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The final version of this manuscript is published in the *World Patent Information*, 34(3): 216-223.

The final publication is available at the following link at www.sciencedirect.com:

<http://www.sciencedirect.com/science/article/pii/S0172219012000439/pdfft?md5=4eab557522166229ffb037c902688973&pid=1-s2.0-S0172219012000439-main.pdf>

DOI: 10.1016/j.wpi.2012.03.005

<http://dx.doi.org/10.1016/j.wpi.2012.03.005>

Please note that differences between this manuscript and the final publication may exist. In case of questions, please contact the corresponding author as indicated below.

The role of IT for managing intellectual property– an empirical analysis

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Abstract

The effective management of intellectual property (IP) is an increasingly complex challenge in today's global knowledge economy, especially for firms with large IP portfolios. Although information technology (IT) tools are a means to support the management of these portfolios, there is little insight in how firms actually make use of IT tools in this regard. Hence, this article analyzes how and for which processes firms use IT tools to support their IP management. Based on a data set of 106 IP intensive firms worldwide, we find that firms use at least one of three major IT tools for IP management: search tools, administrative tools, and evaluation tools. We also find that the use of IT for IP processes is decreasing along the IP value chain: firms use IT mainly in the early IP generation phase, e.g., for absorbing technological developments. The article concludes by outlining where and how IT tools can improve the management of IP.

Keywords: Intellectual property (IP) management, IT tools, IP rights, patents

1. Introduction

The number of intellectual property (IP) right applications has been constantly growing over the last century. Since 1985, the annual patent filings worldwide have more than doubled; a similar trend can also be observed with trademarks and industrial designs [1]. This accumulation of intellectual property – and thus the growth of the firm's overall IP portfolio – poses several challenges on the effective management of IP. Firms with large IP portfolios are more than ever challenged to design strategies and to implement structures and processes to enable an efficient IP management. Towards this backdrop, dedicated IT tools which are capable of storing, structuring, and making IP information accessible may represent an important efficiency gain for the firm's IP management. Many firms with large IP portfolios such as IBM or Infineon have already established IT systems for managing their IP. However, there is a lack of insights with respect to where exactly IT tools are used in the management of IP, and how firms can use these tools to increase their IP management effectiveness. This article aims to provide answers to this question by presenting the results of a worldwide survey on IP management and IT support at the firm level. Towards the backdrop of managing IP, we define IT tools to span everything from specific IP based applications to general IP data bases.

The paper is structured as follows. The next section gives an overview of literature on IP tools for IP management. Section 3 describes the research framework and the methods applied for the investigation and provides information on the analyzed sample. Section 4 depicts the findings on the use of IP software which are analyzed in section 5. Finally, section 6 summarizes the paper, presents some recommendations on how firms may boost their IP management, and gives a brief outlook for future research.

2. IT tools for IP management - State of the art

Extant literature on IT solutions for IP management can be divided into three major strands, one which focuses on the technical functionality of IT tools in IP management, one which adopts the user perspective of such tools, and one representing the patent offices' activities. In the functional strand, Fabry et al. [2], for example, present a method of using IT tools to evaluate patent portfolios in order to use this information to identify new business opportunities. Bergmann et al. [3] present an IT tool based on semantic analysis to detect risks of patent infringements through patent information. Moehrle et al. [4] analyze major tasks of patent search and indentify IT tools that can be deployed to accomplish these tasks. Focusing on the challenge of retrieving relevant information from data bases, Dou [5] presents a possibility to link patent data base search with a dedicated software to filter search results according to specific needs (the author presents the case of esp@cenet[®] and Matheo-Patent). This kind of software facilitates search activities and fosters the use of patent information for all user types [5]. Spangler et al. [6] have developed a holistic web-based IP mining tool called SIMPLE that facilitates patent data processing, warehousing, and analysis. Others have investigated data visualization tools which enhance the interpretation and analysis of collected patent information [7]. Based on the experience of a pharmaceutical company, Eldridge [8] gives an overview of selected data visualization tools and their applicability from a practitioner point of view. Moreover, Lupu et al. [9] describe a tool that evaluates the results of different patent information search technologies. They present the TREC Chemical IR (Information Retrieval) Track tool that focuses on evaluating search results of chemical patent information.

In the literature strand adopting a user perspective, Bonino et al. [10] analyze the functionality and user needs of current patent information tools including data bases, search

tools, benchmark tools, and semantics-based tools. They find that the requirements on these tools depend firstly on the user type, e.g., patent specialists or managers, and secondly the objective of the patent information activity, e.g., technology scouting or patent monitoring. Radauer and Walter [11] adopt an SME (small and medium-sized enterprises) focus and discuss, based on a benchmarking study of 72 IP services in the EU-27 countries, the gap between the need of SMEs for patent information and the existing patent information services in the European Union. They find that SMEs need more than mere technical patent information and especially require support in the interpretation of the search results. In the light of data base search, Emmerich [12] investigates the level of information of different patent data bases and analyzes in a case study of the pharmaceutical industry how firms can generate high quality search results of a patent search. The results emphasize the necessity to search all high information level patent data bases in order to provide high quality results.

Finally, also patent offices increasingly integrate IT solutions into their service systems. For example, the World Intellectual Property Office (WIPO) developed the online filing system PCT-SAFE (Patent Cooperation Treaty – Secure Applications Filed Electronically). The software was launched in 2004 and enables inventors and firms from all PCT member countries to file their PCT patent applications electronically [13]. More recently, the WIPO also launched an online tool for filing trademark applications and searching internationally registered trademarks via the Global Brand Database [14]. The European Patent Office (EPO) offers with EPO Online Services a comprehensive online service portal including the PatXML software for online patent filings, and Register Plus and WebRegMT (for details see Rogier [15]) for IP monitoring and search activities. Furthermore, EPO provides patent organizing systems and an online fee payment tool¹. The Swedish and the Australian Patent Office have gradually improved their online services over the last years and recently replaced their old patent data base systems by new online and freely available systems [16, 17]. Furthermore, with the Centralized Access to Search and Examination system (CASE), the IP offices of Australia, Canada and the United Kingdom as well as the WIPO have started a pilot system that facilitates the online search of the participating IP offices [18].

However, while extant literature has mainly focused on the technical functionality of e.g., searching for IP and extracting valuable information from patent information, the investigation of the user perspective, i.e., how and to what extent the users deploy IT for all IP management activities, starting with technology scouting and ending with divestment decisions, is under-researched. Firms' IP management focus increasingly shifts from the traditional defensive approach to a more proactive approach of exploiting the IP portfolio [19-21]. Thus, effectively leveraging IP information in order to identify new technology areas, new business opportunities, or to assess the value of the portfolio is an important part of modern IP management [10]. The field of application of IP software extends from mere search activities to the evaluation and external exploitation (i.e., out-licensing and sale etc.) of IP. Therefore, this paper adopts a user perspective and investigates how and for which processes firms use IT tools to support their entire IP management.

3. Research methodology

3.1. Research framework

Intellectual property rights are the most visible form of intangible assets and are therefore defined as explicit knowledge assets [25]. Hence, managing intellectual property constitutes a specific form of knowledge management. Knowledge management literature distinguishes between *creating* knowledge and *appropriating* returns based on this knowledge as major

¹ Information under www.epoline.org

steps for firms to gain competitive advantage [25, 26]. From an IP management perspective, these activities can be reflected in the *generation* of IP, i.e., creating ideas and protecting them through IP rights, and the subsequent *exploitation* thereof to appropriate returns, either internally through securing own products, or externally through, for example, licensing. [27]. Furthermore, IP management literature emphasizes the importance of valuating IP within the IP management process [28]. Due to its impact on the firms' decision making, IP valuation is seen as a central activity of IP management, especially in preparation of the commercialization of the IP [29, 30].

Thus, drawing on the contributions from knowledge management and IP management literatures, we identify three core phases for managing intellectual property: *Generate*, *assess*, and *exploit* IP. We will call this the IP value chain model.

The first phase, *IP generation*, includes the idea finding and realization process as well as the IP registration. This phase is characterized by a strong technology focus mainly resulting from R&D outcomes and is driven by technology search activities. In a first step, potentially relevant technological fields are scanned broadly via, e.g., patent data bases, including also cross-industry searches. In a second step, the IP search is narrowed focusing on the identified relevant areas [31]. Also the patentability of new technologies and the freedom to operate is checked in this phase. Ensuring freedom to operate, i.e., creating and maintaining a position through IP rights where the firm can continue its research and development in the specific technological field free from third party IP rights is a crucial aspect of generating new IP [32]. Based on the search and idea generation, IP right applications are filed with respect to the firm's IP strategy. Blind et al. [33] state that besides the traditional and still major reason for patenting *protection from imitation*, strategic motives such as blocking competitors, enhancing firm reputation, and improving the firm's negotiation position are becoming increasingly important and thus are increasingly taken into account by firms when defining their IP strategy.

In the second phase *assessing IP*, the IP portfolio or single IP rights are assessed to obtain a qualitative or quantitative value, mostly applied for patents. While the quantitative *valuation* approach aims to give the patent an absolute value in terms of money, e.g., for balancing, tax, enforcement, or commercialization reasons [34], the qualitative *evaluation* of IP stresses the strategic value of a patent such as its legal strength or relative importance in its technological area [35, 36]. The evaluation of IP also includes IP portfolio analyses classifying the patents according to the products or processes they protect and analyzing the patent portfolio pertaining to which strategic value the patent creates for the firm, e.g., protecting own technologies, blocking competitors, licensing and alliance options, and future potential.

The third phase *exploitation of IP* entails internal and external exploitation activities of the firm as well as enforcing IP rights. Traditional internal patent exploitation in own products and processes ensures freedom to operate and generates a temporary monopoly for the patent owner [33, 37]. External IP exploitation through e.g., licensing permits generating additional revenues or strategic benefits like setting standards or accessing third party [21, 38]. Finally, IP rights only create value if they are defended, i.e., enforced in case of infringement by third parties [39]. Thus, detecting the infringement, defining the enforcement strategy and managing the enforcement process forms also part of the IP exploitation phase. IP infringement cases are either decided in court or by a direct settlement between the concerned parties out of court. In a settlement out of court the IP owner and the infringing party usually agree on a defined compensation payment or a cross-licensing agreement, allowing the infringing party the continued use of the IP of question by giving licenses of their IP portfolio to the infringed party [40].

3.2. Method and data

Our research approach consisted of two phases. In the first phase, we conducted a worldwide online questionnaire survey to obtain a broad picture of how firms use IT tools within their IP management. In this survey, we focused on IP intensive firms, i.e., firms where intellectual property is of strategic importance and which actively manage an IP portfolio. 1210 IP intensive firms in cross-industry sectors were contacted and investigated regarding their IP management including patents, trademarks, industrial designs, and, for some specific questions, domain names. In total, we received 106 usable questionnaires which corresponds to a response rate of 8.8%.

In the second phase, case studies were conducted to deepen the insights obtained from the questionnaire survey. We applied purposeful sampling and chose those firms which provided the most detailed and insightful information [22]. Table 1 provides a brief overview of these firms. They are characterized by well-structured IP management and the deployment of IT tools for specific IP processes, either self-developed tools or commercial tools. The case studies allowed to gain in-depth information on how firms use IT tools within their IP management. The data were primarily collected through semi-structured face-to-face interviews with IP and R&D managers [23]. In addition, desk research of firm reports and public announcements was conducted for data triangulation and to increase the robustness of the results [24].

In the subsequent sections, the results of the survey and the case studies are presented and discussed using the IP value chain model as a guideline.

<< insert table 1 about here >>

4. Results and case findings

This section presents the findings of our analysis on how firms' manage their IP using IT tools. Descriptive statistics resulting from the questionnaire survey are depicted and the insights are deepened by the findings from the case studies. First, the results on the firms' use of IT tools regarding the entire IP value chain are presented. Second, the IP management and IT use of each phase of the IP value chain, i.e., generate, assess, and exploit IP, is analyzed in detail. Third, the satisfaction of the firms with the usability and utility of these tools for IP management is examined.

4.1. General results

Analyzing the firms' deployment of IT along the IP value chain, three major categories of IT tools for IP management can be identified. The first category *search tools* includes all tools helping to gain information on existing IP rights, technological state of the art, technological trends, and competitive environment activities. Next, *administrative tools* are tools supporting the firms' internal IP management with regards to annual IP rights renewal payments, storing information of the firms' IP portfolio such as the current use of the IP rights in products, services, or other forms, patent specifications, pending IP right applications, lifetime of IP rights, etc. Finally, the category *evaluation tools* comprises tools supporting to give a

qualitative and quantitative value to the IP portfolio or single IP rights. The results also show that firms use both commercial IT tools as well as internally developed tools.

The results of the use of IT tools for IP management reveal two major findings. Firstly, the firms' use of IT decreases along the IP value chain (Figure 1). This behavior is similar for all forms of IP rights, i.e., for patents, trademarks, industrial designs, and domain names. While firms mostly use IT tools in the IP generation phase, they are rarely used in the IP exploitation phase. The second major finding is that patents are the form of IP rights supported most by IT tools followed by trademarks and industrial designs. Almost no IT support is provided for domain name management.

Overall, 98% of the investigated firms use IT tools to support their IP management. 74% use IT tools for patent management, 60% for trademark management, 53% for industrial design management, and 45% for domain name management. Only 2% do not use any supporting IT tools for their IP management at all.

In the following section each phase of the IP value chain is depicted in detail.

<< insert figure 1 about here >>

4.2. Use of IT tools along the IP value chain

In the *IP generation* phase, 72% of the firms use IT applications for patents, 49% for trademarks, and 26% for designs. The IP generation phase is characterized by a broad range of activities including technology scouting, IP monitoring, idea management, and IP registration (patent filing, trademark registration, etc.). In order to get a more detailed picture of the firms' management of IP generation, we also analyzed for which activities the tools are used. Search tools include technology and IP search and monitoring tools, idea management tools are tools supporting the creativity process at the firm, the inventor's bonus tool supports the remuneration of important inventions. Despite the latter two may not specifically be IP tools, these activities are crucial for generating IP at all and are therefore included in our analysis. Docketing and term management, document management systems, and electronic files are tools supporting IP administration, such as the punctual payment of renewal fees, controlling the filing process, and the legal status of the IP right. The investigated firms used, for example, software tools provided by Dennemeyer (DIAMS), CPA (Memotech, Inprotech, FoundationIP), Thomson Reuters (Thomson IP Manager), GSI (WINPAT), Unycom (IPAS), Eidologic (EIDOpat), and Brüggmann (PatOrg). The findings reveal that the firms mainly use IT tools for search activities, followed by administrative tools. 88% of the firms use search tools to optimize their IP search processes (Figure 2). For example, *Henkel* uses the services of *Derwent* and *MicroPatent* to monitor markets and competitors. About 5,000 patents are analyzed per year focusing on the activities of competitors. Additionally, *Henkel* monitors specific technology areas through keyword searches. Technology experts, typically leaders of an R&D group, are responsible for controlling and evaluating the patent data. For example the group leader of dishwasher and laundry tabs is responsible for the search field "tabs". The R&D group leader regularly informs the head of R&D about the patent situation.

Kodak has developed a specific IT tool to support its IP generation process, the so called *Invention Tracker*. The *Invention Tracker* manages the information processing between different departments and involved employees from idea finding and evaluation to patenting decisions and patent filings. Furthermore, *Kodak* uses the commercial data base *MicroPatent* which enables R&D employees to gather IP information, e.g. about external patents and state of the art technology.

Alcatel-Lucent conducts comprehensive patent searches using data profiles and statistical evaluation methods. Typically, *Alcatel* searches in the public data bases *Derwent WPIDS*,

Inpadoc of the European Patent Office, *EUROPatfull* and *USPatfull*. The further data processing including statistical analyses is accomplished in Excel and is structured according to business areas and specific keywords. The results are reviewed by the senior IP counsel and published on Alcatel's internal intranet side. As data base Alcatel uses a self-configured *Lotus Notes* data base. Alcatel made the point that in their experience treating and evaluating the data on their own is cheaper than outsourcing these process steps to an external service provider. Moreover, all researchers and developers have the possibility to conduct own patent searches within the intranet data base.

<< insert figure 2 about here >>

In the second place after search tools are docketing and term management tools followed by electronic file, document management systems, inventor's bonus tools, idea management tools, and others like e.g., budget forecasting tools. *Alcatel* uses the patent management software *Memotech* from CPA to support its IP administration. *Kodak* uses the software *IP Master*, a commercial patent workflow management tool which was designed especially for patent attorneys, to administrate its more than 12'000 patents large portfolio. It helps Kodak to control the patent filing process and to coordinate the patent fees. Also *OC Oerlikon* has established a commercial IT tool which supports the IP management for docketing and term and portfolio management.

Examining the *IP assessment* phase, the results show that valuation and evaluation activities are rarely supported by software. In total, only one third of the firms uses IT tools to support the assessment of their IP rights. Figure 3 illustrates the results of the analysis distinguishing between valuation and evaluation activities. The results reveal that firms behave similarly regarding the use of IT tools for each of the method: 16% respectively 15% of the firms make use of IT tools for IP valuation or evaluation. The investigated firms use either commercial tools offered by IP offices and service providers, e.g., *IPscore*[®], or self-developed systems, e.g., based on Microsoft Excel.

Schindler, for example, has developed an internal IP data base storing ideas, invention disclosures, and patent data. In the data base patents are classified according to defined criteria. The keywords of the classifications are renewed every two years. The patents are evaluated with a standard evaluation form including a point system. The evaluation form considers both the economic perspective, i.e. market success, as well as the legal perspective, i.e. patent sustainability. In addition, technical aspects are assessed, too. The challenge for *Schindler* regarding the data base is on the one side to provide firm-wide communication and, on the other side, to ensure confidentiality of the information. Data communication and communication between the data base users is therefore implemented via a secured intranet. Additionally, *Schindler* has established different levels of access authorization. Moreover, especially for the requirements of the U.S. law of inventions (currently "first-to-invent", soon to become "first-to-file" under the America Invents Act [41]), all documents are marked with a time stamp that "freezes" the new document and makes it unchangeable. In this way, *Schindler* is able to exactly track the date of the inventions.

Kodak uses the internally developed software system *MP-Tools* consisting of patent analysis tools to support acquisition and evaluation decisions. This process is a standardized tool for qualitative patent evaluation which is implemented throughout the firm.

The last phase of the IP value chain, *IP exploitation*, is least supported by IP applications. Even for patents, only 13% of the investigated firms use IT tools for exploitation, 83% of the firms do not use IT support in this phase at all.

<< insert figure 3 about here >>

4.3. *User friendliness of IT tools for IP management*

At the investigated firms, an IT tool for IP management is used on average by 10 employees. About nine employees are involved in patent management tools. For trademark, design, domain, and contract management, the average number lies between two and five employees. To get a picture of the users' mindset regarding the usability and utility of their IT tools an analysis of the degree of satisfaction was conducted. The results reveal that on a five point Likert scale from 1 = *very unsatisfied* to 5 = *very satisfied*, the average degree of satisfaction is 3.21, i.e., neither totally satisfied nor unsatisfied. Also, there is no remarkable difference between the single IP rights. In percentage, 49% of the firms are very satisfied or satisfied with their IT tools for managing IP. 36% are neutral, 15% are unsatisfied or very unsatisfied (Figure 4). Reasons for the users' dissatisfaction are that the tools demand too much working hours, that they lack adequate functionality, cause redundant work, and lack the integration of several functionalities like document management, literature management, and search processes.

<< insert figure 4 about here >>

Another perspective on the satisfaction level of firms with their IT tools reveals that the degree of satisfaction of firms using an integrative IT tool system, i.e., a system including all necessary processes for all IP rights, is higher than those firms working with different single IT tools. About two-thirds of the firms currently work with several IT tools, only one third has an integrative system. But the findings reveal that the users of the integrative systems are more satisfied than those using many different tools. 64% of the integrative tool users are at least satisfied with their system, while not even half of users in the firms using different tools are satisfied with their system.

IBM is an example for the use of an integrative IT tool system helping to generate, assess, and exploit the IP portfolio. *IBM* uses a know-how and management software which helps to align business and IP strategy, identify new patent opportunities, evaluate and leverage patent portfolios. The patent management software has been developed internally by *IBM's* patent and IP experts for over a decade with the aim to support analysis, assessment and administration of *IBM's* patent portfolio with more than 40,000 patents. The integrative IP management tool has enabled *IBM* to balance its IP strategy with business needs and find new ways to derive value from its IP portfolio.

Also *Infineon's* IP software system has been developed towards an integrative system. *Infineon* has established three IT tools: an internally developed patent administration tool, an IP search tool, and an IP portfolio management tool. The three tools are linked and complement each other. The stored data is available for people involved in R&D management, IP management, and the IP decision process.

5. Discussion

5.1. IT tool use along the IP value chain adopting an organizational information processing perspective

The results reveal that the use of IT tools decreases along the IP value chain from IP generation over assessment to exploitation. This can be discussed adopting an organizational information processing theory perspective. The organizational information processing theory assumes that acquiring data, transforming data into information, communicating, and storing data are major challenges of complex organizations [42]. Accordingly, organizations obtain higher performance when they reach a fit between information process requirements and information process capabilities [43]. In this vein, our data supports the theory as most IT support is realized during the IP generation phase where high requirements for information, e.g., patent information, technical state of the art, and market information, matches the search capacities of the firms. The IP generation phase is traditionally the phase where firms have established well structured IP management processes. Searching new technologies and monitoring the IP landscape is a core R&D activity and important for sustained competitiveness of the firm [44, 45]. Consequently, firms proactively attempt to optimize these processes. Today, these attempts are facilitated as search and information processing software has progressed significantly in recent years [10]. Hence, the generation phase offers optimal conditions for integrating software solutions because firms can use their existing structures and processes and complement them by IT tools to increase overall efficiency. In contrast, in the phases IP assessment and IP exploitation many firms do not meet the above described fit of requirements and capabilities, i.e., they do not have defined processes for their evaluation and exploitation activities, resulting in a difficult integration of IT tools. At Henkel, for example, the effort for IP evaluation currently does not require automated processes. Instead, Henkel's IT tools offer requested support for reliable information for monitoring the competitive environment and detecting new technological and marketing trends. In contrast, Kodak has established IT tool support for the evaluation of parts of its portfolio for acquisition, maintenance, or out-licensing reasons, activities representing a crucial part within their IP management.

Although there is a persistent demand for the firms' assessment of IP (especially patents) [46], the firms' valuation and evaluation processes are rather underdeveloped and lack respective IT support. This situation is exacerbated as firm strategies increasingly consider IP as a valuable asset which contributes to sustainable firm success. In particular, firms increasingly require IT tools as they try to value their IP portfolio to optimize tax and balancing matters. IPscore[®] is an example of a successful patent evaluation software tool which was originally developed by the Danish Patent and Trademark Office and which was later acquired by the European Patent Office². The tool offers both a qualitative and quantitative assessment of patent portfolios and technology development processes [47]. But also IP service providers increasingly offer IT tools for IP valuation, such as PatentRatings[®] by Ocean Tomo³, the Patent Value Predictor by Pantros IP⁴, and the Global IP Estimator[®] by Global IP Net⁵, of which the latter besides patents also values trademarks and designs. Furthermore, in a recent research project of the European Commission an IP valuation tool specifically for SMEs has been developed: The AIDA IP diagnosis tool helps SMEs to analyze their IP portfolio by applying an three-step IP auditing approach with a visual representation of the results at the end [48]. Through the organizational information

² <http://www.epo.org/patents/patent-information/business/valuation/ipscore.html>

³ <http://www.oceantomo.com/ratings/system>

⁴ <http://www.patentvaluepredictor.com/>

⁵ <http://www.globalip.com/>

processing lens, these tools can support the firms by supplementing their capabilities and thus helping reaching the fit between requirements and capabilities.

Despite the potential that IT solutions offers for the external exploitation of IP [3], the results show that only a few firms use IT tools for licensing, IP transactions, or financing. A reason for this could be that external IP exploitation is still not a standard activity at most firms. Apart from pioneering firms such as IBM or Philips, where external IP exploitation is implemented in business strategy, the majority of the firms engage in external IP exploitation on a – if at all – ad hoc basis [49]. As a consequence of the low frequency of external exploitation, the development of respective IT tools and support is difficult or may not yet be required. This again points to the need of an increased match between requirements and capabilities of the organizational information processing theory. Considering current developments, the increasing proactive IP management approach of firms including burgeoning out-licensing and sale strategies will enhance the need for IT support tools in the future [50].

Moreover, the findings show that patents are the type of IP rights which is supported most by IT tools. Due to the large amount of technical data included in one patent application, public and firms' internal patent data bases entail an enormous amount of data. As a consequence, it is difficult for the firms to search the patent data base in the absence of efficient IT support. Also, as the characteristics of patent specification and patent data can be easily classified, a target-oriented search is enabled. In their conceptual work, Moehrle et al. [4] have developed a patent information process model structuring the variety tasks related to patent information management and highlighting for which patent management tasks IT tools could possibly be used. Our empirical investigation supports their model by finding that especially the authors' defined tasks related to searching and analyzing the search results (document query, content analysis, and visualization) are frequently supported by IT within our investigated firms. Moehrle et al. also propose the task "evaluation" for being supported by IT tools, which is in line with the above discussion on the increasing demand of IT tools for IP assessment.

Finally, organizational information requirements increase with complex environments, uncertainty, and interdependence of work processes [31, 32]. Our data supports earlier findings that these characteristics can be found at intellectual property management processes [50-52]. Growing IP portfolios, increasing emphasis on intellectual assets, and a high multidisciplinary have made IP management increasingly complex and the availability of technical and managerial information a major success factor. This trend is also supported by the findings from the case studies. For example, OC Oerlikon, which has the smallest portfolio of the sample firms with about 1'600 patents, uses IT support less than the other firms. For OC Oerlikon, the most important aspect for automation are administrative processes, while other firms with larger IP portfolios have extended the IT support for IP search, evaluation, and exploitation activities. In summary, these findings suggest a positive relation between firm size, IP portfolio size and the use of IT tools for IP management.

5.2. Firms' satisfaction and requirements of IT tools for IP management

The results on the user satisfaction of IT tools for IP management show that firms tend to prefer integrative IT tool systems instead of using many different tools. An integrative tool system offers the user several functionalities combined in one tool instead of working with different tools. Working with a range of different tools entails the risk of redundancies, i.e., that identical information must be entered separately in several tools or basic information analyses have to be conducted several times. Integrative IT tool systems potentially avoid such redundancies because all functionalities and analyses can be based on a central data base

containing all relevant information. In summary, the findings show that integrative IT tool systems provide more efficient support to firms' IP management than many single tools.

Different types of users and a broad spectrum of tasks inherent in IP management present important challenges for the development of IT tools for IP management [10]. Our findings reveal that customization to individual processes and firm characteristics is the most important requirement of an IT tool. Firms profit best from IT solutions for their IP management when they have the possibility to complement the basic standard functionalities according to their individual needs. This is also confirmed by the findings of the case studies which provide insights in how firms with large IP portfolios and established IP management structures integrate IT tools. In line with Daizadeh [53], the cases show that many firms have developed own IT solutions for their IP management instead of using commercial tools. Thus, because specific needs of the firms are often not met by commercial products, firms are willing to invest in own software development programs because they consider IT tools to improve their IP management processes.

6. Conclusion and future research potential

Firms are increasingly challenged by growing IP portfolios and have to adapt structures and processes to ensure efficient IP management. Towards this backdrop, IT may be a powerful tool to improve the effective management of IP. As the current user behavior shows, IT tools can significantly improve how IP data is managed and how information can be efficiently processed. The present paper provided insights into the use of IT tools in the entire IP management of firms by presenting the results of a worldwide survey. Three key findings can be derived from the results:

- Three major categories of IT tools for IP management were identified: search tools, administrative tools, and evaluation tools.
- The firms' use of IT tools decreases along the IP value chain: Firms most frequently use IT tools in the IP generation phase for searching activities. The IP evaluation and IP exploitation phases are less frequently supported through IT.
- Patents are the form of IP rights which are supported most by IT tools.

Based on the findings of this paper, several recommendation emerge. Besides patents, firms should also consider IT support for trademark and design management, e.g., by integrating trademark and industrial design data in the data base and search systems. This allows the firm to maintain a reliable overview of their entire IP portfolio and increases the efficiency of the overall IP management.

Furthermore, evaluation and valuation activities have gained increasing importance for firms in recent years. By supporting these activities through IT tools, firms can improve the reliability of their evaluation results. Using an IT tool for the assessment of the IP portfolio or for single IP rights implies that the data used for the evaluation and the proceeding of the evaluation is documented within the system. Hence, the tool ensures to trace back the evaluation activity and increases the validity of the results.

Also, with respect to the ongoing trend towards a more proactive IP management, firms should consider using IT tools to efficiently leverage their IP portfolios. A data base system, for example, can be used to structure the IP rights according to their current use and thus helps to identify patents for external commercialization.

Moreover, from our analysis of the various activities along the IP value chain, it seems that IP information is not only important for the firm's patent department but also for R&D (e.g., new technology and state of the art searches) and marketing or business development

functions (e.g., pricing considering the patent value, entering new markets through licensing). Hence, firms should consider that IT tools may facilitate the access to IP information which can then be used for improved strategy making.

Finally, it is worth noting that we addressed IP intensive firms worldwide regardless of industry sector or firm size. Thus, the investigation of the impact of industry, firm size, and geographical effects would enhance our understanding of contingency factors important for IP management. Furthermore, in the case studies we focused on those firms that already have implemented well-structured IP management processes. To extend and complement our findings, longitudinal studies on how firms starting to establish IP processes use IT solutions for their IP management would provide important insights in the success factors of IT tool support. Lastly, due to the fact that much less attention has been paid to phases two (assess) and three (exploit) of the IP value chain, a promising further research avenue would be to investigate the impact of using IT tools in these phases on the overall effectiveness of the firms' IP management as well as to analyze the role of different user types of these IT tools.

Acknowledgments

The authors wish to thank Marco Zeschky and the two anonymous reviewers for their valuable comments on earlier versions of the paper.

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Tables and Figures

Table 1: Overview of the case study firms.

<i>Firm</i>	<i>Industry</i>	<i>Turnover</i>	<i>Employees</i>	<i>IP portfolio</i>
Alcatel-Lucent	Telecommunication	16 billion EUR	78,000	27,600 patents
Henkel	Consumer goods	15.1 billion EUR	48,141	8,000 patents
IBM	Information technology	75.4 billion EUR	426,751	40,000 patents
Infineon	Semiconductors	3.3 billion EUR	25,216	17,700 patents
Kodak	Chemicals, Imaging	5.4 billion EUR	18,800	12,100 patents
OC Oerlikon	Mechanical engineering	2.9 billion EUR	16,657	1,600 patents
Schindler	Mechanical engineering	6.6 billion EUR	43,010	9,000 patents

Figure 1. The use of IT tools along the IP value chain.

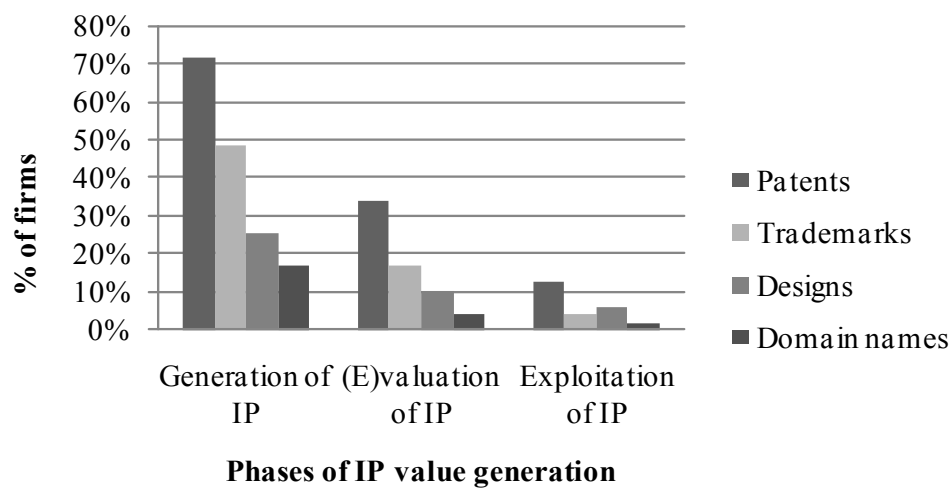


Figure 2. IT tools used by the surveyed firms.

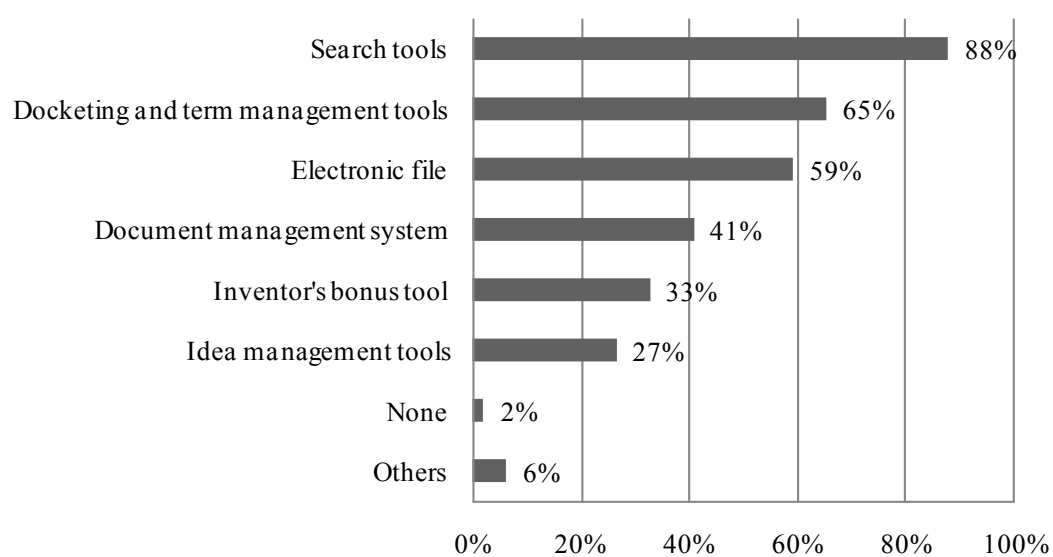


Figure 3. The use of IT tools for valuation and evaluation activities.

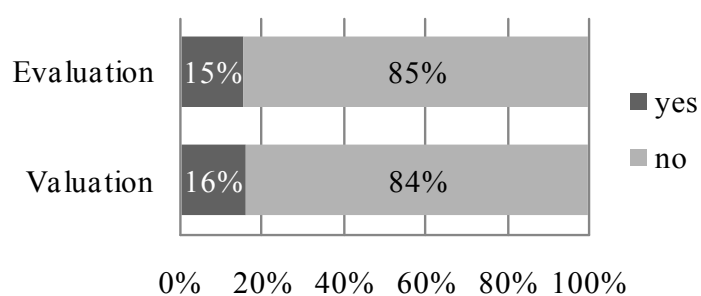


Figure 4. Satisfaction of firms with their IT tools for IP management.

