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Estimating Future Patent Litigation Behavior in the Automotive Industry

Using patent data to examine the new competitive environment and foresee conflict risks

Master of Science Thesis
in the Management and Economics of Innovation Programme

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Abstract

Patenting statistics show how the automotive industry has experienced more growth in terms of innovations than any other industry over the last few years and the car is seen to be far more technologically advanced than ever before, and is currently transferring into being a software based product. Hence, the automotive industry is experiencing a tremendous change where incumbent firms will face competition from other industries where a much more intense patent litigation behavior has been recognized.

The research has been conducted within the area of autonomous drive (self-driving cars) which is described as futuristic and often consists of highly advanced software innovations. It has been identified that over 75 percent of the firms who are actively patenting within autonomous drive are from outside the automotive industry, and almost half of these actors have their core technological competence area in the IT industry. Therefore, the aim of this study is to give managerial suggestions on how to identify competitive firms' patent litigation behavior within these new market settings in order to avoid future patent litigations and stay competitive.

While patent data is a fairly common research topic, there has been less academic work done in the gap between firm behavior and using patent data as a source for innovation measures. By connecting prior patent data literature when trying to define firms' patent litigation behavior within different technology areas, the use of patent application statistics is seen as the most applicable and quantifiable measurements.

It has been concluded from this study that by collecting and combining patenting data with patent litigation statistics, firms' patent litigation behavior can be estimated from two descriptive indicators; (1) the frequency of litigation involvement and (2) the litigant positioning by the firm for each case. As a result, a framework which is illustrating firms' behavior changes and suggest how to calculate the amount of change by the use of said indicators has been constructed. Moreover, by the use of our framework four firms who are actively patenting within AD were investigated, and four different types of behavior changes were identified.

Keywords: *Automotive, competitive surroundings, patent litigation behavior, conflict risks, patent data, emerging markets, core technological competence area, diversification.*

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1. Introduction

1.1 Background

The automotive industry has experienced more growth in terms of innovations than any other industry over the last few years and the car is seen to be far more technologically advanced than ever before (PWC, 2015; Thomson Reuters, 2015). It has even been described by the Center for Automotive Research (2014) to be shifting from being a mechanical based industry into a software based industry, where the automotive production consists of more and more technologically advanced implementations. The most technologically advanced innovations are described by many to be within the self-driving car area, called autonomous drive (AD) (Foy, 2013; Kpmg & Car group, 2012; PWC, 2015).

News published by several automotive manufacturing firms' such as BMW, Tesla, Volvo and Toyota describes how they will put self-driving cars in public traffic as early as in 2020 (Fortune, 2015; Kpmg & Car group, 2012; The Guardian, 2015). Also, proved during this research is that most technology classes within AD have an increase in terms of innovations by over 300% since the beginning of 2010, and that over 75 percent of the actively innovating firms are non-automotive manufacturers. This reflects the state of transition which the automotive industry is currently experiencing; the highly advanced technologies implemented in the cars have generated a new unpredictable competitive landscape containing conflict risks with actors from non-automotive industries.

Even though these new risks of conflicts are present, it is important for firms to still bring new technology to the market in order to stay competitive (BCG, 2014; Stevens, 2014). To do so it is necessary to manage the firm's patent portfolio and adapt the patenting strategy since a strong and unified intellectual property strategy combined with the ability to execute it, will reduce the conflicts risks and increase the company value (Cronin & DiGiammarino, 2009; Harrison & Sullivan Sr, 2000). Further, when comparing litigation statistics between the automotive industry and the IT industry, the tremendous differences in number of litigations and the compensations paid for infringements describes how important it is for automotive firms to obtain information about competitive patenting litigation behavior surroundings.

As a consequence of these major environmental changes, firms' competitive surroundings needs to be monitored and defined in order for the managerial decision making to be accurate, and in the case for automotive manufacturers there is a crucial need to identify the patent litigation behavior by those non-automotive firms that are becoming the new competitors. By managing the patent portfolio, firms can reduce costs and increase the value of the portfolio and hence giving them a stronger market position (Harrison & Sullivan Sr, 2000; Hunter, 2005).

1.2 Purpose and Aim

The purpose of this thesis is to estimate firms' patent litigation behavior and develop a framework that will facilitate managerial decision making in the process of adapting the patent portfolio and patenting strategy in order to increase the competitiveness when entering new emerging markets. The aim is to construct such a framework by investigating how competitive firms' patent litigation behavior change when developing technology outside their core technological competence area. By doing so, managers can use this work to gain useful understanding of forthcoming competitive patenting behavior.

1.3 Research Question

For the purpose of this thesis to be achieved, firstly several areas of firms' activities are to be explored and investigated in order to find and map current competitive surroundings in the automotive industry. By doing so, it is possible for the researchers to further explore this thesis research question, that is:

How does a firm's patent litigation behavior change when acting outside its core technological competence area?

The research has been conducted and constructed in collaboration with the R&D department at Volvo Car Corporation (VCC), a Swedish automotive manufacturer within the premium car segment. VCC are putting much effort in the work of adapting its strategy towards the recent changes within the automotive industry, and have shown great interest in further investigating the patenting trends within these new competitive surroundings.

A single case study has been conducted of a technology fitting the circumstances of being outside their core technology competence area, from here on referred to as "technology X". Technology X has been used as an explanatory example throughout the researcher's work of

fulfilling the purpose of this thesis, and will together with the results from the conducted research answer the research question.

1.4 Delimitations

The study is limited to the evaluation of patent litigation behavior and how it changes, therefore the outcomes of litigations have not been taking into consideration. As time was a constraining factor, it was not possible to investigate the counterparties involved in the litigations, consequently, it could be market leaders, as well as non-practicing entities. Further, due to the time and resource constraints, the study was limited to the automotive industry and the emerging technology AD, which consists of mainly IT actors. Lastly, the aim with the research is to facilitate the decision-making process when a firm is developing technology outside its core technological competence area, thus, there are no answers provided how the firm should behave facing these situations.

1.5 Disposition of the Report

Introduction

The first chapter starts with a brief explanation of the background of the research in order to prepare the reader for the following presentation of research purpose, aim, and also this thesis one and only research question.

Theoretical framework

In this chapter the theoretical framework is presented, which has been written with the aim of giving the reader an understanding of the research context. Theories of how firms' behavior can be extracted by interpreting patent data are the main topic.

Methodology

Firstly in the methodology section, the research design is described, and secondly a descriptive explanation of how the data collection and data analysis has been conducted is presented. This is then followed up by a discussion of chosen methods and designs.

Case Study Context

In this chapter the case study context is described, as an initial understanding of the research problem is seen to be needed. Case selection, research background, and previous activity within AD are the main topics.

Patent Litigation Behavior of the Individual Firm

In this section each investigated firm will be presented individually, with the aim of describing empirical findings and demonstrate how it was inferred, examined, and further analyzed.

Collective Examination of Technological Activity

Following the individual investigation is a collective examination. Identified patterns of behavior are illustrated and discussed.

Conclusions and Managerial Suggestions

In the final chapter conclusions that can be drawn from the study is presented, and also three managerial suggestions which has been extracted from our results.

2. Theoretical Framework

In this chapter the theoretical framework is presented, first with an introduction of patents and patent data, and how it is connected to technological innovation. This is followed by a description of firm behavior in connection with patent data, where analyzing patenting activity, patent litigations, and adaption to firm behavior changes, are further explained.

Among many other scholars, (Mogee, 1997) has proven that it is possible to use patent data as a source of information when identifying firms' innovation activity and also describes how patent classification data can be used in order to define a firms diversified and core business areas. While patent data is a fairly common research topic, there has been less academic work done in the gap between firm behavior and using patent data as a source for innovation measures. However, existing theory has been investigated in order to gain the knowledge needed to further explore how to construct our own framework by collecting and interpreting quantitative data in an accurate manner.

2.1 Technological Innovation and Patents

Patents are a way for organizations to protect what they believe are important (Porter & Cunningham, 2005), further patents can be used as a way of quantify and measure organizations activity within technology areas (Mogee, 1997). Analyzing patent data is also a way of finding information about a certain technology or industry, which can be useful when assessing competitors or emerging technologies (Daim, et al., 2006). Hence, patents comprise a considerable amount of information that can be exploited when comparing companies and what different technology fields they are involved in.

Patent data can be used to look at how technology has been developed within specific fields, Porter and Cunningham (2005) describes how looking at patenting trends indicates where companies are heading and helps to forecast what kind of products and services that might emerge within an investigated technology. Further, the forecasting of a growing technology is of importance when predicting future options for a firm, hence, which path they will take and what decisions to be made (Intepe & Koc, 2012). There are several ways of observing the technology development, and when looking at trends and the growth of a technology, one indicator is Foster's S-curve, see figure 1, that describes in which stage a specific technology is in its life cycle (Nieto, et al., 1998).

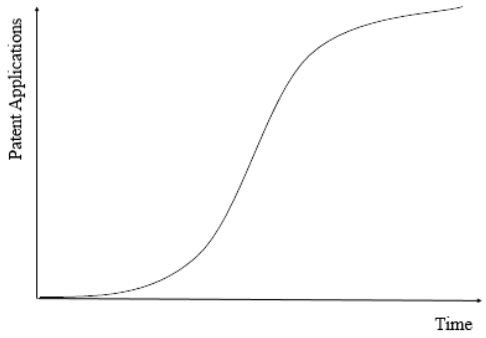

Figure 1- Technology S-curve.

The S-curve is adaptable and used in a variety of fields, where the main characteristics of the curve is a slow start, followed by an exponential growth, reaching an upper limit that slows down the growth, and then saturates, illustrated in figure 1. One example of applying the S-curve to a technology is given by Intepe and Koc (2012) who analyzes the 3D TV development by using patent data, and predicting how the future for the product will look like. Thus, using the S-curve in relation to patent applications gives an estimation of how far the technology has gone, and if it will continue to develop over time.

2.2 Patents and Firm Behavior

2.2.1 Usage of Patents to Analyze Firms Activity

A patent application is the earliest source of information about an invention, often obtainable at least 18 months before a granted panted (PatBase, 2015). Therefore, it is possible to use patent applications as a source to determine when a firm takes its first step towards a new technology. Patents and patent applications can be categorized into technological fields, called patent classifications. These classifications can be divided into main areas, as well as subcategories, and is therefore possible to use when searching for a particular technology (WIPO, 2015a). Further, classifications can be used in order to compare the technology profile of different firms (Mogee, 1997). Thus, patent classifications are useful as indicators when searching for firms and information about their technologies.

Patents are indexed in databases where they are sorted by their classifications, and one patent index used in most patents and available in database searches is the International Patent Classification (IPC). Other indexes are often specific for a certain country, while the IPC is used universally, thus making it possible to search for patents in several different countries at

the same time (WIPO, 2015a). An important purpose of the IPC is to work as an effective tool when searching in databases but also to provide statistics that can assess the development in various technology areas (WIPO, 2015b). Therefore, a search with IPC as the primary function gives a good indication of the total number of patents that belongs to the specified technology classification.

Porter and Cunningham (2005) uses patent data and the number of patents as an indication of the technological activity in firms, and by observing the distribution of patents through patent classifications, a firm's most active technological field can be decided. As Mogee (1997) describes, the classification with highest percentage compared to total number of patent classifications is therefore seen as the field where the company has their core technological competence. Thus, it is interpreted that a firm's core technological competence can be defined as the classification where the company has the most patent applications.

2.2.2 Patent Litigation

When a patent is either infringing or is believed to be invalid, there are different actions to take depending on what situation the firm is in. It is possible to challenge a patent application that is submitted to the USPTO if there are uncertainties about its validation. One way to challenge a patent, is to issue an inter partes review, or a covered business method patent review to the USPTO (USPTO, 2015a). These challenges is made after a patent is granted, when a competitor believes the patent should be reviewed and revised as it does not meet the required originality that is necessary in order to be valid.

If a patent is under infringement by another party's patent, it is also possible to sue the party infringing (USPTO, 2015a). A firm can become involved in a case either as claimant, which is the party who initiates the litigation, as defendant, the party that stands accused for the patent infringement, or as in another role (from here on referred to as other) such as objector, observant and intervenor, which are parties that can be on both the claimant as well as on the defendant side (Docket Navigator, 2015). In table 1, an explanation of the roles in litigations has been summarized.

Role	Synonyms	Explanation
Claimant	Plaintiff, Petitioner, Movant	The party/parties that takes legal action (filing) against another/other party/parties
Defendant	Respondent, Patent-owner	The party/parties that are being filed against
Other	E.g. Role Unknown, Amiscus curiae, Miscellaneous	Party/parties that are involved as not defendant nor claimant

Table 1- Explanation of firms' roles in litigations.

2.2.3 Adapt to Firm Behavior Changes

Firms spend a large amount of money on R&D to continue to innovate and create new products in order to stay competitive (Porter & Cunningham, 2005). As a consequence, industries transforms, where one example is the automotive industry, which has experienced a large growth in terms of innovation over the last few years, transforming from a mechanical based industry to more of software based industry (Center for Automotive Research, 2014; PWC, 2015; Thomson Reuters, 2015).

Firms are described as being closely linked to their core competences, where the decisions made in the firm is affected by its history, and that the decision-making concerning routines and capabilities are path dependent (Welfens, et al., 1999). However, as the technology quickly changes, where new actors and competitors emerges, it is necessary for firms to adapt its decision-making process in order to stay competitive (BCG, 2014; Stevens, 2014).

Further, as the competitive landscape changes, the importance of an effective technology management increases (Porter & Cunningham, 2005), where the patent portfolio is an important component as it contains a lot of information about a firm's technology, and what kind of competence the firm possesses (Ernst, 2003). Also, another important aspect of patent data is the patent strategy management and how it can be used in order to increase the company value and at the same time reduce the risk of conflicts (Cronin & DiGiammarino, 2009; Ernst, 2003). Thus, it is necessary for managers to stay updated about the patent portfolio in order to enhance the decision-making process both internally as well as externally.

3. Methodology

In this chapter the methodology used for this paper is presented and motivated. Firstly, the research design is described, which is then followed by the methodology of the data collection. The latter part of this chapter consists of a discussion about the methods and design chosen.

3.1 Research Design

The research design of this thesis is of a cross-sectional design, involving quantitative sources consisting of patenting data searches and a literature review, complemented with interviews and a case study conducted at the R&D department at VCC. A cross-sectional design is described by Bryman and Bell (2011) as being the correct selection when collecting quantifiable data from several units with the aim of finding linkage between variables and has further increased the validity in the research work of defining relations and patterns.

In order to visualize and explain the decision making process, vital decisions made during the research are presented in table 2. Multiple sources have been reoccurring several times throughout the research project, depending on what source being best suited for a certain decision, thus making it an iterated process that involved combining interviews with literature review, complemented with patent searches and patent litigation searches. Since a number of sources have been used and combined the decisions have been validated thoroughly at each step.

The decisions made during research	Interviews	Literature review	Patent search	Litigation search
Defining the research setting	X	X		
Problem definiton	X	X		
Identify actors and technologies in AD	X	X	X	
Case study: Technology X	X	X		
Actors of interest	X		X	
Defining actors technology activity	X	X	X	X
Analyze recent activity within AD			X	
Indicators describing conflict risks	X	X	X	X

Table 2 - Description of sources used in decisions made during the research

A case study was conducted at the R&D department at VCC which allowed the researchers to obtain a deeper understanding of the research problem as a lot of time was spent with stakeholders at the investigated firm. The case study has been used as an explanatory example throughout the researcher's work, fulfilling the purpose of constructing a tool that will facilitate

decision making in a managers process of adapting the patenting strategy to new competitive surroundings. As described, a case study method is useful when one should describe a rich picture of the behavior of an organization (Easterby-Smith, et al., 2012), by using both quantitative and qualitative sources (Bryman & Bell, 2011).

3.2 Data Collection

The data collection consists mainly of secondary data, gathered from patent searches, patent litigation searches and literature review. Further, this has been complemented with primary data, collected from interviews and case study observations. These sources will be presented in the following chapter.

3.2.1 Literature Review

As seen in table 3, literature reviews have been used continuously during the research in order to construct and validate the decision-making process. Initially, the background of the problem and the setting for this research were carefully reviewed through multiple articles concerning AD technologies and firms' patenting behavior collected from Google Scholar and Chalmers Library. The aim was to give the researchers understanding and knowledge needed to further make decisions on how to proceed with the problem definition. In the initial literature review, theory concerning technological change within the automotive industry and how to interpret patenting statistics supported the suggested research problem earlier presented at VCC.

Decisions made during the research	Literature review
Defining the research setting	A, B, C, D, E, F
Problem definiton	A, C, G, H, I, J
Identify actors and technologies in AD	D, E, F, K
Case study: Technology X	F
Actors of interest	
Defining actors technology activity	A, D, E, G, H, I, K, L, M, N, O, P
Analyze recent activity within AD	
Indicators describing conflict risks	-

Literature
A) Thomson Reuters (2015) B) Thomson Reuters (2014)
C) Kpmg and CAR (2012) D) Mogee (1997)
E) Porter and Cunningham (2005) F) Daim et al. (2006)
F) Ekberg and Gärdelöv (2015) G) BCG (2014)
H) Stevens (2014) I) Center for Autmotive Research (2014)
J) PatBase (2015) K) Wipo (2015a); Wipo (2015b)
L) Google (2014); Ericsson (2014); Intel (2014); Bosch (2014)
M) Welfens, et al. (1999) N) Ernst (2003) O) PWC (2015)
P) Cronin & DiGiammarino (2009)

Table 3 - Decisions made during the research have been supported with literature described in this table.

In an earlier master's thesis work by Ekberg and Gärdelöv (2015), likewise conducted at the R&D division at VCC, AD was categorized into three different areas. Moreover, search strings that were constructed during the categorization have been used in this thesis to identify activity and actors within AD. These search strings were created by key words consisting of vehicles,

AD, and the specific technology that was being investigated. This was done in order to define actors, technology, and the competitive settings surrounding these with the aim of establish boundaries for the research. Further, these searches were also one of the main sources of input during the work when deciding which technology and which actors to further investigate in the case study.

When defining firms' technology activity it was necessary to review literature concerning innovations and how innovations and emerging technologies can be identified. By searching for technological activity and emerging technology, explained by Mogee (1997), and Porter and Cunningham (2005), the best way of describing firms' technological activity was concluded to be patenting statistics, and primarily patent applications. Additionally, the activity is best described by looking at applications between 2009 and 2013, due to the recent major development in patenting trends and litigations (Lex Machina, 2015; Thomson Reuters, 2015; WIPO, 2015c), and since patents is not available until 18 months after first filed (PatBase, 2015). Moreover, the literature review in this step also provided information on how to identify firms' core technological competence area by looking at patenting statistics, and how IPCs can be used to sort patents and patent litigations into technology classes. The core business identification process was also validated by reviewing each respective firm's most recent annual report, comparing the result in the PatBase searches with the definition of the firms' core technological competence area.

During the latter part of the research, when decisions on how to analyze the empirical findings in order to validate the choice of indicators that are defining the investigated firms' conflict risks, a literature review concerning litigant positioning was conducted. The knowledge gained from this review was compared to earlier knowledge obtained from interviews and reviews concerning patent applications, which led to the decision of using the frequency of patent applications, and the frequency of having the claiming litigant position, as main indicators for determine the risks of conflicts.

3.2.2 Interviews

Interviews with stakeholders at VCC and scholars from Chalmers University have been held continuously during the project, and these interviews were structured differently depending on the aim, the interviewees, and if it was an individual or a group interview. In table 4 it is

described for what purpose the interviews have been held, and also with whom they have been conducted.

The decisions made during research	Interviews
Defining the research setting	A
Problem definiton	A, B, C
Identify actors and technologies in AD	A, D
Case study: Technology X	A, B, D
Actors of interest	A , B , D
Defining actors technology activity	D, E, F
Analyze recent activity within AD	
Indicators describing conflict risks	A, B, C, D, E, F

A) Manager, R&D (VCC) *B) Manager, Technology X (VCC)*
C) Strategist (VCC) *D) Senior Patent Attorney (VCC)*
E) VP, Intellectual Property (VCC) *F) PhD, Assistant Professor (CTH)*

Table 4 - Interviews that have had impact on decisions made during the research.

During the first interview, which was conducted with a manager from the R&D department at VCC, the research setting together with prior knowledge about the research problem was presented and discussed. Since this research is part of a large project which the mentioned R&D manager is leading, this interview was conducted with the aim of gaining knowledge of VCC's current patenting strategy, and define the setting of where this research was to be conducted. Further, literature review was conducted to gain more insights into patents and how they can be used when developing technology and innovations, which then led to meetings with managers greatly involved in early product development work, as can be seen in table 4.

By identifying the strong connection between the work of strategizing the patent portfolio and the product development work, more interviews were conducted with managers from different divisions. The knowledge gained from these interviews, combined with patent search results, yet again presented to these same managers made the final decisions on what technology and which firms' was to be investigated during the case study. From each of these interviews, which are summarized in table 4, it was observed that the main emerging area of technology is within AD; this also delimited the research setting and led the researchers to the decision of conducting a case study of technology X.

During the case study of technology X and the work of constructing a tool to facilitate the decision making process for managers involved in work of strategizing firms' patent portfolio to fit emerging technology markets, interviews were held with managers from the IP division at VCC, and also an assistant Professor in technology management and economics at Chalmers University. During these interviews, discussions contributed to the decision of which indicators and factors were to be used in order to best describe firms' patent litigation behavior. As earlier presented in section 3.2.1, the knowledge gained from these interviews was combined with literature reviews concerning patenting and patent litigations, and further led to the decision of choosing the main indicators.

3.2.3 Patent Search

The database that was used for searching patents was PatBase, and it was chosen because it consists of over 47 million patent families with 38 million full-text records, and also has the possibility to search, save and analyze the patent data (PatBase, 2015). Mogee (1997) describes how patent data can be used as a way of finding information about a certain technology or industry, which then can be useful when assessing competitors or emerging technologies. By searching for patents that later can be analyzed and quantified, it will help to define the technological landscape and what actors and competitors it contains, and that is also how patenting data has been used during this research. This made it able to find actively patenting firms within different technology areas that can be defined either by search strings or by IPC.

When technology X had been defined through interviews and technology specifications, this method was used to extract actively patenting firms within AD by calculating the number of appearance in each technology. The next step was to identify actors of interest, which was done using several search methods: search strings from an earlier thesis work by Ekberg and Gärdelöv (2015), search strings constructed from technology specifications, and by using the IPCs of technology X as the primary search function. The selected firms from the different searches were compared and discussed in meetings, which contributed to the final decision of what actors to investigate.

By sorting all the chosen firm's IPCs by size, the top 25 largest technology areas were identified. The IPC containing the highest number of patent families represents a firm's core technological competence area (Mogee, 1997), and the other 24 classes defines the firm's technology activity in less familiar technological fields. The activity of the identified actors was then analyzed by

using patent applications since it is the earliest source of information and has the shortest time until publication (PatBase, 2015), and therefore is the most up to date information about the technology.

Summarizing the patent search method, there has been four steps in the process; (1) a search for all patents was made in order to identify actively patenting firms, (2) the decision on which actors was of interest to further investigate, (3) identification of the top 25 largest technology areas for every firm, and (4) defining technology activity by sorting the firms' patent applications.

3.2.4 Patent Litigation Search

As it was observed during the literature review, patent litigations in the U.S. have been increasing during the 21st century, therefore, the information received from a firm's patent portfolio together with patent litigations connected to that firm's patent, gave insights in how the patenting and patent litigation behaviors were connected and further led to an investigation of patent litigations.

The database used for litigation searches is called Docket Navigator, which is one of the databases recommended by the United States Patent and Trademark office (USPTO, 2015b). Docket Navigator handles more than 58 000 patent cases and is updated daily. Every case provides information about the different parties involved and what has happened through documentation (Docket Navigator, 2015). The information available made it possible to know how often the respective firm was involved in litigation and what role they had. The firms could either be claimant, defendant or a number of other positions like objector, observant, and intervenor, these positions are hard to define and therefore categorized into the same group, named as 'others'.

3.2.5 Case Selection

An investigation of technology X was chosen as a case study since it concerns a technological field that is currently emerging and somewhat unfamiliar to VCC. Using this technology as a case study example will help VCC to understand how they need to behave in the future when facing a similar situation. Technology X was defined in a group interview with stakeholders at both the R&D department and the IP department, which was helpful for the researchers when searching for patent data and doing further interviews in relation to the case study.

The case study was conducted throughout the entire research process, where the information gathered was primarily taken from interviews and observations. Thus, the case study made it possible for the researchers to adapt the practicing tool to a real and relevant investigation, which helped to develop the software prototype and find out what kind of result that was expected by VCC.

3.3 Data Analysis

Analyzing patenting data is a way of finding information of emerging technologies, and forecasts of what products and services that might evolve within an industry (Daim, et al., 2006). Therefore, the research setting concerning the AD technology and its 17 subcategories were analyzed in order to recognize the activity within AD and show the recent behavior among firms. By doing this, technology X could be defined together with interviews conducted at VCC.

The chosen actors connected to technology X were assessed in order to compare the results from the patent and patent litigation searches. The searches were limited to 2009-2013, since both patents and patent litigations have increased heavily since 2007 (Lex Machina, 2015; WIPO, 2015c), and since patent applications, which were used in the analysis, are published at latest 18 months after the filing, makes 2013 the most recent complete year of patent application statistics. Taking several aspects into consideration, such as the percentage of claimants and defendants compared to how many litigation cases the firms had been involved in, and the total number of involvement in litigation cases compared to the total number of the firm's patent applications, helped defining the activity of the firms.

To better visualize the behavior of the investigated firms graphs were used to plot and present the data. As the firms have various number of patent and patent litigations, quotas were built to make it possible to compare firms to one another. When the firms were analyzed collectively, the accumulated average was used, since the number would have been too sensitive otherwise as some classes only consists of one or two litigations.

The whole data analysis process was done step-by-step in a close collaboration with the manager at the R&D-department to make sure that the numbers and quota discussed would be of importance to VCC.

3.4 Discussion of Methodology

3.4.1 Research Design

A cross-sectional design was chosen as research design, as the research is about different patent data variables and finding connections between them. However, using this design has an impact on the validation of the report (Bryman & Bell, 2011), as the connections and results that have been found between the patent data variables, have been analyzed from one perspective. Therefore, the causality of the relations cannot be verified, even though they have been supported by literature and interviews to increase the replicability.

Further, as a part of the cross-sectional design, a case study was conducted to understand how a firm acts in a real case scenario, when a firm is entering a new emerging market where the behaviors of the competitors are unknown. Choosing a case study as the way of conducting the research made it possible to collect data from both quantitative and qualitative sources, which was necessary in this research as both interviews and patent data were required. Also, a case study was preferable in this research, since the work had to fit into the organization of the focal firm, as the research is a part of a larger project, and therefore, a significant time was spent at the firm to get an understanding of the project and processes in order to adapt the research to VCC.

As a case study gives insights of how it is in one place, the generalizability is reduced since it is difficult to argue that a case study at one firm would be applicable at another firm. However, there are persons (Bryman & Bell, 2011) that argues that even though it is a case study, the results gained through the research have a theoretical generalizability. In this case, the archetypes created when categorizing the firms would be possible to apply in other studies, in order to test the theoretical generalizability.

3.4.2 Data Collection

The data collected has been gathered through different sources of information, mainly in form of a theoretical framework, interviews and database searches. The information from the literature has had several sources which have been compared to each other in order to endorse the findings. Further, these results have then been validated with opinions and ideas from a number of interviews. Conducting interviews is seen as a one of the best ways of gathering information, however, it is necessary to be well prepared as the complexity of the method is

often underestimated (Easterby-Smith, et al., 2012). Therefore, the interviews have been adapted depending on the aim of the interview.

The interviews conducted with the manager at the R&D department at VCC were carried out in a semi structured manner. This was done in order to gain knowledge about VCC's patenting strategy and the research setting, and since the manager is responsible for a large project, which the research is a part of, open discussions helped the researchers to understand the background and the prior knowledge about the research problem. Further, using a more structured interview method would not have allowed the complete understanding of the background, as several follow up questions needed to be answered during the interviews.

When conducting interviews to find emerging technologies and define technology X, the interviews were carried out with several pre stated questions that would lead the discussions into the right field of research, within AD. However, discussions were still encourage by asking follow up questions, which makes the chosen interview method also of a semi structured character. Additionally, all conducted interviews were carried out in person, as it was easier to create a connection to the interviewee, which was useful when a second meeting was necessary, or when sending an e-mail with further questions.

Searching for data in large databases, such as PatBase and DocketNavigator, is an advanced process which includes several steps, with a number of choices to make (Porter & Cunningham, 2005). Therefore, the information gathered through the theoretical framework and the interviews has been the foundation of the database searches, in order to validate the choices being made when searching for patents and patent litigations.

3.4.3 Data Analysis

During the whole analysis process, interviews were continuously held with managers and stakeholders at the R&D department, discussing what was important to VCC and how the numbers from the patent data searches should be presented in order to find reliable and replicable patterns and quota. Working that closely to stakeholders at a firm reduces the generalizability of the research results, as previously discussed, as it will be most suited for the investigated firm and not to firms in general. However, discussing the data analysis with the stakeholders at VCC, validates the results as they know what is important to the firm where the research was conducted.

3.4.4 Limitations of methodology

There are a few limitations with the methodology which have influenced the research and affected the outcome. Due to lack of examples covering the theoretical review, the literature background, and how to continue the research, was gathered partly from several different sources, which might have limit the research and affected the reliability. Difficulties reaching stakeholders, which was important to the continued research, limited the time frame as it was hard to continue without the input, thus, delaying the research.

According to PatBase (2015), when searching a large sampled dataset, the accuracy is calculated to 95%, therefore, searches with similar classifications can generate differences in the results. Moreover, searching for patent litigations, a difference is seen before and after September 16, 2012, since the inter partes review and covered business method were taken into effect that date. Since this made it possible for firms, in an easier way and to a larger extent, to file petitions, an increase in petitions could be seen. However, as it was possible to file petitions before, this change has not been taken into consideration when investigating firms.

4. Case Study Context

In this chapter the case study context is described, as an initial understanding of the research problem was needed in order to proceed with the research. Firstly, the case selection is presented, where the background of the research problem is explained, and also why AD became the chosen technology. Then, the competitive surrounding is outlined, where the previous activity of AD is described.

4.1 Case Selection

VCC has in recent years experienced a changed market surrounding due to the highly increase of technology implementations in the cars, and firms outside the automotive manufacturing industry are identified to be actively patenting within these technologies. Many of these non-automotive firms have their core technology competence within the IT sector which historically has had a much higher intensity in patenting and patent litigation activity. Also, as seen in statistics the computer industry has an average cost of $9.5 million per litigation, where the automotive industry has an average of $0.7 million per litigation (PwC, 2015). Given VCC's historically patent litigation statistics and realization of the new competitive surroundings; major conflict risks were identified.

In order to adapt to these changes and decrease the conflict risks, much effort is put by VCC in the patent portfolio strategizing work, which is also where this study has been performed. For the purpose of this research, the emerging technology area of AD was of interest since that is where most advanced automotive technologically are being developed (Kpmg & Car group, 2012; Foy, 2013; PWC, 2015). Within AD, 34 of the 44 most actively patenting firms are non-automotive manufacturing firms, which is further presented in appendix 1.

An earlier master's thesis work by Ekberg and Gärdelöv (2015), likewise conducted at the R&D division at VCC, AD was categorized into three different areas and then further subcategorized into 17 different technology classes; these are presented in table 5. From patent searches within those 17 classes confirmed the highly increase of activity within the area of AD but also showed much more activity from non-automotive firms than what was expected by VCC. These results lead this research to facilitate decision-making for managers when striving towards a more adapted patenting strategy when operating in these emerging markets, which is the context this study has been performed.

AD Areas	Technology Classes
Information	Communication
	Dependability
	Environmental Scanning
	HMI
	Obstacle Identification
	Positioning
Traveling	Breaking
	Cruising
	Maneuver
	Navigating
	Speed Regulation
Application	Accident Prevention
	Deactivation
	Interior Design
	Parking
	Platooning

Table 5 - The categorization of AD done by Ekberg and Gärdelöv (2015).

Search strings adapted for patent database searches were also created during that earlier thesis for each of these 17 technology classes and in table 6 an example for one of the searches is presented. This example shows the spread of different types of firms that are active within the AD area, where Google Inc. is in top with 80 filed applications.

HMI			
Company	No of Appl	Overall	
		Year	No of Appl
Google Inc	80	1996	8
Gm Global Tech Operations Inc	51	1997	11
Audi Ag	45	1998	9
Bosch Gmbh Robert	45	1999	8
Ford Global Technologies Llc	43	2000	2
Fatdoor Inc	39	2001	15
Irobot Corp	33	2002	18
Continental Teves And Co Ohg Ag	32	2003	26
Gm Global Technology Operations Llc	32	2004	10
Continental Automotive Systems Inc	27	2005	14
Daimler Ag	26	2006	36
Volvo Car Corp	20	2007	41
Deere And Co	16	2008	26
Samsung Electronics Co Ltd	16	2009	31
Mobileye Vision Technologies Ltd	15	2010	46
Robert Bosch Gmbh	14	2011	81
Xinshu Man L L C	14	2012	138
Bayerische Motoren Werke Ag	13	2013	219
Ford Global Tech Llc	13	2014	153

Table 6 – Information merged from one of the 17 patent searches done for technologies within AD.

In appendix 1 the full search is presented from which actively patenting firms within AD were extracted. For the purpose of this investigation, the final list of non-automotive firms who are

actively patenting within the AD area are presented in table 7 by preference to the total percentage of how many AD technology classes the firm is actively patenting within.

Top non-automotive actors	Appear in % of technology areas
Bosch Gmbh	88%
Google Inc	53%
Irobot Corp	53%
Continental Teves And Co Ohg Ag	41%
Samsung Electronics Co Ltd	41%
Hk Systems Inc	29%
Mobileye Vision Technologies Ltd	29%
Wabco Gmbh	29%
Fatdoor Inc	24%
Intel Corp	24%
Siemens Ag	24%
5D Robotics Inc	18%
Intuitive Surgical Operations	18%
Valeo Schalter And Sensoren Gmbh	18%
Apple Inc	12%
Lg Electronics Inc	12%
Microsoft Technology Licensing Llc	12%

Table 7 - Non-automotive firms who are actively patenting within AD.

The firms that were selected to become investigated for further research were; (1) Google Inc., (2) Telefonaktiebolaget LM Ericsson, (3) Robert Bosch GmbH, and (4) Intel Corporation. As seen in table X, three of the chosen firms were actively patenting within the total area of AD technologies. However, the selection of including Telefonaktiebolaget LM Ericsson was based on case-study observations.

4.2 Competitive Surroundings

As described in section 2.1.3, analyzing patenting statistics is a powerful tool when trying to recognize emerging technologies and facilitate forecasts of what products and services that might evolve within. Patents comprise lots of information and indicators describing firms' activity, and when using patents as a source of information about firms' inventions, patent applications will describe the most recent activity. During the early research work of this thesis, the most recent activity within AD was recognized by using the search strings created by Ekberg & Gärdelöv (2015) that is defining the different technology classes, see section 4.1, which is illustrated in table 5.

However, there are large differences in number of patent applications within each of the 17 classes, and in figure 2 the activity is presented by percentage of application within the technology classes each year (yearly applications / total number of applications).

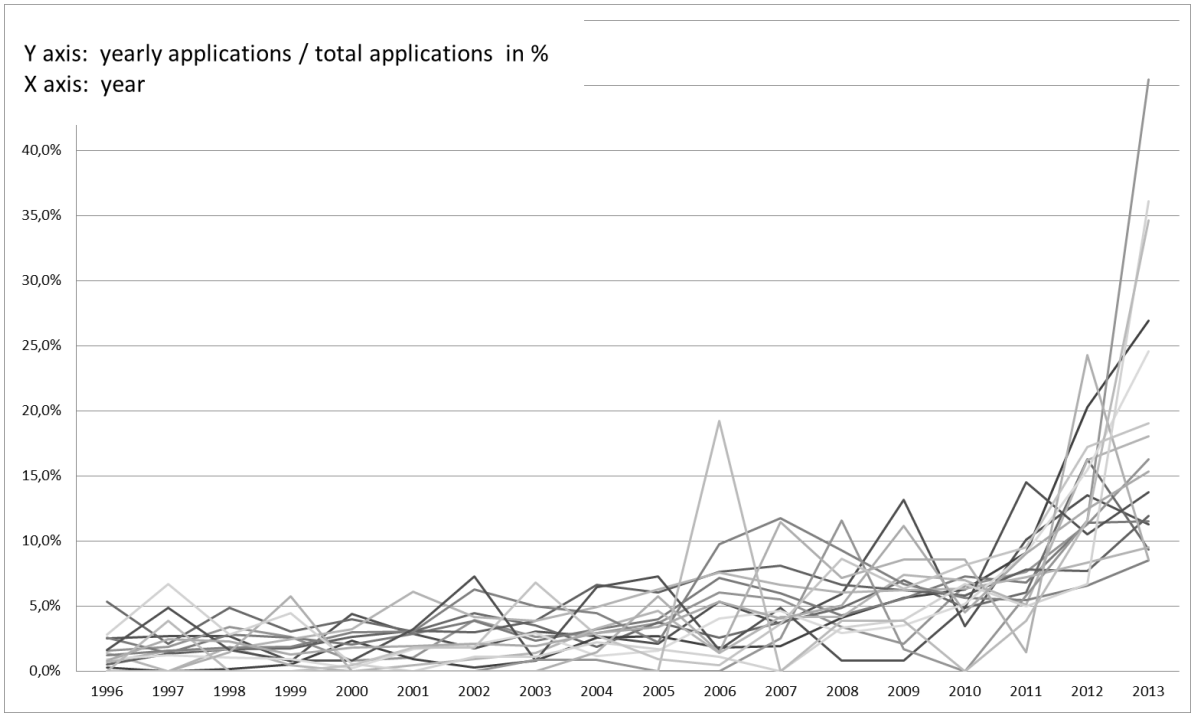

Figure 2- The activity within AD divided into 17 different technology classes.

Figure 2 is illustrating the tremendous growth of activity within AD since 2009, and the accumulated activity is calculated to an increase of almost 300%.

5. Patent Litigation Behavior of the Individual Firm

In this section each investigated firm will be presented individually, with the aim of describing empirical findings and demonstrate how it was inferred, examined, and further analyzed.

First collected data will be presented, which is mainly secondary and consists of merged information from patent and patent litigation database searches. All data has been combined with the objective of demonstrating each investigated firm's patent litigation behavior individually, and has also been analyzed with the aim of identifying and visualizing behavior patterns. By doing so, this section will be followed by a collective examination where all firm results are compared, analyzed, and discussed.

5.1 Google Inc.

Google Inc. (hereinafter referred to as Google) is an American multinational technology company specializing in internet-related services and products (Google Inc., 2015a) which declared revenues of 66 billion USD in 2014 (Google Inc, 2015b).

In November 2015, Google held a total of 21,132 registered patent families (PatBase, 2015) and had been involved in 504 different patent litigations (Docket Navigator, 2015). Google's core technological competence area is G06F – Electrical digital data processing (WIPO, 2015d). In their annual report of year 2015 they describe their main area of business as: "We generate revenues primarily by delivering online advertising that consumers find relevant and that advertisers find cost-effective" (Google Inc, 2015b).

5.1.1 Patent and Litigation Statistics

In table 8 Google's top 25 technology areas are presented by preference of the highest number of patent families, together with their litigant positioning and total litigation statistics between 2009 and 2013.

	All Time		2009-2013				
IPC	Families	Litigations	Appl	Litigant Positioning			Total lit
				Claim	Def	Other	
G06F	**10368**	**206**	**20 534**	**14**	**83**	**13**	**110**
H04L	4015	128	7 762	11	49	2	62
H04W	2868	66	7 739	10	63	3	76
H04B	2721	13	5 852	9	24	7	40
G06Q	2398	170	4 803	6	30	2	38
H04N	2074	77	3 640	0	7	1	8
H04M	1574	67	3 137	0	1	1	2
G06K	1265	4	2 963	6	27	8	41
H04Q	1059	8	2 295	2	10	0	12
H04J	839	0	1 984	1	3	0	4
G06T	795	25	1 779	1	5	0	6
G09G	633	5	1 579	0	3	0	3
H01L	471	5	1 525	1	12	0	13
G10L	456	5	1 219	0	0	0	0
G02B	442	4	1 149	1	5	0	6
H05K	427	2	957	2	4	0	6
G01C	339	15	612	0	7	0	7
G01R	309	0	567	0	2	0	2
G08B	280	13	479	0	0	1	1
H03M	280	8	450	0	1	0	1
G01S	250	12	450	0	0	0	0
G11B	250	2	359	1	1	0	2
B41J	250	0	335	1	3	0	4
G07F	236	26	284	0	0	0	0
G11C	206	6	214	0	9	1	10

Table 8- Google's top 25 all-time patent families and patent applications from 2009-2013, sorted by IPCs together with litigation statistics for each. In appendix 2 the top IPCs are further explained.

Google's core technology competence area (G06F, marked bold in table 8) contains 20 534 patent applications and have 110 different patent litigations between 2009 and 2013, which is 53% of their total number of litigations.

5.1.2 Technological Activity

Google's number of patent applications filed within each of their top 25 technology areas between 01/01/09 – 12/31/13, together with statistics of the litigant positioning in connected litigations is illustrated in table 9. As described, patent application statistics describes their most recent activity more extensive than patent family statistics.

Google 2009-2013								
IPC	Appl	Litigant Position			Total lit	Claim/Tot	Def/Tot	Lit/Appl
		Claim	Def	Other				
G06F	**20 534**	**14**	**83**	**13**	**110**	**13%**	**75%**	**0,54%**
H04L	7 762	11	49	2	62	18%	79%	0,80%
H04W	7 739	10	63	3	76	13%	83%	0,98%
H04B	5 852	9	24	7	40	23%	60%	0,68%
G06Q	4 803	6	30	2	38	16%	79%	0,79%
H04N	3 640	0	7	1	8	0%	88%	0,22%
H04M	3 137	0	1	1	2	0%	50%	0,06%
G06K	2 963	6	27	8	41	15%	66%	1,38%
H04Q	2 295	2	10	0	12	17%	83%	0,52%
H04J	1 984	1	3	0	4	25%	75%	0,20%
G06T	1 779	1	5	0	6	17%	83%	0,34%
G09G	1 579	0	3	0	3	0%	100%	0,19%
H01L	1 525	1	12	0	13	8%	92%	0,85%
G10L	1 219	0	0	0	0	0%	0%	0,00%
G02B	1 149	1	5	0	6	17%	83%	0,52%
H05K	957	2	4	0	6	33%	67%	0,63%
G01C	612	0	7	0	7	0%	100%	1,14%
G01R	567	0	2	0	2	0%	100%	0,35%
G08B	479	0	0	1	1	0%	0%	0,21%
H03M	450	0	1	0	1	0%	100%	0,22%
G01S	450	0	0	0	0	0%	0%	0,00%
G11B	359	1	1	0	2	50%	50%	0,56%
B41J	335	1	3	0	4	25%	75%	1,19%
G07F	284	0	0	0	0	0%	0%	0,00%
G11C	214	0	9	1	10	0%	90%	4,67%
Average	**52 133**	**52**	**266**	**26**	**344**	**15%**	**77%**	**0,66%**

Table 9 - Indicators that are defining Google's patent litigation behavior are calculated from their recent activity within the IPCs.

In table 9 it is calculated how often Google held a claimant litigant position and also how frequently they had been involved in litigations for each class. In their core technological competence area they held a claimant position in 13% of the litigations, and 0.54% of the applications resulted in litigation. Their accumulated statistics when operating outside their core technological competence area is calculated as being claimant in 15% of the litigations, and 0.66% applications resulted in litigation. The difference between them both is shown in table 10.

Total Change in Variables	
Claimant litigations / Total litigations	2 percentage points
Litigations / Applications	0.12 percentage points

Table 10 - The calculated difference between when operating inside and outside the core technology competence area.

Figure 3 is illustrating the patent litigation behavior within each of Google's top 25 IPCs in terms of the mentioned two main indicators; (1) the frequency of litigation involvement, and (2) how often they have had a claimant position. The core IPC and the accumulated average for the non-core IPCs are presented as main dots and the minor dots represent each non-core IPC individually.

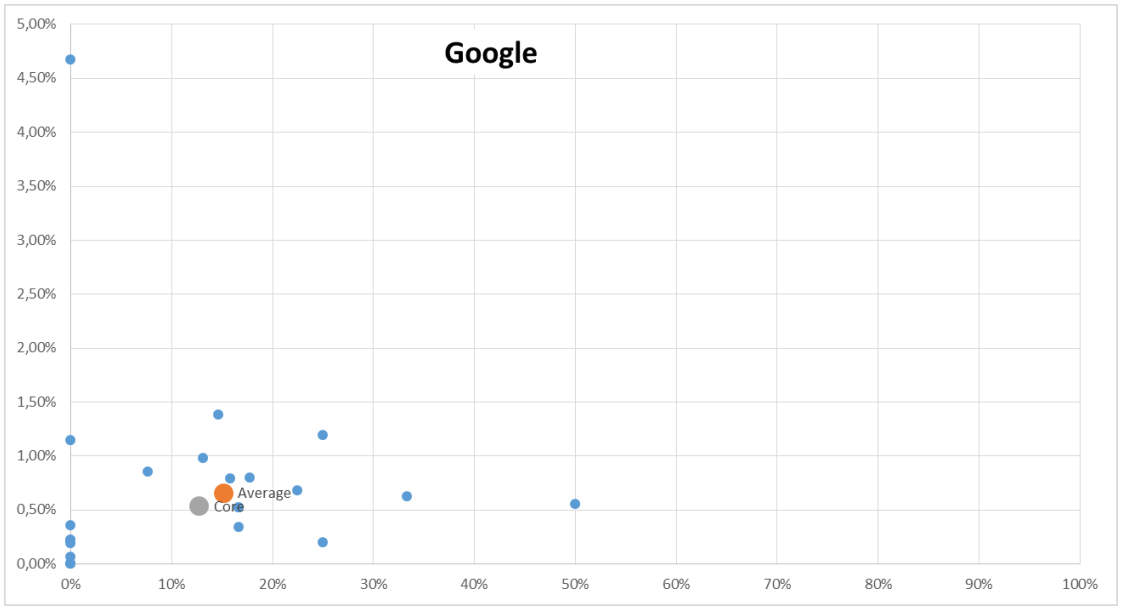

Figure 3 - Illustration of Google's patent litigation behavior within their top 25 IPCs and the accumulated average for IPCs outside their core IPC

As shown in table 9, Google has been involved in litigations in 22 of their top 25 IPCs, and the majority of the IPC litigation statistics shows an area of diffusion in connection to the average. However, G11B (semiconductor devices for information storage between record carrier and transducer) and G11C (static information storage based on G11B; devices) are extreme points where Google have had a patent litigation behavior significantly separated from their accumulated average when operating in non-core IPCs. Both G11B and G11C represent technology development within digital or analogue information storage (WIPO, 2015d).

5.2 Telefonaktiebolaget LM Ericsson

Telefonaktiebolaget LM Ericsson (hereon after referred to as Ericsson) is a Swedish multinational provider of communication technology and services, which declared a revenue of SEK 26.6 billion USD in 2014 (Ericsson, 2015).

In November 2015, Ericsson held a total of 37,019 registered patent families (PatBase, 2015) and had been involved in 171 different patent litigations (Docket Navigator, 2015). Ericsson's core technological competence area is H04L – Transmission of digital information, e.g. telegraphic communication (WIPO, 2015d). In their annual report of 2014 it is written; 'Ericsson is a driving force behind the Networked Society – a world leader in communications technology and services' (Ericsson, 2015).

5.2.1 Patent and Litigation Statistics

In table 11 Ericsson's top 25 technology areas are presented by preference of the highest number of patent families, together with their litigant positioning and total litigation statistics between 2009 and 2013.

	All Time		2009-2013				
IPC	Families	Litigations	Appl	Litigant Positioning			Total lit
				Claim	Def	Other	
H04L	11225	90	12 182	8	12	5	25
H04W	10750	88	10 928	4	2	0	6
H04B	7050	46	4 002	5	5	7	17
H04M	5750	38	1 997	6	0	1	7
H04Q	5550	17	627	1	3	6	10
G06F	5100	32	2 672	5	3	3	11
H04J	2400	36	1 155	2	5	8	15
H04N	1500	19	1 688	0	2	8	10
H01Q	1050	0	572	0	0	0	0
H03M	800	13	356	1	0	6	7
H05K	775	1	178	0	1	0	1
G06Q	675	1	584	1	0	0	1
G01R	675	1	114	0	0	0	0
H01H	650	1	85	1	0	0	1
H03F	625	5	382	1	2	0	3
H03K	575	1	148	1	0	0	1
G02B	550	0	139	0	0	0	0
H01L	500	5	321	2	2	0	4
H03D	500	1	184	1	0	0	1
G01S	475	18	463	0	0	0	0
G06K	475	1	242	1	0	0	1
H03H	425	0	96	0	0	0	0
H03B	400	1	66	1	0	0	1
G10L	350	10	434	4	0	0	4
H02J	275	6	113	0	1	0	1

Table 11- Ericsson's top 25 all-time patent families and patent applications from 2009-2013, sorted by IPCs together with litigation statistics for each. In appendix 2 the top IPCs are further explained.

5.2.2 Technological Activity

Ericsson's number of patent applications filed within each of their top 25 technology areas between 01/01/09 – 12/31/13, together with statistics of the litigant positioning in connected

litigations is illustrated in table 12. As described, patent application statistics describes their most recent activity more extensive than patent family statistics.

Ericsson 2009-2013							
IPC	Appl	Litigant Position			Total lit	Claim/Tot	Lit/Appl
		Claim	Def	Other			
H04L	**12 182**	**8**	**12**	**5**	**25**	**32%**	**0,21%**
H04W	10 928	4	2	0	6	67%	0,05%
H04B	4 002	5	5	7	17	29%	0,42%
H04M	1 997	6	0	1	7	86%	0,35%
H04Q	627	1	3	6	10	10%	1,59%
G06F	2 672	5	3	3	11	45%	0,41%
H04J	1 155	2	5	8	15	13%	1,30%
H04N	1 688	0	2	8	10	0%	0,59%
H01Q	572	0	0	0	0	0%	0,00%
H03M	356	1	0	6	7	14%	1,97%
H05K	178	0	1	0	1	0%	0,56%
G06Q	584	1	0	0	1	100%	0,17%
G01R	114	0	0	0	0	0%	0,00%
H01H	85	1	0	0	1	100%	1,18%
H03F	382	1	2	0	3	33%	0,79%
H03K	148	1	0	0	1	100%	0,68%
G02B	139	0	0	0	0	0%	0,00%
H01L	321	2	2	0	4	50%	1,25%
H03D	184	1	0	0	1	100%	0,54%
G01S	463	0	0	0	0	0%	0,00%
G06K	242	1	0	0	1	100%	0,41%
H03H	96	0	0	0	0	0%	0,00%
H03B	66	1	0	0	1	100%	1,52%
G10L	434	4	0	0	4	100%	0,92%
H02J	113	0	1	0	1	0%	0,88%
Average	**27 546**	**37**	**26**	**39**	**102**	**36%**	**0,37%**

Table 12 - Indicators that are defining Ericsson's patent litigation behavior are calculated from their recent activity within the IPCs.

In table 12 it is calculated how often Ericsson held a claimant litigant position and also how frequently they had been involved in litigations for each class. In their core technology competence area they held a claimant position in 32% of the litigations, and 0.21% of the applications resulted in litigation. Their accumulated statistics when operating outside their core technology competence area is calculated as being claimant in 36% of the litigations, and 0.37% of the applications resulted in litigation. The difference between them both is shown in table 13.

Total Change in Variables	
Claimant litigations / Total litigations	4 percentage points
Litigations / Applications	0.16 percentage points

Table 13 - The calculated difference between when operating inside and outside the core technology competence area.

Figure 4 is illustrating the patent litigation behavior within each of Ericsson's top 25 IPCs in terms of the mentioned two main indicators; (1) the frequency of litigation involvement, and (2) how often they have had a claimant position. The core IPC and the accumulated average for the non-core IPCs are presented as main dots and the minor dots represent each non-core IPC individually.

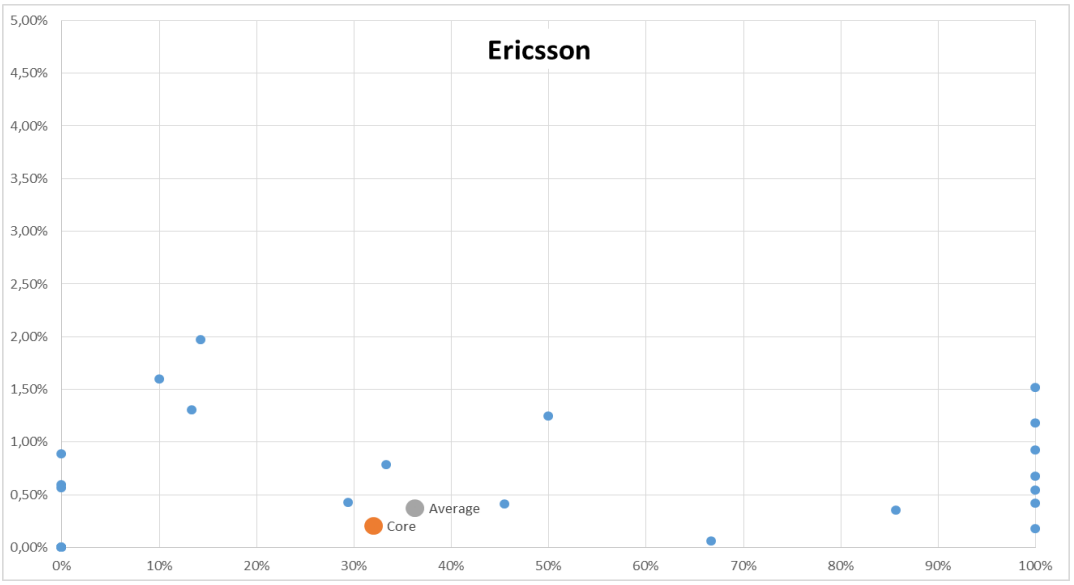

Figure 4 – Illustration of Ericsson's patent litigation behavior within their top 25 IPCs and the accumulated average for IPCs outside their core IPC.

As shown in table 12, Ericsson has been involved in litigations in 20 of their top 25 IPCs, and the majority of the IPC litigation statistics shows an widely spread area of diffusion in terms of claimant frequency, but their litigation frequency is not as diffused. By that, Ericsson tends to alter their litigant positioning, but are more stagnate in their litigation frequency.

5.3 Robert Bosch GmbH

Robert Bosch GmbH (hereon after referred to as Bosch) is German multinational engineering and electronics company, which declared a revenue 52.9 billion USD in 2014 (Robert Bosch GmbH, 2014).

In November 2015, Bosch held a total of more than 105,000 registered patent families (PatBase, 2015) and had been involved in 149 different patent litigations (Docket Navigator, 2015). Bosch's core technological competence area is F02M – Supplying combustion engines in general with combustible mixtures or constituents thereof (WIPO, 2015d), and in their annual

report of 2014 their core business is described as producing and selling automotive components (e.g. electrical drives and steering systems) and industrial products (e.g. drives and controls) (Robert Bosch GmbH, 2014).

5.3.1 Patent and Litigation Statistics

In table 14 Ericsson's top 30 technology areas are presented by preference of the highest number of patent families, together with their litigant positioning and total litigation statistics between 2009 and 2013.

	All Time		2009-2013				
IPC	Families	Litigations	Appl	Litigant Positioning			Total lit
				Claim	Def	Other	
F02M	10 786	7	3 815	0	0	0	0
F02D	7 072	6	2 179	0	0	0	0
B60T	6 072	1	2 636	0	0	0	0
B60R	4 715	4	929	0	0	0	0
H02K	4 215	0	1 833	0	0	0	0
F04B	3 500	0	1 681	0	0	0	0
F24C	3 429	0	1 256	0	0	0	0
H01L	3 429	0	1 391	0	0	0	0
F15B	2 929	0	518	0	0	0	0
G06F	2 929	31	966	8	14	0	22
D06F	2 858	0	1 927	0	0	0	0
F01N	2 858	0	1 151	0	0	0	0
F16K	2 643	0	1 062	0	0	0	0
H01M	2 643	2	2 285	0	0	0	0
F25D	2 429	0	2 243	0	0	0	0
H01R	2 286	1	850	0	1	0	1
G01N	2 215	4	1 171	4	0	0	4
G01D	2 143	0	532	0	0	0	0
B60K	2 072	1	779	0	0	0	0
F16H	2 072	0	726	0	0	0	0
H05K	1 929	1	786	0	0	0	0
F02P	1 858	4	553	0	0	0	0
B60S	1 643	29	1 878	15	2	1	18
H02J	1 643	4	827	0	0	0	0
G01C	1 643	5	911	0	5	0	5
F02B	1 358	4	297	0	1	0	1
G01S	1 286	1	800	0	1	0	1
H04L	167	8	1 030	0	5	0	5
H04N	62	18	292	5	9	0	14
H04M	21	9	110	0	4	0	4

Table 14 - Bosch's top 30 all-time patent families and patent applications from 2009-2013, sorted by IPCs together with litigation statistics for each. In appendix 2 the top IPCs are further explained.

5.3.2 Technological Activity

Bosch's number of patent applications filed within each of their top 30 technology areas between 01/01/09 – 12/31/13, together with statistics of the litigant positioning in connected

litigations is illustrated in table 15. As described, patent application statistics describes their most recent activity more extensive than patent family statistics.

Bosch 2009-2013								
IPC	Appl	Litigant Position			Total lit	Claim/Tot	Def/Tot	Lit/Appl
		Claim	Def	Other				
F02M	3 815	0	0	0	0	0%	0%	0,00%
F02D	2 179	0	0	0	0	0%	0%	0,00%
B60T	2 636	0	0	0	0	0%	0%	0,00%
B60R	929	0	0	0	0	0%	0%	0,00%
H02K	1 833	0	0	0	0	0%	0%	0,00%
F04B	1 681	0	0	0	0	0%	0%	0,00%
F24C	1 256	0	0	0	0	0%	0%	0,00%
H01L	1 391	0	0	0	0	0%	0%	0,00%
F15B	518	0	0	0	0	0%	0%	0,00%
G06F	966	8	14	0	22	36%	64%	2,28%
D06F	1 927	0	0	0	0	0%	0%	0,00%
F01N	1 151	0	0	0	0	0%	0%	0,00%
F16K	1 062	0	0	0	0	0%	0%	0,00%
H01M	2 285	0	0	0	0	0%	0%	0,00%
F25D	2 243	0	0	0	0	0%	0%	0,00%
H01R	850	0	1	0	1	0%	100%	0,12%
G01N	1 171	4	0	0	4	100%	0%	0,34%
G01D	532	0	0	0	0	0%	0%	0,00%
B60K	779	0	0	0	0	0%	0%	0,00%
F16H	726	0	0	0	0	0%	0%	0,00%
H05K	786	0	0	0	0	0%	0%	0,00%
F02P	553	0	0	0	0	0%	0%	0,00%
B60S	1 878	15	2	1	18	83%	11%	0,96%
H02J	827	0	0	0	0	0%	0%	0,00%
G01C	911	0	5	0	5	0%	100%	0,55%
F02B	297	0	1	0	1	0%	100%	0,34%
G01S	800	0	1	0	1	0%	100%	0,13%
H04L	1 030	0	5	0	5	0%	100%	0,49%
H04N	292	5	9	0	14	36%	64%	4,79%
H04M	110	0	4	0	4	0%	100%	3,64%
Average	28 784	32	42	1	75	43%	56%	0,26%

Table 15 - Indicators that are defining Bosch's patent litigation behavior are calculated from their recent activity within the IPCs.

In table 15 it is calculated how often Bosch held a claimant litigant position and also how frequently they had been involved in litigations for each class. Since 01/01/09 Bosch has not been involved in any litigation within their core technological competence area. However, accumulated statistics when operating outside the core technological competence area is calculated as being claimant in 43% of the litigations, and 0.26% of the applications resulted in litigation. The difference between them both is shown in table 16.

Total Change in Variables	
Claimant litigations / Total litigations	43 percentage points
Litigations / Applications	0.26 percentage points

Table 16 - The calculated difference between when operating inside and outside the core technology competence area.

Figure 5 is illustrating the patent litigation behavior within each of Bosch's top 30 IPCs in terms of the mentioned two main indicators; (1) the frequency of litigation involvement, and (2) how often they have had a claimant position. The core IPC and the accumulated average for the non-core IPCs are presented as main dots and the minor dots represent each non-core IPC individually.

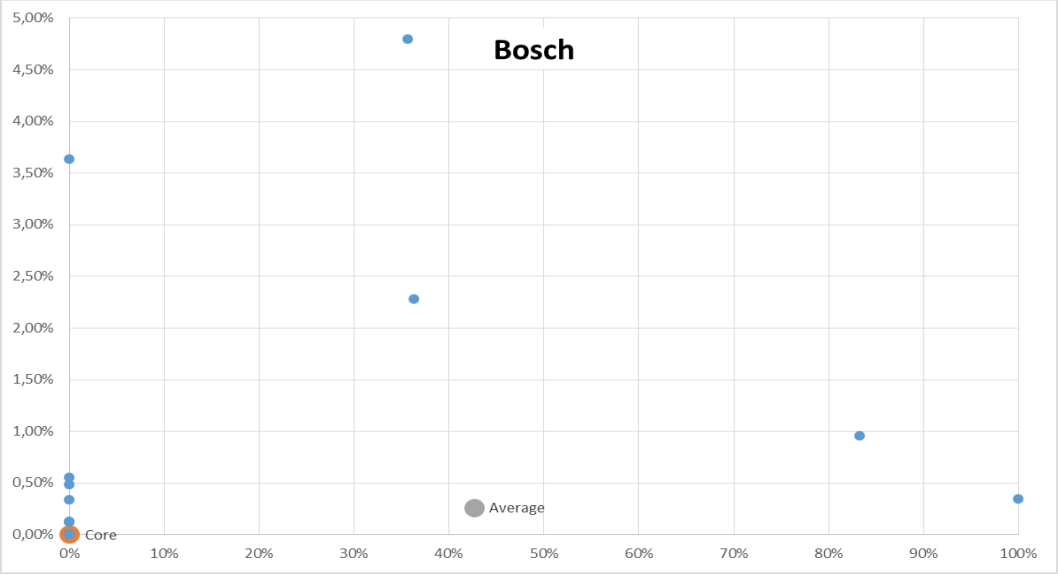

Figure 5 - Illustration of Bosch's patent litigation behavior within their top 30 IPCs and the accumulated average for IPCs outside their core IPC.

As shown in table 15, Bosch has been involved in litigations in 10 of their top 30 IPCs where 5 of those 10 IPCs are in close connection to their core behavior but rest of the litigations are highly diffused. This indicates that Bosch is either altering their behavior much or fairly less, and the diffusion also tends to be in both directions.

5.4 Intel Corporation

Intel Corporation (hereon after referred to as Intel) is one of the largest and highest valued semiconductor chip makers that are integrated in both Macintosh and Windows computers. In 2014, revenues of 55.9 billion USD were declared (Intel Corporation, 2014).

In November 2015, Intel held a total of 34,208 registered patent families (PatBase, 2015) and had been involved in 288 different patent litigations (Docket Navigator, 2015). Intel's core technological competence area is G06F – Electrical digital data processing (WIPO, 2015d). In its annual report of 2014, Intel describes their core business as producing and selling semiconducting computer chips (Intel Corporation, 2014).

5.4.1 Patent and Litigation Statistics

In table 17 Intel's top 25 technology areas are presented by preference of the highest number of patent families, together with their litigant positioning and total litigation statistics between 2009 and 2013.

	All Time		2009-2013				
IPC	Families	Litigations	Appl	Litigant Positioning			Total lit
				Claim	Def	Other	
G06F	15025	84	23803	0	21	9	30
H04L	7025	58	14598	0	17	6	23
H01L	4575	25	5505	0	5	0	5
H04B	3675	20	10275	1	9	2	12
H04W	3250	17	11640	1	6	5	12
H04N	2475	7	5627	0	1	3	4
H05K	1925	1	1761	0	0	0	0
G11C	1575	17	2311	0	6	1	7
H04J	1525	9	5991	1	1	1	3
H04Q	1425	7	3356	0	2	0	2
G06T	1350	7	2830	0	2	2	4
H04M	1100	13	4080	1	1	2	4
H03K	1075	7	945	2	2	0	4
G01R	1025	3	1714	1	0	0	1
G09G	950	5	1567	1	1	1	3
G02B	925	3	1257	0	2	0	2
G06K	775	2	2056	1	0	0	1
H03M	750	3	1847	1	1	0	2
H03F	625	0	395	0	0	0	0
G06Q	550	7	2138	1	4	0	5
G05F	525	0	507	0	0	0	0
H01R	500	2	392	0	0	0	0
H01Q	500	0	850	0	0	0	0
H03L	500	2	486	0	0	1	1
H04K	375	1	1128	0	1	0	1

Table 17 - Intel's top 25 all-time patent families and patent applications from 2009-2013, sorted by IPCs together with litigation statistics for each. In appendix 2 the top IPCs are further explained.

5.4.2 Technological Activity

Intel's number of patent applications filed within each of their top 25 technology areas between 01/01/09 – 12/31/13, together with statistics of the litigant positioning in connected litigations is illustrated in table 18. As described, patent application statistics is defining their most recent activity more extensive than patent family statistics.

Intel Corp 2009-2013								
IPC	Appl	Litigant Position			Total lit	Claim/Tot	Def/Tot	Lit/Appl
		Claim	Def	Other				
G06F	**23803**	**0**	**21**	**9**	**30**	**0%**	**70%**	**0,13%**
H04L	14598	0	17	6	23	0%	74%	0,16%
H01L	5505	0	5	0	5	0%	100%	0,09%
H04B	10275	1	9	2	12	8%	75%	0,12%
H04W	11640	1	6	5	12	8%	50%	0,10%
H04N	5627	0	1	3	4	0%	25%	0,07%
H05K	1761	0	0	0	0			0,00%
G11C	2311	0	6	1	7	0%	86%	0,30%
H04J	5991	1	1	1	3	33%	33%	0,05%
H04Q	3356	0	2	0	2	0%	100%	0,06%
G06T	2830	0	2	2	4	0%	50%	0,14%
H04M	4080	1	1	2	4	25%	25%	0,10%
H03K	945	2	2	0	4	50%	50%	0,42%
G01R	1714	1	0	0	1	0%	0%	0,06%
G09G	1567	1	1	1	3	33%	33%	0,19%
G02B	1257	0	2	0	2	0%	100%	0,16%
G06K	2056	1	0	0	1	100%	0%	0,05%
H03M	1847	1	1	0	2	50%	50%	0,11%
H03F	395	0	0	0	0			0,00%
G06Q	2138	1	4	0	5	20%	80%	0,23%
G05F	507	0	0	0	0	0%	0%	0,00%
H01R	392	0	0	0	0			0,00%
H01Q	850	0	0	0	0			0,00%
H03L	486	0	0	1	1	0%	0%	0,21%
H04K	1128	0	1	0	1	0%	100%	0,09%
Average	**83 256**	**11**	**61**	**24**	**96**	**11%**	**64%**	**0,12%**

Table 18 - Indicators that are defining Intel's patent litigation behavior are calculated from their recent activity within the IPCs.

In table 18 it is calculated how often Intel held a claimant litigant position and also how frequently they had been involved in litigations for each class. In their core technology competence area they held a claimant position in 0% of the litigations and 0.13% of the applications resulted in litigation. Their accumulated statistics when operating outside their core technology competence area is calculated as being claimant in 11% of the litigations, and 0.12% of the applications resulted in litigation. The difference between them both is shown in table 19.

Total Change in Variables	
Claimant litigations / Total litigations	4 percentage points
Litigations / Applications	0.16 percentage points

Table 19 - The calculated difference between when operating inside and outside the core technology competence area.

Figure 6 is illustrating the patent litigation behavior within each of Intel's top 25 IPCs in terms of the mentioned two main indicators; (1) the frequency of litigation involvement, and (2) how often they have had a claimant position. The core IPC and the accumulated average for the non-core IPCs are presented as main dots and the minor dots represent each non-core IPC individually.

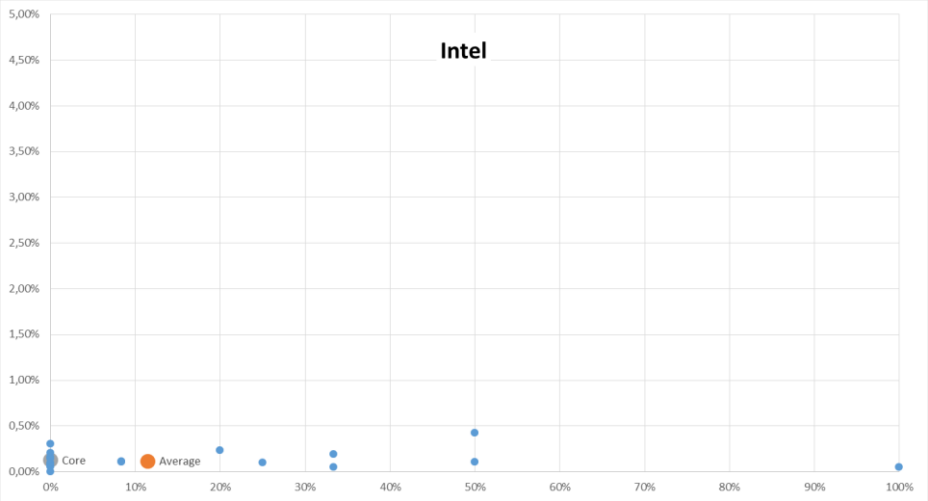

Figure 6 - Illustration of Intel's patent litigation behavior within their top 25 IPCs and the accumulated average for IPCs outside their core IPC.

As shown in table 18, Intel has been involved in litigations in 20 of their top 25 IPCs, and the majority of the IPC litigation statistics shows an widely spread area of diffusion in terms of claimant frequency, but their litigation frequency is not as diffused. By that, Intel tends to alter their litigant positioning, but are more stagnate in their litigation frequency.

6. Collective Examination of Technological Activity

In this section firms will be examined collectively with the aim of visualizing identified patterns of behavior. Given measures and statistics between the investigated firms, archetypes of behavior have been defined and further also types of patent litigation changes.

6.1 Categorization of Firms

To further analyze the patent litigation behavior among the investigated firms, a categorization of different archetypes is hereby presented in figure 7. The figure has been divided into four quadrants, each describing an archetype that represents a certain type of identified behavior. The categorization is based on the insights given when investigating patents and patent litigations, where the two most important indicators were identified, the Litigation frequency and the Claimant frequency. These indicators have been used to define the degree of involvement and the role of a firm from a patent litigation behavior perspective, which has then been labeled with four different archetypes: Careless, Intense, Cautious and Specific.

The frequency of conflicts is defined as number of litigations within one IPC divided with number of applications within that same IPC; frequency of conflict = IPC litigations / IPC applications. However, it is described in section 2.1.2 that a firm might be involved differently in litigations and how the involvement are identified by defining firms' litigant positioning as claimant, defendant, or other. If a firms' litigant positioning is mainly as defendant, meaning that the firm is not the filing part in the litigation, it was not seen as a risk of conflict for the VCC manager since the main concern is to gain information about how big the risk is of being filed against. Therefore, the claimant positioning statistics of investigated firms defines how big the risk of being filed against might be.

Further, to collectively compare and analyze the investigated firms, figure 7 has been adapted accordingly to the firms and their results. This facilitates the comparison between the firms, and makes patterns and relations understandable, and easy to define and relate to each other. Also, by doing this, the research questions becomes answered, as categorizing the investigated firms into different behaviors describes how the firms patent litigation behavior can be estimated. Additionally, figure 7 contains information about to what extent a firm changes, which answers the research question of how a firm's patent litigation behavior change when acting outside its core technological competence area.

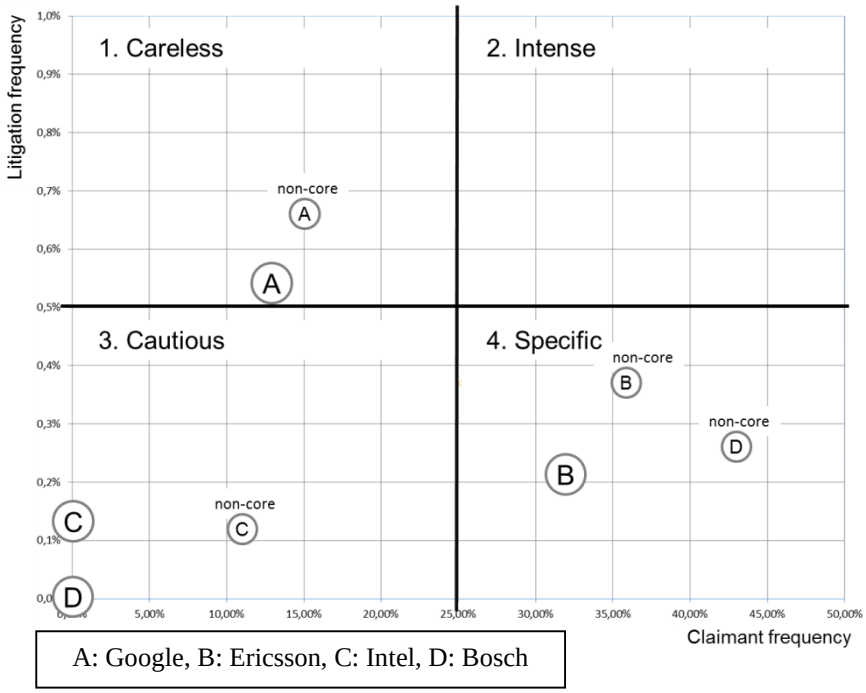

Figure 7 – Categorization of firms' patent litigation behavior.

6.1.1 The Careless Archetype

As seen in figure 7, the careless archetype is located in the upper left corner, where the percentage exceeds 0.5% comparing litigations with applications, and where the frequency of the claimant role in litigations involved is lower than 25%.

The litigation frequency involvement increases with the height on the X axis in figure 7, and since the area of the fourth quadrant, the careless archetype, is located in the upper left section, firms situated there have a high involvement in litigations compared to the competitive landscape. Further, a firm located in this quadrant only has the claimant role in up to 25% of the total number of litigations, and is therefore more likely to be the defendant party in litigations.

The term careless was given since a firm located in this quadrant is typically involved in much litigation, but is usually not the party taking the legal action. Of the investigated firms, Google was categorized as careless since the company had a litigation frequency of 0.54% and a 13% claimant frequency in their core technological competence area. An extreme of this archetype would be involved in a lot of litigations but not have the role of claimant. This behavior suggests ignorance toward other firms' patents as part of a firm's strategy, where having an aggressive

product development could be one of the reasons to this behavior. As the costs of patent litigations are high, only firms with sufficient funds can be successful within this archetype.

1. High involvement and low frequency of claims: Careless

6.1.2 The Intense Archetype

The archetype labeled Intense is located in the top right corner, illustrated in figure 7. In this quadrant, the Litigation frequency exceeds 0.5%, similar to the Careless archetype, and the Claimant frequency is higher than 25%. Comparing the Intense archetype to the other quadrants in the competitive landscape, firms in this quadrant combines a high frequency of the claimant role together with a high frequency of involvement in litigations. This is seen in figure 7, as the quadrant is located to the right on the X axis, and in the upper section on the Y axis, next to the Careless archetype.

There were none of the investigated firms that suited this archetype, but an extreme of the this type suggests a behavior that is protective toward its own patent portfolio, as it is involved in many litigations and often is the filing party, hence the name Intense archetype. The behavior is both aggressive as well as protective, since the extreme would take legal action against any firm that infringes on its patents. This strategy demands plenty of resources as patent litigations are associated with high costs and long trials.

2. High involvement and high frequency of claims: Intense

6.1.3 The Cautious Archetype

The quadrant of the Cautious archetype is situated to the left, in the bottom corner, seen in figure 7. The Claimant frequency is less than 25% and the Litigation frequency does not exceed 0.5%. Thus, the Cautious archetype is involved in less litigations compared to the Careless and Intense archetype, and has at the same time a low Claimant frequency. Therefore, firms located in this quadrant rarely get involved in litigations, but when they do, it is predominantly as the defendant party.

As seen in figure 7, Intel and Bosch are located in the third quadrant and both are closely to the bottom left corner. Bosch is an extreme, since the firm has not been involved in a single patent litigation within its core technological competence area, even though having a lot of patents in its portfolio. Intel has had a few involvements in patent litigations, however, never as a claimant, which suggests a cautious patent litigation behavior, thus the name of the archetype.

3. Low involvement and low frequency of claims: Cautious

6.1.4 The Specific Archetype

In the bottom right corner in figure 7 is the quadrant of the Specific archetype positioned. Here, the Litigation frequency does not surpass 0.5% but where the Claimant frequency is higher than 25%. Firms in the fourth quadrant is therefore more selective with their litigations compared to the competitive landscape, as they are not involved in as many patent litigations as the Careless and Intense archetype, but have a high Claimant frequency, which suggests a behavior towards being more selective and specific than the other archetypes, thus the name given.

Ericsson is the only one of the investigated firms that is located in this quadrant, with a Claimant frequency of 32% and a Litigation frequency of 0.21%, which places the firm close to the middle of the quadrant. Thus, Ericsson is, within its core technological competence area, claimant in almost a third of their patent litigations, and since the firm has a frequency of only 0.21% in litigations compared to patent applications, this patent litigation behavior indicates that the firm is selective when to get involved.

4. Low involvement and high frequency of claims: Specific

6.2 The Change of Behavior

A firm can change its patent litigation behavior in two potential directions when operating outside its core technological competence area, that is: (1) They will keep their core technological competence behavior and the behavior will be unchanged, or (2) they will not keep their core competence technological behavior and the behavior will be changed.

In scenario one, the firms' patent litigation behavior is unchanged, therefore the manager can estimate firms' non-core behavior by its core technological competence area.

In scenario two, firms' patent litigation behavior is changed and the manager can estimate those firms' behavior by their earlier operations outside the core technological competence area. Defined is that there are two descriptive measures for estimating the type of change; (1) the extent of change and (2) the direction of change. In figure 8 firms' difference between the core behavior and the accumulated non-core behavior is demonstrated. As illustrated in figure 8, the distance between the nods shows the *extent of change* by the firm when operating outside its core technological competence area. The *direction of change* shows towards which archetype of behavior the firm is estimated to approach.

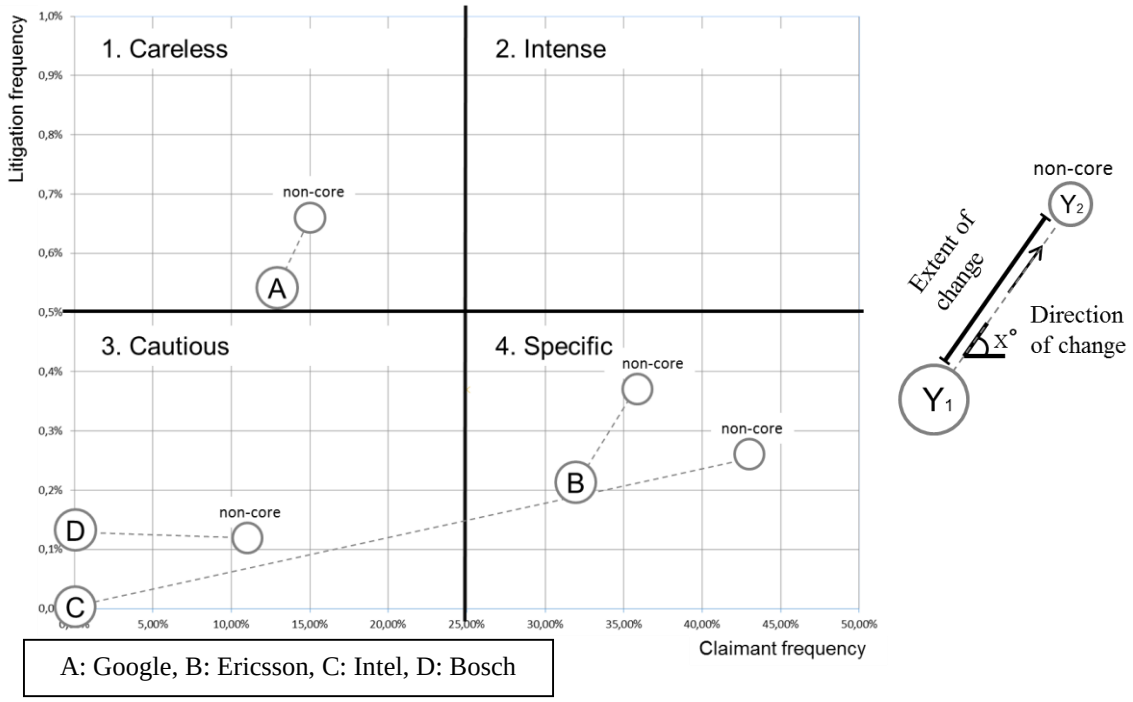

Figure 8 - The change of behavior from core to non-core technology areas by investigated firms and a description on how to calculate the change.

6.2.1 The Change of Behavior by Investigated Firms

Firm behavior in general has been described as being closely linked to the core competence behavior, and suggestively firms are path dependent and will not change the behavior when entering diversified business (Welfens, et al., 1999). In this study four firms' were investigated and four different types of behavior changes was recognized, which distinguishes that firms do change the patent litigation behavior. However, the amount of change was varying both in extent and in direction, and three out of four firms did not change their archetype of behavior

when acting outside their core area. Still, a change was revealed in the firm's behavior, which was seen as a limited as it was within their respective archetypes. Hence, firms might still be affected by and linked to their core competence even in patent litigation behavior, and the behavior changes identified suggests that the core competence behavior merely links the behavior; the firm does change the type of behavior when operating in emerging technology areas. Herein, under each type of behavior, changes that have been identified will be presented and explained, with constraints to earlier described archetypes.

Google

The first recognized behavior change was the one practiced by Google, which is defined as:

A. No change of archetype but became more intense

Google did not change their archetype of behavior, but their recent non-core patenting and patent litigation statistics indicates a more intense approach where they are involved in more litigation and are also more aggressive. However, the largest change is in terms of litigation frequency and since they are still active in the upper left area seen as the most careless actor in the competitive landscape and even more careless in the non-core area.

Ericsson

The second recognized behavior change was the one practiced by Ericsson, which is defined as:

B. No change of archetype but became more intense

Ericsson showed most of its changes in the litigant frequency range, and approached the intense area of figure 8. Also, the claimant frequency became a bit higher which puts their non-core behavior more to the right. They are still active in the lower right area, but are becoming the most intense actor in the competitive landscape.

Bosch

The third recognized behavior change was the one practiced by Bosch, which is defined as:

C. A change of archetype from 'Cautious' to 'Specific'

Bosch is the actor that has the most obvious change of behavior within the competitive surrounding, changing from (0, 0) to being the most frequent claimant. A reason for the great extent of change might be due to their non-litigation occurring core area but the recent patenting and patenting litigation statistics indicates a totally different behavior when they are operating

outside. Bosch changes to the most frequent claimant in the competitive landscape and is positioned in the lower right area.

Intel

The fourth recognized behavior change was the one practiced by Intel, which is defined as:

D. No change of archetype but became more specific

Intel did not change their archetype of behavior, but is becoming more specific in their non-core behavior. There was not much change of behavior recognized in the terms of litigant frequency, but as the only actor they become slightly less frequent. This indicates their more aggressive behavior in the non-core area, but is still categorized in the cautious archetype both for core and non-core behavior.

Intel and Google have their core competence area within the same technological class but the behavior changes are not alike, which neither gives any indication of an industry affected behavior change. Most alike in terms of extent and direction are Google and Ericsson, but the behaviors are categorized in different archetypes where Google is more frequently involved in litigations and Ericsson is more aggressive. However, all investigated firms tend to increase the claimant frequency and three out of four forms tend to increase the litigation frequency when operating outside its core technological competence area, hence seen to be more aggressive

The findings suggests that when a competitive surrounding emerges together with new technologies, involved firms tend to take legal action against one another more frequently than in each respective core competence area. By that, managers are to experience a competitive patent litigation behavior differed from what is seen in the industries from where the competitive firms origins.

7. Conclusions

Through this research project work, several firms have been investigated in order to discover and display possible litigation behaviors when firms are acting outside its core technological competence area. Further, the differences between behaviors, and also between firms, have been analyzed and discussed, thus helping answering the research question stated in this thesis:

How does a firm's patent litigation behavior change when acting outside its core technological competence area?

This study has given the results of that two vital indicators would answer how firms' patent litigation behavior might change; (1) the litigations frequency and (2) the claimant frequency. By then combining these indicators and exploiting the technology categorization of patent applications, it is possible for a manager to estimate future patent litigation behavior within new emerging markets.

In order to illustrate our findings that are describing a firm's patent litigation behavior we constructed a framework consisting of four different archetypes of behavior. These archetypes indicate the patent litigation behavior of a firm, and are also used to see how the firm changes its behavior when acting outside its core technological competence. The result of the investigation is that the behavior of the investigated firms shifts towards a behavior where the firms, at a more frequent rate, become the claimant party when acting outside their core technological competence area. However, as the involvement in litigations differs between the firms, as well as the extent of the behavioral changes, no general patent behavior change can be concluded, apart from the fact that the patent litigation behavior is unpredictable and depends on several factors.

7.1 Managerial Suggestions

For the purpose of providing useful managerial understanding of forthcoming competitive patenting behavior, this section will present three managerial suggestions constructed by the insights and knowledge originated from the study. The aim is to complement the findings and better facilitate managerial decision making during the work of adapting a firm's patent portfolio and patenting strategy to increase firms' competitiveness. Thus, what a manager

should consider when estimating patent litigation behavior in new emerging competitive surroundings are:

1. Define the emerging technology and distinguish the competitive surroundings.
When developing products within an emerging technology area, the competitive surroundings is most likely unknown to the firm. For the purpose of distinguish the surroundings, it is first recommended to descriptively define the emerging technology. By doing so, it is possible to map out the competitive landscape and acknowledge actors within, by for example analyzing patent application data.

2. Examine the competitive firms' patent litigation behavior.
In many emerging technologies within the automotive industry actors from other software based industries are present, which are new and unknown competitors for most of the automotive manufacturers. Such competitive surroundings suggest for an examination of the probable competitive firms' patent litigation behavior in order to avoid conflicts and/or technology infringements, especially since the distinct industry differences. By creating measures, such as the 'Litigation Frequency' and 'Claimant Frequency' generated during this study, it is possible for the manager to better understand how patent litigation behavior will be transpiring. Firms who are operating outside its' core competence area should be examined by their non-core behavior, and not their core behavior nor their total behavior since changes between has been proven during this study.

3. Keep track of the competitive landscape and foresee conflict risks.
Emerging technologies are quickly evolving, as best described in the technology S-curve, where increased activity generates new actors and changes the behavior of the already acknowledged actors. Therefore, it has been established that it is seen as vital for the manager to keep track of how the competitive landscape changes and by that foresee conflict risks. Suggested is to build a tool that will streamline the examination process of suggestion 1 and 2. An example of how such a tool can be constructed is illustrated in figure 9. The software prototype has been implemented at VCC during the study and validated through multiple presentations and ongoing meetings with R&D and innovation managers.

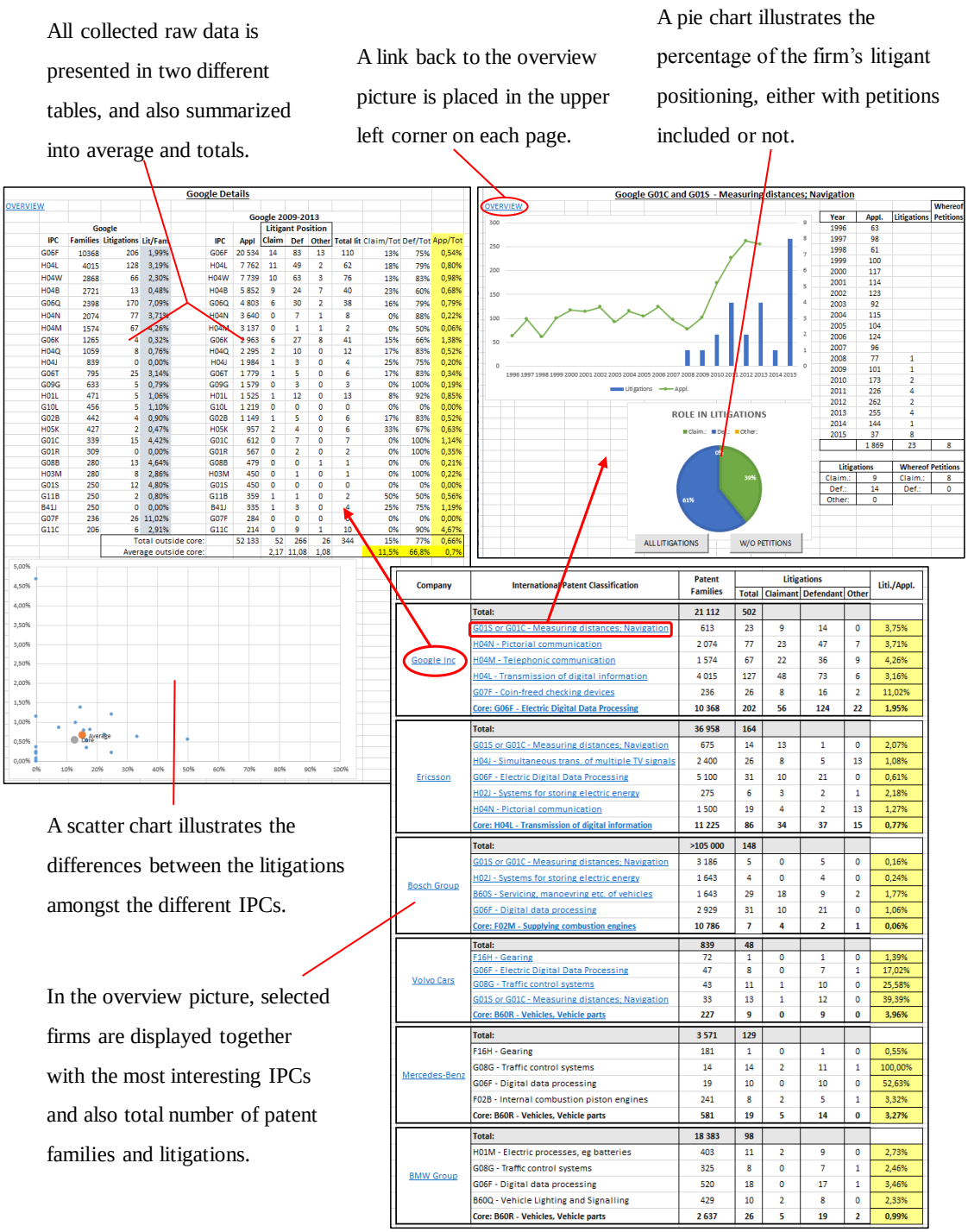

Figure 9 – Illustration of how the software prototype was constructed by using Microsoft Excel.

The layout consists of an overview page, an IPC page, and an individual firm page. On the overview page most basic information is presented with the aim of providing essential updated information of each firm in the competitive landscape of the investigated technology. As seen in figure 9, the firm page and the IPC page will provide more specific information and are also where data from litigation and patent databases has been inserted.

8. Further research

This study has been conducted in a research area where not much earlier research has been conducted, and by that there is neither literature nor papers comprehending all areas where more knowledge is seen to be needed. We have during this study identified gaps where further research can be suggested, some examples of these will be presented below.

First topic of suggested further research is why firms tend to act more aggressive when they are operating outside their core technological competence area. Investigating such a question would give much managerial value in terms of understanding competitive forces and strategies. Moreover, to cluster firms from different industries and examine them collectively could provide patterns of behavior differences and similarities amongst industries and give answers of how the industry is affecting firms patent litigation behavior.

Secondly, this study has not taken under consideration how the firms are evaluating their patents, and how the behavior might be different when infringements are comprehending an internally high valued patent. Therefor in order to strengthen this thesis topic and provide a more definite result, further research is suggested within patent valuation.

This thesis gives suggestions and information that are facilitating managerial decisions when working towards adapting the firm's patent portfolio in order to adapt to changes in the competitive surroundings. Further research might be to investigate if it is possible for incumbent firms to adapt to any market changes or how new market surroundings will transpire. Moreover, when different firms are entering emerging markets, which type of firm will change and who are more exposed to litigation.

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Appendix

Appendix 1 – List of patent activity and actors within AD

Appendix 2 – International patent classifications

Appendix 1

The most patenting firms within the 17 AD technology classes, sorted by the number of appearance in the different technology classes.

Most active firms within AD	Appearance in no of technology classes
GM Global	17
Ford Global Tech	13
Bosch Gmbh	15
Google Inc	9
Irobot Corp	9
Audi Ag	7
Daimler Ag	10
Caterpillar Inc	6
Continental Teves And Co Ohg Ag	7
Samsung Electronics Co Ltd	7
Continental Automotive Gmbh	6
Fatdoor Inc	4
Intel Corp	4
Hk Systems Inc	5
Wabco Gmbh	5
Mobileye Vision Technologies Ltd	5
Volvo Car Corp	4
Siemens Ag	4
Qualcomm Inc	2
Daimler Chrysler Ag	3
Autonomous Solutions Inc	2
5D Robotics Inc	3
Microsoft Technology Licensing Llc	2
Lg Electronics Inc	2
Intuitive Surgical Operations	3
Witricity Corp	2
Apple Inc	2
Valeo Schalter And Sensoren Gmbh	3
Bae Systems Plc	2
Jervis B Webb Co	2
Shinko Electric Co Ltd	2
Honeywell Int Inc	2
Hyundai Motor Co	3
Toyota Jidosha Kk	5
Xinshu Man L L C	2
Lord Corp	2

Commw Scientific And Industrial Research Organisation	2
Sony Corp	2
Panasonic Electric Works Co Ltd	2
Tower Sec Ltd	2
Clarion Co Ltd	2
Advanced Computing Inc Z	2
Volkswagen Ag	2
Texas Instruments Inc	2

Appendix 2

International Patent Classifications

B ***PERFORMING OPERATIONS; TRANSPORTING***

B41 **PRINTING; LINING MACHINES; TYPEWRITERS; STAMPS**

B41J TYPEWRITERS; SELECTIVE PRINTING MECHANISMS, i.e. MECHANISMS PRINTING OTHERWISE THAN FROM A FORME; CORRECTION OF TYPOGRAPHICAL ERRORS

B60 **VEHICLES IN GENERAL**

B60K ARRANGEMENT OR MOUNTING OF PROPULSION UNITS OR OF TRANSMISSIONS IN VEHICLES; ARRANGEMENT OR MOUNTING OF PLURAL DIVERSE PRIME-MOVERS IN VEHICLES; AUXILIARY DRIVES FOR VEHICLES; INSTRUMENTATION OR DASHBOARDS FOR VEHICLES; ARRANGEMENTS IN CONNECTION WITH COOLING, AIR INTAKE, GAS EXHAUST OR FUEL SUPPLY OF PROPULSION UNITS IN VEHICLES

B60R VEHICLES, VEHICLE FITTINGS, OR VEHICLE PARTS, NOT OTHERWISE PROVIDED FOR

B60S SERVICING, CLEANING, REPAIRING, SUPPORTING, LIFTING, OR MANOEUVRING OF VEHICLES, NOT OTHERWISE PROVIDED FOR

B60T VEHICLE BRAKE CONTROL SYSTEMS OR PARTS THEREOF; BRAKE CONTROL SYSTEMS OR PARTS THEREOF, IN GENERAL

D ***TEXTILES; PAPER***

D06 **TREATMENT OF TEXTILES OR THE LIKE; LAUNDERING; FLEXIBLE MATERIALS NOT OTHERWISE PROVIDED FOR**

D06F LAUNDERING, DRYING, IRONING, PRESSING OR FOLDING TEXTILE ARTICLES

F MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING

F01 **MACHINES OR ENGINES IN GENERAL; ENGINE PLANTS IN GENERAL; STEAM ENGINES**

F01N GAS-FLOW SILENCERS OR EXHAUST APPARATUS FOR MACHINES OR ENGINES IN GENERAL; GAS-FLOW SILENCERS OR EXHAUST APPARATUS FOR INTERNAL-COMBUSTION ENGINES

F02 **COMBUSTION ENGINES; HOT-GAS OR COMBUSTION-PRODUCT ENGINE PLANTS**

F02B INTERNAL-COMBUSTION PISTON ENGINES; COMBUSTION ENGINES IN GENERAL

F02D CONTROLLING COMBUSTION ENGINES

F02M SUPPLYING COMBUSTION ENGINES IN GENERAL WITH COMBUSTIBLE MIXTURES OR CONSTITUENTS THEREOF

F02P IGNITION, OTHER THAN COMPRESSION IGNITION, FOR INTERNAL-COMBUSTION ENGINES; TESTING OF IGNITION TIMING IN COMPRESSION-IGNITION ENGINES

F04 **POSITIVE-DISPLACEMENT MACHINES FOR LIQUIDS; PUMPS FOR LIQUIDS OR ELASTIC FLUIDS**

F04B POSITIVE-DISPLACEMENT MACHINES FOR LIQUIDS; PUMPS

F15 **FLUID-PRESSURE ACTUATORS; HYDRAULICS OR PNEUMATICS IN GENERAL**

F15B SYSTEMS ACTING BY MEANS OF FLUIDS IN GENERAL; FLUID-PRESSURE ACTUATORS, e.g. SERVOMOTORS; DETAILS OF FLUID-PRESSURE SYSTEMS, NOT OTHERWISE PROVIDED FOR

F16 ENGINEERING ELEMENTS OR UNITS; GENERAL MEASURES FOR PRODUCING AND MAINTAINING EFFECTIVE FUNCTIONING OF MACHINES OR INSTALLATIONS; THERMAL INSULATION IN GENERAL

F16H GEARING

F16K VALVES; TAPS; COCKS; ACTUATING-FLOATS; DEVICES FOR VENTING OR AERATING

F24 HEATING; RANGES; VENTILATING

F24C OTHER DOMESTIC STOVES OR RANGES; DETAILS OF DOMESTIC STOVES OR RANGES, OF GENERAL APPLICATION

F25 REFRIGERATION OR COOLING; COMBINED HEATING AND REFRIGERATION SYSTEMS; HEAT PUMP SYSTEMS; MANUFACTURE OR STORAGE OF ICE; LIQUEFACTION OR SOLIDIFICATION OF GASES

F25D REFRIGERATORS; COLD ROOMS; ICE-BOXES; COOLING OR FREEZING APPARATUS NOT COVERED BY ANY OTHER SUBCLASS

G PHYSICS

G01 MEASURING; TESTING

G01C MEASURING DISTANCES, LEVELS OR BEARINGS; SURVEYING; NAVIGATION;GYROSCOPIC INSTRUMENTS; PHOTOGRAMMETRY OR VIDEOGRAMMETRY

G01D MEASURING NOT SPECIALLY ADAPTED FOR A SPECIFIC VARIABLE; ARRANGEMENTS FOR MEASURING TWO OR MORE VARIABLES NOT COVERED BY A SINGLE OTHER SUBCLASS; TARIFF METERING APPARATUS; TRANSFERRING OR TRANSDUCING ARRANGEMENTS NOT SPECIALLY ADAPTED FOR A SPECIFIC VARIABLE; MEASURING OR TESTING NOT OTHERWISE PROVIDED FOR

G01N INVESTIGATING OR ANALYSING MATERIALS BY DETERMINING THEIR CHEMICAL OR PHYSICAL PROPERTIES

G01R MEASURING ELECTRIC VARIABLES; MEASURING MAGNETIC VARIABLES

G01S RADIO DIRECTION-FINDING; RADIO NAVIGATION; DETERMINING DISTANCE OR VELOCITY BY USE OF RADIO WAVES; LOCATING OR PRESENCE-DETECTING BY USE OF THE REFLECTION OR RERADIATION OF RADIO WAVES; ANALOGOUS ARRANGEMENTS USING OTHER WAVES

G02 OPTICS

G02B OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS

G05 CONTROLLING; REGULATING

G05F SYSTEMS FOR REGULATING ELECTRIC OR MAGNETIC VARIABLES

G06 COMPUTING; CALCULATING; COUNTING

G06F ELECTRIC DIGITAL DATA PROCESSING

G06K RECOGNITION OF DATA; PRESENTATION OF DATA; RECORD CARRIERS; HANDLINGRECORD CARRIERS

G06Q DATA PROCESSING SYSTEMS OR METHODS, SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES; SYSTEMS OR METHODS SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES, NOT OTHERWISE PROVIDED FOR

G06T IMAGE DATA PROCESSING OR GENERATION, IN GENERAL

G07 CHECKING-DEVICES

G07F COIN-FREED OR LIKE APPARATUS

G08 SIGNALLING

G08B SIGNALLING OR CALLING SYSTEMS; ORDER TELEGRAPHS; ALARM SYSTEMS

G09 EDUCATING; CRYPTOGRAPHY; DISPLAY; ADVERTISING; SEALS

G09G ARRANGEMENTS OR CIRCUITS FOR CONTROL OF INDICATING DEVICES USING STATIC MEANS TO PRESENT VARIABLE INFORMATION

G10 MUSICAL INSTRUMENTS; ACOUSTICS

G10L SPEECH ANALYSIS OR SYNTHESIS; SPEECH RECOGNITION; SPEECH OR VOICEPROCESSING; SPEECH OR AUDIO CODING OR DECODING

G11 INFORMATION STORAGE

G11B INFORMATION STORAGE BASED ON RELATIVE MOVEMENT BETWEEN RECORD CARRIER AND TRANSDUCER

G11C STATIC STORES

H ELECTRICITY

H01 BASIC ELECTRIC ELEMENTS

H01H ELECTRIC SWITCHES; RELAYS; SELECTORS; EMERGENCY PROTECTIVE DEVICES

H01L SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR

H01M PROCESSES OR MEANS, e.g. BATTERIES, FOR THE DIRECT CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL ENERGY

H01Q AERIALS

H01R ELECTRICALLY-CONDUCTIVE CONNECTIONS; STRUCTURAL ASSOCIATIONS OF A PLURALITY OF MUTUALLY-INSULATED ELECTRICAL CONNECTING ELEMENTS;COUPLING DEVICES; CURRENT COLLECTORS

H02 GENERATION, CONVERSION, OR DISTRIBUTION OF ELECTRIC POWER

H02J CIRCUIT ARRANGEMENTS OR SYSTEMS FOR SUPPLYING OR DISTRIBUTING ELECTRIC POWER; SYSTEMS FOR STORING ELECTRIC ENERGY

H02K DYNAMO-ELECTRIC MACHINES

H03 BASIC ELECTRONIC CIRCUITRY

	GENERATION OF OSCILLATIONS, DIRECTLY OR BY FREQUENCY-CHANGING, BY CIRCUITS
H03B	EMPLOYING ACTIVE ELEMENTS WHICH OPERATE IN A NON-SWITCHING MANNER; GENERATION OF NOISE BY SUCH CIRCUITS
H03D	DEMODULATION OR TRANSFERENCE OF MODULATION FROM ONE CARRIER TO ANOTHER
H03F	AMPLIFIERS
H03H	IMPEDANCE NETWORKS, e.g. RESONANT CIRCUITS; RESONATORS
H03K	PULSE TECHNIQUE
H03L	AUTOMATIC CONTROL, STARTING, SYNCHRONISATION, OR STABILISATION OF GENERATORS OF ELECTRONIC OSCILLATIONS OR PULSES
H03M	CODING, DECODING OR CODE CONVERSION, IN GENERAL

H04 ELECTRIC COMMUNICATION TECHNIQUE

H04B	TRANSMISSION
H04J	MULTIPLEX COMMUNICATION
H04K	SECRET COMMUNICATION; JAMMING OF COMMUNICATION
H04L	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION
H04M	TELEPHONIC COMMUNICATION
H04N	PICTORIAL COMMUNICATION, e.g. TELEVISION
H04Q	SELECTING
H04W	WIRELESS COMMUNICATION NETWORKS

H05 ELECTRIC TECHNIQUES NOT OTHERWISE PROVIDED FOR

H05K	PRINTED CIRCUITS; CASINGS OR CONSTRUCTIONAL DETAILS OF ELECTRICAPPARATUS; MANUFACTURE OF ASSEMBLAGES OF ELECTRICAL COMPONENTS