o	o	o
21. Our firm develops future courses of action based on the information provided by patent information searches.	o	o	o	o	o
22. Our company evaluates the possibility of license deals based on the information provided by patent information searches.	o	o	o	o	o

Patent Infringement Risk

In this section of the questionnaire, the aim is to evaluate whether risks are being thought of and whether they pose any real danger. These items try to evaluate a firms standing on patent infringement risk.

Please state your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
23. Patent infringement risk reduction is worth the cost of a patent information search	o	o	o	o	o
24. It is unlikely that we face litigation for cases related to patents held by others.	o	o	o	o	o
25. We evaluate the financial consequences that litigation cases can have on our business	o	o	o	o	o

Technology Adoption

In this section of the questionnaire, the aim is to evaluate the technology adoption process and whether patent information plays any role in this process. A decision regarding technology adoption is often the final step after conducting a patent information search. Gathering information about this decision is the concluding step of this questionnaire.

Please state your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
26. When selling new products, we make sure we do not infringe on patents held by others.	o	o	o	o	o
27. When we sell products that include technologies we do not own ourselves, we always have appropriate license deals arranged.	o	o	o	o	o

28. We do not sell products for which we do not own the appropriate patents or license.	o	o	o	o	o

Please share your opinion on this questionnaire to help improve it for future occasions. What did you find difficult or unclear?

……

Thank you for completing this questionnaire.

Appendix V: Preliminary New Survey Design

Survey:

Patent Situational Awareness

University of Twente

Thank you for participating in this survey. This questionnaire is aimed at gathering data about patent situational awareness and patent infringement risk concerning new product development. With this survey, we hope to gain insight into patent situational awareness of firms and how this translates to risks when adopting new technologies. We want to investigate whether firms actively use patent literature when researching new technologies. This area of research is relatively new and a significant contribution to academic literature is possible with your help. In order to achieve accurate results, questions must be answered truthfully. Therefore, when filling out the questionnaire, please answer questions as truthfully as possible.

This survey will be administered anonymously. You are not required to fill in your or your company name. In order to complete this survey, organizational knowledge about new product development and the use of intellectual property is required. The initial question will focus on general firm information, while later questions focus more specifically on IP aspects. The survey segments are separated by color. For every section, possible unclear words are defined in the section introduction. If you wish to receive a small rapport on your patent awareness score, please leave your email address at the end of the survey.

General Information

In this section of the questionnaire, a typology of the company and the participant will be established. Questions are aimed at establishing participant background information and establishing firm size as well as the industry the firm is active in. This information is required to evaluate whether firm size or the industry in which a firm is active influences the use of patent information.

1. What function do you currently hold at your company?

……

2. How many years of experience do you have at your company?

…….Years

3. How many employees (FTE) does your firm employ?

…… FTE

4. What is the estimated annual turnover of your company?

…… Euro

5. In which industry is your company active?

……

Patenting Experience

In this section of the questionnaire, questions are aimed at gathering information on previous experience of the area of patenting. Patenting experience is expected to influence the accuracy of patent searches, allowing for better results when conducting patent searches.

Definitions:

License in – The process of obtaining a license/contract/permission so that patented technologies owned by other firms can be used without risk of legal consequences.

License out – The process of giving out a license/contract/permission so that patented technologies owned by your firm can be used by others without risk of legal consequences.

Apply for a patent - The process of filing a patent applications in the hope of obtaining a patent.

6. How many patent applications for self-developed technologies does your firm do on a yearly basis?

……

7. How many patents does your company hold?

……

8. How often does your firm license in patented technologies from other parties (to allow your company to use patented technologies owned or controlled by others)?

o	o	o	o	o
Never	Less than yearly	Yearly	Monthly	Weekly

9. How often does your firm license out patented technologies to other parties (to allow others to use intellectual property owned or controlled by you)?

o	o	o	o	o
Never	Less than yearly	Yearly	Monthly	Weekly

State your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
10. Our has specifically assigned responsibility of managing patents and patent information to atleast one of our employees	o	o	o	o	o
11. Our company tries to assess the value of patents being held (e.g. citation count, impact score)	o	o	o	o	o
12. Our company has an overall patent policy that our employees are aware of	o	o	o	o	o

Patent Situational Awareness

In this section of the questionnaire, questions are aimed at gathering information on the frequency of patent searches, where information is being searched and to what extent it used and found useful. This information is important, because it shows in which way firms use patent information.

Definitions:

Infringement - Violation of patent right

Litigation - Legal procedure following from infringement

Perception of elements

13. Does your company ever use information obtained from a patent information search in new product development to establish freedom to operate?

o Yes	o No

14. How often do employees in your firm search for information in Patent Databases (e.g. Espacenet) to establish freedom to operate?

o Never	o Less than	o Yearly	o Monthly	o Weekly

yearly

15. Which of the following databases do employees of your company use?

Database	Yes	No
Espacenet	o	o
Patstat	o	o
Patentscope	o	o
Google Patent	o	o
Other	o	o

16. How often does your firm consult an agent (intermediary) to assist in patent information search activities? (e.g. a patent attorney)

o Never	o Less than yearly	o Yearly	o Monthly	o Weekly

Comprehension of Current Situation

17. To what extent is information from patents/patent databases used by your organization?

o	Not at all
o	To evaluate the strength and value of patents (e.g. citation count)
o	To evaluate the strength of patents, but also as input for ideas and/or own research
o	To evaluate the strength of patents, for use as input for ideas and/or own research and to assess the strategy of competitors

18. How do you grade the usefulness of information of patent documents you are supplied with when a patent search has been conducted by your company?

o Not at all useful	o Not useful	o Neutral	o Useful	o Very useful

19. How would you grade the usefulness of information in patent documents you are supplied with when a patent search has been conducted by an agent on behalf of your company?

o Not at all useful	o Not useful	o Neutral	o Useful	o Very useful

Projection of future state

Considering your company, please state your level of agreement with the following statements:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
20. Our firm assesses the likelihood of future litigation based on the information provided by patent information searches.	o	o	o	o	o
21. Our firm develops future courses of action based on the information provided by patent information searches.	o	o	o	o	o
22. Our company evaluates the possibility of license deals based on the information provided by patent information searches.	o	o	o	o	o

Patent Infringement Risk

In this section of the questionnaire, the aim is to evaluate whether risks are being thought of and whether they pose any real danger. These items try to evaluate a firms standing on patent infringement risk.

Please state your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
23. Patent infringement risk reduction is worth the cost of a patent information search	o	o	o	o	o
24. It is unlikely that we face litigation for cases related to patents owned by others.	o	o	o	o	o
25. We evaluate the financial consequences that litigation cases can have on our business	o	o	o	o	o

Technology Adoption

In this section of the questionnaire, the aim is to evaluate the technology adoption process and whether patent information plays any role in this process. A decision regarding technology adoption is often the final step after conducting a patent information search. Gathering information about this decision is the concluding step of this questionnaire.

Please state your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
26. When selling new products, we make sure we do not infringe on patents held by others.	o	o	o	o	o
27. When we sell products patented by others, we always have appropriate license deals arranged.	o	o	o	o	o
28. We do not sell products for which	o	o	o	o	o

other parties own patents					

Please share your opinion on this questionnaire to help improve it for future occasions. What did you find difficult or unclear?

……

Thank you for completing this questionnaire.

Appendix VI: Interview Questions

Interview questions with potential probes

The role of patent awareness in new product development

1. Could you tell me something about your responsibilities and experience with the company?

   Please, could you tell me something about your background?

   What is an area of strength and expertise for you?

   You mentioned _____, could you please expand on that?

2. Can you elaborate on the industry the firm is active in?

   Can you give some details about the products your firm is producing?

   How does your product differ from your competitors?

   Could you please expand on _____?

3. Could you describe in as much detail as possible how your firm tries to structure the NPD process?

   How do you try to go from ideas to market?

   Are there any major milestones involved to make go / no go decisions?

   Do you have any examples of this?

4. Could you elaborate on the use of information in designing new products?

   Where does information come from?

   How is information being used?

   You mentioned _____, could you expand on that point?

5. Could you share some details about how and how often your firm deals with patents?

   Could you tell something about patents held by your company?

   Are there any license deals in place?

   Is there anybody responsible for IP within your firm?

Is there an overall IP strategy?

6. Can you tell me how your firm evaluates whether a technology is free to use?

Do you feel that your firm actively tries to avoid infringement by arranging licensing deals?

Do you have any examples of this?

You mentioned _____, could you please elaborate on that?

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Appendix VII: Interview Protocol Form

Interview Protocol Form

Patent awareness in new product development

Date: _____

Time: _____

Location: _____

Note to participant:

Thank you for your participation. Your input will be valuable to this research project and will help lead to advancement in the understanding of the role of patent awareness in the new product development process.

Confidentiality of responses is guaranteed.

Approximate length of interview: 45 minutes.

1. Could you tell me something about your responsibilities and experience with the company?

   Please, could you tell me something about your background?

   What is an area of strength and expertise for you?

   You mentioned _____, could you please expand on that?

Participant response:

Interviewer notes:

2. Can you elaborate on the industry the firm is active in?

Can you give some details about the products your firm is producing?

How does your product differ from your competitors?

Could you please expand on _____?

Participant response:

Interviewer notes:

3. Could you describe in as much detail as possible how your firm tries to structure the NPD process?

How do you try to go from ideas to market?

Are there any major milestones involved to make go / no go decisions?

Do you have any examples of this?

Participant response:

Interviewer notes:

4. Could you elaborate on the use of information in designing new products?

Where does information come from?

How is information being used?

You mentioned _____, could you expand on that point?

Participant response:

Interviewer notes:

5. Could you share some details about how and how often your firm deals with patents?

Could you tell something about patents held by your company?

Are there any license deals in place?

Is there anybody responsible for IP within your firm?

Is there an overall IP strategy?

Participant response:

Interviewer notes:

6. Can you tell me how your firm evaluates whether a technology is free to use?

Do you feel that your firm actively tries to avoid infringement by arranging licensing deals?

Do you have any examples of this?

You mentioned _____, could you please elaborate on that?

Participant response:

Interviewer notes:

Appendix VIII: Descriptive Results

How many years of experience do you have at your company?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1,00	1	4,8	4,8	4,8
	3,00	1	4,8	4,8	9,5
	4,00	2	9,5	9,5	19,0
	6,00	4	19,0	19,0	38,1
	7,00	2	9,5	9,5	47,6
	10,00	2	9,5	9,5	57,1
	12,00	1	4,8	4,8	61,9
	15,00	2	9,5	9,5	71,4
	16,00	1	4,8	4,8	76,2
	20,00	1	4,8	4,8	81,0
	25,00	1	4,8	4,8	85,7
	29,00	1	4,8	4,8	90,5
	30,00	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

How often does your firm apply for patents on self-developed technologies?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	3	14,3	14,3	14,3
	Less than yearly	5	23,8	23,8	38,1
	Yearly	10	47,6	47,6	85,7
	Monthly	1	4,8	4,8	90,5
	Weekly	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

How often does your firm license in patented technologies from other parties (to allow your company to use patented technologies owned or controlled by others)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	9	42,9	42,9	42,9
	Less than yearly	11	52,4	52,4	95,2
	Yearly	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

How often does your firm license out patented technologies to other parties (to allow others to use intellectual property owned or controlled by you)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	14	66,7	66,7	66,7
	Less than yearly	4	19,0	19,0	85,7
	Yearly	2	9,5	9,5	95,2
	Monthly	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

Our company employs someone specifically assigned for responsibility of managing patents and patent information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	9	42,9	42,9	42,9
	Neutral	3	14,3	14,3	57,1
	Agree	5	23,8	23,8	81,0
	Strongly Agree	4	19,0	19,0	100,0
	Total	21	100,0	100,0	

Our company tries to assess the value of patents being held

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	9,5	9,5	9,5
	Disagree	5	23,8	23,8	33,3
	Neutral	5	23,8	23,8	57,1
	Agree	6	28,6	28,6	85,7
	Strongly Agree	3	14,3	14,3	100,0
	Total	21	100,0	100,0	

Our company has an overall patent policy that our employees are aware of

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4,8	4,8	4,8
	Disagree	5	23,8	23,8	28,6
	Neutral	7	33,3	33,3	61,9
	Agree	6	28,6	28,6	90,5
	Strongly Agree	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

Does your company ever use information obtained from a patent information search in new product development?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	95,2	95,2	95,2
	No	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

How often do employees in your firm search for information in Patent Databases (e.g. Espacenet)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than yearly	3	14,3	14,3	14,3
	Yearly	12	57,1	57,1	71,4
	Monthly	4	19,0	19,0	90,5
	Weekly	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

How often does your firm consult an agent (intermediary) to assist in patent information search activities? (e.g. a patent attorney)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	7	33,3	33,3	33,3
	Less than yearly	4	19,0	19,0	52,4
	Yearly	8	38,1	38,1	90,5
	Monthly	1	4,8	4,8	95,2
	Weekly	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

To what extent is information from patents/patent databases used by your organization?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	1	4,8	4,8	4,8
	To evaluate the strength and value of patents (e.g. citation count)	7	33,3	33,3	38,1
	To evaluate the strength of patents, but also as input for ideas and/or own research	8	38,1	38,1	76,2
	Evaluate the strength of patents, for use as input for ideas and/or own research and assess the strategy of competitors	5	23,8	23,8	100,0
	Total	21	100,0	100,0	

How do you grade the usefulness of information of patent documents you are supplied with when a patent search has been conducted by your company?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all useful	1	4,8	4,8	4,8
	Not useful	1	4,8	4,8	9,5
	Neutral	8	38,1	38,1	47,6
	Useful	11	52,4	52,4	100,0
	Total	21	100,0	100,0	

How would you grade the usefulness of information in patent documents you are supplied with when a patent search has been conducted by an agent on behalf of your company?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not useful	2	9,5	9,5	9,5
	Neutral	8	38,1	38,1	47,6
	Useful	10	47,6	47,6	95,2
	Very useful	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

Our firm assesses the likelihood of future litigation based on the information provided by patent information searches.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4,8	4,8	4,8
	Disagree	5	23,8	23,8	28,6
	Neutral	7	33,3	33,3	61,9
	Agree	6	28,6	28,6	90,5
	Strongly Agree	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

Our firm develops future courses of action based on the information provided by patent information searches.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	23,8	23,8	23,8
	Neutral	4	19,0	19,0	42,9
	Agree	11	52,4	52,4	95,2
	Strongly Agree	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

Our company evaluates the possibility of license deals based on the information provided by patent information searches.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	9,5	9,5	9,5
	Disagree	7	33,3	33,3	42,9
	Neutral	6	28,6	28,6	71,4
	Agree	4	19,0	19,0	90,5
	Strongly Agree	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

Patent infringement risk reduction is worth the cost of a patent information search

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	9,5	9,5	9,5
	Neutral	7	33,3	33,3	42,9
	Agree	7	33,3	33,3	76,2
	Strongly Agree	5	23,8	23,8	100,0
	Total	21	100,0	100,0	

It is unlikely that we face litigation for cases related to patents held by others.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	23,8	23,8	23,8
	Neutral	8	38,1	38,1	61,9
	Agree	7	33,3	33,3	95,2
	Strongly Agree	1	4,8	4,8	100,0
	Total	21	100,0	100,0	

We evaluate the financial consequences that litigation cases can have on our business

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4,8	4,8	4,8
	Disagree	7	33,3	33,3	38,1
	Neutral	4	19,0	19,0	57,1
	Agree	6	28,6	28,6	85,7
	Strongly Agree	3	14,3	14,3	100,0
	Total	21	100,0	100,0	

When selling new products, we make sure we do not infringe on patents held by others.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	4,8	4,8	4,8
	Neutral	5	23,8	23,8	28,6
	Agree	10	47,6	47,6	76,2
	Strongly Agree	5	23,8	23,8	100,0
	Total	21	100,0	100,0	

When we sell products that include technologies we do not own ourselves, we always have appropriate license deals arranged.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4,8	4,8	4,8
	Disagree	2	9,5	9,5	14,3
	Neutral	8	38,1	38,1	52,4
	Agree	7	33,3	33,3	85,7
	Strongly Agree	3	14,3	14,3	100,0
	Total	21	100,0	100,0	

We do not sell products for which we do not own the appropriate patents or license.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	4,8	4,8	4,8
	Neutral	7	33,3	33,3	38,1
	Agree	11	52,4	52,4	90,5
	Strongly Agree	2	9,5	9,5	100,0
	Total	21	100,0	100,0	

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Patent Awareness	21	1,83	4,50	3,0476	,80475
Propensity to Patent	21	,25	,74	,5326	,14216
Patent Infringement Risk	21	2,00	5,00	3,3492	,81973
Adoption Decision	21	2,33	5,00	3,6667	,72265
Patenting Experience	21	1,33	4,33	2,5556	,83222
Valid N (listwise)	21				

Report

Patent Awareness

Firm Size	Mean	N	Std. Deviation
Small	2,7143	7	,66468
Medium	2,8095	7	,77237
Large	3,6190	7	,73733
Total	3,0476	21	,80475

Tests of Between-Subjects Effects

Dependent Variable: Patent Awareness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8,171[a]	1	8,171	32,471	,000
Intercept	2,267	1	2,267	9,009	,007
PatentingExperience	8,171	1	8,171	32,471	,000
Error	4,781	19	,252		
Total	208,000	21			
Corrected Total	12,952	20			

a. R Squared = ,631 (Adjusted R Squared = ,611)

Tests of Between-Subjects Effects

Dependent Variable: Patent Awareness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2,865[a]	1	2,865	5,397	,031
Intercept	13,776	1	13,776	25,947	,000
FirmSize	2,865	1	2,865	5,397	,031
Error	10,087	19	,531		
Total	208,000	21			
Corrected Total	12,952	20			

a. R Squared = ,221 (Adjusted R Squared = ,180)

Tests of Between-Subjects Effects

Dependent Variable: Patent Awareness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	,560[a]	1	,560	,858	,366
Intercept	7,822	1	7,822	11,992	,003
IndustryPropensityToPatent	,560	1	,560	,858	,366
Error	12,393	19	,652		
Total	208,000	21			
Corrected Total	12,952	20			

a. R Squared = ,043 (Adjusted R Squared = -,007)

Tests of Between-Subjects Effects

Dependent Variable: Patent Infringement Risk

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8,307[a]	1	8,307	30,757	,000
Intercept	1,079	1	1,079	3,996	,060
PatentAwareness	8,307	1	8,307	30,757	,000
Error	5,132	19	,270		
Total	249,000	21			
Corrected Total	13,439	20			

a. R Squared = ,618 (Adjusted R Squared = ,598)

Tests of Between-Subjects Effects

Dependent Variable: Adoption Decision

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4,343[a]	1	4,343	13,523	,002
Intercept	4,731	1	4,731	14,731	,001
PatentAwareness	4,343	1	4,343	13,523	,002
Error	6,102	19	,321		
Total	292,778	21			
Corrected Total	10,444	20			

a. R Squared = ,416 (Adjusted R Squared = ,385)

Tests of Between-Subjects Effects

Dependent Variable: Adoption Decision

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4,124[a]	1	4,124	12,396	,002
Intercept	3,719	1	3,719	11,179	,003
PatentInfringementRisk	4,124	1	4,124	12,396	,002
Error	6,321	19	,333		
Total	292,778	21			
Corrected Total	10,444	20			

a. R Squared = ,395 (Adjusted R Squared = ,363)

Tests of Between-Subjects Effects

Dependent Variable: Adoption Decision

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4,746[a]	2	2,373	7,495	,004
Intercept	2,932	1	2,932	9,262	,007
PatentInfringementRisk	,403	1	,403	1,273	,274
PatentAwareness	,622	1	,622	1,965	,178
Error	5,699	18	,317		
Total	292,778	21			
Corrected Total	10,444	20			

a. R Squared = ,454 (Adjusted R Squared = ,394)

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