Centre for Technology Management working paper series
ISSN 2058-8887

No. 2019/09

August 2019

Integrating Patent Management and R&D. An explorative analysis of the new product development process

https://doi:10.17863/CAM.44063

Lilian Hardorp *
Cihat Cengiz
Dr Frank Tietze
Institute for Manufacturing

* Please contact the corresponding author for feedback:

l.hardorp@gmail.com

UNIVERSITY OF CAMBRIDGE

IfM Centre for Technology Management

Integrating Patent Management and R&D
–
An explorative analysis of the new product development process

Authors

Lilian Hardorp
+49(0)1722829793
l.hardorp@gmail.com

Cihat Cengiz
+44(0)7378597475
cc922@cam.ac.uk

Dr. Frank Tietze
+44(0)7711 500460
frank.tietze@eng.cam.ac.uk

Institute for Manufacturing
University of Cambridge
17 Charles Babbage Rd, Cambridge CB3 0FS, UK

Submitted on 31.05.2019

Abstract

Complex processes within firms require more than one department's input, and a functioning integration among the departments is crucial. This is true for the R&D and the patent department in research and development intensive manufacturing firms. Patent-related activities, such as securing freedom to operate, positively influence a new product's commercial success. However, low patent awareness among research and development (R&D) personnel and limited patenting resources lead to lacking guidance, risks, and missed opportunities.

This paper qualitatively explores how internal patent departments are integrated with R&D along the stages of the new product development process. Capturing triangulated experiences from both the patent management (PM) and R&D perspective within 12 manufacturing firms, the research demonstrates that the R&D and PM representatives localise their integration in the early stages of new product development (NPD), which appears to be especially beneficial at the scoping stage where ideas are mature, whilst no heavy development investments occurred yet. While facing heterogenous patent awareness among R&D employees that impedes the integration on a behavioural dimension, the firms successfully employ several mechanisms to improve the cross-functional integration between R&D and PM.

1. Introduction

The competitiveness and commercial success of a firm depend strongly on the knowledge it generates and acquires, and how it can profit from it (Carneiro 2000, P. 97; Sullivan 1999, P. 133). Firms make use of patents not only to protect ideas from imitation, but also to achieve a time-limited technological monopoly in a targeted field, and to create revenue (Sullivan 1999, P. 137). Patents are considered to provide the strongest legal protection of a firm's technologies and inventions among the intellectual property rights (IPR) and to have the most significant effect on the commercial performance of a firm (Rivette and Kline 2000, P. 56).

Patent-related activities, such as securing freedom to operate (FTO) to prevent infringements by third parties, have a positive influence on a new product's success (Ernst and Fischer 2014, P. 127) and the number of patents a firm creates (Somaya et al. 2007, P. 934). Therefore, the role of patents must be considered already throughout the development process of new products (Grindley and Teece 1997, P. 9). Yet there is little research on how these two processes interact: There is vast research focussing on how ideas become marketable products and increasing research about the importance of patents to the overall performance of a firm, and how intellectual property (IP) has evolved into a managerial issue (Chang et al. 2012, P. 136; Ernst 2001, P. 143). There is, however, is little research on how and when the NPD and PM processes interact. Only a few works are devoted to illustrating patents as an internal resource to an NPD process, which contains several stages where the consideration of patents and the involvement of the patent department is relevant. Knowledge diffusion, technology intelligence, and invention workshops at the stage of idea generation, for instance, are just the beginning of various patent-related activities that support the NPD process.

The timing of such activities and strategic patent decisions is important for firms to legally protect their products in an efficient way (Reitzig 2004, P. 37). Therefore, the mere existence of patent-related activities and expertise in managing patents in a firm is not enough to support new product success. NPD consists of numerous, complex activities, where PM is to be integrated economically and efficiently. Resources devoted to patenting activities are limited, which is particularly true for small or medium-sized firms (Graham et al. 2009, P. 1297; Rivette and Kline 2000, P. 59; Soranzo et al. 2017, P. 1102). Often, PM is hard to incorporate into the development of new products, as there are barriers between the two functions (Al-Aali and Teece 2013, P. 27; Somaya et al. 2007, P. 930), such as different departmental thought worlds (Dougherty 1992, P. 181). The management of patents and NPD are, however, highly interdependent. Yet a framework of a well-functioning integration of these two business areas is missing (Fisher and Oberholzer-Gee 2013, P. 158; Ernst and Fischer 2014, P. 129).

This paper's aim is to identify the contribution of PM to R&D-based NPD process stages by matching certain activities of PM with activities in NPD that require the support of PM. Further, a reasonable timing of PM practices during the R&D-based stages of the NPD process, as well as enabling mechanisms are identified. These goals are reflected in the research questions as follows:

How can PM activities efficiently support NPD activities along the stages in the NPD process? What mechanisms benefit the integration between PM and R&D along the NPD process?

The study reacts to recent calls of more research that goes in-depth into the practices of PM processes in firms (Di Minin and Faems 2013, 7; 12; Cesaroni and Piccaluga 2013, P. 153; Somaya 2012, P. 1102). With exploratory cases of R&D intensive manufacturing firms, a stage-gate based integration pattern of managing patents in the course of NPD is illuminated qualitatively, which contributes to closing the research gap in the academic literature (Di Minin and Faems 2013, P. 7; Candelin-Palmqvist et al. 2012, P. 508). In a second step, this integration pattern is used for identifying mechanisms that benefit the integration. A sampling of R&D intensive firms narrows down the scope towards firms with high R&D expenses (Directorate-General for Research and Innovation 2011, 107; 125) and high inventive activity as a result, which implies existing structures of PM (Duguet and Kabla 1998, P. 294).
The paper is structured as follows. It continues with a review of the relevant literature in section 2. In section 3, the qualitative research approach and description of the data collection process are presented. In section 4, the findings are reported with an emphasis on PM and NPD activity matches and the integration of PM along the stage-gate NPD process. Finally, future directions for PM research are discussed and managerial implications provided.

2. Literature review

Dealing with patents has become far more than a legal issue and is recognised as a managerial challenge within a business strategy (Smith and Hansen 2002, P. 372; Granstrand 2000, P. 1070). Especially technology-intensive firms require an effective PM system (Moehrle et al. 2017, P. 27) encompassing the planning, realisation, and control of patent-related strategies (Faix 1998, 80; 330; 343). The systematic management, organisation, and exploitation of IP in general have been summarised with the term *'IP management'* (MacCormack and Iansiti 2009, P. 248; Manzini et al. 2012, P. 119; Minagawa et al. 2007, P. 455). Sullivan describes it as *IP-related activities, decision processes, work processes and databases used for commercialising patented technologies or innovations, stressing that value extractions from patents are strategies that must be aligned with the overall corporate strategy (1999, P. 135–141).* For Granstrand, the managerial function of IP management is to "*formulate and execute strategies at corporate, technology, product and IP level"* (1999, P. 132). Focussing on patents only among IP, the *"generation, evaluation and exploitation of patents"* are differentiated within PM (Gassmann and Bader 2011, P. 26–27), and PM is considered to *"support technology management in the internal and external creation, storage and use of technology"* (Ernst 2003, P. 233–234).

In order to be effective, the PM needs to be integrated into other functions and departments. Cross-functional integration of departments within firms has been investigated by numerous academic studies. A general definition of cross-functional integration differentiates two general dimensions of integration, namely collaboration (collective goals, mutual understandings, informal activity, shared resources, common vision) and interaction (meetings, committees, phone calls, standard forms, reports) (Kahn 1996, P. 141). The integration of two entities may face barriers such as different departmental thought worlds (Lawrence and Lorsch 1967, P. 9) and conflicting goals (Di Minin and Faems 2013, P. 13), which also holds for R&D and PM (Gassmann and Bader 2011, P. 139; Jell et al. 2015, 182; 199). Ernst and Fischer 2014 is one of few works that investigated the positive impact of cross-functional integration between R&D and PM and are focussing on the NPD process (2014, P. 119). They found that the specific functional contributions of the patent department matter more than a collaborative attitude in the two departments does for the integration in the case of innovative products (2014, P. 128). The integration is found to be positively correlated with product success in terms of achieved turnover, profit objectives, expected market share, and whether it was an overall commercial success (2014, P. 130).

Nonetheless, the academic literature on the integration of PM and R&D is still scarce. Besides a positive impact of PM integration into R&D processes (Ernst and Fischer 2014, P. 119; Cesaroni and Piccaluga 2013, P. 143; Somaya et al. 2007, P. 922), it has been shown that the different phases of NPD processes incorporate different IP-related activities (Großmann et al. 2016, P. 321–322; Manzini and Lazzarotti 2016, P. 583; Soranzo et al. 2017, P. 1110–1111). Wagner and Wakemen find that the speed of commercialisation of a new product decreases with uncertainty regarding the patenting process, i.e. the scope and strength of patent protection, whether a patent will be granted, and what specification it will have eventually (2016, 1092; 1101). It is, however, referring to a sample of the pharmaceutical industry which usually has a small number of patents that end up being associated with a final product, whereas in other industries, products are more complex and comprise various patents.

The literature specifically investigated the PM integration in the stage-gate innovation process of Cooper (1990, P. 46). PM appears to be formally integrated and tied to the NPD process, and adding IP to existing patents in the company, for instance, is recommended to be done in the idea, scoping and business case stages by conducting FTO searches (Großmann et al. 2016, p.312). A good understanding of the existing patent landscape is recommended already for early NPD stages in order to file conceptually broader patents that increase the scope of protection (Ernst and Fischer 2014, P. 119; Soranzo et al. 2017, P. 1119). This way, R&D costs can be optimised as it prevents the costly modification of a product or component (Soranzo et al. 2017, P. 1119). Throughout the NPD process, external patent screening becomes more detailed in order to identify patentable assets of a product, while the inventory stock evolving from new patent applications continuously feeds into the process.

The existing literature on PM integration limit PM to patent filing processes and do not provide reasoning behind how NPD activities are tied to PM, and when exactly the two are supposed to interact. Works such as Tiefel and Dirschka (2008, P. 2–23) propose a number of interaction points between R&D and IP, starting with a strategy formulation right at the beginning, as all of the parties aim to secure a long-term success of the firm by identifying, creating and safeguarding potentially successful ideas (Tiefel and Dirschka 2008, P. 20). Another point of interaction they propose is the competitor analysis where, by means of the International Patent Classification (IPC), patent families and activities are observed. In this context, changes are observed by means of patent growth rates to discover technology strategy changes of the competitors (2008, P. 16–17). The next phase they recommend to come together at is where the R&D, innovation and PM are determining technology procurement and technology exploitation strategies (Ernst 2014, P. 46, 2017, P. 486).

The literature suggests a number of mechanisms to improve the integration: A good coordination between R&D, legal and marketing entities is needed (Cantrell 1996, P. 69; Tiefel and Dirschka 2008, P. 3) that enables PM and R&D integration on a strategic level, organisational, and on the operative level of the IP assets (Di Minin and Faems 2013, P. 12). At the same time, intermediate levels of cross-functional integration between R&D, legal, and business development activities are suggested to maintain the knowledge and focus of specialists and to simultaneously improve the coordination between them (Somaya et al. 2007, P. 930; Reitzig and Puranam 2009, P. 784). In the matter of PM, top management and cross-functional teams should be involved (Cesaroni and Piccaluga 2013, P. 143; Tiefel 2008, P. 15) as well as a responsible person for IPR who represents the IP management in the firm, and who creates an information network about IP (Tiefel and Dirschka 2008, P. 15–20). Another important mechanism is the raising of IP awareness and expertise in the firm (Ernst 2017, P. 486–488; Somaya et al. 2007, P. 931; Soranzo et al. 2017, P. 1119), which not only improves the collaboration, but also saves costs of outsourcing the management of IP to external patent lawyers and IP consultants. In addition, a shared patent database is recommended to avoid filtering of information between the different teams (Al-Aali and Teece 2013, P. 15).

The literature findings are manifold, but mostly limited to patent filing processes and do not provide explanations and reasoning behind this (Großmann et al. 2016, P. 322). The most relevant paper of Ernst and Fischer 2014 does not specifically elaborate at which points exactly or in association with which NPD activities patent functions are applied. They indicate rather generically that PM activities take place during the NPD process, or that they are supposed to take place at multiple milestones of the NPD project. Tiefel and Dirschka's interaction points do not present practical cases to prove whether they are indeed improving the development process of new products. Therefore, they are calling for more theoretical frameworks and empirical insights on how to design and optimize the proposed integration points (Tiefel and Dirschka 2008, P. 20), which is the aim of this qualitative study.

3. Methodology

Qualitative research

To understand how PM is integrated into NPD, an in-depth qualitative study based on primary data (interviews and workshops) is applied (Eisenhardt et al. 2016, P. 1121; Eisenhardt 1989, P. 533). 24 explorative semi-structured interviews and 2 interactive workshops were conducted via Skype, telephone or in person. Interviewees were guided through the R&D-based stages of the stage-gate innovation process by Cooper (1990, P. 52), namely *idea generation, scoping, business case and development.* The interviewers indicated where PM activities take place in their firms and why, and how they support NPD activities. When needed, the model was adapted to the NPD process model in place at the respective firm. This way, room for the interviewee was left to for them to not rigidly stick to the stage-gate model, but rather to explain, in which context of a certain NPD activity, such as for instance "brainstorming" or "prototyping", PM is taking place, and where they would allocate them along their individual NPD process model.

An interview guideline was supporting the conduction of the interview (please see Appendix B). Its semi-structured nature allowed to tie up on new aspects that have not been covered by the guideline.

Sampling

The 12 investigated firms are from manufacturing industries which are traditionally R&D-intensive (Directorate-General for Research and Innovation 2011, 107;125), which, in turn, is shown to be correlated with substantial patenting activities (Hall et al. 1986, P. 282). In particular, the sampling covered a range of different industries including the automotive, automation, chemical, electrical and wind energy industries, elevator and heating and cooling technologies, as well as manufacturing plants. All firms had dedicated internal PM employees. Manufacturing-based industries are exemplary for R&D intensive industries, namely industries with high R&D to sales ratio (Duguet and Kabla 1998, P. 295; Cohen et al. 2000, P. 5; Directorate-General for Research and Innovation 2011, P. 107). Therefore, the selected companies are likely to generate many inventions resulting in patents and are in need of a substantial, well-working PM (Griliches 1990, 1701-1702; 1673; Duguet and Kabla 1998, P. 294). By including several industries, an approach of diverse theoretical sampling is followed in order to recognise a pattern across industries and to increase the scope of the findings (Eisenhardt 1989, P. 537). Following the logic of polar sampling (Eisenhardt and Graebner 2007, P. 27), one firm was deliberately chosen for its low R&D-intensity to provide a

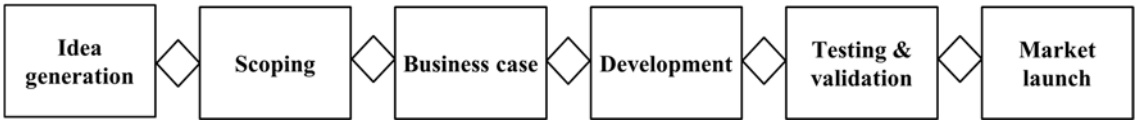
contrasting case to R&D-intensive firms for clear pattern recognition of central constructs. For triangulation of the results, data was collected both from NPD and PM representatives (please see Appendix A for all firms and interviewee profiles). The firm and interviewee names are anonymised and are referred to as PM representatives and NPD representatives of firm "A-J". The interviews were conducted in summer 2018 and took approximately 45 minutes each. The data collection stopped after the 27th interview (this is the overall number of participants including all participants of both the interviews and the two workshops), as a theoretical saturation in the data output was perceived (Fusch and Ness 2015, P. 1408). In two cases, it was possible to conduct workshops to gather data interactively from several firm representatives. One workshop was conducted virtually by means of the online workshop software 'Stormboard'[1] (please find the completed workshop template in Appendix C). The other workshop was conducted at the firm's headquarter.

Data collection

The interviewees received a simple graphic of the stage-gate innovation process one day in advance of the interview as a supportive document.

The stage-gate innovation process, displayed in Figure 1, argues that successful companies use formal processes with defined decision-making criteria and proposes a sequential model with defined stages and decision-making points (gates) (Cooper 1990, P. 52). It is one of the most prominent definitions of NPD (Solomon et al. 2008, P. 291), whose sequential logic has been improved and adopted in similar ways (Crawford and Di Benedetto 2015, P. 26; Ulrich and Eppinger 1995, P. 15; Urban and Hauser 1993, P. 38; Veryzer 1998, P. 317; Phillips et al. 1999, P. 290). .

Figure 1: Stage-gate innovation process



Source: Own representation (derived from Cooper (1990, P. 46))

The last two stages, "Technology & validation" and "Market launch" are neglected in this study, as they are considered to involve R&D to a lower degree, assuming that the product is developed in R&D at the fourth stage, the development stage (Cooper 1990, P. 49). The later works of Cooper briefly mention patent-related activities such as "patent and IP search" and "forward plans of IP" in the scoping and business case stage, but without any further elaboration,

[1] https://stormboard.com/

empirical foundation or justification about why the activities should happen at these stages (Cooper 2008, P. 231; Cooper et al. 2002, P. 27). A list of PM activities from the literature can be found in Appendix F, and a collection of reported NPD activities across the stages can be found in Appendix E.

Data analysis

An iterative approach of data analysis, data reduction, and coding guided the data collection (Miles and Huberman 1994, P. 12). The interviewees' names were anonymised[2] and transcribed before analysing the content. Following Miles and Huberman, deductive and inductive approaches are combined by creating a provisional start list of categories derived from existing concepts in the extant literature before entering the data collection, which was iteratively further developed and detailed as the data collection progresses (1994, P. 58). Hence a list of categories from the extant research had been created before the start of the data collection, which is a deductive way of analysis, whilst during the whole data analysis, data was explored inductively by open coding of new categories that are not included yet in the existing literature (Corbin and Strauss 2015, P. 101–103). In the case at hand, the literature-based categories used in the start list are listed below:

Table 1: Start list coding categories

Start list category	Literature
NPD activities (see list in Appendix F)	(see references in Appendix F)
Patent management activities (see list in Appendix G)	(see references in Appendix G)
Organisation of PM	(Gassmann und Bader 2011, P. 140)
Stage-gate innovation process	(Cooper 1990, P. 46)
Task-based integration (e.g. specific tasks, interaction points); Behavioural-based integration (e.g. collaboration, communication)	(Kahn 1996, P. 137)
Barriers to CFI	(Di Minin und Faems 2013, P. 13)
Conflicting goals	(Gassmann und Bader 2011, P. 139)
Departmental thought worlds	(Dougherty 1992, P. 181; Lawrence und Lorsch 1967, P. 9)

Transcripts were coded at different levels of analysis in categories and sub-categories using the software MaxQda and were iteratively revised throughout the collection of further data. The final coding scheme consisted of 3 reoccurring themes on 4 hierarchical code levels. Firms were first analysed individually and then across firms to identify similarities and patterns (Eisenhardt 1989, P. 544).

[2] The interviewees names were all changed to "NPD (PM) representative of firm XYZ"

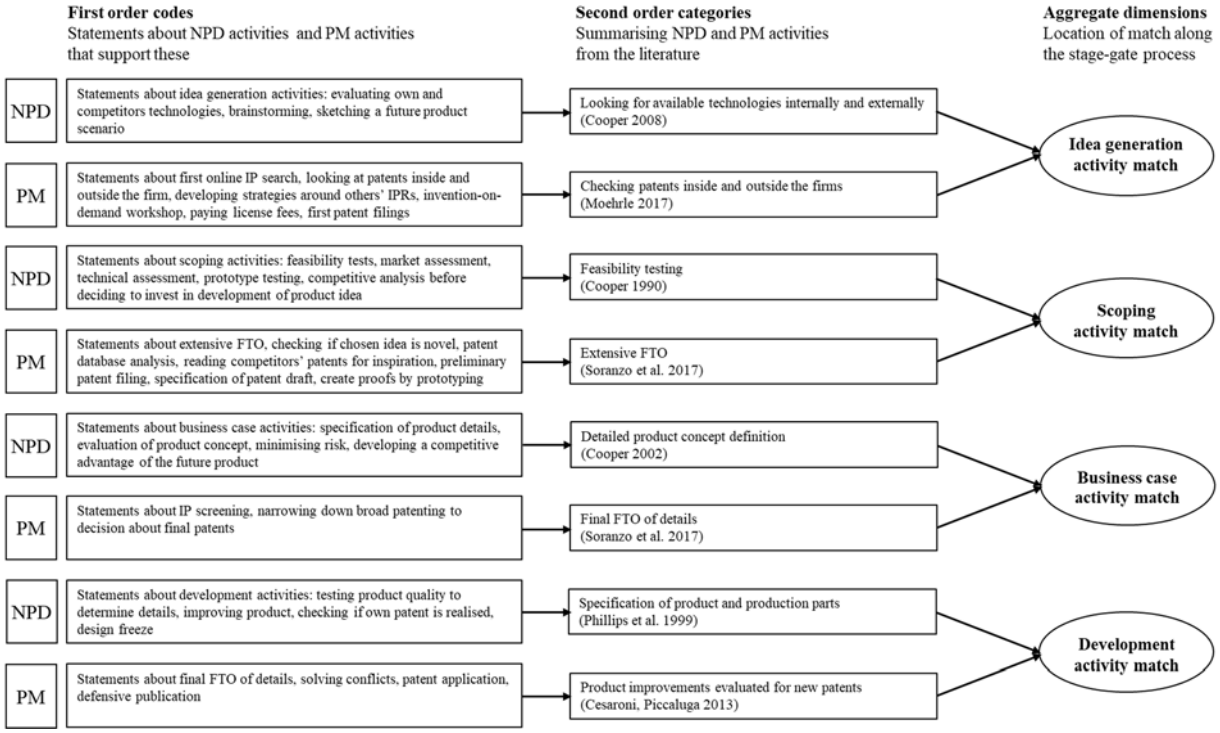
4. Results

Based on the interviews and workshops, in this section, the identified integration pattern is presented and described. Additionally, barriers and mechanisms associated with the integration are briefly presented.

The interviewees considered the timing of PM integration relevant:*(…) These workshops are only effective if they are really done at the right point of time, with the right people, with appropriate moderation (*PM representative, firm B). As stated in 3., the interviewees were asked to indicate where during the NPD stages PM is integrated, and for which reasons. Overall, they revealed that the PM activities support the NPD process at more than one stage throughout the process and emphasised that a continuous involvement into these stages is important. For instance, several iterations of checking FTO are needed, as the product concept gets more and more detailed. The patent representative of firm E, for instance, stated: *„That never stops. It does not even stop when the production of the product is finished, and the product is on the market. (…) So, at no time, the patent department is decoupled."* The patent representative of firm G1 said: *"Well, it is indeed something which accompanies us over the entire process. We think about it over and over again."*.

Along the continuous involvement the interviewees reported, the specific contributions to NPD on the part of the PM appear to differ. The following figure summarises the relationships of the analysed statements about the NPD-PM integration along stage-gate based NPD stages and the aggregate dimensions of the codes identified in the data analysis.

Figure 2: Coding scheme for the identification of NPD-PM matches



From the interviewees' statements, PM and NPD activities described in the academic literature were identified. When a PM activity supports an NPD activity, an "activity match" is revealed and located along the NPD stages. These activity pairs are displayed as the aggregate dimensions on the right side of the figure. In addition to the identification of PM activities taking place along NPD and how PM activities can support these NPD activities, the importance of these "matches" for NPD compared to other NPD-PM activity pairs is assessed:

Figure 3: Coding scheme for the identification of the importance of the NPD-PM matches

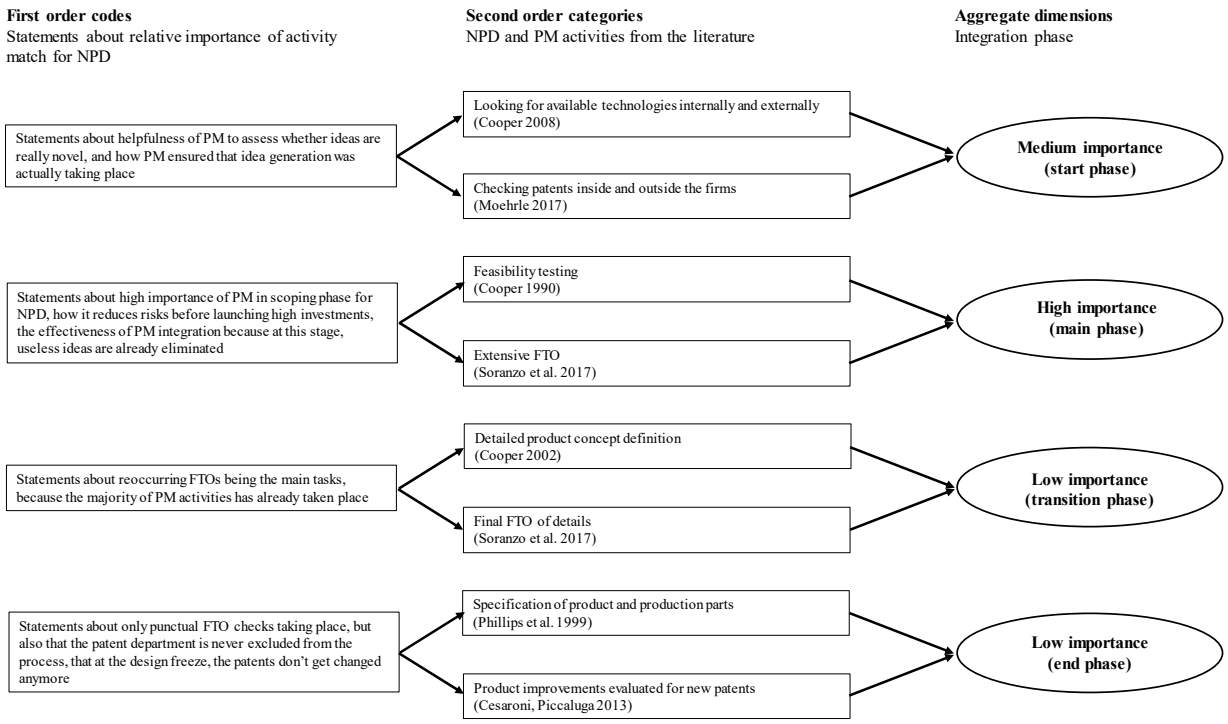
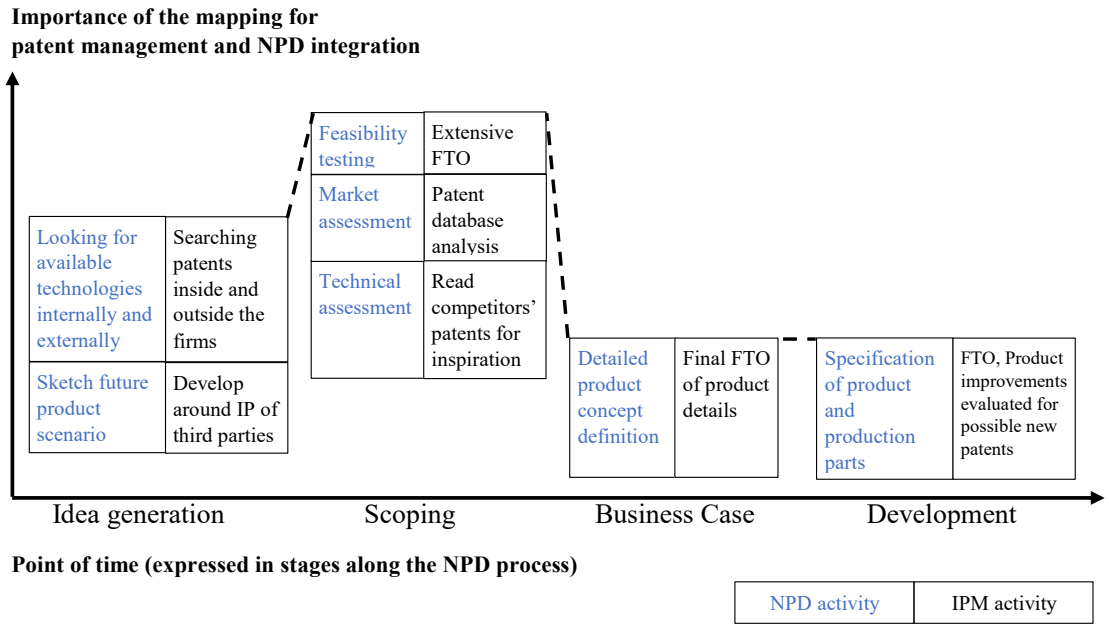


Figure 3 summarises the results by means of the degree of integration of PM in the four different stages as reported for the investigated firms. The table summarises the PM activities conducted at one stage at a specific firm, given that the activities were mentioned by at least one of the representatives of that firm. They further give an indicator of whether the integration is high or little. This differentiation was derived from the description and the words the interviewees used (e.g. "Scoping is a *very important* stage", or "We are usually *not much* involved in that."). Taking both the activity matches and their relative importance for NPD into account, the following relationship emerges:

Figure 4: Integration along the NPD stages



The graph indicates the importance of PM involvement throughout the NPD stages as defined by Cooper (1990, P. 46). PM support appears to be necessary for NPD from early stages onwards and is especially important at the scoping stage, where ideas are mature, whilst no heavy development investments have occurred yet. The interviewees did not only stress that PM directly supported certain NPD activities here, but that it was also the stage where the patent department was most active during the process. On a broad scale, more emphasis was put on early involvement than on late involvement of PM into NPD, which is expressed by the higher position on the y-axis of the activity pairs of the idea generation and scoping stages. In the later stages, the integration decreases, thus the boxes are placed lower. As indicated already in the second order categories in Figure 2, the displayed activity pairs are summaries of the connected NPD and PM activities taking place at the stages, which are described in more detail below for each of the stages:

Idea generation

This stage is a discovery stage where ideas for new products are generated and identified. Here, mostly research activities take place on the part of PM to support the NPD process in looking for available technologies by investigating own as well as competitors' patents. Patent managers consider it important to know, in the course of the further development, whether the ideas are indeed novel, and to sketch how a future product and its technologies could look like. When ideas pop up, workshops for inventors are organised to think about whether they are worth protecting, and whether the degree of innovativeness is high enough.

Being really open in the idea generation and not really looking into it. That's why I think it's not bad if the PM representative of firm I or generally someone from the IP management is not there, when we are just in the idea generation, but rather as gleaning, that really tests: Are the things we have there, is there anything to be considered, can we perhaps register it, or will we possibly hurt competitors?
(NPD representative, firm I)

The interviewees agreed that an integration from the beginning of the NPD process on is important. Some interviewees, however, pointed out that at this idea stage, the inventions are not precise enough for PM to start getting involved in the NPD process heavily. As an explanation, the PM representative of firm B referred to the maturity state of inventions at the idea generation stage, where inventors are just about to recognise a problem that has to be solved and do not yet a solution for it: *"So, the blue idea that falls from the sky. This is mostly, let's say, for ... not, not usable, for intellectual property, it is mostly unprecise, it is, say, in such a stage that (...) You can only register a patent if you have a solution for it. And not just a problem. "* Further, the actual part of generating ideas was not necessarily considered to require the presence of patent managers. In contrast, postponing the thought about possible IPRs of third parties can leave room to create an open atmosphere at the idea generation stage by leaving out possible restrictions of creativity imposed by the bureaucracy of patents.
Overall, a first integration is considered reasonable at this early stage of NPD. The next section about the scoping stage, however, will show that in this stage, the involvement is higher.

Scoping

In the scoping stage, the feasibility of the preliminary product concept is tested, and competitive and technical analyses are conducted. If there was any stage considered predominant by the interviewees in the integration of PM, it was the scoping stage. Here, the most promising inventions have already been selected among a pool of ideas, and the PM can now dedicate efforts to find out if these promising ideas already exist somewhere else. It is appropriate to do it at this stage, as here, projects are more feasible and more thought out. The requirements are clearer, and no large investments for a later roll-out of the development process have occurred. Therefore, a detailed and sound patent database analysis and FTO analysis supports the competitive analysis at this stage to ensure that investing in further costly developing activities such as prototyping and industrialisation are worth the effort and cost. At the scoping stage, technical and market analyses typically also take place. In this context, an analysis of the patent landscape inside and outside the firm provides inspiration by providing new thought-provoking impulses with detailed descriptions of how final concepts are shaped. Prototypes are also sometimes created at this stage and serve as proofs for the filing of the patents. Analysis tests

and drafts are other typical activities taking place at the scoping stage and they are supported by PM.

Scoping is so also a very important phase. If the company decides to do a particular project on a particular process or develop a particular product, we need to know if somebody else is doing it and that information we usually find out with patents. We call it a clearance search or a freedom to operate right at the scoping stage. Because if we go ahead and invest without knowing about the risks then, later on, we would be sued. So, we really need to be careful about that.
(Patent management representative, firm A)

But when it comes to scoping then you do technical feasibility studies, first tests. One tries to define the requirements more precisely. We work with first prototypes to prove things or with some pilot application, or demonstrators, where we do certain things to show that something principally works. And that's exactly when creative phases occur, and then also ideas that you write down, and then also file as a patent (…).
(NPD representative, firm H)

If you wanted me to choose one of the four steps, I would actually rather say the second one. So, in the selection and analysis of ideas, because ideally you have already excluded ideas where you don't have Freedom-to-Operate.
(NPD representative, firm I)

Business Case

In the business case stage, a final definition of the product typically occurs and the attractiveness of the final product concept on the respective market is screened and verified. In the cases where interviewees talked about PM integration in the context of this stage, the intensity of PM integration appears to be lower than in the previous scoping stage. Usually, an FTO check should be done by now, only exceptionally in some unclear cases, it is checked again. Therefore, a final and detailed FTO check is executed to ensure that infringements of third parties will be avoided with the, by now, more detailed product concept definition. While in the earlier stages, some broad patent filing occurs, here patenting on details in a product takes place to achieve a competitive advantage with a novel technical solution.

When it goes into the business case, we usually are not involved very much because we are already involved in scoping and we've done analysis and we've presented it to them. So, by that time they have a report for at least two to three different possibilities (…). So, while in the scoping stage they come to us with two, three, four, even five different possibilities and we perform analysis on all those different possibilities and give it to them and they can choose what they want for their business case and we usually are not involved in that.
(Patent management representative, firm A)

And then you look at the business case, make a detailed product concept, also know how high the development needs are and are there still development risks. (...) What is the complete business case of the project, is there a business case for the product? That is, cost estimation, price estimation, volume estimation on the market, these are the activities that run at this time. This, however, has relatively little to do with IP. Then, in this phase, there is really only a check to see if the product concept, what you actually have considered concretely, whether that is actually free of third-party rights. Then you do again a screening and then get a rating for the product concept again.
(NPD representative, firm H)

Development

As stated at the beginning of this chapter, the interviewees find a continuous integration beneficial that does not stop in the final stage of the development process of the product. When the development is more mature, a final FTO check is conducted to ensure that the final product is not infringing third parties; with regard to portfolio management, product managers check if the invention fits to the overall firm portfolio, as by this point of time, there is more information at hand about the potential clients and their interests. In the development stage, the manufacturing processes of the product production are laid out. With respect to PM, the FTO of a product is checked that is ready for series production.

Not much. Not much. At the development stage when they have finally come with the idea of a product they come to us for one final analysis for the freedom to operate because during the scoping stage the description or the definition was not very clear. But now it's for sure that this is how it's going to look like and they come back to us for analysis for doing the freedom to operate or the clearance analysis. (…) we are involved earlier in the development stage.
(Patent management representative, firm A)

So later, development, I see it more like industrialisation, so almost the market launch and there, as I said, for me both from the product side and the technology side, everything is already fixed with little scope to make any more changes (...).
(Patent management representative, firm I)

Usually, however, compared to the foregoing stages, the work of the PM is limited at this stage and the largest parts have been finished before, as there will be no more changes to the product once the series production starts. At this late stage of NPD, the PM only still monitors the series production process and checks for some new ideas that pop up while the product is being developed. Then again, additional patents can be filed that help to specify how the final production parts and the development process look like.

NPD-PM integration barriers and mechanisms

Besides the timing of the integration, the interviewees reported the barriers it is facing.

There is, for instance, generally low awareness among R&D personnel about patents. This causes several problems: As some inventors are not trained in patent and IP matters, they do

not know how and when it is relevant, and therefore when to approach the PM. Some R&D employees do not see the direct necessity of the department. This results in lacking alignment of inventive activities in R&D and PM activities. Different though worlds exist between the legal perspective of patent managers and the R&D perspective of the inventors. As a result, the inventors have difficulties to read patents, therefore are reluctant to read them and must be pushed by the patent department to fulfil patent-related tasks:

And, yes, where it was for some reason just very, very expensive and why they just all say suddenly: "True. IP is important. We never would have thought that." In all the areas, in which so far everything has always gone well until now, of course, this IP awareness just does not exist. And in these cases, I'm just very sure that many topics still pass us by, while we do not really know that they even exist.
(Patent management representative, firm G2)

I've been in NPD for 27 years now. It was getting strongly on my nerves when all the patent texts arrived., Back then I – How should I say that? There were more convenient tasks than that. From today's perspective, where I am on the other side, of course, I say:" That's the most important thing because our task is not to infringe third parties' IPRs. For this, you need certain knowledge, and there are colleagues in NPD, they see it this way, they have understood and comprehend it. Others have only understood, but they do not do anything for it, or relatively little, and then they come last minute.
(Patent management representative, firm I)

The interviewees further reported resource constraints in the form of budget restriction, limited staff in the patent department, as well as insufficient time capacity on the part of R&D staff to appropriately consider the meaning of PM and to integrate it into their work. These forms of resource constraints impose negative conditions for the integration of PM and NPD: "*We have to be careful to spend our money for IP in every year– which is not little - at the right place."*
(Patent representative, firm F)
In order to tackle these barriers, and to achieve the appropriate integration pattern described above, the firms developed several mechanisms. Broadly, many of the important mechanisms identified concern the organisational structure of PM. To improve the interaction, the investigated firms deploy a single patent software in the firm, and they split patent related tasks among the personnel appropriately. R&D personnel, can, for instance, perform basic patent related tasks such as a prior art search themselves, and thus relieve the often small and budgeted patent department.

The workshops are, on the one hand, embedded in the process that one encounters it in this very early phase, please from time to time, involve colleagues from the IP area. That's the one point. On the other hand, there are also regular training courses.
R&D representative, firm H

In order for them to develop the appropriate skills, it is therefore important to offer regular mandatory training and workshops about IP and patents in particular, and also to raise the

awareness and attractiveness of patents, for instance by giving IP awards for excellent inventions. Firm B, for example, organises a festive event, where the best invention is awarded a monetary prize, which has gained high popularity among the inventors. The patent representative of G further suggests that it is important that the R&D staff in leading positions have comprehensive IP skills and promotes high awareness in their team.

The employment of patent managers who previously worked in the R&D department of that firm who know the firm well was perceived to be another successful measure. Further, an allocation to the R&D department instead of the legal department is promoted, and that PM must be interdisciplinary, consisting of legal, management, and engineering staff:

I would say that if you look at the support in the various stages of this process from the IP side, then I firmly believe that it does not need just patent attorneys. (…) Especially local in the business units, people are needed who do IP management from the point of view of technology and development. And that should finally go hand in hand. That does not have to be someone who really puts a focus on legal issues. But who really knows in detail about the technologies, who is familiar with the competitors and knows enough about competitors, about a foreign portfolio, going beyond the rights of the competitor.
(NPD representative, firm C)

Polar case: Low R&D firm J

The patent output of firm J is substantially smaller than from all the other cases, as J has only just started to move from a pure secrecy strategy for IP into a strategy that deploys more active patenting. The data shows that there are misunderstandings and misalignments of activities between NPD and PM employees as a consequence of missing guidelines for a PM integration into NPD.

Nevertheless, despite the still immature implementation of PM, the process of deciding on patent protection, is comparable, and the intuition for an improved integration along the NPD stages aligns with data from firms where PM and NPD are highly integrated. From one interviewee of the NPD side, a very similar pattern with a focus on the scoping stage was suggested. She stressed that this was the starting point of forming teams, and more precise product decisions, which is why strong integration is needed: *I agree with you that this is an important stage for IP management, because this is where teams are formed. Here, they need to be more active than later (NPD representative, firm J).* Their PM management system is still immature and lacks a clear PM guideline to follow along NPD. Together with very low patent awareness, the integration faces various miscommunication between R&D and PM employees and an overburdened patent department (for a summary of the results for firm J please see Appendix D).

5. Discussion

Discussion & Implications

The interviewees acknowledged that PM is a field that is connected to several steps within the NPD process, and the interaction points suggested from theoretic literature (Tiefel and Dirschka 2008, P. 2–23) are extended by the empirically revealed activity matches. Ernst and Fischer (2014, P. 130) found that PM integration increases the NPD performance, as it ensures that the product has technical features that meet both the market demands as well as avoid infringements of other parties. The data showed that the NPD process is a substantial intersection between the R&D and the PM departments, and that these integration points are approached by the PM across the selected firms from different industries.

Based on the results, insights into the timing of PM activities along the NPD processes were acquired, showing that the collaboration is continuous, and that even at the development stage, there is a last final check of FTO before the product starts series production. As Ernst and Fischer (2014, P. 119), Großmann (2016, P. 316) and (Soranzo et al. 2017, P. 1119) suggest, however, early involvement of the PM appears to be heavier. In contrast to earlier papers, the study specified the timing narrowed down to certain activities within the NPD stages and identified the scoping stage as predominant. Timing appears to be indeed relevant. The idea generation stage is seen as a stage that should be open for any creative input without any creativity boundaries like the bureaucracy of patents can be (Friedman et al. 2003, P. 277), thus the integration is encouraged to be limited. The interviewees explained that the scoping stage, in contrast, is a good timing as promising ideas promising are selected at this point of time, and that the ideas are more mature than at the beginning of the NPD process. Further, it is early enough to change technical details to prevent infringement of third parties, before heavy production investments are undertaken.

When interviewee statements are analysed, their strengths and emphasis must be considered. Many statements about PM activities integrated into the NPD process do not give indications of how intense this integration is. What they consider as integration could, in an extreme case, just mean one email from PM to an R&D director, which is not representative for substantial integration. This drawback, however, is limited, as overall, a substantial amount of statements that indicated the intensity of integration have been found. In the cases a triangulation was possible, the PM and NPD perspective revealed nearly no contradictions between the two different representatives, which increases the quality of the results.

The precise time indication is useful to improve the integration, especially given that the firms often face a limited number of employees in PM. Hence there is a need for efficient

collaboration with them instead of expecting a continuous accompaniment of NPD on the part of PM. This also supports the view of Reitzig and Puranam (2009, P. 784), who encourage intermediate integration levels between the legal, management and R&D departments. A complex process as NPD involves numerous activities and takes place across many departments (Brown and Eisenhardt 1995, P. 366), which calls for useful directions about on which stage to set the focus in the collaboration between two specific departments.

The data provided information about the barriers the firms are facing in the integration, as well as mechanisms the firms suggest for improving the integration. The interviewed patent managers have strong knowledge about PM, and with respect to the positions that the R&D representative hold and the fact that they had a considerably strong knowledge about patents, their insights were highly valuable as well. The interviewees confirm what the previous literature suggests concerning appropriate mechanisms to respond to the reported barriers, and, moreover, provide holistic insights into the challenges of PM integration: many firms complain about lacking IP awareness resulting in sloppy engrossments and unsystematic organisation of invention disclosures and, consequently, high workloads for the few employees in the PM as they have to cover all of the upcoming patent-related activities. The fact that low IP skills cause "follow-up issues" becomes visible in the comparison of firms B and E: E has a large patent department compared to a very small department in firm B. While the R&D staff at E performs patent researches independently, in firm B, nearly all patent-related activities are forwarded to the patent department. The patent manager of B reports a very high workload, and they would need even more support on part of the R&D employees, given their small department size compared to firm E.

Ernst and Fischer (2014, P. 128) and Somaya et al. (2007, P. 930) find a counteracting relationship between innovativeness and PM integration into NPD and R&D respectively, which is an intriguing result: How should PM be integrated, and to what extent? Data from one interviewee indicate that the negative effect of integration may be due to the contrast of high innovation, including for instance open innovation activities, and the restriction and bureaucracy that is perceived in patenting. Hence employees may be likely to accept high levels of integration less than in the case of lower innovativeness levels, which is a relationship worth investigating for future research.

This study's research questions have been answered by the identification of an integration pattern for NPD and PM, and by providing applied mechanisms that accompany this integration. Even though the mechanisms and barriers reported by the interviewees are not new, the interviewees emphasize that they are a pre-condition that enables such an integration

pattern. Most importantly, combining awareness-raising mechanisms with a more cross-functional management of NPD process stages, PM and R&D can successfully be aligned along the stages of NPD.

Polar case: Low R&D firm J

The low R&D firm's PM is less mature than the other firms' PM. Generally, the employees of J reported that the integration of PM is problematic and faces a lot of challenges. First and foremost, their main measure to take is to create awareness among R&D personnel and managers and to establish a clear guideline to follow. Still, one interviewee intuitively suggested a focus on the scoping stage for the integration for a most efficient integration of the limited resources available for PM. The results, therefore, appear robust to the differences between the firms. Future research can take up on this and investigate potential differences across firms, especially when the preferred appropriability mechanisms are different.

Contributions of the study

Theoretical

This study contributes to the previous literature showing the positive impact of PM integration into R&D processes (Jell et al. 2015, P. 182; Ernst and Fischer 2014, P. 119; Cesaroni and Piccaluga 2013, P. 143), and that the different stage-gate phases of NPD processes incorporate different IP-related activities (Großmann et al. 2016, P. 321–322; Manzini and Lazzarotti 2016, P. 583; Soranzo et al. 2017, P. 1102). Starting with a list of PM activities and stage-gate based NPD activities, activity pairs were revealed that not only allocate PM activities along the NPD process stages but also indicate the direct connection and support of PM for NPD, this study provides an in-depth qualitative analysis where, unlike precedent studies, a detailed investigation of the timing and relevance of patenting activities was undertaken. This way, the scoping stage was identified as being particularly heavy on integration between the NPD and PM.

The sampling includes various firms across different manufacturing industries and therefore focusses on firms that conduct substantial patenting activities. Thus, implications are derived from relatively mature PM concepts and contribute towards enlarging the literature on R&D and IP management integration.

Practical/ Contextual

Besides its theoretical contribution to the research gap on NPD and PM integration, this study deducts managerial implications for the practice of this integration.

The stage-gate innovation process is often applied in practice, and the NPD activities that this study shows to be supported by PM take place across many different NPD processes. The integration of PM activities with NPD activities that the interviewees reported for every stage can be used by those in charge (e.g. the head of innovation or technology manager) as a guideline to structure PM processes along NPD. The findings are particularly useful for firms that have limited resources devoted to PM and hence a strong need for efficient PM integration in NPD.

Limitations and suggestions for further research

This study faces drawbacks that future research can take up. The data shows that PM is related to the process of NPD, as well as to incremental innovations, where new details of existing products must be protected with patents. Future research could, therefore, tie up on this study by analysing the integration of PM in different stages of other R&D processes, such as technology development, or by means of a differentiation between incremental and radical innovation processes. Further, there is a substantial reduction of comparability of the results due to different industries where different patenting strategies exist. The analysed data is taken from firms in different industries producing different products, which always demands differentiation when results are discussed with regard to comparability. Cohen et al. (2000, P. 21) have shown that product complexity is one reason for varying degrees of patenting activities within manufacturing firms. Therefore, a reasonable path for future research would be the analysis of best practice PM integration in one industry, where the cases follow highly similar patenting strategies.

From a methodological perspective, this study suffers from a bias of unknown unknowns: It is unknown, whether the interviewees held back important information they just did not want to share (Bourdieu 1977, P. 167; Drury et al. 2011, P. 22–23). In addition, in some firms, a triangulation capturing both the NPD and PM perspective could not be achieved, which results in a less balanced insight into the firm. Future research could focus on extending the number of triangulated case studies on the topic to obtain a more in-depth insight into the field. Further, the high satisfaction levels may indicate a self-selection of participants, where only those were interested in participating that are confident about the PM integration.[3]

[3] Patent managers were always approached first.

The high satisfaction level is an indication of well-functioning cases of IPM and R&D collaboration. Yet it remains a personal perception of the interviewees. The results of the study do not allow the conclusion that the IPM of the selected cases are the only existing best practices, and what a best practice of IPM and R&D integration implies. There is, in fact, no KPI that determines the performance of IPM, which would be an interesting research for the future.

Another limitation is that the stage-gate process biased the interviewees in their answers, by "framing" them to fit in PM activities in a pre-given process model, instead of asking them to locate the PM activities in any processes in their firm, which could be a direction for future research.

This study finds that the scoping stage is a very important stage for PM activities to take place. It would, therefore, be an interesting road for future research to extend this study with a larger sampling and by looking deeper into this stage to give more detailed managerial recommendations. Another limitation is that this study focuses exclusively on the management of patents within all IPRs. The patent department, however, is often strongly tied to the management of other IPRs within an IP department. Therefore, it would be interesting to conduct the study focussing on the other IPR rights such as trademarks or registered designs.

6. Conclusion

The foregoing analysis investigated the integration of two departments within a firm. It explored when this integration should occur, and how single activities from NPD can be supported by single activities of PM. The data provided in-depth insights into the NPD and PM integration across different industries, that revealed an efficient pattern for such integration. It is this pattern that can be applied in practice as a guideline for PM and NPD integration, and that enables an efficient use of often limited PM resources.

While the focus is on the integration pattern along the NPD stages, the revealed mechanisms and barriers show that the interdepartmental integration is not self-evident. Naturally, departments and connected goals push employees towards specialisation within their discipline. This leads to a division of the organisation into truncated departments. The case of R&D and PM is an example of departments that are, both rooted in R&D activities, highly interconnected, but drift apart in their priorities and perspectives. This complicates integration, as the employees have, firstly, to align tasks, and secondly, to overcome the differences between them. The study aims to address this by providing insights into how the integration between the patent and the R&D department can be achieved in an efficient way with the correct timing. It showed that there are barriers to face, but that these barriers are worth overcoming. Inventors need to closely collaborate with patent managers, as many do not know how the patent protection process works and therefore cannot protect their inventions. Patent managers, on the other side, need to approach inventors to understand the details in technologies that are to be patented. Complex processes like NPD are team tasks where different parties and activities depend on each other. The R&D and the patent functions are no exception to this, and their integration contributes substantially to the successful development of a new product.

References

Al-Aali, Abdulrahman Y.; Teece, David J. (2013): Towards the (strategic) management of intellectual property. Retrospective and prospective. In: *California Management Review* 55 (4), S. 15–30. DOI: 10.1525/cmr.2013.55.4.15.

Bourdieu, Pierre (1977): Outline of a theory of practice. 1. Aufl. Cambridge: Cambridge University Press.

Brown, Shona L.; Eisenhardt, Kathleen M. (1995): Product development. Past research present findings, and future directions. In: *Academy of Management Review* 20 (2), S. 343–378. DOI: 10.5465/amr.1995.9507312922.

Candelin-Palmqvist, Hanni; Sandberg, Birgitta; Mylly, Ulla-Maija (2012): Intellectual property rights in innovation management research. A review. In: *Technovation* 32 (9-10), S. 502–512. DOI: 10.1016/j.technovation.2012.01.005.

Cantrell, Robert (1996): Patent intelligence - information to compete before products are launched. In: *Competitive Intelligence Review* 7 (1), S. 65–69. DOI: 10.1002/cir.3880070113.

Carneiro, Alberto (2000): How does knowledge management influence innovation and competitiveness? In: *Journal of Knowledge Management* 4 (2), S. 87–98. DOI: 10.1108/13673270010372242.

Cesaroni, Fabrizio; Piccaluga, Andrea (2013): Operational challenges and ST's proposed solutions to improve collaboration between IP and R&D in innovation processes. In: *California Management Review* 55 (4), S. 143–156. DOI: 10.1525/cmr.2013.55.4.143.

Chang, Ke Chiun; Chen, Dar Zen; Huang, Mu Hsuan (2012): The relationships between the patent performance and corporation performance. In: *Journal of Informetrics* 6 (1), S. 131–139. DOI: 10.1016/j.joi.2011.09.001.

Cohen, Wesley; Nelson, Richard; Walsh, John (2000): Protecting their intellectual assets. Appropriability conditions and why U.S. manufacturing firms patent (or not). National Bureau of Economic Research. Cambridge, MA (No. w7552).

Cooper, Robert G. (1990): Stage-gate systems. A new tool for managing new products. In: *Business Horizons* 33 (3), S. 44–54. DOI: 10.1016/0007-6813(90)90040-I.

Cooper, Robert G. (2008): Perspective. The Stage-Gate ® Idea-to-Launch Process - Update, what's new, and NexGen systems. In: *Journal of Product Innovation Management* 25 (3), S. 213–232. DOI: 10.1111/j.1540-5885.2008.00296.x.

Cooper, Robert G.; Edgett, Scott J.; Kleinschmidt, Elko J. (2002): Optimizing the stage-gate process. What best-practice companies do. In: *Research Technology Management* 45 (5), S. 21–27. DOI: 10.1080/08956308.2002.11671518.

Cooper, Robert G.; Sommer, Anita Friis (2018): Agile - Stage-Gate for manufacturers. In: *Research Technology Management* 61 (2), S. 17–26. DOI: 10.1080/08956308.2018.1421380.

Corbin, Juliet M.; Strauss, Anselm L. (2015): Basics of qualitative research. Techniques and procedures for developing grounded theory. Fourth edition. Los Angeles, London, New Delhi, Singapore, Washington DC, Boston: SAGE.

Crawford, C. Merle; Di Benedetto, C. Anthony (2015): New products management. 11. ed. New York: McGraw-Hill Education.

Di Minin, Alberto; Faems, Dries (2013): Building appropriation advantage. An introduction to the special Issue on intellectual property management. In: *California Management Review* 55 (4), S. 7–14. DOI: 10.1525/cmr.2013.55.4.7.

Directorate-General for Research and Innovation (2011): Innovation Union competitiveness report 2011. Brussels: European Comission.

Dougherty, Deborah (1992): Interpretive barriers to successful product innovation in large firms. In: *Organization Science* 3 (2), S. 179–202. DOI: 10.1287/orsc.3.2.179.

Drury, R.; Homewood, K.; Randall, S. (2011): Less is more. The potential of qualitative approaches in conservation research. In: *Animal Conservation* 14 (1), S. 18–24. DOI: 10.1111/j.1469-1795.2010.00375.x.

Duguet, Emmanuel; Kabla, Isabelle (1998): Appropriation strategy and the motivations to use the patent system. An econometric analysis at the firm level in french manufacturing. In: *Annales d'Économie et de Statistique* (49/50), S. 289–327. DOI: 10.2307/20076119.

Eisenhardt, Kathleen M. (1989): Building theories from case study research. In: *Academy of Management Review* 14 (4), S. 532–550. DOI: 10.5465/amr.1989.4308385.

Eisenhardt, Kathleen M.; Graebner, Melissa E. (2007): Theory Building From Cases. Opportunities and challenges. In: *Academy of Management Journal* 50 (1), S. 25–32. DOI: 10.5465/amj.2007.24160888.

Eisenhardt, Kathleen M.; Graebner, Melissa E.; Sonenshein, Scott (2016): Grand challenges and inductive methods. Rigor without rigor mortis. In: *Academy of Management Journal* 59 (4), S. 1113–1123. DOI: 10.5465/amj.2016.4004.

Ernst, Holger (2001): Patent applications and subsequent changes of performance. Evidence from time-series cross-section analyses on the firm level. In: *World Patent Information* 30 (1), S. 143–157. DOI: 10.1016/S0048-7333(99)00098-0.

Ernst, Holger (2003): Patent information for strategic technology management. In: *World Patent Information* 25 (3), S. 233–242. DOI: 10.1016/S0172-2190(03)00077-2.

Ernst, Holger (2014): Die Patentabteilung als Motor des Technologiemanagements. Bestandsaufnahme und Ausblick. In: Carsten Schultz und Katharina Hölzle (Hg.): Motoren der Innovation. Wiesbaden: Springer Fachmedien Wiesbaden, S. 39–56.

Ernst, Holger (2017): Intellectual property as a management discipline. In: *Technology & Innovation* 19 (2), S. 481–492. DOI: 10.21300/19.2.2017.481.

Ernst, Holger; Fischer, Martin (2014): Integrating the R&D and patent functions. Implications for new product performance. In: *Journal of Product Innovation Management* 31 (4), S. 118–132. DOI: 10.1111/jpim.12196.

Faix, Axel (1998): Patente im strategischen Marketing. Sicherung der Wettbewerbsfähigkeit durch systematische Patentanalyse und Patentnutzung. Berlin: E. Schmidt.

Fisher, William W.; Oberholzer-Gee, Felix (2013): Strategic management of intellectual property. An integrated approach. In: *California Management Review* 55 (4), S. 157–183. DOI: 10.1525/cmr.2013.55.4.157.

Friedman, Ronald S.; Fishbach, Ayelet; Förster, Jens; Werth, Lioba (2003): Attentional priming effects on creativity. In: *Creativity Research Journal* 15 (2-3), S. 277–286. DOI: 10.1080/10400419.2003.9651420.

Fusch, Patricia; Ness, Lawrence (2015): Are we there yet? Data saturation in qualitative research. In: *The Qualitative Report* 20 (9), S. 1408–1416. Online verfügbar unter https://nsuworks.nova.edu/tqr/vol20/iss9/3.

Gassmann, Oliver; Bader, Martin A. (2011): Patentmanagement. Innovationen erfolgreich nutzen und schützen. 3. Aufl. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg. Online verfügbar unter http://dx.doi.org/10.1007/978-3-642-16605-1.

Graham, Stuart J. H.; Merges, Robert P.; Samuelson, Pamela; Sichelman, Ted M. (2009): High technology entrepreneurs and the patent system. Results of the 2008 Berkeley patent Survey. In: *Berkeley Technology Law Journal* 24 (4), S. 1255–1327. DOI: 10.2139/ssrn.1429049.

Granstrand, Ove (1999): The economics and management of intellectual property. Towards intellectual capitalism. Cheltenham: Edward Elgar Publishing Ltd.

Granstrand, Ove (2000): The shift towards intellectual capitalism. The role of infocom technologies. In: *Research Policy* 29 (9), S. 1061–1080. DOI: 10.1016/S0048-7333(99)00070-0.

Griliches, Zvi (1990): Patent statistics as economic indicators. A survey. In: *Journal of Economic Literature* 28 (4), S. 1661–1707.

Grindley, Peter C.; Teece, David J. (1997): Managing intellectual capital. Licensing and cross-licensing in semiconductors and electronics. In: *California Management Review* 39 (2), S. 8–41. DOI: 10.2307/41165885.

Großmann, Anne-Marie; Filipović, Ellen; Lazina, Luisa (2016): The strategic use of patents and standards for new product development knowledge transfer. In: *R&D Management* 46 (2), S. 312–325. DOI: 10.1111/radm.12193.

Hall, Bronwyn H.; Griliches, Zvi; Hausman, Jerry A. (1986): Patents and R and D. Is there a lag? In: *International Economic Review* 27 (2), S. 265–283.

Jell, Florian; Block, Joern H.; Henkel, Joachim; Spiegel, Frank; Zischka, Hans (2015): Cross-functional patent management in family firms. In: *Journal of Business Economics* 85 (2), S. 181–203. DOI: 10.1007/s11573-014-0732-6.

Kahn, Kenneth B. (1996): Interdepartmental integration. A definition with implications for product development performance. In: *Journal of Product Innovation Management* 13 (2), S. 137–151. DOI: 10.1016/0737-6782(95)00110-7.

Khurana, Anil; Rosenthal, Stephen R. (1998): Towards holistic "Front Ends" in new product development. In: *Journal of Product Innovation Management* 15 (1), S. 57–74. DOI: 10.1111/1540-5885.1510057.

Lawrence, Paul R.; Lorsch, Jay W. (1967): Organisation and environment. Managing differentiation and integration. 7. Aufl. Boston: Division of Research, Graduate School of Business Administration, Harvard University.

MacCormack, Alan; Iansiti, Marco (2009): Intellectual Property, Architecture, and the Management of Technological Transitions: Evidence from Microsoft Corporation. In: *J Product Innovation Man* 26 (3), S. 248–263. DOI: 10.1111/j.1540-5885.2009.00656.x.

Manzini, Raffaella; Lazzarotti, Valentina (2016): Intellectual property protection mechanisms in collaborative new product development. In: *R&D Management* 46 (S2), S. 579–595. DOI: 10.1111/radm.12126.

Manzini, Raffaella; Lazzarotti, Valentina; Pellegrini, Luisa (2012): IP and open innovation: theory and practice. In: *IJTMKT* 7 (2), S. 119–134. DOI: 10.1504/IJTMKT.2012.046903.

Miles, Matthew B.; Huberman, Alan M. (1994): Qualitative data analysis. An expanded sourcebook. 2. ed. Thousand Oaks: SAGE Publications.

Minagawa, Tetsuya; Trott, Paul; Hoecht, Andreas (2007): Counterfeit, imitation, reverse engineering and learning: reflections from Chinese manufacturing firms. In: *R&D Management* 37 (5), S. 455–467. DOI: 10.1111/j.1467-9310.2007.00488.x.

Moehrle, Martin G.; Walter, Lothar; Wustmans, Michael (2017): Designing the 7D patent management maturity model. A capability-based approach. In: *World Patent Information* 50, S. 27–33. DOI: 10.1016/j.wpi.2017.08.003.

Phillips, Rachel; Neailey, Kevin; Broughton, Trevor (1999): A comparative study of six stage-gate approaches to product development. In: *Integrated Manufacturing Systems* 10 (5), S. 289–297. DOI: 10.1108/09576069910371106.

Reitzig, Markus (2004): Strategic management of intellectual property. In: *MIT Sloan Management Review* 45 (3), 35-40.

Reitzig, Markus; Puranam, Phanish (2009): Value appropriation as an organisational capability. The case of IP protection through patents. In: *Strategic Management Journal* 30 (7), S. 765–789. DOI: 10.1002/smj.761.

Rivette, Kevin G.; Kline, David (2000): Discovering new value in intellectual property. In: *Harvard Business Review* 78 (1), S. 54–66.

Smith, Michele; Hansen, Frederick (2002): Managing intellectual property. A strategic point of view. In: *Journal of Intellectual Capital* 3 (4), S. 366–374. DOI: 10.1108/14691930210448305.

Solomon, George; Barringer, Bruce B.; Gresock, Amy R. (2008): Formalizing the front-end of the entrepreneurial process using the stage-gate model as a guide. In: *Journal of Small Business and Enterprise Development* 15 (2), S. 289–303. DOI: 10.1108/14626000810871682.

Somaya, Deepak (2012): Patent strategy and management. An integrative review and research agenda. In: *Journal of Management* 38 (4), S. 1084–1114. DOI: 10.1177/0149206312444447.

Somaya, Deepak; Williamson, Ian O.; Zhang, Xiaomeng (2007): Combining patent law expertise with R&D for patenting performance 18 (6), S. 922–937. DOI: 10.1287/orsc.1070.0292.

Soranzo, Benedetta; Nosella, Anna; Filippini, Roberto (2017): Redesigning patent management process. An action research study. In: *Management Decision* 55 (6), S. 1100–1121. DOI: 10.1108/MD-04-2016-0226.

Sullivan, Patrick H. (1999): Profiting from intellectual capital. In: *Journal of Knowledge Management* 3 (2), S. 132–143. DOI: 10.1108/13673279910275585.

Tiefel, Thomas (Hg.) (2008): Gewerbliche Schutzrechte im Innovationsprozess. 1. Aufl. Wiesbaden: Deutscher Universitäts-Verlag, GWV Fachverlage GmbH.

Tiefel, Thomas; Dirschka, Felix (2008): FuE-, Innovations- und Patentmanagement - Eine Schnittstellenbestimmung. In: Thomas Tiefel (Hg.): Gewerbliche Schutzrechte im

Innovationsprozess. 1. Aufl. Wiesbaden: Deutscher Universitäts-Verlag, GWV Fachverlage GmbH, S. 1–23.

Ulrich, Karl T.; Eppinger, Steven D. (1995): Product design and development. New York: McGraw-Hill.

Urban, Glen L.; Hauser, John R. (1993): Design and marketing of new products. 2. Aufl. Englewood Cliffs: Prentice-Hall.

Veryzer, Robert W. (1998): Discontinuous innovation and the new product development process. In: *Journal of Product Innovation Management* 15 (4), S. 304–321. DOI: 10.1111/1540-5885.1540304.

Wagner, Stefan; Wakeman, Simon (2016): What do patent-based measures tell us about product commercialization? Evidence from the pharmaceutical industry. In: *Research Policy* 45 (5), S. 1091–1102. DOI: 10.1016/j.respol.2016.02.006.

Appendices

A. Firm and interviewee profiles

Table 2: Firm and interviewee profiles

Firm code	Number of employees	Industry	Interviewee position PM	Interviewee position NPD
A	> 10,000	Chemicals	IP manager	-
B	> 20,000	Automation	Head of IP	Head of Development of a product group
C	> 40,000	Electrical	Vice President IP	Manager Innovation Scouting
D	> 70,000	Automotive supply*	1. Corporate IP department 2. IP manager aftermarket and services	1. Innovation Manager of a product group 2. Innovation Manager of a product group
E	> 90,000	Automotive supply	Vice president IP of a business unit	-
F	> 3,000	Wind energy	Head of IP	-
G1[4]	> 20,000	Manufacturing plants	1. Head of IP Strategy / IP Research 2. Head of IP & Services[5]	Head of R&D of a business unit
G2	> 40,000	Elevator technologies	1. Head of IP Strategy / IP Research 2. Head of IP & Services	Head of Research
G3	> 4,000	Automotive supply	1. Head of IP Strategy / IP Research/ 2. Head of IP & Services	Head of R&D of a business unit
H	> 10,000	Heating and cooling technologies	Patentassessor	1. Director Product Management 2. Director Group R&D of a product group
I	> 10,000	Heating and cooling technologies	IP Manager	Requirements engineer/ CTO assistant
J	> 5,000	Explosives*	1. IP manager 2. IP analyst 3. IP analyst	1. Technology manager 2. R&D manager 3. R&D manager

*In firm D and firm J, workshops on top of single interviews were conducted. The cells show all the workshop participants and interviewees together.

B. Interview guideline

Patent management (R&D) perspective

Metadata firm

• Size of patent department

• What patent management activities are outsourced?

• NPD cycle (years)

Metadata interviewee

• Position, responsibilities

[4] Firm G is a conglomerate with different independent business units with their own profit centre and management acting in different manufacturing industries but with one central global IP department. Thus the three firms all provided the same persons from the PM side for the interviews.

• Years of employment at this company, previous roles in this company

Part I: Timing of patent management activities

• Can you describe the NPD process at your firm? For instance, for a recent standard product?

• Do you have a patenting process framework? If so, do you have a graphic showing the steps?

Walk through the NPD phases:

• Linking patent management and product development activities: What patent management tasks do you do here? Why here?

• What is your goal of integration? Faster patenting process? More patents? Better patents? Efficiency?

• NPD activities are just examples, there might be others where patent management is applied

Short description of activities these stages are defined to include by the literature

Idea generation: Brainstorming, idea generation and evaluation

Scoping: Preliminary tests, market, and technical analyses, designs

Business case: Product definition

Development: Product design and development

Part II: Patent department and R&D collaboration

Training

• What kind of training/workshop do you conduct for the R&D (patent) department? Are you getting any training from the R&D (patent) department?

• Overall, how do you rate the collaboration between the patent department and the R&D at your company? Is patent management well integrated? Compared to the integration with other departments within your company or your competitors?

Communication

• How do you communicate with the R&D (patent) department?

• Are there shared databases between the patent and the R&D department?

• Did you ever get infringement information from R&D (the patent department)?

• Do you monitor the process/result from the R&D (patent) department/processes?

Interaction

• Is the patent integration leaned on the structure of the NPD process?

• Do you have milestone meetings with R&D (the patent management)?

• Is your interaction with R&D (the patent department) based on a regular schedule?

• Do you have joint meetings with each other to share knowledge?

C. Template of virtual post-it session with firm D

In one case, the interviewees had enough time capacities to conduct a virtual workshop by means of a workshop software and Skype instead of an interview. This opportunity was seized, as a graphical support has been shown to be particularly suitable for the timing assessment of NPD and PM activities. An interactive post-it session replaced Part I of the interview guideline, and Part II and III were conducted after the interactive session. With two R&D representatives and one Corporate IP manager of firm D, the stage-gate innovation process by Cooper was again used (1990, P. 46) as a guide to allocate the integration at certain stages and activities along the NPD process. The participants were to assess their NPD processes with regard to the timing of PM tasks to find out, how and when they are used to support the NPD process (Reitzig 2004, 37). The preparation of the workshop consisted of the collection of NPD tasks reported in the reviewed NPD literature in order to find out how NPD can be supported with PM tasks not only on a stage, but also on a more detailed activity-based level. The software "Stormboard" was used where the participants put virtual post-its to the different stages along the NPD process. In a first step, the participants had to place yellow post-its to indicate the timing of NPD activities from the literature along the stages. In a second step, pink post-its were placed to indicate the timing of the PM activities, either only on a stage level, or also more detailed in connection with specific NPD tasks. Lastly, the participants were asked to place green post-its indicating PM activities that the participant found potentially beneficial to support the NPD process at a certain NPD activity or on a certain stage. The template of the workshop with firm D can be found below:

Figure 5: Blank virtual workshop template

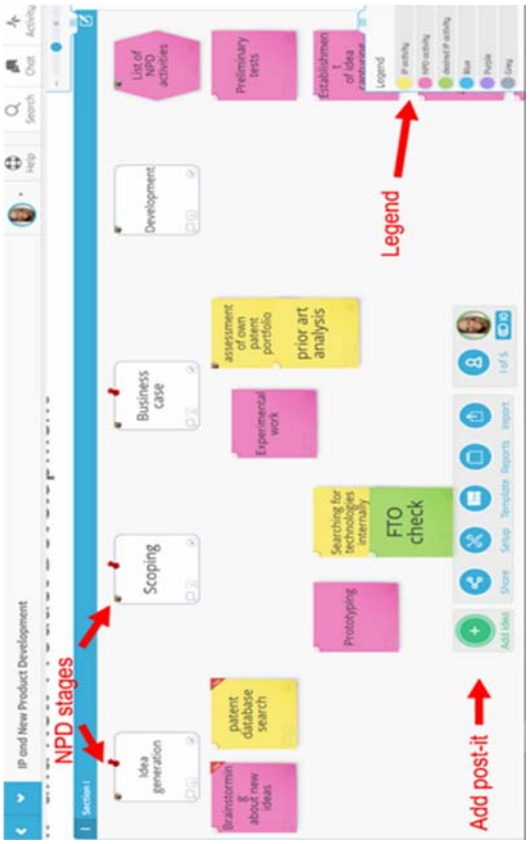


Figure 6: Virtual workshop template with firm D

D. Low R&D firm J

Results a) The case of IP management @ J

IP is perceived as an "add-on topic" and receives insufficient awareness

- Low awareness about the importance of IP protection and how IP protection processes work
- There is an award for the most innovative IP, but it's not perceived attractive by inventors

The biggest issue is the lack of a clear procedure of IPM

- Missing guidelines about the correct procedure of IPM along NPD processes (including gate decisions) lead to high insecurity among R&D personnel
- No clear process description for developing a new product
- No clear information flow to all concerned parties due to incomplete communication via both the management and the corporate IP software
- Low awareness and a missing guideline combined lead to last minute tackling of IPM because inventors and engineers from R&D don't know what to do

R&D managers need to support the IP team by emphasizing IP more to their personnel

- All interviewees and workshop participants are highly valuing the IPM manager's work whilst still seeing substantial need for change for IPM integration into NPD processes
- Proactive approaching on IP topics and the IPM team is needed instead of the current reactive collaboration behaviour of R&D personnel
- IP skilled R&D could take on basic IP tasks and thus relieve the overloaded IPM team

Results b) Benchmarking J's IPM with the other cases: the biggest differences

Table 3: Differences between low R&D firm J and other cases

Area	Other cases	J
Reported satisfaction level	No severe problems reported, mostly successful collaboration	Low satisfaction on both the NPD and IPM side
Maturity	Clear guidelines established	Lack of clear IPM roadmap and NPD process based on stages and gates
IP awareness	Low for many R&D employees	Very low, strong negative connotation (behaviours) → demotivation
IP protection rights used	Most activity on patenting, almost no trade secrets	Patenting activities on the rise, traditionally focus on trade secrets

E. Stage-gate based NPD activities

Table 4: Stage-gate based NPD activities

Stage	NPD*	Source
0: Idea generation	Establishment of idea capturing system	(Cooper et al. 2002, P. 22)
	Brainstorming	(Solomon et al. 2008, P. 296)
	Sketching scenarios of future product	(Cooper et al. 2002, P. 24)
	Looking for available technologies internally and externally (inventors, start-ups, partners)	(Cooper 2008, P. 231)
	Idea evaluation	(Cooper et al. 2002, P. 22)
1: Scoping	Market assessment	(Cooper 1990, P. 47)
	Technical assessment	(Cooper 1990, P. 47)
	Resource gaps identification	(Cooper et al. 2002, P. 27)
	Feasibility testing	(Cooper 1990, P. 52)
	Conceptual design	(Phillips et al. 1999, P. 292)
	Product definition	(Solomon et al. 2008, P. 293)
2: Business Case	Competitive analysis	(Cooper 1990, P. 47)
	Design configuration	(Cooper and Sommer 2018, P. 19)
	Manufacturing process assessment	(Cooper et al. 2002, P. 27)
	Defining commercial product possibilities	(Cooper et al. 2002, P. 27)
	*Alignment with existing business and technology plans***	(Khurana and Rosenthal 1998, P. 60)
3: Development	*Resource allocation planning*	(Khurana and Rosenthal 1998, P. 58)
	Specification of geometry, materials, process plans and production parts	(Phillips et al. 1999, P. 292)
	Lay-out manufacturing process	(Solomon et al. 2008, P. 293)
	Prototyping	(Solomon et al. 2008, P. 293)

Source: Own representation

* Please note: this is an exemplary list of NPD activities that were found in the academic literature. In practice, firm may name them differently.

***No indication about location or timing in literature; all other listed activities are allocated to the stages in the first column by the cited literature.*

F. PM activities

Table 5: PM activities from the literature

PM activity	Source
IP search	Cooper 2002
analysis of own patent portfolio	Moehrle 2017
quantitative and qualitative analysis of patents	Moehrle 2017
prior-art analysis	Soranzo et al. 2017
freedom-to-operate analysis	Soranzo et al. 2017
detailed idea proposal and invention disclosure	Cesaroni, Piccaluga 2013
invention notification to the IP department	Soranzo et al. 2017
invention evaluation	Cesaroni, Piccaluga 2013
filing of provisional patents	Cesaroni, Piccaluga 2013
IP training for R&D staff	Soranzo et al. 2017
consulting of R&D personnel by IP department	Soranzo et al. 2017
detailed IP assessment (legal, Patent, copyright)	Cooper 1990
development of technology protection strategy	Cooper 2002
solution of legal/patent/copyright issues	Cooper 1990
preparation of patent application	Moehrle 2017
draft of patent application	Cesaroni, Piccaluga 2013
review of patent application	Cesaroni, Piccaluga 2013
Patent filing	Cesaroni, Piccaluga 2013
patent referee consulting with other managers	Soranzo et al. 2017