

Product Development in the Wood Industry

- Breaking Gresham's Law

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Abstract

It is common advice from strategy consultants that companies in the wood industry should increase their rate of innovation in order to survive global competition. Neither consultants nor academics, however, provide much advice on how this is to be achieved. For example, what resources are crucial for product innovation to take place and are current organizational structures suitable for development work?

In this study, the product development processes of companies in this industry were examined. Product development was defined as the span of activities leading to products that are new to the firm, but not necessarily new to the market. The study combined the resource-based view of the firm and the organizational capabilities approach with innovation management theory. Thematic coding was used to analyze the comprehensive information obtained from semi-structured interviews with 19 product development experts in the industry. In addition, binary logistic regression, factor analysis and multiple regression analysis were used to analyze data obtained from structured interviews with 110 strategic business unit (SBU) managers in the industry.

The product development processes in the investigated firms were informal and flexible, with an approach that emphasized testing and feedback procedures. The occurrence of recent product development projects among the investigated SBUs was positively influenced by the educational level among white-collar workers in these SBUs. Furthermore, the perceived level of success in product development projects in these SBUs was positively influenced by well-defined project targets and strong project leadership. The influence of customer involvement on project success, however, was more complex than expected – a finding that calls for further research on this topic. Finally, resource constraints, high pressure from daily operative work, and the ensuing difficulty of prioritizing development work were the most important perceived barriers to product development in this industry. Thus, promoting long-term innovative work in an environment focused on short-term management of operations is a true challenge for wood industry managers.

Keywords: forest sector, wood industry, sawmilling, innovation, product development, strategic management, organization science, resource-based view

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“Jägmästare är som potatis. Man kan ha dem till allt.”

Jan-Erik Hällgren, Dean of the Faculty of Forestry, SLU.

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List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

- I Stendahl, M., Roos, A. & Hugosson, M. (2007) Product development in the Swedish and Finnish sawmilling industry – a qualitative study of managerial perceptions. *Journal of Forest Products Business Research*. [online] 4: 1-24. Available from: <http://www.forestprod.org/jfpbr-online.html>
- II Stendahl, M. & Roos, A. (2008) Antecedents and barriers to product innovation – a comparison between innovating and non-innovating strategic business units in the wood industry. *Silva Fennica* 42(4): 659–681.
- III Stendahl, M. (submitted manuscript) Management of product development projects in the wood industry.

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The contribution of Matti Stendahl to the papers included in this thesis was as follows:

- I In paper I, Stendahl was responsible for design and implementation of the study and was the main author of the paper. Roos assisted throughout the study, especially in data analysis and review of earlier versions of the paper. Hugosson reviewed the emerging manuscript and contributed with valuable suggestions on the contents.
- II In paper II, Stendahl was responsible for design and implementation of the study and was the main author of the paper. Roos assisted throughout the study, and was responsible for a part of the data analysis and accompanying writing of results.
- III In paper III, Stendahl was responsible for design and implementation of the study and was the main author of the paper.

1 Background and purpose of the study

1.1 'Talk of the trade'

“Unfortunately, I must say that there has been very little product development in the industry. [...] Much more product development and design is needed in the companies to meet the demand of customers” (Lars-Göran Sandberg, CEO Timwood AB, cited in IVA Aktuell No. 2, 2003).

“A brave, new world of products” (Lennart Wilhelmsson, development director SCA Timber AB, cited in SCA Timber News No. 1, 2005)

“Swedish forestry and forest industry are at the forefront. This has served the country well so far. To keep the lead, the way forward for the Swedish forest sector is a development towards products with more added value and identification of new business opportunities based on the forest as a resource.” (Marie S. Arwidson, CEO Swedish Forest Industries Federation, cited in a press release from NRA-Sweden 20 Nov. 2006).

1.2 Short introduction to the topic of the study – and why it was chosen

This is a study of innovation, or, more precisely, of product development, in the Swedish and Finnish wood industry. My interest in this topic is primarily based on two factors: First, my four years as a sales representative at SCA Timber AB (from 2000 to 2004) provided me with plenty of practical experience with product development in the wood industry context. I encountered challenges connected to business strategy as well as to the organization of development work that triggered in me a personal interest in

innovation management. Secondly, as will be further explained in section 1.3, innovation and product development form a contemporary ‘hot topic’ among practitioners in the Nordic wood industry. It is common advice from strategy consultants that companies in this industry should increase their rate of innovation in order to survive global competition. Consultants and academics, however, provide little advice on how this is to be achieved. For example, what resources are crucial for innovation and are current organizational structures suitable for development work? Based on this connection to, and interest in, industry practice, a special driving force throughout this project has been to produce knowledge that could be valuable for industry practitioners.

To begin with, what is innovation and product development? In addition, what types of companies constitute the Swedish and Finnish wood industry? A classic definition of innovation is that it is comprised of the generation, acceptance, and implementation of new ideas, processes, products, or services (Thompson, 1967). In this study, the definition found in the Oslo Manual is used (OECD/Eurostat, 2005): a *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment, and/or software. A *marketing innovation* is the implementation of a new marketing method involving significant changes in product design or packaging, placement, promotion or pricing. An *organizational innovation* is the implementation of a new organizational method in the firm’s business practices, workplace organization, or external relations. In this study, product innovation is in focus and *product development* is used as a term for the span of activities leading to, or that are intended to lead to, product innovations (OECD/Eurostat, 2005). A *product* is defined in this study as a good or a combination of a good and service, that is to say, innovations in services alone were not included.

Product development includes many different activities. According to Trott (2005, p. 15), however, most scholars agree that the innovation process consists of the following basic phases:

theoretical conception + technical invention + commercial exploitation

Theoretical conception is the stage where an idea is born and formulated conceptually. Technical invention occurs when the concept is converted into a tangible new artifact (e.g., a good, a service, or a process) with the help of science and technology. Commercial exploitation is when the new artifact is adapted to fit the need of users and introduced to the market (ibid.). This conception also marks the difference between invention and innovation clearly – invention is a necessary but not sufficient part of the innovation process.

The definition of innovation includes the concept of newness. Newness is, however, a relative quality. In this study, the requirement for an idea, process, or product to be considered new, and thus qualify as an innovation, is that it be new or significantly improved with respect to its characteristics or intended uses in the eye of the beholder. In this study, the focus is on companies and business units, which implies that innovations are ideas, processes, products, or services that are new to the participating companies or business units. This relative view on what qualifies as an innovation is conventional in European studies of innovation, for example the Community Innovation Survey (CIS) (OECD/Eurostat, 2005).

The term *wood industry* is used in this thesis as a label for companies with their main activities in sawmilling (SNI 20101/TOL 20100), planing (SNI 20102/TOL 20100) and preservative treatment of wood, that is, wood impregnation (SNI 20103/TOL 20100)^{1,2}. The wood industry is a part of the wood products chain in the forest-based sector. According to FTP, (the European forest-based technology platform), the forest-based sector accounts for 8% of manufacturing added value in the European Union (EU) and provides between three and four million industrial jobs (CEI-Bois et al., 2008). Forests play a number of significant roles in European society. In addition to the production of versatile and renewable materials, forests provide a range of ecosystem services that meet important needs in society. The sector's activities can be categorized in five major value chains (ibid.):

- the paper chain

¹ SNI (Sweden) and TOL (Finland) are the industry classification systems used by government statistics bureaus in the two countries. The classification systems are based on the European standard NACE. In this thesis, the 2002 versions of SNI and TOL are used, which are based on the European standard NACE Rev.1.1.

² The SNI/TOL category 'sawmilling' includes companies active in production of sawn goods. The SNI/TOL category 'planing' includes companies active in production of flooring, panels, mouldings, blanks, and components. The SNI/TOL category 'wood impregnation' includes companies active in production of impregnated boards and utility poles.

- the wood products chain
- the bio-energy chain
- the wood-based chemicals chain
- services and non-wood products from forests.

The activities and product scope of the wood products chain are illustrated in Figure 1 below.

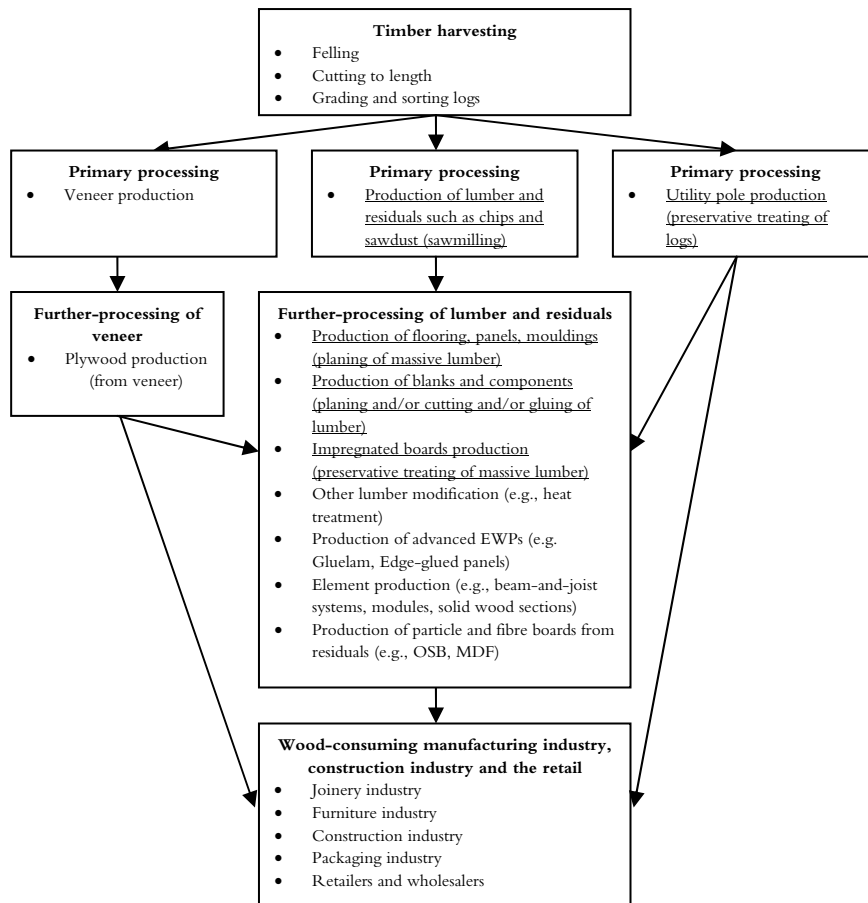


Figure 1. Overview of activities and product flow in the wood products chain. The activities of the wood industry, as defined in this thesis, are underlined. Adapted from Sande (2007, p. 108) and modified by the author. Arrows indicate the basic direction of the product flow. However, some products can go directly from early steps in the chain to later steps without necessary passing through all steps on the way. The product flow excludes the flow of chips, dust and bark that is sold to pulp mills, pellet producers, heating plants and power plants.

In 2006, the Finnish wood industry consisted of 1 025 enterprises, had a total turnover of MEUR 3 792, and employed 8 990 persons (Statistics Finland, 2008). In the same year, the Swedish wood industry consisted of 1539 enterprises, had a total turnover of MSEK 33 514 (MEUR 3 604), and employed 13 945 persons (Statistics Sweden, 2008).

Sawmills are major players in the wood products chain. They also play an important role in the forest-based sector as a whole because of their high ability to pay for saw logs and thereby finance silviculture. According to Thörnqvist (2002), about 70% of the Swedish forest owners' revenue comes from sales of saw logs. Sawmills also act as an important supplier of raw material for the pulp and paper industry and the energy industry. In conventional Nordic softwood sawmills, about 50% of the wood volume is processed into wood chips and sawdust that is partly sold to pulp mills and bio-energy and pellet plants (Staland et al., 2002). The other two focal categories of companies in this thesis – planing companies and wood impregnation companies – are often closely connected to sawmills in the value chain, either as part of an integrated industry unit or as close customer partners. The production process of the sawmilling industry is illustrated in Figure 2 below.

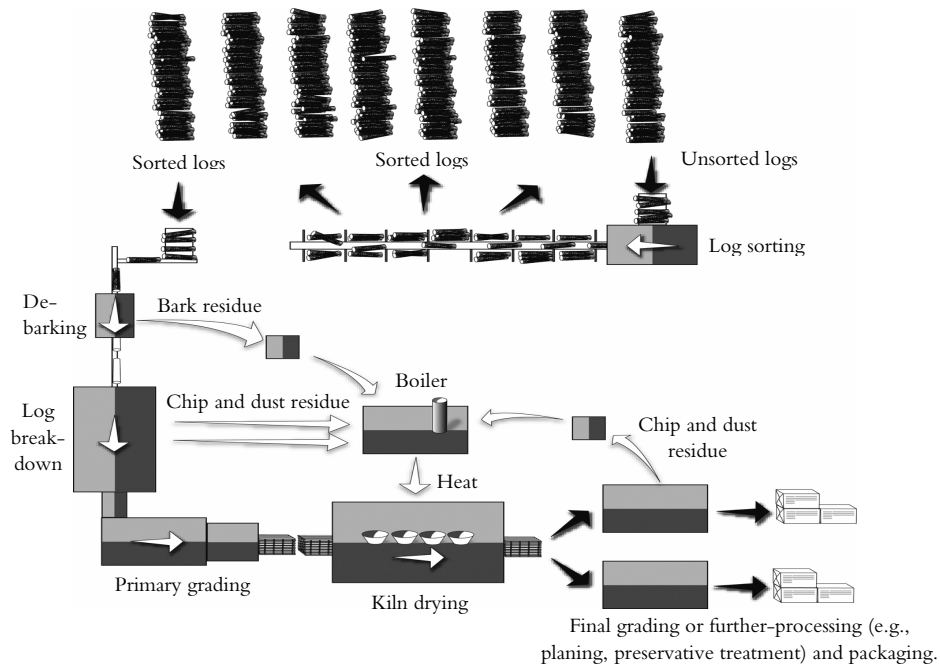


Figure 2. The production process of the sawmilling industry. Illustration: Hans Fryk.

Finally, there are a couple of different study units in this study. Aspects of product development have been studied on company- (article I), strategic business unit- (article II), and project-level (article III). A strategic business unit (SBU) was defined as “an organizational unit which has responsibility for its profitability and, within given frames, formulates its own strategy”³. Accordingly, a company can include several SBUs. More on this can be found in the methods section.

To summarize, this is a study of innovation management in the Swedish and Finnish wood industry. The aim is to understand the mechanisms of product innovation in this context and provide advice for the improvement of product innovation practice.

1.3 Current position and future development of the Swedish and Finnish wood industry

To provide background for the increased interest in innovation in the Swedish and Finnish wood industry, this section presents a basic overview of the current position and future development of the industry.

1.3.1 A traditional industry heavily influenced by business cycles

The Nordic wood industry has traditionally been focused on the effective production of commodity goods (Juslin & Hansen, 2003). For example, the product standards set up in the Swedish Green book, the Finnish Green book and, subsequently, Nordic Timber (The association of Swedish sawmillmen, the association of Finnish sawmillmen and the Norwegian sawmillmen's association, 1995)⁴ have significantly influenced the production and trade of Nordic sawn goods during the later part of the 20th century (Juslin & Hansen, 2003). About 70% of the products from the wood industry are consumed within the construction industry (CEI-Bois (ed.), 2004; Brege et al., 2004). A large share of the Nordic production has been consumed within Europe. Agents and other middlemen have played a big role in the marketing channel, which has resulted in poor communication

³ Similar definitions have been used by other authors, see, e.g., Narver et al., (2004) and Juslin & Hansen (2003).

⁴ To facilitate sales and purchase of sawn wood, it is commonly sorted in classes based on its features. Sawn wood can be characterized according to species, dimension, quality grade (occurrence of knots and defects on a specific board), moisture content and degree of processing. The Swedish and Finnish Green books and the Nordic Timber publication provide standardized rules for the quality grading of sawn wood in classes adapted for different end-uses. See Juslin & Hansen (2003, pp. 90-96) for further explanation of the major grading systems used in the world trade of sawn wood.

and coordination between producers, further-processing industry and end-consumers (Hansen et al., 2006; Hansen & Juslin, 2005). Now, however, the role of middlemen is in a state of change. Value-creation is put in focus, and even though business conducted through middlemen is a good solution in some cases, a need for better information exchange with customers has made direct business more common (Hugosson & McCluskey, 2008).

To match the consolidation in the retailing and industry customer segments, and to achieve scale economies, consolidation has gained momentum in the wood industry over the past decade. Lately, two 'new' globally oriented strategic groups have emerged in the wood industry: large companies with a broad product portfolio and smaller, niche-oriented companies (Korhonen & Niemelä, 2003). However, compared to the cement and steel industry, the wood industry is very fragmented, and a large share of the companies are quite small and domestically oriented (CEI-Bois (ed.), 2004; Hansen et al., 2006; Korhonen & Niemelä, 2003).

The profitability of the industry has generally been on a low level but has also shown heavy fluctuation over time. The business cycle of the construction industry is an important determinant of the demand for wood products. For example, in 2006, house construction in the U.S. fell sharply as a result of credit losses, tougher lending standards, higher interest rates and a weakening economy. As a consequence, wood prices dropped to their lowest levels since 1991 (UNECE/FAO, 2008). At the same time, European markets boomed and prices of wood reached record levels (ibid.). At present, though, a dramatic recoiling has driven the European market back to lower levels and production curtailments are common (ibid.). Information uncertainties and production lead times cause the demand fluctuations in the construction industry to transplant to preceding parts of the supply chain with increasing amplitude at each progressive location, a phenomenon termed the 'bullwhip effect' (Forrester, 1958). It is also the belief of the author of this thesis that the fluctuations are reinforced by speculation by actors of the supply chain. Downstream customers build inventory in times of increasing wood prices and rely on short-term spot purchases in times of decreasing prices.

As a contrast to the short-term fluctuations in the construction industry, the underlying economical growth in the UNECE region is on a low but solid level. Growth was at 3.2 percent in 2007, and economic growth was present in all countries (UNECE/FAO, 2008). However, annual growth rates of wood consumption have been estimated at 1 percent (CEI-Bois (ed.), 2004), a figure well below the general economic growth rate presented above.

1.3.2 Globalization offers new markets but increases competition

In a situation similar to that of the situation in the manufacturing industry in general, wood product markets has internationalized during the late part of the 20th century as a result of decreased trade barriers, reduced freight costs and increased use of IT. This has opened up possibilities for exports for European firms, for example in the sawn softwood segment, where the European export surplus amounted to approximately 11 million m³ in 2002 (CEI-Bois (ed.), 2004). However, uncertain developments regarding currency exchange rates, increased competition from low-cost regions (e.g., South America, Russia, Eastern Europe, and Asia) and substitute materials also presents a threat for the European wood industry connected to this internationalization. The European furniture sector, an important customer for the Swedish and Finnish wood industry, for example, has experienced severe competition from China, which recently became the world's largest exporter of furniture (UNECE/FAO, 2008).

1.3.3 Sharpened competition for raw-material

The supply of logs from the forestry sector to the European wood industry exhibits a stable trend (Korhonen & Niemelä, 2003). During the recent decade, however, several storms have caused severe storm-fellings, which has resulted in large volumes of low-quality cheap timber that have reached the markets. Storms increase the supply of logs temporarily, but negatively affect the harvesting potential in the medium term. Furthermore, Russia, which is a big exporter of saw logs to Europe (especially Finland) and Asia, implemented policies to develop its forest sector in 2006. To improve domestic value-adding, export duties on roundwood were raised, which negatively influenced the profitability of importing logs into Europe (UNECE/FAO, 2007). The export duties are to be raised gradually until 2009 (until 2011 on birch pulpwood) and the industry is preparing for a situation where Russian roundwood exports are completely halted (see, for example the press release by StoraEnso 10 september 2008 at www.storaenso.com).

At the same time as the supply is tightening, the production in the European sawmilling and paper industry is at a high level. In combination with an increasing demand for wood from the energy sector, the competition for wood raw material has sharpened in the European forest-based sector (UNECE/FAO 2008). This has caused the price of logs to rise considerably in Europe during recent years. Because a large share of the production cost of sawmills (60–70% according to Alkbring, 2003, p. 162) consist of costs for logs, this has considerable short- and long-term

consequences for the wood industry. The industry advocates the necessity of mobilizing more wood from the forests, something that many times is in conflict with other interests of the society, like conservation and recreational needs. Many countries have made a long-term political commitment that goods and services should provide economical, social and environmental benefits on a sustainable basis while not diminishing the future generations' freedom of action (The World Commission on Environment and Development, 1987).

As a consequence of the increased interest for sustainability, the certification of forestry and forest products according to environmental standards is more common nowadays (Korhonen & Niemelä, 2003; Kärnä, 2003). In 2007, certified forest area amounted to 292 million hectares, which equals 7.6 % of the global forest area (UNECE/FAO, 2007). In Western Europe, 50% of the forest area is certified, in North America about one third is, and in Africa and Asia only 0.1% is (UNECE/FAO, 2008).

1.3.4 New possibilities challenges old competences

As the supply of logs tightens and the global competition sharpens, the competitive pressure felt in the wood industry increases. However, a 'new' interest in modern and environmentally friendly methods of construction and refurbishing entails a great possibility for the industry to increase its markets shares through value-adding (Brege et al., 2004).

The Construction Products Directive published by the European Union in the 1980's changed the focus of the national building codes from specifications regarding the type of materials used in construction to specifications regarding the performance of the materials used (for example, see the new national building codes in Sweden in 1995). As a consequence, regulatory barriers to the use of wood in construction have decreased. Functional product requirements (institutional, technical and economic), rather than regulatory requirements, are now the main barriers to the increased used of wood in construction in Europe (Nord, 2005; CEI-Bois (ed.), 2004).

In the construction industry value chain, the actors have historically striven towards maximization of their own value, not considering the effects on the efficiency of the value chain as a whole (Nord, 2005). Recently, however, there has been an increased focus on cooperation and on the maximization of total value. The idea is that modern methods of construction and lean production thinking (e.g., modular design, off-site component manufacturing, and just-in-time delivery) will increase the profitability of all actors in the value chain (ibid.). Wood-based construction

solutions have many advantages for off-site component manufacturing (e.g., light weight, which makes transporting of prefabricated modules easier) and are energy-efficient both in production and operation (Björnfot, 2006; Sardén, 2005).

In the single-family housing segment, wood-based construction is very common in Sweden and Finland. In Sweden, companies such as Martinsons, Lindbäcks Bygg and Derome have developed timber-based building systems for multi-family housing as well. In 2008, approximately 15% of all apartments in multi-storey residential construction are being built with timber frame (The national office of wood construction, press release 13 Nov. 2008). The increased focus by the construction industry on eco-effective modern methods of construction has also resulted in sharpened demands on the suppliers to this industry. Wood product suppliers are required to take larger responsibility for product development, production and just-in-time delivery of building material components to the factory or the construction site (Nord, 2008).

In the retail segment (builders merchants and DIY), the recent trends have involved a wide product range, competitive pricing, and product design and user-friendliness. As a consequence, wood product suppliers are faced with demands for large volumes and a wide range of ready-to-use products in consumer-adapted packaging solutions. They are also required to handle just-in-time distribution directly to stores and distribution centers (Henningsson, 2005). In the furniture and joinery segment, companies have moved down-stream, outsourcing their wood processing activities and focusing on the assembly, design and marketing of system solutions. Resulting demands on the wood product suppliers include just-in-time delivery of customized blanks and components as well as technical and marketing support (Fransson, 2005).

1.3.5 Future development: a need for innovation

To summarize, the Swedish and Finnish wood industry is under pressure from increased competition in a global market, has relatively high costs for raw material and personnel, and experiences sharpening demands from customers. Real prices of wood products show a stagnating trend, as illustrated for example by the real price of sawn wood exported from Finland, which decreased 15 percent from 1997 to 2004 (Finnish Forest Research Institute, 2005).

The interest in wood as an eco-effective material has, however, never been greater (Upton et al., 2008; Gustavsson et al., 2006). The European (including the Swedish and Finnish) wood industry is therefore in a ‘make

or break' situation, and product development, together with promotion of wood-based solutions and the maintenance of cost-effectiveness in operations, are important ingredients in the recipe for future success (CEI-Bois (ed.), 2004). Recent strategic developments involve continued movement downstream in the value chain, especially by sawmilling companies who become active actors in the construction and refurbishing sector rather than plain producers of commodity sawn goods (Nord, 2005). Some examples are the Swedish-based SCA Timber's acquisition of a British building products distributor (Henningsson, 2005) and the acquisition of the construction company Plusshus by the Swedish sawmilling company Setra Group AB (Jakobsson et al. (eds.), 2005).

1.4 The state of innovation research in the wood industry

Innovation has received much attention from researchers over the years. With regard to the forest sector, however, the topic has only been briefly explored (Kubeczko & Rametsteiner, 2002). According to Hansen et al. (2006), research on innovation in the forest products industry can be categorized according to three main areas of interest: *organizational innovativeness* (what are the determinants of innovativeness within organizations?)⁵; *new product development* (how can a successful new product best be developed?); and *innovation systems* (what composition of, and interaction between, actors and institutions best facilitates innovation?). Previous research on innovation in the forest products industry has recognized the distinct categories of product, process and business systems innovation (Hovgaard & Hansen, 2004). Among these types, researchers have given the highest attention to process innovation (Hansen et al., 2006).

Regarding *organizational innovativeness*, findings from the wood industry give no clear picture of what factors influence innovativeness (Hansen et al., 2006). From recent studies, there is some evidence that organizational size and market orientation can have a positive influence (Crespell et al., 2006; Cao & Hansen, 2006; Wagner & Hansen 2006; West & Sinclair, 1991, Cohen & Sinclair, 1990). Another recent contribution in this area is that of Korhonen (2006) who studies the seemingly dual strategy of combining innovativeness with cost-efficiency. She has found that a lack of slack resources, a goal of lean centralized organizational designs, and an inward communication climate were the main barriers to organizational renewal.

⁵ In this study, organizational innovativeness will be defined as the propensity to adopt or create, develop, and implement innovations (Hansen et al., 2006). See section 2.1.1.

Within the domain of *new product development*, very little research specific to the wood industry exists (Hansen et al., 2006). This might be due to its lack of a structured product development process (Hansen, 2006). Interestingly enough, companies that employ a structured product development process tend to be more innovative (Crespell et al., 2006). In a study of new wood product commercialization, Bull & Ferguson (2006) found that a market-driven product, flexible management, firm-wide support, and the presence of an innovation champion (project leader) increased the chances of successful commercialization. However, research on product development in the wood industry is ‘a wide open field’, and further research is needed (Hansen et al., 2006).

Until recently, the concept of *innovation systems* was not put into use by forest sector researchers. Recent studies, however, found that the forest-sector innovation system focuses mainly on process innovation and that frameworks and policies to promote cross-sectional interaction could be improved (Kubeczko et al., 2006; Rametsteiner et al., 2005). An analysis of the influence of policy on the effectiveness of innovation systems is currently underway (e.g., in COST Action E 51). In addition, strategy consultants and industry organizations are increasingly adopting the concept of innovation systems and acknowledge its importance (CEI-Bois (ed.), 2004; Brege et al., 2004).

1.5 The need for this study

Increased R&D, especially product development, is a clear ingredient in the strategic visions set up for the industry by researchers and consultants (NRA-council, 2008; Nord, 2005; CEI-Bois (ed.), 2004). Because strategy is (or should be) unique for each individual firm (Baden-Fuller & Stopford in DeWit & Meyer (eds.), 2004), one could discuss the validity of such common strategic recipes (Alkbring, 2003). What qualifies as product development can also be discussed. Is product development limited only to ‘new’ products – products never seen before? In addition, how ‘new’ does a product have to be to qualify as a new product? As explained further in the theory and methods sections of this thesis, this study takes a relative view of newness, i.e., what qualifies as product development is specific to the individual company. For the leading companies, product development can involve ground-breaking new-to-the-world products, but for the majority of companies it involves smaller (but still significant) changes to the current product portfolio. As a consequence, this study focuses on the development of products that are new to the individual firm, but not necessarily new to

the market. It is assumed, however, that the basic uncertainties and the strategic and organizational mechanisms involved in the process are reasonably similar in radical and incremental innovation (with some exceptions that are further explained in the theory section).

Product development is often discussed from a strategic perspective by industry experts. A common view is that product development is necessary, and companies are advised to focus their efforts on it. Sometimes advice is also given on what type of products should be developed. However, no matter the type of development project, traditional strategies, organizational forms and structures in the wood industry constitute barriers to such development (Nord, 2005). In addition, conservatism among customers might be another challenge (Korhonen & Niemelä, 2003). Running a product development project in the wood industry can therefore be assumed to be far from a straightforward process. Furthermore, in order for a business to become and stay profitable, the maintenance of cost-effectiveness is truly necessary – during innovation activities, too (Korhonen, 2006). Because research on innovation in the wood industry has mainly concentrated on process innovation (Hansen et al., 2006), scholars have limited advice to give about how to manage product development in an effective way and overcome these barriers. This study aims to further the knowledge about product development in the wood industry and to provide insights that can help managers make their companies' product development process more effective.

1.6 Purpose of the study

This is an exploratory study and, accordingly, its scope is rather wide. The purpose is to further the knowledge about product development in the wood industry, working from both a strategic and an operational perspective. This is accomplished through theoretical and empirical studies that are accounted for in three scientific articles and in this doctoral thesis. The articles and the thesis have specific aims in themselves. One specific aim of this thesis is to summarize the findings of my studies and synthesize them with existing literature to construct valid and reliable recommendations for innovation management that could be used by wood industry managers. Very little other research on product development in the wood industry exists (Hansen et al., 2006). Another aim is therefore to account for my experiences in doing research on this topic, experiences that can hopefully be of value to future scholars. A final aim of the thesis is to deepen the theoretical and methodological texts included in the articles.

The purpose of article I is to give a broad and basic overview of product development in the wood industry. Article II deals with the first objective of innovation management: to be more innovative. The focus is on identifying factors that can increase product development activity in a company. Article III deals with the second main objective of innovation management: to innovate more effectively. In this case, the focus is on identifying factors that positively influence the degree of success in product development projects. The specific research questions for the articles are:

Article I (qualitative):

- What are the strategic objectives for product development?
- What are the outcomes of product development?
- What are the drivers of product development?
- What activities and actors are included in the product development process?
- What are the key factors for successful product development?
- What are the most important barriers to product development?

Article II (quantitative):

- What organizational characteristics influence organizational innovativeness, as manifested in the amount of product development activity?
- What factors do managers perceive to be the most important barriers to product development?

Article III (quantitative):

- What project management factors influence the degree of success in product development projects?
- How does product newness affect this influence?

1.7 Implementation of the study

The studies accounted for in articles I-III and in this thesis were conducted as a PhD project at the Department of Forest Products at the Swedish University of Agricultural Sciences (SLU) between 2004 and 2008. Between 2004 and 2006, the study was a part of the SPWT research consortium (Specific Properties, Competitive Ability and Advanced Conversion of Nordic Scots Pine in Mechanical Wood Processing), a research consortium in the Finnish-Swedish Wood Material Science and Engineering research program. The research consortium was lead by Metla, the Finnish Forest

Research Institute, and dealt with the strategic rejuvenation of the Nordic pine industry. The activities of the consortium were financed by the Academy of Finland, the Finnish Ministry of Agriculture and Forestry, Metla (the Finnish forest research institute), the University of Helsinki, SLU, Woodfocus Ltd., and Setra Group AB. The consortium engaged several researchers and PhD students at Metla, University of Helsinki, and SLU. The main research questions concerned the physical properties of wood, the market development and the organization of product development work in wood industry companies. The research consortium was led by a steering committee consisting of representatives from Metla, the universities and the financing bodies. Annual expert group meetings were held in which distinguished industry experts could reflect on the results of the consortium as they progressed. The SPWT consortium concluded in 2007 and the final results are published in the WMS final report (Poppius-Levlin & Johansson (ed.) 2007).

The implementation of the present study is illustrated in Figure 3 as a sequence of phases that took place between 2004 and 2008.

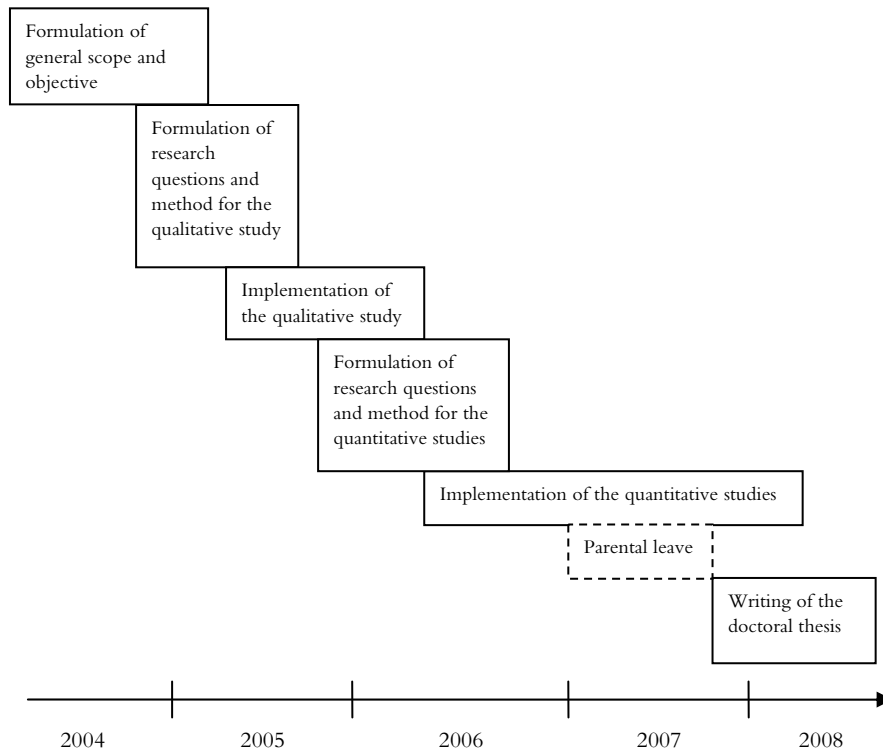


Figure 3. Implementation of the study.

The steps illustrated in Figure 3 contained the following activities:

1. Formulation of general scope and objective
 - Literature study of the strategic position and development of the wood industry
 - Discussions within the SPWT research consortium

2. Formulation of research questions and method for the qualitative study
 - Literature study of business strategy, management of innovation and qualitative research method
 - Writing of research plan for the qualitative study

3. Implementation of the qualitative study
 - Semi-structured interviews with 19 product development managers in Swedish and Finnish wood industry companies
 - Analysis of results and report writing (Article I)

4. Formulation of research questions and method for the quantitative studies
 - Literature study of business strategy, management of innovation, quantitative research method and consideration of the results from the qualitative study
 - Writing of research plan for the quantitative studies

5. Implementation of the quantitative studies
 - Structured telephone interviews with 110 SBU managers in Swedish and Finnish wood industry companies
 - Analysis of results and report writing (Article II and III)

6. Writing of the doctoral thesis
 - Literature study of business strategy and management of innovation, along with consideration of the results from the qualitative and quantitative studies
 - Writing of the doctoral thesis

1.8 Ontological and methodological positioning

In scientific work, one aim is to draw conclusions about the functioning of nature and society. From an intra-science perspective, there are two main logical approaches to drawing conclusions: induction and deduction (Johansson 2003, p. 213). The inductive approach means that the researcher starts by collecting empirical data and *draws conclusions based on recurrences* that seem to be reliable. This approach characterizes the ontological school called 'logical positivism', developed by natural scientists in Vienna in the 1920s (ibid., p. 215). The deductive approach implies that the researcher *tests hypotheses* that have been logically generated from existing theory. This approach is the basis of the hypothetical-deductive approach to science, which is based in the 'falsification' school developed by Karl Popper (also a natural scientist) in the 1920s and 1930s (ibid., p. 215). In more detail, the hypothetical-deductive approach to science implies that the researcher (ibid., p. 53):

- formulates a hypothesis

- extracts empirically testable statements from the hypothesis
- investigates the correctness of the empirically testable statements through experiments or observation
- concludes that the hypothesis is strengthened or weakened depending on the correctness of the empirically testable statements.

Even though the hypothetical-deductive approach seems rather technical and most appropriate for natural science, it can be argued that if the researcher begins with some sort of theoretical conception of the research problem, which normally is the case, the basic principles of this approach are valid for social science as well (even for low-structured research, e.g., qualitative case-studies). It is even a commonly held opinion that the hypothetical-deductive approach to conclusion-drawing is what constitutes science in general (*ibid.*, p. 48).

However, the basic logic of the hypothetical-deductive approach, that is, Popper's principle of falsification, has been criticized. Some science theorists have questioned the possibility of the ultimate falsification of a theory because hypothesis-testing requires that the observations or experiments used to test the hypothesis be held as valid and reliable, and because this assumption is something that can be doubted in most research situations. This is because observation and experiments are dependent both on theoretical conceptions and on the reliability of measurements. The implication is that it cannot be proved whether a false hypothesis or an invalid observation was the cause of the falsification (*ibid.*, p. 217). One way to get around this problem is to postulate certain basic theoretical and methodological clauses and assume these to be correct. If these basic clauses are held to be true, and research is based upon them, hypotheses can be tested through falsification. Basic clauses of this type can be termed a 'paradigm'. The theory about research within paradigms was developed by Thomas Kuhn in the 1960s (*ibid.*, p. 219). Even with the support of a paradigm, however, it is very difficult to avoid all uncertainty surrounding the individual researcher's possibilities of falsifying a theory. The scientific community has therefore adopted a collective approach to knowledge creation: knowledge is not what is advocated by a single researcher, but what is accepted as knowledge by the group of researchers active on the front lines of the focal research area (*ibid.*, p. 229). In this way, individual researchers do not produce knowledge but leave a contribution to the knowledge-generation of the scientific community. Scientific discourse and peer review before publication play a large role in this collective knowledge creation. To summarize, a researcher who applies the basics of the

hypothetical-deductive approach and participates in the scientific discourse within a paradigm can be said to be active in normal science (Kuhn, 1962), and to thereby be contributing to the production of knowledge as we see it today.

Some argue that induction and deduction are intra-science perspectives on knowledge production (i.e., that they concentrate on the interaction between theory and empirical data) and leave the practical application of the theoretical and empirical analysis out of the discourse. As a consequence, when it is of interest to the researcher to make connections between research and practice, an alternative 'externalist' approach, abduction, is instead suggested (Kirkeby in Andersen (ed.), 1994). The 'externalist' label refers to the consideration in research of social and political dimensions, meaning that guiding norms and resulting consequences of research are given bigger room in comparison with the more narrow pursuit of the 'absolute truth' that guides intra-science approaches (Wigblad 2008). Abduction is characterized by a departure and arrival in a practical situation (problem and solution, respectively) and knowledge-production through reflection on reliable experience (ibid.; Schön, 1983). Abduction is a common approach among researchers with reflected practical experience from the research field or researchers that have close connections to practitioners during the research process, i.e., that are 'familiar' with the research area (Wigblad, 2008).

Wigblad (2008) points out that induction, deduction and abduction strictly speaking are ideal types of knowledge production approaches. Most research is, in practice, influenced by all parts of these basic perspectives. This is also valid for this study. Theory about strategy, organization and innovation in companies has influenced data collection and analysis, and findings have been compared to existing knowledge, an approach basically in line with the hypothetical-deductive method. However, inductive elements have also been present in the work, especially in the qualitative study. It is also my belief that the origin of many theories and models in the innovation literature is the result of observations of company behavior, that is, knowledge generated through induction. In addition, the study has also followed the central principle of the abduction approach, namely departure and arrival in a practical situation. As pointed out in section 1.2, even though other researchers are considered to be an important target group for this research, a special driving force through the study has been to produce knowledge that is valuable for industry practitioners.

In addition to the element of abduction that influences this study, traces of what Wigblad (2008) calls 'familiarity' with the research area can be

found. As declared above, ‘familiarity’ is characterized by an abduction approach to knowledge-creation and a researcher with reflected experience from the research area or very close cooperation with practitioners during the research process. This study is influenced by ‘familiarity’ partly because I have practical experience pertaining to the research topic, and partly because it was conducted within a research consortium (SPWT, see section 1.7) that provided close relationships with experienced practitioners. The advantages of ‘familiarity’ are high-quality problem formulation based on deep knowledge about practical problems, the possibility of developing close relationships with practitioners and an ability to validate their accounts (resulting in very good access to experience-based data). The disadvantages are that the researcher might have difficulty viewing data in an objective way, that the researcher might jump to conclusions and lose critical perspective, and that transparency might be low due to concealed (non-reported) assumptions and conclusions (that are ‘self-evident’ in the eyes of the researcher). According to Wigblad (2008), the ‘familiar’ researcher can mitigate these disadvantages through a continuous review of findings in a discourse within a ‘paradigm of practitioners’: a group of practitioners with reflected experience. In this way, the findings are validated by the critical review of one’s peers, and the risk of subjectivity is decreased. The present study gained much from the discussions within the SPWT research consortium and, thereby, was conducted within such a ‘paradigm of practitioners’. To summarize, while departing and arriving in a practical context, the intention of this work has been to follow good research practice and use established methods for data collection and analysis.

2 Theory

2.1 Basic definitions and perspectives on innovation research

This section introduces and defines core concepts used throughout the thesis. It also gives an overview of theoretical perspectives used in innovation research and describes how this thesis relates to these perspectives.

2.1.1 Basic definitions

As described in section 1.2, a classic definition of innovation is the generation, acceptance, and implementation of new ideas, processes, products, or services (Thompson, 1967). Later scholars have suggested other formulations, but the essence of the concept has remained the same (see section 2.3.1). This study uses the definition of innovation found in the Oslo Manual (OECD/Eurostat, 2005): a *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components, and materials, incorporated software, user friendliness or other functional characteristics. A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment, and/or software. A *marketing innovation* is the implementation of a new marketing method involving significant changes in product design or packaging, placement, promotion or pricing. An *organizational innovation* is the implementation of a new organizational method in the firm's business practices, workplace organization, or external relations. In this study, product innovation is the focus and *product development* is used as a term for the span of activities leading to, or that are

intended to lead to, product innovations (OECD/Eurostat, 2005). *A product* is defined in the study as a good or a combination of a good and service.

The definition of innovation includes the relative concept of newness. In this study, the requirement for an idea, process, or product to be considered new, and thus qualify as an innovation, is that it be new or significantly improved with respect to its characteristics or intended uses in the eye of the beholder. The focus in this study is on companies and business units, which implies that innovations are ideas, processes, products, or services that are new to the participating companies or business units. This relative view on what qualifies as an innovation is conventional in European studies of innovation, for example the Community Innovation Survey (OECD/Eurostat, 2005).

Finally, another core concept of the study, *organizational innovativeness*, has mainly been conceptualized from two perspectives: as a behavioral variable, that is, the rate of adoption of innovation, and as the willingness to change (Calantone et al., 2002). In this study, organizational innovativeness will be defined as the propensity to adopt or create, develop, and implement innovations (Hansen et al., 2006).

2.1.2 Perspectives in research about innovation

In the nineteenth century, economic historians noted that the acceleration in economic growth could largely be explained by technological progress rather than by reductions in the prices of existing products. In the 1930s, Joseph Schumpeter acknowledged that technological progress was a result of innovative actions among companies. These insights triggered interest among researchers in investigating the mechanisms of the innovation process and how differences among firms influenced their innovative performance (Trott, 2005). Ever since then, the relationship between the characteristics of companies, their surroundings, and their innovation output has been a topic of great interest to scholars.

According to Hansen et al. (2006), research on innovation can be organized according to three broad categories: organizational innovativeness, new product development, and innovation systems. The first category, organizational innovativeness, is concerned with identifying what factors influence an organization's innovativeness and with the effect of innovativeness on financial performance. The approaches used to study this subject vary between researchers. Gopalakrishnan and Damanpour (1997) find that economists concentrate on the game between actors in an industry and the effects on the innovative performance of the industry, whereas technologists are concerned with the processes of generating new

technology and the improvement of existing technology. Sociologists, finally, are interested in the relationship between organizational characteristics and the degree of adoption of innovations within organizations. Wolfe (1994) discerns three major streams of research dealing with the topic, i.e., diffusion of innovation (DI), organizational innovativeness (OI), and process theory (PT) streams. The first stream is based on a theory about innovation diffusion that is known as the “S-curve”, which, in short, poses that the initial adoption of a new technology in a population is slow because of unfamiliarity with the new technology. Adoption then accelerates when the technology becomes better understood and spread to the mass market, and eventually declines as the market becomes saturated (Rogers, 1983). The DI stream identifies attributes of the innovation and of the adopter as main determinants of adoption behavior. The second stream, OI, also identifies attributes of the innovation and of the adopter (an organization), commonly through the use of variance research models. It is, however, not dependent on the theory about the “S-curve”. The third stream, PT, often uses more qualitative methods to study a) a specific part of the innovation process, or b) the innovation process from a longitudinal perspective. Wolfe (1994) concludes that “DI helps us understand how and why an innovation diffuses over time, OI contributes to differentiating early from late adopters, and PT research helps to discern the stages and processes involved in organizational innovation”. In Hansen et al.’s typology, research about the creation, adoption and diffusion of innovation is included in one common category that deals with one basic research question within this area: what are the determinants of innovativeness within organizations?

The second category, new product development, deals with the description of the product development process, the identification of its challenges, and the suggestion of remedies to those challenges. The central research question is: how can a successful new product best be developed? Brown and Eisenhardt (1995) identify three main perspectives on the product development process used by researchers interested in these questions: seeing the process as a rational plan, as a communication web, and as disciplined problem-solving. The ‘rational plan’ perspective takes a broad, pragmatic and a-theoretical perspective and concentrates on identifying simple correlations between product, market, organizational characteristics and product development success. The ‘communication web’ perspective uses communication theory and focuses more narrowly on the internal and external communication and information processing done in connection to the product development project. The ‘disciplined problem-solving’

perspective, finally, uses problem-solving theory to formulate and test hypotheses about the relation between development project configurations and project outcome (*ibid.*). Another typology of research regarding product development is constructed by Krishnan and Ulrich (2001) who state that the common perspectives employed by scholars are the marketing, organizational, engineering design and operations management perspectives.

The third category, innovation systems research, sees innovation as a product of the interplay between actors (e.g., companies) and institutions (e.g., regulations and policies). Actors and institutions form a system, which can be defined either from a sectoral point-of-view (e.g., the forest sector) or a regional point-of-view (e.g., a geographical territory) (Hansen et al., 2006). The main research question for this research stream is: what is the composition of and interaction between actors and institutions that best facilitates innovation? The product of innovation systems research is often advice on how to formulate sectoral, national or regional (innovation) policy. The Forest Technology Platform, a cooperative effort to define and implement the forest sector's R&D roadmap embarked upon by the European organizations of forest owners (CEPF), the wood industry (CEI-Bois), and the paper industry (CEPI) is a recent example of industry cooperation that departs from a sectoral innovation systems perspective (see www.forestplatform.org).

The present study shares common ground with several of the perspectives described above. It is concerned with questions mainly found in the organizational innovativeness and product development streams in Wolfe's typology. Within the first of these two categories, this study follows the sociologists' view, rather than that of the technologists or economists (Gopalakrishnan & Damanpour, 1997). Thus, the interest is in the relationship between organizational characteristics and the degree of adoption of innovations within organizations. The theoretical framework originates, however, from strategic management theory rather than innovation diffusion research, so that this study is closer to the OI and PT streams than to the DI stream in Wolfe's (1994) typology. Within the second of these two categories – product development – this study takes the straightforward approach of the rational plan perspective (Brown & Eisenhardt, 1995)⁶. The aim has been, however, to provide a deeper theoretical basis for the testing and discussion of the variables, and to use more multivariate quantitative methods, as compared to what has been done using the 'rational plan' perspective (*ibid.*). Furthermore, the study departs

⁶ This position is in line with the analytic and rational approach to strategy that is accounted for in section 2.2.1.

from a strategic management perspective (see Schilling, 2008 and Trott, 2005 for textbooks that deal with innovation from this perspective) and uses concepts and theories found in contemporary strategic management research. It takes the view of the individual company, rather than that of the innovation system. However, because strategic management deals with actors and institutions both inside and outside the company, the company-external innovation system and its dynamics are indirectly considered.

2.2 The strategic management perspective

This section aims to give an introduction to the strategic management perspective that characterizes this study. It introduces the resource-based view of the firm as a foundation for one's understanding about the company and its innovation strategy.

2.2.1 What is strategy?

The term strategy can be used in many ways and with many meanings, depending on the user. Alfred Chandler proposed that (1962, p. 13) strategy can be defined as “the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out the goals”. According to Chandler (1962, p. 13) strategy guides “the adoption of courses of action and the allocation of resources necessary for carrying out the goals”. This guidance occurs mainly through strategy's role as supporter for decision making, coordination and communication, and through the role of strategy as a target (Grant, 2002, pp. 28–29). The strategic decisions about the types of markets to serve, or seek to create, and the types of innovations to attempt there, constitute the basic background for innovation activities (OECD/Eurostat, 1996, p. 23). Decisions on new product strategy are directly connected to the competitive strategy of the firm and draw on decisions regarding differentiation and market positioning or considerations concerning the product portfolio (Trott, 2005, p. 386). The internal fit between strategy and organization facilitates the implementation of the strategic intent (Naman & Slevin, 1993).

According to Ansoff (1965), the formulation and implementation of business strategy should be seen as a controlled process where logic reasoning produces a plan for the strategic development of the firm. This view implies that the strategy process can be divided into two parts, strategy formulation and strategy implementation. Ansoff, in this sense, sees the life of a firm as a long-term deliberate process and views strategy as the plan for

this process. Conversely, Mintzberg (1985) views business strategy as something less controlled and deliberate, and thus, as an emergent process. He views strategy as something heavily influenced by the changes in the environment of the firm and the continuous learning that goes on in the firm. The changes in the environment and the continuous learning cause the firm to drop strategies that no longer are considered to be of value, and adopt new strategies that are inspired by the changes in the environment. In this way, strategy formulation in the eyes of Mintzberg is a process of re-evaluating and re-formulating present strategies. The strategies are “a pattern in a stream of actions”.

This study follows the rationalist, analytic approach to strategy that is advocated by Ansoff. This is not because it is believed that strategy is a static process without influence from the environment or from continuous learning. Instead, this view is adopted to highlight the possibility of actively managing the strategy of a firm and influencing the firm’s development and performance. The basic role of strategy, according to this conceptualization, is to provide an identity for the firm and a vision of where it wants to go, and to determine how the firm will employ its resources within its environment to fulfill this vision (Grant, 2002, p. 13).

2.2.2 The resource-based view of the firm

Scholars have emphasized two factors that influence the performance of firms over the long term (Grant, 1991, p. 117):

1. the attractiveness of the industry in which the firm is located
2. the firm’s establishment of competitive advantage over its rivals.

The industrial organization view on strategy (see for instance Bain, 1965; Porter, 1981) emphasizes the first factor. However, in the 80’s and 90’s, empirical studies revealed that the correlation between industry membership and performance was weak and, conversely, that the correlation between business unit membership and performance was stronger (Schmalensee, 1985; Rumelt, 1991). The insights from this comparison led to an increased interest among scholars in the thoughts of Penrose (1959) who emphasized the differences between companies as a basis for the formulation of strategy. The resulting theoretical perspective that emerged during the last decades of the 20th century was termed ‘the resource-based view of the firm’. The advocates of this perspective claim that companies can be seen as bundles of resources, that resources are heterogeneously distributed across companies, and that the market for resources is imperfect (i.e., resource differences

persist over time) (Eisenhardt & Martin, 2000). As a consequence, firms can create and sustain competitive advantage by acquiring and leveraging resources that are valuable, rare, inimitable and non-substitutable⁷ (Barney, 2001; Barney, 1991; Grant, 1991; Wernerfelt, 1984). These resources allow the implementation of value-creating strategies that are not easily copied by other companies. Evidence for this claim has been provided by numerous empirical studies (see Barney & Arian, 2001 for a review).

Using the definitions of Barney (1991, p. 101) the resources of a firm include all assets, capabilities, organizational processes, firm attributes, information, knowledge etc. that are controlled by the firm and that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness. According to the logic of the resource-based view, the value of resources depends on overlap with the key success factors (Hofer & Schendel, 1978) of the specific market context. The identification of key success factors is external to the resource-based model and requires some type of product/market model (Barney, 2001). Rareness, in turn, simply depends on the uniqueness of the resource in the marketplace. Inimitability refers to the potential for others (competitors) to imitate (e.g., buy, create or acquire in some other way) the resource if they find that it has a unique value. Resource attributes connected to inimitability are resource complexity, intangibility and causal ambiguity regarding the set and combination of resources needed for a certain strategy. Non-substitutability, finally, relates to the uniqueness criterion – uniqueness loses its value if the resource can be substituted for another resource with equivalent value. See Figure 4.

⁷ These criteria were set up by Barney (1991) and are the most commonly used among scholars. However, there are many other interpretations of what makes a resource important, e.g.: Relevant, scarce, durable, non-transferable, non-substitutable (Grant, 1991); Valuable, complementary, scarce, non-tradable, uncertain ex ante, appropriable (Amit & Schoemaker, 1993).

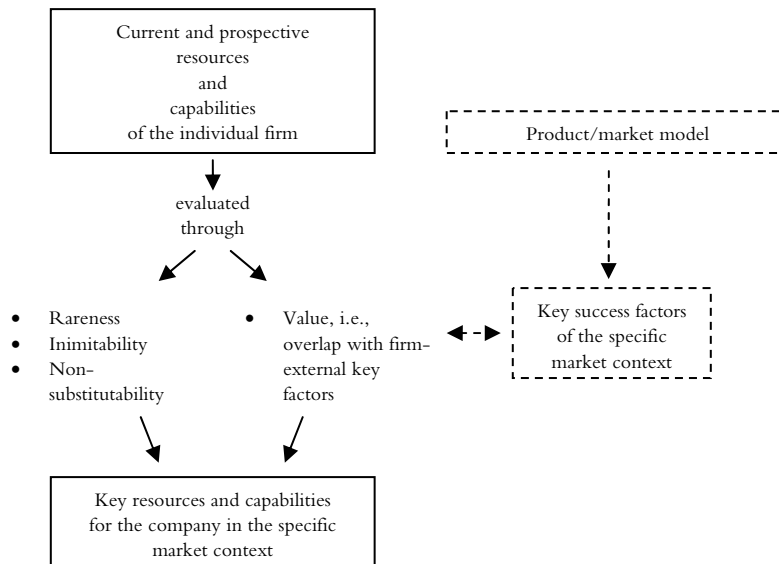


Figure 4. The basic logic of the resource-based view of the firm. The dotted lines indicate concepts and relationships that are external to the theory.

Of considerable importance for a resource-based strategy is to identify the external sources of competitive advantage: the key success factors of the specific market context. The key success factors can be identified by answering the two basic questions (Grant, 2002, p. 97):

1. What do customers want?
2. How does the firm survive competition?

The answers to these questions should provide information about the basic and differentiating activities that the company needs to master, now and in the future. The literature provides several models that facilitate analysis of these questions. Kotler (2000, p. 135, p. 159, p. 191), for example, deals with the analysis of both macro environment (including political, economical, social, and technological factors) and micro environment (e.g., customers and competitors). Customer needs, for example, can be analyzed in terms of functional value (e.g., goods and services) and emotional value (e.g., relationships). Another well-known model is Porter's five forces framework (Porter, 1980), which assesses the

competitive pressure from suppliers, customers, potential and existing competitors and substitutes. Amit and Shoemaker (1993), for example, combine the five forces framework with the resource-based view.

2.2.3 The organizational capabilities approach

Even though the resource-based view has long been acknowledged as an important contribution to our understanding of the creation of competitive advantage, it has not stood without criticism (Barney, 2001). One of the most important criticisms was captured by Priem and Butler (2001), who stated that the process of using valuable, rare, inimitable and non-substitutable resources to gain sustainable competitive advantage is a “black box” not well-understood in the field and that the definition of company resources can be considered all-inclusive and vague. The organizational capability approach (Korhonen & Niemelä, 2005; Foss, 2003) developed by scholars during recent decades, opens up this “black box” and sheds light on how resources and capabilities create value and facilitate competitive advantage for firms. Below follows a short overview of this approach.

Barney (2001) states: “resources are considered valuable if they contribute to either differentiation or cost advantages for a firm in a certain market context.” These basic types of competitive advantage, i.e., differentiation and low cost, are clear, well-known and accepted in the literature (Porter 1985; Baden-Fuller & Stopford in DeWit & Meyer (eds.), 2004). However, the wide definition of resources suggested by Barney (see section 2.2.2) has probably contributed more to the vagueness of the theory claimed by Priem and Butler (2001). A more narrow definition of resources and capabilities would improve clarity. Korhonen and Niemelä (2005) provide a useful overview of the major differences between resources and capabilities:

1. “Whereas resources are either tangible or intangible, capabilities combine both: capabilities are clusters of tangible, input resources and knowledge-based, intangible resources.”
2. “Unlike resources, capabilities have an operational, process dimension - they are not factor stocks, but they are factor flows: capabilities present what a firm can do, they are activities, organizational rather than individual skills.”
3. “Capabilities often take a routine-like form and are path-dependent: if a company were to be dissolved, its capabilities would disappear as well.”

In all, capabilities are an organizationally embedded bundling process of resources. Capabilities represent what a firm can do, that is to say, its potential activities (ibid.).

The combination and coordination of resources is facilitated by the infrastructure of the firm (ibid.). The firm's infrastructure involves management systems, organizational structure, and values and norms captured in the organizational culture⁸ (Leonard-Barton, 1992) (see Figure 5).

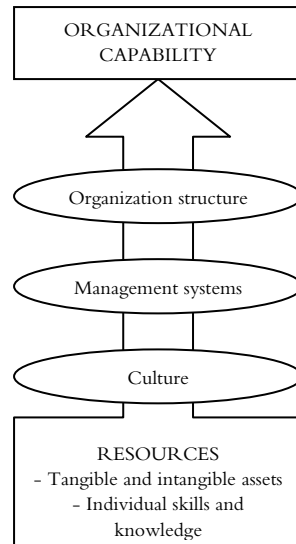


Figure 5. Resources, infrastructure and organizational capabilities.

According to Korhonen and Niemelä (2005), there exists a hierarchy among capabilities, where capabilities range from simple bundles of resources that are designed to perform less complex activities to higher-order resource combinations. The base of the hierarchy comprises specialized tasks (e.g., the purchasing of logs, bookkeeping, market analysis, etc.). On the second level, task-specific capabilities are combined in relation to company functions (e.g., procurement, accounting, marketing). The highest-level capabilities (e.g., entering into new markets, developing innovative product-market strategies) demand the cross-functional integration of tangible and intangible

⁸ Organisational culture can be defined as shared values and norms that influence the behaviour of the organisation (Hult et al., 2004).

resources. In this way, lower-order capabilities (resource combinations) are the building blocks for higher-order capabilities (Galbreath, 2005, p. 980). According to Grant (2002), the hierarchy of a firm's capabilities can be identified and assessed, for example, by utilizing a standard functional classification of company activities, or by utilizing Porter's value-chain classification (Porter, 1985).

Even if resources can produce direct value themselves (e.g., a site in a convenient location), value is more often created through the *activities* that the firm performs through the use of its resources (Porter, 1996). The activities of firms, in turn, are enabled through the process of combining resources to create capabilities. Therefore it is not only the specific set of resources that the firm possesses that are of great importance for the creation of value, but also the process of combining them into resource combinations (i.e., capabilities). Thus, resources can have a value not only as direct bases for cost and differentiation advantages, but also as important building blocks of higher-order resource combinations (i.e., capabilities) that in turn can produce value by enabling value-creating activities.

To compete in a market, the companies make (product-) offerings to the customers in the market. The offerings consist of the suppliers' propositions of value to the customer, and address both functional (goods and service) and emotional (relational) aspects of customer value (Kotler, 2000)⁹. The offerings, hereafter named value propositions, are made possible through a set of supplier capabilities, for example the capability of producing a high-quality window frame component, the capability of delivering it on time and the capability of building and maintaining a good relationship with the customer. Accordingly, the capabilities of a company play a key role in the creation of value propositions and thereby in the creation of competitive advantage in the market. To conclude, a more narrow definition of resources and capabilities, and the insight that firms compete in the market with capability-based value propositions, helps open up the black box of how the resources of a firm can contribute to competitive advantage in the market.

2.2.4 Strategic Fit and the contingency perspective

A common conclusion regarding strategy formulation found in contemporary resource-based textbooks is that business strategy should be consistent with:

⁹ Trott (2005, p. 393) outlines the following aspects of the product: technology, features, quality specifications, packaging, level of service, brand name, and price.

- the goals and values of the firm
- the external environment of the firm
- a firm-specific set of resources and capabilities
- organizational structures and systems.

This consistency can be termed “strategic fit” (Grant, 2002, p. 16; Liedtka, 2000 (in DeWit & Meyer (eds.), 2004)). See Figure 6.

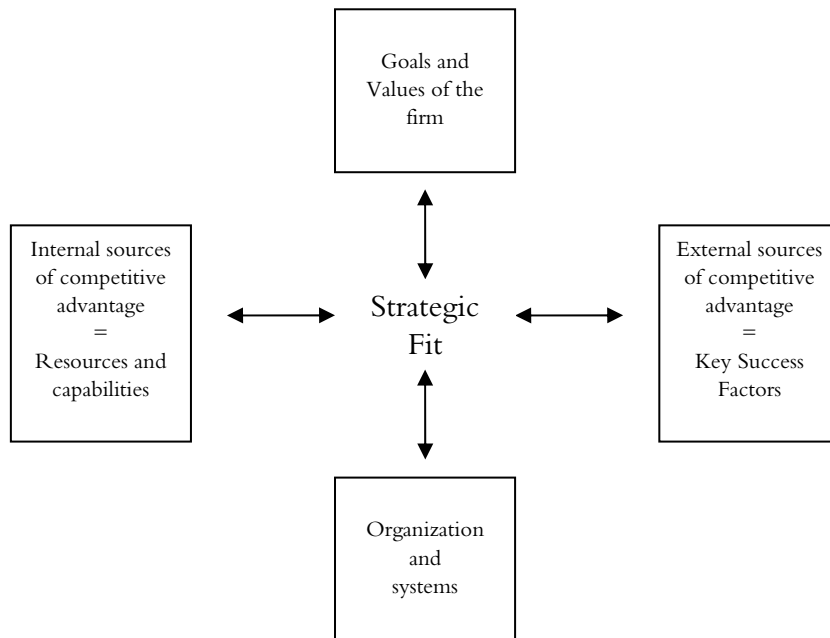


Figure 6. Strategic Fit (illustration developed by the author of this thesis based on Grant, 2002, p. 16 and Liedtka, 2000 (in DeWit and Meyer (eds.), 2004)).

The notion of strategic fit seems to provide a useful framework for successful strategic management. However, the resource-based view has often, such as in the article by Priem and Butler (2001) been accused of providing a static view of a dynamic process. The position that competitive advantage is enabled through the possession and utilization of valuable, rare, inimitable and non-substitutable resources has been associated with the so-called Ricardian view, in which competitive advantage is based on a more or less static environment (Ricardo, 1817). Contingency theory (Ginsberg &

Venkatraman, 1985; Lawrence & Lorsch, 1967), however, acknowledges that the KSFs of an industry are continuously being eroded by competitive forces and technological development. A competitive advantage therefore loses its value over time, and firms must pursue constant renewal and achievement of a series of temporary competitive advantages (Collis, 1994). In line with this argument, contingency theorists maintain that an organization is an adaptive system that evolves by reacting to its environment. Reaction takes place mainly in two ways: through selection (entry and exit mechanisms) and adaptation (of products, activities, resources and capabilities) (Grant 2002, p. 317). In addition to reacting to the environment, the firm can also influence the evolution of the industry through its strategic actions (Hamel & Prahalad, 1994).

The contingency perspective simply states that the optimal business strategy partly depends on the context and that the context is constantly in a state of change. Accordingly, in addition to achieving a strategic fit with present conditions, companies must simultaneously aim for strategic fit of tomorrow, that is, they must develop a 'strategic stretch' (Hamel & Prahalad, 1994). Mastering this strategic duality can be considered one of the toughest challenges for managers (Korhonen, 2006; Grant, 2002, pp. 319-320). When tackling this challenge, scenario planning tools (Shoemaker, 1993) can generate foresights about alternate future developments, from which strategic plans can be generated. Then, as we will see, product development plays an important role for firms' capability to manage their portfolio of resources and capabilities accordingly.

2.2.5 The dynamic capability view and the importance of innovation

Eisenhardt and Martin (2000) suggest that product development (and other cross-functional high-order capabilities such as strategic decision-making and the forging of strategic alliances) are examples of so called dynamic capabilities. Dynamic capabilities "create value for firms within dynamic markets by manipulating resources into new value-creating strategies" (ibid.). The value of these capabilities lies not in their direct contribution to differentiation and/or cost advantage (customers hardly care whether a firm is good at product development per se), but instead in their ability to continuously reinvent resource configurations that in turn contribute to differentiation and/or cost advantage across the array of contextual environments that the industry evolution offers.

The details of a dynamic capability are often idiosyncratic and path-dependent, but the main features are more common, displayed in a well-known industry 'best practice' (Eisenhardt & Martin, 2000). Dynamic

capabilities are developed in organizations through well-known learning mechanisms: in volatile market conditions, where the competitive value of resources and capabilities is quickly eroded, they are often simpler procedures, facilitating and emphasizing experimentation and exploring, and evolve through iterative processes and selection. In stable market conditions, where the enhancement of competitive resource configurations is decisive for competitive advantage, they have a more detailed routine-like structure that evolves cumulative over time (ibid.).

The theory about dynamic capabilities is based on the resource-based view of the firm and has been termed the dynamic capability view (Winter, 2003; Eisenhart & Martin, 2000; Teece et al., 1997). The theory acknowledges the constant change of the business environment and the resulting need for a company to continuously develop its portfolio of resources and capabilities, thus adding a contingency perspective to the resource-based view. Eisenhart and Martin (2000) even state that the ultimate performance of a firm depends on its ability to develop and leverage capabilities sooner, more inventively or more fortuitously than its competitors. This, as a contrast to the more static 'Ricardian' perspective on rent creation underpinning the resource-based view, has been termed a 'Schumpeterian' perspective, after the German economist Joseph Schumpeter who pointed out that innovation is the primary driving force behind economic development (Schumpeter, 1934). In essence, the dynamic capability view acknowledges the need for a company to develop its portfolio of resources and capabilities over time, and suggests that product development is one of the capabilities that facilitate this.

Sirmon et al. (2007) provide a model that describes the process where companies actively develop and leverage their portfolio of resources and capabilities through resource management (see Figure 7). The model illustrates the process wherein resources are combined and integrated to form capabilities, and illustrates how new resources and capabilities are built or acquired, partly as a result of influence from the market environment. In the model, this influence primarily comes from two sources: a) feedback from the market and the owners on the value created by the firm, and b) managers' perceptions about the uncertainty of the environment (e.g., industry structure and recipes, market demand, external shocks, resource scarcity).

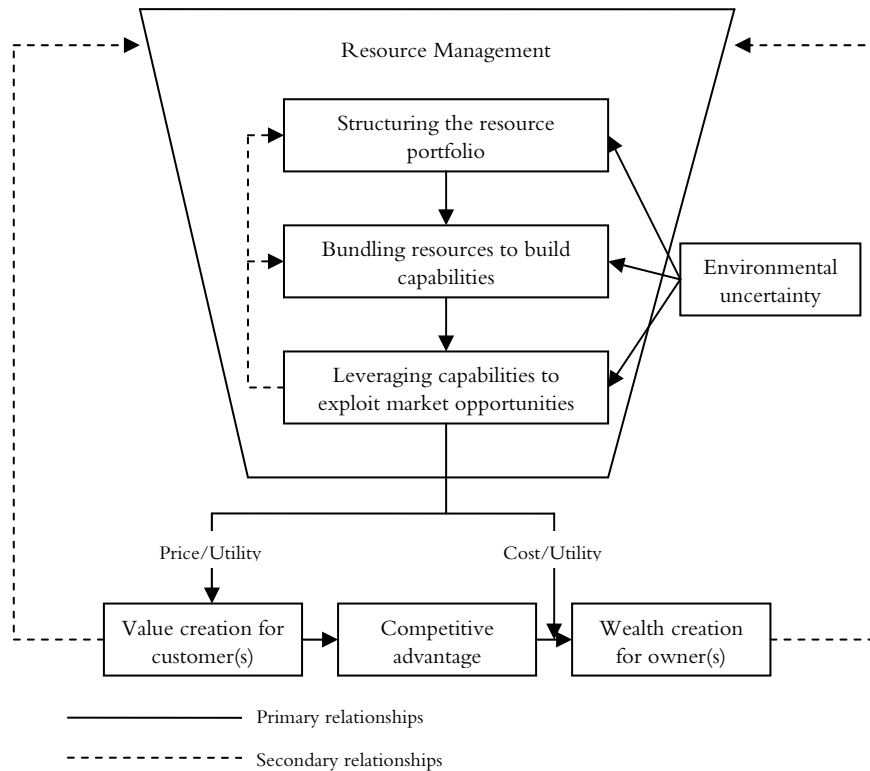


Figure 7. The resource management process. Adapted from Sirmon et al. (2007).

According to Sirmon et al. (2007), resource management includes:

- a) The structuring of the resource portfolio. This is the process where firms acquire, accumulate, develop and divest resources in order to have the most effective resource portfolio at any given time.
- b) The bundling of resources to create effective capabilities. This is the process where firms stabilize, enrich and pioneer resource-bundles to create and maintain an effective capability-set with regards to the opportunities and threats of the marketing environment.
- c) The use/leverage of capabilities to create value. This is the process where managers activate the value inherent in their firm's capabilities, through mobilizing, coordinating and deploying them. Capabilities are, simply put, turned into strategic action to take advantage of market opportunities.

The resource management model illustrates how firms use resources and capabilities to pursue competitive advantage in a changing environment and

thereby opens up the ‘black box’ (Priem & Butler, 2001) of how resources and capabilities are used to create value. Dynamic capabilities facilitate the integration, reconfiguration, creation and release of resources (Eisenhardt & Martin, 2000). Thus, dynamic capabilities, for example product development, facilitate resource management.

To summarize, it is now clear how product development plays an important role for the value creation and the long-term competitiveness of firms: product development yields new value propositions (product offerings) that are used to compete in a changing environment, but also assists in the development of the firm’s resources and capabilities. Thus, product development (similar to other types of innovation, such as process and business systems innovation) facilitates a firm’s adaptation to, and the influence of, the continuously changing market environment. Innovation helps industrial managers devise solutions to business problems and challenges caused by the industry evolution. Innovative activities are carried out either as response or as preemptive action, and are one of the basic pillars for the survival and success of a firm (Hult et. al, 2004, pp. 429-430).

2.3 Innovation

2.3.1 The concept of innovation

As stated in the beginning of this thesis, a classic definition of innovation is the generation, acceptance, and implementation of new ideas, processes, products, or services (Thompson, 1967). In this study, the definition of innovations found in the Oslo Manual (OECD/Eurostat, 2005) is used (see section 1.2). One of the key criteria for products, processes, marketing methods and organizational changes to qualify as innovations are that they be new. Thus, when discussing the definition of innovation, clarifying the concept of *newness* is central. An innovation can, for example, be new to a firm or to an individual, but not new in the market. However, for the sake of the definition of innovation, to whom the innovation is new is less important. As Rogers and Shoemaker (1972) put it: “It matters little, as far as human behavior is concerned, whether or not an idea is ‘objectively’ new as measured by the lapse of time since its first use or discovery... If the idea seems new and different to the individual, it is an innovation.” Thus, what is ‘new’ is up to the beholder, for example the employees of a company. This view is also present in the Oslo Manual (OECD/Eurostat, 2005) and has also been used in the empirical part of this study. The respondents have been

given the opportunity to talk about products new to their firm, even though they might already have existed on the market.

Furthermore, the *degree* of newness can differ. Innovations range from exploration-oriented (radical, disruptive) innovations to exploitation-oriented (incremental, sustaining) innovations depending on their degree of newness (Schilling, 2008; Ireland et al., 2003). Exploitation-oriented innovation is the result of exploiting existing capabilities and helps companies extend their existing competitive advantages, for example by selling better products to their best customers (Ireland et al., 2003). Exploration-oriented innovations introduce “new ways of playing the competitive game”: ways that differ from and are in conflict with current business models. Exploration-oriented innovation involves the development and leverage of totally new resources and capabilities (ibid.).

Another way of defining an innovation is to highlight in which domain its main news value lies. As stated in section 2.3.1, four types of innovations can be distinguished (OECD/Eurostat, 2005): product innovations, process innovations, marketing innovations, and organizational innovations. Hovgaard and Hansen (2004) classify innovations in the forest products industry as product, process or business systems innovations.

For product innovations, Garcia and Calantone (2002) term the continuum of newness as the degree of *product innovativeness*. They suggest that “product innovativeness is a measure of the potential discontinuity a product (process or service) can generate in the marketing and/or technological process. From a macro perspective, ‘innovativeness’ is the capacity of a new innovation to create a paradigm shift in the science and technology and/or market structure in an industry. From a micro perspective, ‘innovativeness’ is the capacity of a new innovation to influence the firm’s existing marketing resources, technological resources, skills, knowledge, capabilities, or strategy.” As a consequence, they define a “radical product innovation” as one that includes a discontinuity in both marketing and technology on micro and macro level; a “really new product innovation” as one that includes a discontinuity in marketing or technology on both macro and micro level; and an “incremental product innovation” as one that includes a discontinuity in marketing or technology on macro or micro level.

Another (common and widely accepted according to Trott, 2005, p. 395) classification of product newness is that suggested by Booz et al. (1982): ‘New-to-the-world products’ create a new market and usually involve a significant shift in technology. The designation ‘product lines new to the firm’ includes products new to the firm that allows it to enter into

established markets for the first time. 'Additions to existing product lines' include products of the same type as the firm's existing products, but with one or more significant changes. The category of 'improvements and revisions to existing products' includes improvements in the performance or reliability of existing products and constitutes the majority of all new product introductions. 'Cost reductions' include no improvements of product performance, but do include increases in value for the firm and/or the customers through the reduction of manufacturing costs and/or price¹⁰. 'Repositionings' are essentially the discovery of new applications for existing products. Examples can be found in the pharmaceutical industry, where drugs can be found to have positive effects on other conditions than those that the drugs were initially intended to address¹¹. Finally, innovations can be classified as 'competence-enhancing' if they build on existing knowledge, or as 'competence-destroying' if they build on new knowledge, and as 'modular' if they imply changes to the components of a system, or as 'architectural' if they imply changes to the structure of a system (Schilling, 2008).

2.3.2 Drivers of innovation

So called market-based views of innovation (Narver & Slater, 1990; Porter, 1985; Porter, 1980) emphasize the scanning and adaptation of the environment as main drivers of innovation. Conversely, the resource-based view (Barney, 2001; Grant, 1991) argues that the assets of the company are a more secure base for the formulation of innovation strategy (Trott, 2005, p. 21). Trott (2005, pp. 21-30) briefly reviews the development of innovation models during the 20th century, describing how either market pull or technology push were the key elements in early models of innovation. Later research asserts that the combination of the two, rather than either one of them solely, should be considered in innovation strategies. In contemporary models, the unique resource and capability base (including the accumulated knowledge base) and the importance of the environment as a network surrounding the company are highlighted (ibid.).

Drucker (2002) concluded that the drivers of innovation are found in process needs, industry and market changes, new knowledge, unexpected success or failure, incongruities, demographic changes, and changes in

¹⁰ In this thesis, this category falls within the definition of process innovation, rather than product innovation.

¹¹ Even though this category could classify as a product innovation according to OECD/Eurostat (2005), it mainly results in innovative marketing and therefore falls outside the definition of product innovation used in this study.

perception. Some of these drivers are visible in the Nordic wood industry. Industry and market changes have led to new process needs, for example, the outsourcing strategies of the joinery and furniture industry have caused a demand for customized blanks (Fransson, 2005), consolidating retail segments have demanded product innovation and supply chain management (Henningsson, 2005), and there has been a general increased focus on environmental performance (Kärnä, 2003). Changes in regulations and perceptions concerning wood in multi-storey construction have resulted in increased interest in wood as a construction material, thus introducing a need for wood-based system solutions for the construction industry (Nord, 2005). New knowledge is also visible in the industry, manifested in new wood processing technology such as automatic camera grading or x-ray-based grading, improved kiln-drying, and wood treatment techniques.

Industrial organization theory suggests that the strategic importance of different types of innovations changes over time (Abernathy and Utterback, 1978). This finding is based on the assumption that industries are born and undergo development in the same way that products do (i.e., in a way similar to the product life-cycle¹²). The implication is that industry evolution is an important driver of innovation. Abernathy and Utterback found that the rate of product innovation is highest in the introduction phase of an industry. When a dominant design among products emerges and possibilities for differentiation decline, product innovation is gradually being replaced by process innovation. When an industry reaches the decline phase, strategic innovation is needed for rejuvenation (Grant 2002, p. 373). Strategic innovation can be both incremental and radical and encompasses the reconfiguration of the value chain, the redefinition of markets and segments, and efforts to break free from the established industry recipe and its trade-offs. Strategic innovation in its most outspoken form is described by Hamel and Prahalad (1994) as 'competition for the future'.

As an illustration of the industrial organization view of the strategic importance of different types of innovations, it is possible to apply the logic to some of the market segments of the Nordic wood industry. Most segments of this industry are in the mature or decline stage, but some can be characterized as being in the introduction or growth phase. An example of a market segment in the introduction phase is the industrialized multi-storey wood construction industry. The demand in the segment is limited to early adopters and there is rapid product development and competition between rival technologies. The products include a wide variety of features and

¹² Regarding the concept of the product life-cycle, see Day (1981).

frequent design changes are common. Manufacturing and distribution are still specialized, and trade is limited to producers and consumers in advanced countries. There are few suppliers and the key success factors of the segment are product development and the establishment of a credible image as a reliable solution.

Inventory management (e.g., at builders merchants) is an example of a complementary service in the late growth phase on its way to maturity. A period of supply deficit is gradually being replaced by market penetration. The quality of the business concept is improving and standardization around dominant business models has come far. Process innovation to press cost is central. Another product segment, industry blanks and components, has been in a growth stage, but increasing signs of maturity is seen. An additional product segment showing clear signs of maturity is custom-graded sawn wood for the furniture industry. The customers are knowledgeable and price-sensitive and the market is characterized by fierce competition. The product design and technology are well-diffused and the competition is based on price and complementary services. Over-capacity is widespread and production is shifting to new industrialized and developing countries. Process innovation and some product innovation dominate among suppliers. Finally, sawn wood as a commodity is clearly in the declining stage. Overcapacity is the norm, differentiation is unprofitable and price wars are common. Strategic innovation towards value-adding vertically integrated and diversified log processing factories is in progress.

2.3.3 Product development models

The product development process can be modeled according to the different activities and corresponding stages included in the process. Activity-stage and decision-stage models are most commonly used to describe the process (Juslin & Hansen, 2003, p. 515; Trott, 2005, p. 400). As stated in section 1.2, the innovation process includes theoretical conception, technical invention and commercial exploitation. On a more detailed level, the Stage-Gate® model (Cooper, 2008; Cooper, 2000; Cooper, 1990) combines the commonly included activities and decision stages of the product development process in a progressive flow (see Figure 8).

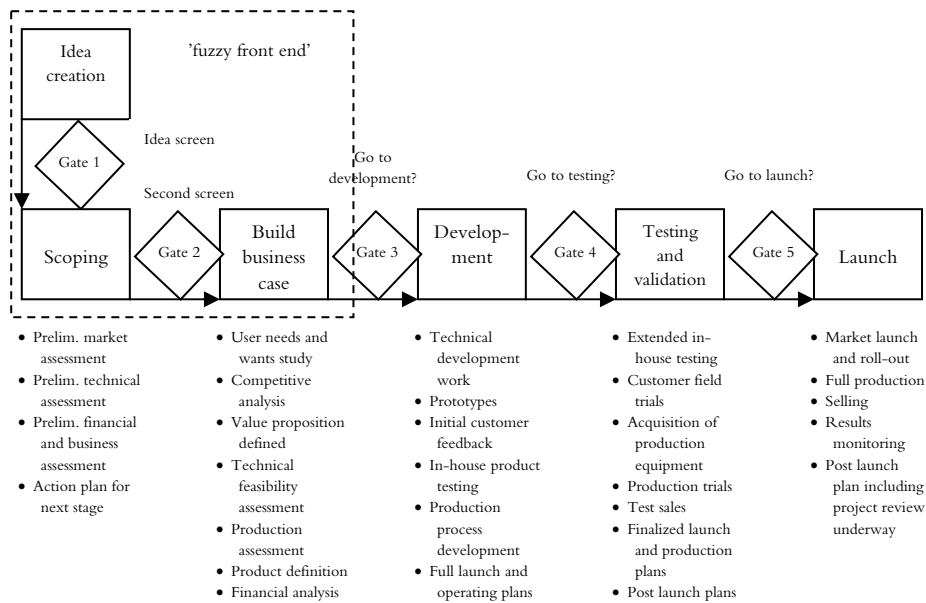


Figure 8. The Stage-Gate® model of product development (Cooper, 2008; Cooper, 2000; Cooper, 1990). An indication of the 'fuzzy front end' has been added by the author of this thesis.

All stages of the model include information-gathering activities by the project team, an integrated analysis by the project team, and a go/kill decision point where a decision to invest more, take a loop back to a previous stage for further analysis, or terminate the project is made (Cooper, 2008). The pre-development stages, or the 'fuzzy front end' of the development process, have generated special interest among researchers (Kim & Wilemon, 2002). The 'fuzzy front end' is the period between when an opportunity is first considered and when an idea is judged to be ready for development. The importance of this phase lies in the fact that important decisions that heavily influence the outcome of the development project are made here, and that altering the project still is possible at a relatively low cost (ibid.).

The arrows in the Stage-Gate® model indicate a linear, sequential flow of separate activities. This is also the conventional way of viewing the innovation process. As mentioned previously, market pull and technology push have been seen as the main driving forces in this process. However, new thoughts question both the linearity and conflict between market pull

and technology push as driving forces (Trott, 2005, p. 23). One main point in the critique has been that market pull (demands) and technology push (new technical opportunities) interact rather than competes as driving forces. Another point has been that successful innovation is dynamic and flexible and involves the simultaneous implementation of activities rather than the linear, bureaucratic, and sequential implementation of activities. The learning processes involved in innovation where knowledge is created and exchanged has also been given too little attention in the classic 'linear' models.

In an attempt to meet this critique, Cooper (2008) points out that even though the graphic presentation of the Stage-Gate® model indicates a linear, sequential, and bureaucratic process, this is not how the model should be interpreted. The possibilities of feedback loops between the stages, of the simultaneous implementation of activities, and of the adaptation of the model to fit the needs of the user prove its dynamism and suitability for illustrating state-of-the-art innovation. It is the opinion of the author of this thesis that the Stage-Gate® model serves the purpose of illustrating the basics of the product development process. However, when using models of the product development process, it is important to consider that even though product development practices often take the form of a well-known best practice, the occurrence and order of product development activities is not completely similar across market, industry or project contexts (Trott, 2005, p. 397; Juslin & Hansen, 2003, p. 516; Eisenhardt & Martin, 2000; Balachandra & Friar, 1997). It is also the belief of the author of this thesis that business process models should be used not as a detailed description, but should rather serve as an illustration of the basic structure of the process and function as a source of inspiration for decision-making and for moving forward.

2.3.4 A resource-based perspective on product development

In research using the resource-based view it has been common to develop measures of firms' resources and capabilities and investigate to what degree they contribute to the overall performance of the firm (Ray et. al, 2004). This approach has been fruitful in many ways, but the evaluation of the possession and employment of resources and capabilities using such a highly aggregated variable as firm performance does also have some drawbacks associated with it. For example, because the total performance of a firm is influenced by many business processes where firms can have competitive advantages in some and disadvantages in others, examining the relationship between resources involved in one business process and the total

performance of the firm can lead to misleading conclusions regarding the contribution of those specific resources to the competitive advantage of the firm. On that basis, it would then be more appropriate to investigate the relation between the resources and the effectiveness of the business process in which they are involved (ibid.). Analyzing the resources and capabilities used in the product development process and their contribution not to the total performance of the firm but to the effectiveness of the product development process is in line with this argument. Furthermore, Sheehan and Foss (2007) argue that strategic management research should benefit from a combination of the (sometimes conflicting) Porter-based activity view and the resource-based view.

Verona (1999) suggests a resource-based framework for analyzing the activities of product development. He highlights the importance of understanding the role of resources, organizational capabilities and agents in the product development process. He writes: "... this perspective shifts the focus of analysis from players (agents) to resources and highlights the role of several capabilities employed in the development process. Using the same metaphor, players (agents) are essential in playing a game because without players there is no game – that is without people there is no knowledge and, therefore, there are no capabilities. But once you have the players – that is, once you have a team and project leader ready to run the process, senior managers ready to coordinate it, and suppliers and customers ready to be involved – you also need to use the knowledge to play and win; in other words, you need to leverage processes, structures, and value to gain the rent." Verona argues that the agents are important for leveraging organizational capabilities (e.g., through leadership) and also as possessors of specific capabilities that themselves are important contributors to the product development process (e.g., deployment of unique strategic visions). The inclusion of agents in a resource-based framework can also be found also in the Sirmon et al. (2007) framework for resource management described earlier.

Verona (1999) classifies the capabilities employed in the product development process as either functional or integrative. The former can be used to produce functional value for customers. Examples include R&D, manufacturing, design, market research, and strategic marketing management. The latter supports the combination and integration of functional capabilities. Examples include internal communication, job training, incentives, process integration, external communication, socializing, recruiting, and networking. Verona states that the knowledge captured in functional capabilities is to a large extent path-dependent and

connected to the accumulated experiences of the company. Referring to research in the area of capability creation and development, Verona argues that integrative capabilities originate in the continuous learning associated with the decisions and actions undertaken in product development projects over time under circumstances of uncertainty. Analogous, functional capabilities are also (re-)shaped through the continuous experimentation and prototyping going on in the development process.

Verona state that integrative capabilities can partly be captured in organizational structure, management systems, and company culture and values, i.e., the elements of the infrastructure in the organizational capability model discussed in section 2.2.3. This is an interesting perspective, because according to the view of the author of this thesis, the elements of the capability infrastructure can be seen as resources with an integrative (rather than a functional) value, for example a certain type of organizational structure, management system, or organizational culture. Verona (1999) continues by arguing for the positive correlation between the existence of both functional and integrative capabilities and the process efficiency and product effectiveness of the product development process. This leads to the important conclusion that a resource-based framework for effective product development should consist of both functional and integrative resources and capabilities, of which the latter partly can be captured in organizational structure, management systems, or organizational culture.

2.4 Innovation management

2.4.1 Introduction

Section 2.2 and 2.3 provided a theoretical background for the study and described a resource-based view of product development. The following section provides an overview of what functional and integrative resources and capabilities and what managerial actions scholars have identified as constituting best practice in product development.

When discussing innovation management, one must distinguish between two separate, yet connected, business objectives. One is the objective of being innovative, i.e., of adopting a strategy that includes a lot of innovation in terms of new products, processes or business systems. Another is the objective of being effective at innovation, i.e., of leveraging the right capabilities properly so that a high degree of success is achieved when a decision to innovate is taken. This section reviews the advice found in the literature for companies that wish to increase their product innovation

activity and/or become more effective at product development work. However, the task of producing more product innovations and being more effective at product development work is far from being a straightforward one. Product development is one of the most difficult tasks that a company can undertake. According to surveys by the Wall Street Journal and Business Week cited by, respectively, Balachandra and Friar (1997, p. 276) and Sivadas and Dwyer (2000, p. 31) a considerable share of new products (90% and 50% respectively) fail to meet business objectives. Product development is a resource-intensive investment involving uncertain outcomes, and it can be assumed that the risk of not meeting stipulated objectives is a major factor causing companies to refrain from entering into product development projects. To provide a context for innovation management, the following section comprises an overview of some challenges of innovation work.

2.4.2 Challenges of innovation work I: The innovation dilemma

The innovation process contains both the creation and the application of new knowledge. Thus, it requires a balancing of explorative and exploitative behavior (Grant, 2002, pp. 357-358). This is described by Trott (2005, pp. 77-78) as the 'innovation dilemma'. According to March (1991), exploration can be described as a combination of search, experimentation, variation and discovery, whereas exploitation includes such elements as refinement, efficiency, implementation and execution. These dichotomous activities demand very different organizational structure, systems and culture. Burns and Stalker (1961) suggested that 'organic' organizational structures permit better organizational response in unpredictable situations, whereas 'mechanistic' organizational structures are better suited to achieving effectiveness in predictable situations. Organic structures are characterized as flat, as non-standardized, and as emphasizing autonomy, whereas mechanistic structures aim for promotion of operational efficiency through control, bureaucracy and coordination systems.

Accordingly, there is no predetermined relationship between the investment in R&D resources and the output of innovations. Instead, productivity depends heavily on the organizational structure, systems and culture with which the R&D resources are integrated and coordinated. Cho and Pucik (2005) found that neither exploration (in terms of achievement in innovation) nor exploitation (in terms of achievement in quality) can be sole drivers of growth or profitability, but that both aspects must be balanced in the overall strategy of the company. They even formulated the act of balancing explorative and exploitative behavior as the most important intangible capability of firms.

It is not obvious, however, that there needs to be a trade-off between exploration and exploitation. Some even conclude that managers of today have to find ways to excel in both areas – simultaneously – through a combination of advantage-seeking and opportunity-seeking behaviors (Korhonen, 2006; Ireland et al., 2003). Kyriakopoulos and Moorman (2004) found evidence that an organizational culture characterized by high market orientation enabled companies to combine exploration and exploitation as it provided a common cognitive frame for employees when interpreting market information flows. They state that a market-oriented culture allows both market-driven and market-driving approaches, which are considered to be the two main strategic driving forces for innovation (Trott, 2005, pp. 21-22). According to Kyriakopoulos and Moorman (2004, pp. 223-224) market orientation can be defined as:

1. a firm-level belief or unifying frame of reference that emphasizes serving the customer or understanding buyers' current and latent needs so as to create value for them
2. a set of organization-wide processes involving the generation, dissemination, and responsiveness to intelligence pertaining to current and future customer needs
3. a firm-level capability that links a firm to its external environment and enables the business to compete by anticipating market requirements ahead of competitors and by creating durable relationships with customers, channel members, and suppliers¹³.

2.4.3 Challenges of innovation work II: The path-dependency of resources and capabilities

As is made evident in the model by Sirmon et al. (2007), resource management in established firms does not start from scratch. When new capabilities are formed from the reconfiguration of current resources or the incorporation of new ones, there already exists a resource and capability portfolio in the firm that will influence the process. This implies that the resource and capability portfolio is, at least to a degree, path-dependent, something that complicates the resource management process.

In a much-cited work, Leonard-Barton (1992), examines the connection between the product development process and the core capabilities of the

¹³ See also Hurley and Hult (1998, p. 43), who state that market orientation can be studied both as a part of the organisational culture (i.e. values and beliefs) and as behaviours and processes. The culture can thereby be recognised as a path-dependent complex system that influences the behavioural part of the concept.

firm. Leonard-Barton defines core capabilities as the knowledge set that distinguishes the firm and provides a competitive advantage. It has four dimensions: the skills and knowledge of employees; the knowledge captured in technical systems; the managerial systems of the firm; and the values and norms of the firm¹⁴. Leonard-Barton discusses the advantages and disadvantages of core capabilities for the product development process. She suggests that the core capabilities can act as enhancers of product development if the capabilities necessary for the development of the new product are closely enough aligned with the existing core capabilities. They can, on the other hand, act as inhibitors of development if the required capability-set of the new product is too different from the core capability. However, if the firms were to only select project development projects that are in full congruence with their existing core capabilities, the competitiveness of the firm would be eroded by the lack of capability-renewal.

The wood products industry is commonly judged to be traditionalistic and captured in old core competencies (Juslin & Hansen, 2003). Accordingly, traditional and production-oriented organizational structures and cultures have been identified as hurdles for innovation in the wood products industry (Hansen et al., 2007; Nord, 2005). The same result has also been found in a study of another process-based industry: the Danish plastics industry (Hansen & Serin, 1993).

2.4.4 Challenges of innovation work III: Coping with uncertainty

Uncertainty is one of the basic problems that companies have to cope with (Thompson, 1967). Uncertainties are especially present in the first phases of an innovation project, during the 'fuzzy front end' (Kim & Wilemon, 2002). Milliken (1987) presents three different types of uncertainties for the firm:

- state uncertainty: uncertainty about the state of the environment, for example about development of market or technology
- effect uncertainty: uncertainty about the effects of state uncertainties on the firm
- response uncertainty: uncertainty about the measures that managers can take to handle uncertainties perceived by the firm.

¹⁴ This can be compared with Hamel and Prahalad's (1990) definition of core competence as a capability a) with a significant contribution to customer value; b) that is difficult to imitate for competitors; c) that gives entrance to a broad array of product markets.

The following factors are identified by Nord (2005, pp. 2-6) as important uncertainties in the Nordic wood industry:

- Uncertain availability or cost of raw material
- Uncertain determination of the interior wood properties of a tree stem
- Uncertain yield of the production process
- Uncertain or lack of profitable outlet of consequential products
- Uncertainties regarding national regulations and standards between markets
- Uncertain development of currency exchange rate differences
- Uncertainties regarding development of market and industry structure
- Uncertainties regarding cost of transportation
- Risk that new products and/or production processes are imitated by competitors

Uncertainty complicates the resource management process that firms use to create value (Sirmon et al., 2007). Product development projects with higher degree of newness and complexity require greater information processing during implementation compared to projects with lower degree of newness and complexity (Tatikonda & Montoya-Weiss, 2001; Olson et al., 1995; Lawrence & Lorsch, 1967). The reason is that a complex project involving innovative products entails more uncertainty and requires the exploration of new knowledge. As stated above (see section 2.4.2), exploration and exploitation demand different types of organizational infrastructure. Burns and Stalker (1961) suggested that ‘organic’ organizational structures permit better organizational response in unpredictable situations, whereas ‘mechanistic’ organizational structures are better suited to achieving effectiveness in predictable situations. Accordingly, product development projects with higher degree of uncertainty should benefit from a more ‘organic’ organizational approach. Conversely, more ‘mechanistic’ structures can be more suitable for projects with a lower degree of uncertainty. This suggests a contingency approach when investigating the effect of project management on project outcomes (Olson et al., 1995, p. 52). In the case of incremental product development (low uncertainty), Danneels (2002) argue that a firm’s new product capability relies on its ability to combine its existing market- and technology related capabilities and that, in the case of radical product development (high uncertainty), it relies more on its ability to identify, evaluate, and incorporate new technological or customer competences. As a consequence (2002, p. 1116), he concludes that “conventional approaches to product development, whereas appropriate for exploitative innovation, may be

inappropriate, and even detrimental, when applied to explorative innovation”.

One way of handling uncertainty is to acquire additional resources as real options (Ireland et al., 2003). This strategy may be valuable if market or production requirements have turned out differently than was expected, but results in increased need for time and other resources during development projects.

2.4.5 Mastering the challenges of innovation work I: To be more innovative

The first objective of innovation management, to adopt a strategy that includes a lot of innovation, is the main interest of the organizational innovativeness research stream (Wolfe, 1994). The objective of much of this research is to identify the factors that overcome the challenges of innovation work and drive organizational innovativeness. Research on the determinants of organizational innovativeness have often been accused of producing conflicting results, and one reason for this might be the lack of precision and consistency in the definition and measurement of innovation and innovativeness (Hansen et al., 2007). This lack of precision and consistency might be a consequence of the difficulties associated with the measurement of such a complex concept as innovativeness.

The classical model in the antecedents-to-innovation literature includes several types of predictors of innovativeness: characteristics of organizational members, characteristics of the organization, and environmental factors (Hadjimanolis, 2000). According to some recent reviews on the topic (Hansen et al., 2006; Becheikh et al., 2006; Trott, 2005), contemporary research has consistently identified a number of factors as antecedents to innovativeness (see Table 1).

Table 1. *Antecedents to organizational innovativeness according to general innovation management literature.*

Hansen et al. (2006)	Becheikh et al. (2006)	Trott (2005)
Specialization and professionalism among managers	Strategic focus on differentiation, innovation and continuous improvement	Growth orientation Vigilance
Managerial support for innovation	Share of exports	Commitment to technology Acceptance of risks
Market- and learning-oriented organizational culture	Flexible and informal organizational structure	Cross-functional cooperation Receptivity
Internal and external communication ability	Well-educated personnel	Slack resources
Company size	Market orientation	Adaptability
Slack resources	Optimal size and location of the firm	A diverse range of skills
Formality, centrality and complexity of organizational structure (neg.)		
Industry maturity (neg.)		

In this thesis, the focus is on those factors that are under the direct control of managers, in essence, the organizational factors. Within recent forest industry research, a diverse range of skills, organizational slack, a management team that encourages exploration and tolerates mistakes (Korhonen, 2006), organizational size (Wagner & Hansen, 2005), a structured product development process and a market-oriented culture (Crespell et al., 2006) have been pointed out as antecedents to innovativeness. The operationalization of organizational innovativeness and its antecedents are described in more detail in article II.

2.4.6 Mastering the challenges of innovation work II: To innovate more effectively

As explained in section 2.2.5, the main features of the product development capability among top performers in product development management can be described in a partly context-dependent ‘best practice’. Research on this ‘best practice’, i.e., research with the aim of identifying key factors for successful product development, is extensive. Authors of review articles on the subject (Ernst, 2002; Cooper, 2000; Brown & Eisenhardt, 1995; Montoya-Weiss & Calantone, 1994) acknowledge the heterogeneity of this research, especially regarding methodology and the definition of successful

product development, and point out the resulting difficulties in finding a consensus regarding key factors for successful product development. Despite these difficulties, a number of important key factors for success actually have been pointed out by these authors (see Table 2).

Table 2. Key success factors for product development according to the literature.

Key factor	Ernst 2002	Cooper 2000	Brown and Eisenhardt 1995	Montoya- Weiss and Calantone 1994	Confirmed in wood industry studies*
Product strategy					
Competitive advantage	√	√		√	
Fit with existing resources		√		√	
Project management					
A structured process	√	√			C
Quality of pre-development analysis	√	√		√	
Clear and early definition of the product concept	√	√		√	
Continuous evaluation with go/no-go decisions	√	√			
Cross-functional team	√	√	√		
Dedicated team	√	√	√		
Strong team leader	√	√	√		B
Autonomous and accountable team	√	√			
Customer involvement		√	√		
Speed to market			√	√	
Organizational characteristics					
Senior management promotes innovation		√	√	√	
Market orientation	√	√			C; B
Market environment					
Market potential			√	√	
Market competitiveness (neg.)			√	√	

*: C refers to Crespell et al. (2006). B refers to Bull & Ferguson (2006).

Within recent forest industry research, a structured product development process (Crespell et al., 2006; Sommerhäuser, 2005), a competent and strong team leader (Bull & Ferguson, 2006) and market orientation (Crespell et al., 2006, Bull & Ferguson, 2006) have been pointed out as important key factors for success in product development projects. The key success factors of product development are described in more detail in articles I and III.

2.5 Theoretical framework of the study

In sections 2.1-2.4 I have tried to present a wider theoretical frame of reference for the study and positioned product development within the resource-based view of the firm. In figure 9 below, I summarize the frame of reference in a graphical model that constitutes the theoretical framework of the study. This framework does not aim to give a complete picture of the company and its environment. The objective is, however, to present my basic comprehension about the role of product development in a wood-industry company. Basically, product development yields new products that are the bases of the value propositions that the firm uses to compete in the market. In addition, by acting as a facilitator of resource management, product development plays an important role in the development of the resources and capabilities of the firm and thus generates new strategic options. Both the challenges of innovation and how innovation is managed influence the innovation process and its outcomes.

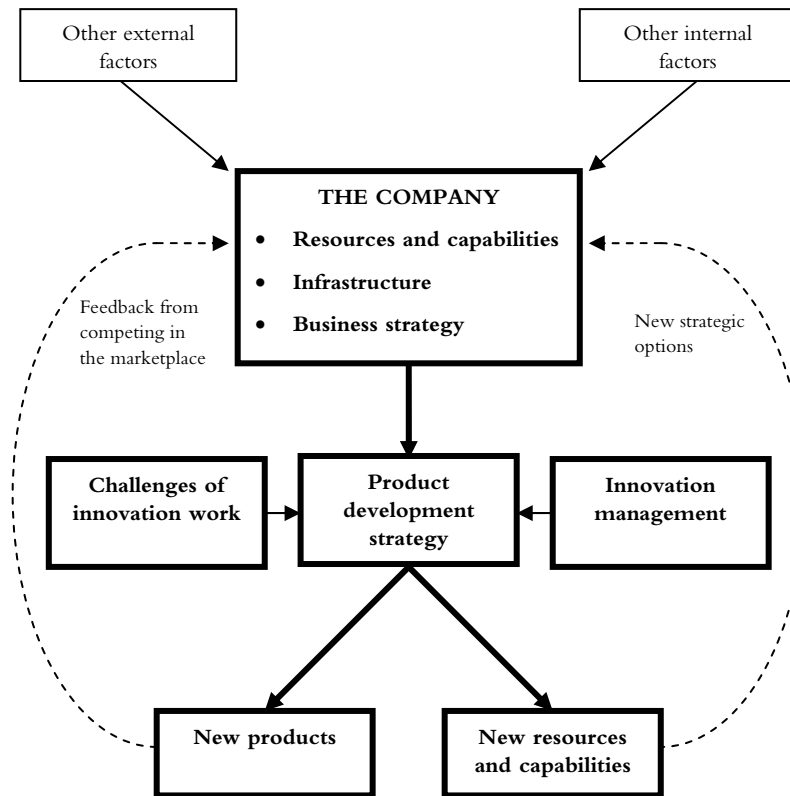


Figure 9. Theoretical framework of the study.

As we will see, the qualitative study (article I) studies all concepts of the framework in a holistic manner. The quantitative studies are a little more specific. Article II focuses on the relationship between the characteristics of the company (including perceptions among managers) and one part of its product development strategy – the recent occurrence of product development projects. The article aims to identify organizational characteristics that influence innovation activity, both antecedents and perceived barriers. Article III focuses on the relationship between another part of the product development strategy: how product development projects are managed, and the perceived degree of success in those projects.

3 Method

3.1 Introduction

As was described in section 1.7, the studies accounted for in this thesis were comprised of a qualitative and a quantitative part. In short, the research was conducted in this way: after the general objectives of the study had been decided, qualitative studies of managerial perceptions about product development were initiated. Semi-structured interviews with 19 product development managers were used to acquire information about drivers, motives and outcomes of product development, about the structure of the product development process, and about key success factors and barriers to product development. Analysis and conclusions from this study was then used as a basis for the design of the quantitative studies. In this phase of the research, a structured questionnaire was used in telephone interviews with 110 SBU managers conducted to gain information about innovation activity, about perceived barriers to product development, about organizational characteristics and about the management and degree of perceived success of a recent product development project. Analyses and conclusions drawn from the qualitative and quantitative studies resulted in recommendations for academics and practitioners about the management of product development in the wood industry and about the need for further research. In the sections below, an overview of the methods used in the qualitative and quantitative studies is given. The overview is complemented with comments about, and a discussion of, some methodological challenges encountered during the research process. A more detailed description of the exact line of actions is given in article I (qualitative) and articles II and III (quantitative).

3.2 The qualitative study

3.2.1 Introduction

The objective of the qualitative study (article I) was to gain initial broad and comprehensive knowledge about product development in the wood industry and to identify managers' views on the subject. The focus was on investigating the occurrence of events and consequences, and the meanings given to those events and consequences by key actors, rather than identifying the frequency of events. For this task, an exploratory multi-case study utilizing qualitative methodology was chosen (Yin, 2003, Silverman, 2001; Merriam, 1994; Eisenhardt, 1989). Qualitative case study research has also been used in other recent exploratory research about the forest industry (Hovgaard & Hansen, 2004; Korhonen & Niemelä, 2004).

Some characterize the qualitative research approach within social science as being unstructured with the aim of avoiding a theoretical pre-understanding that could possibly disturb the analysis of the empiry. This is seen in opposition to the more structured quantitative approach, where theoretical pre-understanding is made central through the use of predefined theoretical concepts (Silverman, 2000, pp. 61-62). However, this is not how the present study should be seen. The reason for this is that the research questions of the study, even though they were open-ended and allowed for the development of a reasoned answer without necessarily using specific theory-grounded concepts, nevertheless were grounded in a conceptual orientation influenced by a theoretical pre-understanding.

3.2.2 Population and sample

Purposive theoretical sampling was used to locate eight Swedish and six Finnish case companies with considerable product development experience. Purposive sampling allows the researcher to choose a case because it represents some feature or process in which he or she is interested (Silverman, 2000, p. 104) and because it is 'transparently observable' (Eisenhardt, 1989, p. 537). Purposive sampling demands a critical evaluation of the parameters of the population in which the researcher is interested. The evaluation should be based on the relevance of the parameter to the research questions, the theoretical position, and the account that the researcher is developing (Silverman, 2000, p. 105). In this study, the nominated companies were categorized based on two variables that were believed to influence managers' views on product development, namely organizational size and integration structure. Further details about the sampling procedure are reported in article I.

3.2.3 Data collection

Common methods of gathering qualitative data are: observation, text analysis, interviewing, and audio/video recording (Silverman, 2000, p. 90). In this study, semi-structured interviews (Troost, 1997, pp. 19-20; Merriam, 1994, p. 88) were used. Interviewing is a very powerful research tool. It provides one with the possibility of capturing a large amount of complex data at a limited cost. It also allows the researcher to ‘run deep’, that is, to obtain information about motives for behavior or beliefs, neither of which would be easily observable using other methods. Merriam (1994, p. 86) argues that the objective of interviewing is to gauge the perspective of another person. This is necessary if the researcher is interested in feelings, thoughts, intentions, the way people create meaning and what consequences that have had on the course of events, in essence, all things that are not observable, but which rather have to be found out by asking people. Merriam (1994, p. 87) concludes that “the interview is to be preferred as a strategy for data gathering when [...] this gives better information or more information at less cost than other methods”.

Observation, text analysis and audio/video recording were not used as data collection methods for the following reasons:

- Observation: Observing the procedures of product development in each case would be too time-consuming and thus would have limited the breadth of the collected data.
- Analyzing texts and documents: Even though some companies have written information describing product development (e.g., quality manuals, brochures for external and internal communication) these sources were considered to provide insufficient understanding of the topic.
- Audio and video recordings: This is another form of observation, usually used to capture the organization of interactions between people. Even though these interactions between people, for example at management meetings, would be interesting to consider when analyzing the meaning and effects of innovation practices, this method was rejected with the same reason as was the method of observation.

According to Silverman (2000, p. 176), the qualitative researcher has to take measures to avoid the problem of ‘anecdotalism’, or the risk of producing invalid findings based on a few well-chosen examples. A common response to this challenge, especially in case study research, is to use multiple types of data and methods, i.e. ‘triangulation’ (Yin 2003, p. 34;

Merriam, 1994, pp. 179–183; Eisenhardt, 1989, pp. 537–538). According to Silverman (2000, p. 98), this is, however, a bit misleading. The reason is that different methods reveal different facts depending on the context-boundedness of the sources used and the theoretical underpinnings of each method. Accordingly, different methods should not be used to validate each other, but instead should enlarge the scope of the data gathered about a topic. This, however, means a wider overall research scope, which can imply a decrease of focus. In sum, data and method triangulation cannot be recommended for ensuring the validity of qualitative research, but only to increase the understanding of the studied phenomenon through a holistic view of the situation in which it occurs (Merriam, 1994, p. 179).

The interviews were carried out during 2005. Key persons responsible for product development activities in each company were targeted as respondents. The interviews were conducted at the office of the respondents. The interviews were tape-recorded and field notes were taken. For each interview an interview guide was used. It included the interview questions as well as general instructions for the conducting of the interview, thus functioning as a case study protocol (Yin, 2003). Further details about the interview procedures are reported in article I. The interview questions focused on product development and were put to all respondents, partly using follow-up telephone interviews. The following set of interview questions was used:

- How is product development work organized in your company?
- Please describe two recent product development projects:
 - What was the new product idea?
 - Why was the project started?
 - What activities were carried out during the development process?
 - What was the outcome of the process?
 - Were you satisfied with the results?
 - What were the key factors for success (or failure)?
- How is product development included in your business strategy?
- What are the strength and weaknesses of the Nordic pine sawmilling industry compared to competing industries?

Traditionally, interviews are used to gain information about the experiences of respondents (e.g. feelings and meanings), or alternatively, about some reality that is external to the respondent (e.g. facts, events). Whereas the realist approach to interview data views the accounts given by the interviewees as representative of these individuals' reality, the narrative

approach views the information gained in an interview as being influenced by the interplay between the interviewer and the interviewee and, thus, as being specific to the interview situation (Silverman, 2000, p. 122). It is assumed that a person adapts his/her way of telling stories depending on the context, for example on what relationship he/she has with the conversation partner, on what he/she believes that the partner knows about the topic of discussion, or on the interview setting in general (ibid.). There are different opinions regarding the meaning and importance that these biases potentially have with regard to the quality of research. Nevertheless, it is safe to say that the social interaction between humans will have some impact on both the reliability and validity of interview-based research. In this study, data were viewed as true accounts of the interviewees' reality, that is, our method of interpretation was in line with the realist approach. Accordingly, we were interested in the issues that the narrative answer gave an account of, rather than in the properties of the narrative itself. However, because the aim of the interviewer should be to try to understand the interviewee and the account he/she gives, the researcher must acknowledge the social interaction between humans that occurs in the interview situation (Ryen, 2004, p. 102). Therefore, in some cases, specific characteristics of how interviewees answered the questions (e.g., making accentuations, using body language) were recorded in field notes and considered in the interpretation of the accounts.

3.2.4 Data analysis

The analysis of the data set followed a strategy for qualitative data analysis recommended by Miles and Huberman (1994). The first step was to concentrate the data by writing summaries of the information gained from each case. To increase the validity of single accounts and the reliability of the data set as a whole, summaries were sent to each respondent for feedback (Yin, 2003; Merriam, 1994). In the next step of the reduction phase, the data were categorized using thematic coding (see Boyatzis, 1998, 'theory-driven coding' pp. 33-37) according to the following themes:

- strategic objectives for product development
- outcomes of product development
- drivers of product development
- the product development process
- key factors for successful product development
- obstacles for product development

Following the categorization of data, the information gained from each case was displayed and compared for each theme. In line with the principles of replication logic (Yin, 2003), a view or opinion stated by several companies was considered to be a main finding of each theme. Finally, pattern-matching (Yin, 2003; Eisenhardt, 1989) was used to compare our findings with those in the literature. For additional details about data analysis, please see article I.

In a remark concerning data analysis, Silverman (2000, p. 119) argues that data analysis is not, and should not be, a separate activity subsequent to the process of data gathering. Conversely, the analysis of data is an activity that is going on all throughout the research project. It begins with the formulation of research questions and continues with the adaptation of the form, content and order of the interview questions both in the office and in the field. When interviews are used as a method for data gathering, the analysis continues with the interaction of the interviewer and the interviewee, and later on with the workup of the information gained. The analysis is a journey between theory and practice executed in order to increase one's understanding of the topic (Danneels, 2002; Eisenhardt, 1989, pp. 544-546). The continuously ongoing analysis influences the research process and might have consequences for the use of methods or for the scope of research questions (Eisenhardt, 1989, pp. 538-539). In this study, this was illustrated by the step-wise development of the set of interview questions (see article I).

The data analysis is one of the most difficult stages of qualitative research (Yin, 2003, p. 109). The challenge is, according to Silverman (2000, p. 176), to produce valid findings and avoid the problem of 'anecdotalism'. With support from the logic of Poppers principle of falsification and avocation of critical rationalism, Silverman (2000, pp. 178-185) suggests some measures to be taken in order to increase the validity of the analysis by exposing the emerging findings to tests of refutability.

- *The constant comparative method* includes testing the emerging generalizations from a small sample on an expanding sample, i.e., using replication logic.
- *Comprehensive data treatment* and *deviant case analysis* means including all relevant data from all cases (the deviant ones, too) in the analysis, so that the generalizations are formulated to cover every bit of relevant data gathered.
- *Using tabulations* derived from theory or the respondents own categories and *appropriate counting techniques* can give straightforward indications of the accuracy of the conclusions made from the data.

In this study, we took into account these issues by through taking several measures, as described in the following section.

3.2.5 Measures to improve validity and reliability

To increase the validity and reliability of the research, especially with regard to the aspects noted above, several actions recommended by Yin (2003), Silverman (2000), Silverman (2001), Merriam (1994) and Eisenhardt (1989) were taken in different phases of the research (see Table 3).

Table 3. *Measures to improve validity and reliability.*

Aspect of research quality	Actions taken in this study
Internal validity (The extent to which an account accurately represents the social phenomena to which it refers (Silverman, 2000)).	<ul style="list-style-type: none"> - purposive and theoretical sampling - respondents reviewed case study reports - multiple coders for data categorization - replication logic in the cross-case analysis
External validity (The extent to which the results from a study are applicable in other situations than the one investigated (Merriam, 1994)).	<ul style="list-style-type: none"> - purposive and theoretical sampling - replication logic in the cross-case analysis - pattern matching during the conclusion-drawing and verification phase
Reliability (The degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions (Silverman, 2000)).	<ul style="list-style-type: none"> - use of established qualitative methodology as the basis for research design - use of a case-study protocol for interviews - respondents reviewed case study reports - detailed description of methods in research reports

3.3 The quantitative studies

3.3.1 Introduction

In this part of the research, the objectives were to identify antecedents and barriers to product innovation activity in the wood industry and to identify key factors for successful product development in the wood industry. These objectives were addressed through the collection of quantitative data from business units in the wood industry and the evaluation of the data using multivariate statistical methods. The studies are accounted for in detail in articles II and III.

3.3.2 Population and Sample

The empirical setting of these studies was the wood industry in Sweden and Finland. The official industry classification systems (SNI code and TOL code for Sweden and Finland, respectively), which classify companies based on their main activities, were used to frame the population¹⁵. Companies with at least 20 employees and the following main activities were targeted in the studies:

- Sawmilling: SNI 20101/TOL 20100
- Planing: SNI 20102/TOL 20100
- Impregnation/wood treatment: SNI 20103/TOL 20100

Because the survey contained both strategic and operational questions, strategic business units (SBUs) within each company were addressed. A pre-study of SBU structure in the companies produced a list of 110 (Sweden) and 59 (Finland) SBUs that comprised the sample frame.

In order to describe the population, it is necessary that the sample be representative with regards to the population. In order to study relationships between variables, it is necessary that the sample cover a wide variation for the relevant variables in the population, and that the sample contain a certain amount of units. Furthermore, because a small sample size results in a risk of low statistical power, and because the population itself is rather small in this study, a total investigation of all units in the sample frame was attempted. The initial sample thus contained all 169 SBUs in the sample frame.

In the study that focused on antecedents and barriers to product innovation (article II), the SBUs were the study units. In the study that focused on key factors for successful product development project management (article III), the most recent product development projects in each of the innovating SBUs¹⁶ were the study units. Further details about the scope of the population and the sampling procedures can be found in articles II and III.

¹⁵ The industry classification codes classify the companies based on their main activities. However, other activities than the one under which each is classified can also be carried out by the company. To clarify the activity structure of participating SBUs, the total extent of the units' activities was investigated in the survey questionnaire.

¹⁶ An innovating SBU was defined as an SBU that had operated a product development project within the last five years.

3.3.3 Data Collection

Even if the sample frame is representative, the final sample may not be. The reason for this is the effect of loss due to non-respondents. The rate of response in surveys depends mainly on two factors: the respondents' cognition of the questions and the respondents' motivation to answer the questions (Dillman, 2000). It is therefore necessary to ensure the high quality of the questionnaire. In this study, the tailored design method (Dillman, 2000) guided the design of the study and the construction of the survey questionnaire. Because the small sample size resulted in a need for a high response rate, telephone interviews were preferred before the more common procedure of using a self-administered questionnaire. In Sweden, responses from 87 SBUs were received, yielding a response rate of 79%. In Finland, responses from 23 SBUs were received, giving a response rate of 39%. The final sample thus consisted of 110 SBUs in the study focusing on antecedents and barriers to product innovation (article II). In order to control the effect of the loss, a non-respondent analysis was made. It revealed that small SBUs with sawmilling as their main activity were slightly underrepresented in the final sample. In the study that focused on key factors for successful product development project management (article III), the final sample consisted of the most recent product development projects in each of all innovating SBUs, yielding a total of 70 cases (projects). The basic characteristics of the SBUs that returned the questionnaire are displayed in Table 4.

Table 4. Characteristics of SBUs that returned the questionnaire.

Characteristic	Type	Number of SBUs	Share of SBUs (%)
Country of origin	Sweden	87	79
	Finland	23	21
	Total	110	100
Size ^a	Micro and small	22	20
	Medium	60	55
	Large	24	22
	Missing data	4	3
	Total	110	100
Integration structure	Production of...		
	...sawn goods only	14	13
	...sawn and furtherprocessed ^b goods	75	68
	...furtherprocessed goods only	21	19
	Total	110	100
Raw material mix ^c	Spruce focus	48	43
	Pine focus	36	33
	Hardwood focus	2	2
	No focus	23	21
	Missing data	1	1
	Total	110	100
Innovation activity	Innovating ^d	70	64
	Non-innovating	40	36
	Total	110	100

^a: micro and small = turnover 2005 up to EUR 9 999 999; medium = turnover 2005 EUR 10 000 000 – 49 999 999; large = turnover 2005 more than EUR 49 999 999.

^b: furtherprocessed goods = impregnated goods, poles, paneling, mouldings, floorings, planed construction wood, blanks, engineered wood products, building modules

^c: spruce focus = a raw material mix consisting of more than 66% spruce; pine focus = a raw material mix consisting of more than 66% pine; hardwood focus = a raw material mix consisting of more than 66% hardwood (in subsequent analyses where data about raw material mix were used, SBUs with a hardwood focus were excluded from the analysis due to the small size of this group); no focus = neither a spruce, nor pine nor hardwood focus

^d: An innovating SBU was defined as an SBU that had operated a product development project within the last five years.

Interviews with managing directors or other members of each SBU's management group with knowledge about the SBU's product development strategy were carried out during the fall of 2006. In Sweden, bookings and interviews were carried out by one of the researchers. In Finland, bookings and interviews were carried out by a commercial data collection agency. The interviews followed a pre-tested structured questionnaire that was sent to the respondents beforehand.

In the quantitative studies, data consisted of managers' opinions about the characteristics and performance of their organizations. Field studies analyzing the correlations between two or more self-reported variables suffer from problems associated with common method variance (Podsakoff & Organ, 1986; Philips, 1981). Briefly, common method variance is when respondent bias influences the two variables in the same fashion and in the same direction and thus causes artificial covariance. The researcher has to try to identify these potential causes of artificial correlation and reduce the magnitude of the problem or, at least, discuss their impact on the validity of the results. The most well-known sources of this type of respondent bias are social desirability, the consistency motif, and cues in the stimulus setting (Podsakoff & Organ, 1986). 'Social desirability' refers to the propensity of people to answer questions in a way that present them in a favorable light. 'The consistency motif' is related to the general opinions among people about 'how things work' and their propensity to answer in ways consistent with these beliefs. The idea of 'cues in the stimulus setting' is related to various circumstances in the interview setting, for example, the respondent is very happy, is under stress or suffers from hunger. These are circumstances that can influence the answer for independent and dependent variables in the same direction (*ibid.*). Whereas factual data that are verifiable and easier for the respondent to report pose less serious problems of this type, non-verifiable data concerning characteristic behavior, psychological states or perceptions about the environment cause more of a problem. This study contained both factual data (e.g. size, educational level among white-collar workers, export share), behavioral data (e.g. market orientation) and perceptual data (e.g. perceptions about innovation barriers).

There are various methods available to mitigate the problems associated with the common method variance. Of these, procedural measures are referable to statistical post hoc measures (Podsakoff & Organ, 1986). To reduce the possible effects of the consistency motif in these studies, questions about the dependent variables in article III (degree of success in a recent product development project) were placed subsequent to questions about the independent variables in the questionnaire. For the same reason, the

question about the dependent variable in article II (product innovation activity) was placed as an introductory question that was free-standing from the questions about organizational characteristics – the independent variables that were used to explain product innovation activity. In addition, some of the items in the multi-item scales were reverse coded (i.e., a statement was presented that, in theory, had a negative correlation with the dependent variable).

The variables displayed in Table 5 were gathered for the quantitative studies. The variables included both qualitative and quantitative data. Some of the former was quantified using five-step one-item or multiple-item Likert scales. Likert scales commonly present an item as a declarative sentence, followed by response options that indicate varying degrees of agreement with the statement from 1=strongly disagree to 5=strongly agree (De Vellis, 1991, p. 68). A good Likert scale item should state the opinion, attitude, belief or other construct under study in clear terms. It is not proper nor necessary to span the range of strong to weak assertions of the construct; the response options provide the opportunity for gradations (DeVellis, 1991, p. 70). The idea with multiple-item Likert scales is to capture a latent construct through the use of several indicator questions. In order for a multiple-item Likert scale to be considered reliable, the answer to all items (questions) must point in the same direction. Confirmatory factor analysis and the calculation of Cronbach alpha values and inter-item and item-to-total correlations were used to confirm the reliability of multi-item scales in this study. In line with common practice in this type of management research, we assumed equal distance between the alternatives on the scale. Accordingly, mean scores could be calculated for each respondent.

To avoid missing data, an 'I don't know/I can't answer' alternative was not offered to the respondents. However, the Likert scales included a midpoint (3). This gives the respondent the option of answering at the midpoint when they are unable to give any clear yes/no statement about the question (DeVellis, 1991, p. 67). The drawback is that this approach results in ambiguity concerning the meaning of answers from respondents that answered "three" to a question: did they express neutrality or did they express disinterest or inability to answer? Once again, this study followed the common assumption in this type of management research, considering an answer at the midpoint of the scale to represent neutrality (James Sallis, senior lecturer, dept. of business economics, Uppsala University, personal conversation 2006).

For further details about how the variables were operationalized and measured, please refer to articles II and III.

Table 5. *Variables in the quantitative studies*

For use in article II

With reference to the situation in the SBU...

Organizational innovativeness: Has your SBU operated a product development project within the last five years? (yes/no)
Size (turnover 2005)
Export share (share of exports 2005)
Production of sawn goods (yes/no)
Production of further-processed goods (yes/no)
Raw material mix (processed cbms. round wood in different species)
Educational level among white-collars (share of white-collars with university education)
Market orientation (multi-item perceptual scale)
Perceived importance of some hypothetical barriers to product development (one-item perceptual scales)

For use in article III

With reference to the most recent product development project...

Product newness (multi-item perceptual scale)
Degree of success (multi-item perceptual scale)
Product advantage (multi-item perceptual scale)
Sharpness of product concept definition (multi-item perceptual scale)
Customer involvement (one-item perceptual scale)
Cross-functionality of the development team (one-item perceptual scale)
Strength of the project leader (one-item perceptual scale)

3.3.4 Data analysis

Data from the survey were saved in a database and analyzed with a computer program for statistical analysis (SPSS 14.0). For the objectives of identifying antecedents and barriers to product innovation in the wood industry (article II), the unit of analysis was the 110 responding SBUs. The details of the data analysis for achieving these objectives are reported in article II, and a brief summary is given below.

To describe the difference between innovating and non-innovating SBUs with regard to size, integration structure and raw material mix, observed and

expected frequencies of innovating and non-innovating SBUs in the descriptive categories of the variables were calculated. The significance of the differences between observed and expected frequency was then determined through chi-square tests. The differences between innovating and non-innovating SBUs with regard to market orientation, educational level among white-collar workers, and export share were determined through the comparison of mean values among innovating and non-innovating SBUs. The significance of the differences was then tested with t-tests and Mann-Whitney U-tests. To examine group differences more closely, binary logistic regression was applied. Similar to discriminant analysis, this is a multivariate technique that can be used either as a type of profile analysis or as an analytical predictive technique (Hair et al., 1998). In this study, logistic regression was used to profile the innovating SBUs and to determine the influence of each individual organizational characteristic on the probability of the organizations being an innovating SBU. Information about perceived barriers to product development was obtained through the calculation of the means of agreement with each barrier statement for all respondents and for innovating and non-innovating SBUs, respectively. In addition, answers to an open-ended question about additional barriers were scrutinized. Finally, to investigate multidimensional relationships among perceived barriers to product development and to provide a more concise picture of these barriers, a principal component factor analysis was conducted. Factor scores were then compared between innovating and non-innovating SBUs and the significance of the differences was tested with t-tests and Mann-Whitney U-tests.

For the objective of testing the influence of a number of variables (hypothetical key success factors) on the perceived degree of success of product development projects (article III), the most recent product development project in the 70 innovating SBUs was the unit of analysis. First, descriptive statistics and factor analysis were used to evaluate the suitability of the data for multivariate analysis and identify simple correlations between variables. Second, hierarchical ordinary least squares (OLS) multiple regression was used to determine the influence of the hypothetical success factors on the perceived degree of success, and, also, the effect of product newness on this influence. This part of the quantitative analysis is presented in detail in article III.

The models of the quantitative studies illustrate causal relationships. However, there are many requirements to be fulfilled in order to establish causality (Johansson, 2003, p. 132; Cook & Campbell, 1979, p. 31):

- Cause and effect appear together (association or correlation)
- The ruling out of other possible factors as causes (isolation)
- Cause precedes effect in time (directionality)

The research design used in the quantitative studies offers good statistical possibilities for dealing with association or correlation, but it yields only limited statistical possibilities for dealing with isolation and no statistical possibilities for dealing with directionality.

Association or *correlation* can be tested with statistical techniques, provided that there is a sufficient variance among the variables between study units, that the variables show a certain degree of stability over time within the individual study unit, and that the independent variable has already caused the dependent variable (Calder et al., 1981). Because the details of a dynamic capability like product development are partly idiosyncratic and path dependent (Eisenhardt & Martin, 2000), a certain amount of variance between companies in terms of their product development practices can be assumed. Furthermore, the variables in the study were considered to be relatively stable over time and not very quickly changed by management. This is especially true for cultural factors such as market orientation (Hurley & Hult, 1998, p. 48). To summarize, this suggests that both the criterion of variable variance between study units and variable stability within study units is fulfilled in this industry context. Most of the variables in the quantitative studies are also well-known and have been used by researchers in similar studies both within and outside the wood industry context.

Even if a correlation between two variables is found, it is not certain that the correlation is a sign of a causal relationship. It might be the case that a third variable causes both variables, resulting in an apparent relationship between the two studied ones. If all variables can be controlled for, this type of interrelationship can be identified with multivariate statistical methods and the *isolated* effects of one variable on another could be determined. This is easier in an experimental setting than in a field setting, in which many variables are difficult to control. Here, a choice must be made in terms of which variables that can be assumed to be most important (explaining most of the variance in the dependent variable) and should be included in the model. Model specification, that is to say, the choice of variables to be included in the model, thus becomes important.

In the quantitative studies, several parameters guided the model specification. First, a literature review, including results from the qualitative study, was carried out to identify the most relevant variables. Second, the literature was examined to identify alternative ways of operationalizing these

variables. These operationalizations were preliminary assessed by the researchers with regard to their suitability for use in the Nordic wood industry research context. The variables for which a suitable operationalization was found was then included in a preliminary version of the survey questionnaire. This was pre-tested among industry experts and potential respondents so that we arrived at a final set of variables and operationalizing survey questions. Thus, the choice of variables for inclusion in the models of the quantitative studies was made based on both theoretical and methodological concerns. The validity of the chosen set of variables (i.e. the validity of the model specification) was then assessed through a comparison of the explained percent of variance for the models of the quantitative studies with that of other similar models found in recent literature. Furthermore, the choice of a single industry for investigation limits the external validity of our results. However, it also reduces problems of inter-industry variance that normally require the control of many inter-industry factors to account for the heterogeneity of estimates (as pointed out by Kyriakopoulos & Moorman, 2004, p. 226). The choice of a single industry as the setting of the study thereby lessens the uncertainty about the fulfillment of the isolation criteria. However, because some variables must be omitted, some uncertainty regarding their influence – and regarding the validity of the model – remains. Therefore, among other things, it is important to recognize that this study can only be seen as exploratory, rather than explanatory.

Directionality is even more problematic. Since this is a cross-sectional study, data were collected at one point in time and it is not possible to determine which element was the cause and which element was the effect in a correlational relationship. Without the inclusion of the time dimension in data collection, only existing theory remains as a basis for the determination of the directionality of social correlational relationships.

To summarize, only correlation or association between variables can be shown statistically with this research design. The degree of the isolated effect of certain variables is limited to the variables included in the models, that is to say, interaction with other (omitted) variables is left unknown. Regarding causality, only theory can provide support with this research design.

Furthermore, causal relationships are often more complex than what normally is described in scientific models. The meaning given to the *cause-construct* by scholars of the realistic school results in the following view on a causal relationship: “Events (E) are caused by causal mechanisms (CM) that in turn is activated by certain conditions (C). The causal mechanisms can

most often not be observed directly.” (Djurfeldt et al., 2003, p. 26). This conceptualization is illustrated in Figure 10.

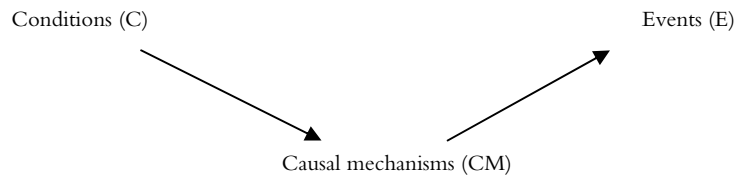


Figure 10. The realistic view on casual relationships. Adapted from Djurfeldt et al. (2003).

It follows from the last sentence in the citation that the causal mechanisms are often excluded from direct measurement. Instead, they can be represented with latent constructs (such as market orientation) or included in a theoretical discussion of why a condition is believed to cause an event. The quantitative studies are examples of the realistic view of causal relationships. Managers’ perceptions about *conditions* and *events* are gauged, and theory is used to describe and discuss possible causal mechanisms that exist between them.

Finally, a statistical analysis of causal relationships consists of two main phases: a) identifying relationships in the sample, and b) testing to see if these relationships are likely true in the population with the help of statistical methods based on probability theory (Djurfeldt et al., 2003, p. 143). Because the initial sample is equal to the sample frame, the quantitative studies can be considered an analysis of the whole population and tests of the relationships might seem unnecessary. Loss due to non-respondents, however, resulted in a final sample smaller than the initial sample, which, in essence, means that it is not a total investigation. Furthermore, statistical tests are also commonly used in investigations of the total population to test whether the identified relationships are significant or not (ibid.).

4 Findings

4.1 Introduction

In this section, the main results of the qualitative and quantitative studies are summarized. A more detailed report of findings can be found in articles I, II, and III. The research questions of the studies were as follows:

Article I (qualitative):

- What are the strategic objectives for product development?
- What are the outcomes of product development?
- What are the drivers of product development?
- What activities and actors are included in the product development process?
- What are the key factors for successful product development?
- What are the most important barriers to product development?

Article II (quantitative):

- What organizational characteristics influence organizational innovativeness, as manifested in the amount of product development activity?
- What factors do managers perceive to be the most important barriers to product development?

Article III (quantitative):

- What project management factors influence the degree of success in product development projects?
- How does product newness affect this influence?

4.2 Drivers, strategic objectives, outcomes and antecedents of product development

The interviews with product development managers in the qualitative study accounted for in article I revealed that industry and market changes (leading to changing customer needs) were commonly perceived as drivers of product development in the industry. The respondents of this study also commonly stated that their companies started product development projects to increase the competitiveness of their product portfolios. However, narratives about these projects revealed that they also had a considerable effect on the renewal of the companies' resources and capabilities.

The analysis of quantitative data accounted for in article II showed that 57 (66%) SBUs in Sweden (N=87) were innovating SBUs and that 13 (57%) SBUs in Finland (N=23) were innovating SBUs. In total, 70 (64%) SBUs in the two countries (N=110) were innovating SBUs. Furthermore, binary logistic regression analysis showed that organizational size and educational level among white-collar workers have significant individual influence on product development activity in the industry. Market orientation, share of exports, vertical focus (only sawmilling or only furtherprocessing activities), or raw material focus (more than 66% pine or more than 66% spruce) had no significant independent influence on product development activity.

4.3 The product development process and its key success factors

The product development process was described by the product development managers in the qualitative study as informal and flexible, emphasizing testing and feedback procedures. Commonly cited key factors for successful product development among these respondents included the promotion of entrepreneurship and market orientation among the personnel and the set-up of rapid and informal, yet complete and well-defined development projects led by a strong leader. The allocation of competent people to development work specifically, as well as access to flexible and versatile production equipment, was also commonly mentioned as an important prerequisite for success among these respondents. Read more about this in article I.

The analysis of the quantitative data accounted for in article III confirmed that the sharpness of the product concept definition (characteristics, performance, target market, and positioning strategy of the product) before one enters into development work (i.e., well-defined project targets) is crucial for product development success in the wood industry. The analysis

also indicated that the strength of the project team leader has a significant positive influence and that the degree of customer involvement has a negative influence on product development success. Conversely, product advantage and the cross-functionality of the development team did not show a significant influence on product development project success. These findings were found to be robust for incremental as well as more radical product development projects. Further details can be found in article III.

4.4 Barriers to product development

Finally, resource constraints, production process uncertainties, the weaknesses of the wood material, and structural shortcomings of supply chains to some market segments were identified by product development managers in the qualitative study as barriers to product development (see article I). The analysis of quantitative data from the cross-sectional survey described in article II showed that the difficulty of giving practical priority to development work during the stress of everyday activity was perceived as the most important barrier to product development among managers in both innovating and non-innovating SBUs. A low competence level among the personnel and a low need to innovate were perceived to be the second most important barriers to product development among managers in, respectively, innovating and non-innovating SBUs.

5 Discussion and conclusions

5.1 Introduction

This section first reports and discusses the reliability, validity and limitations of the study. Then, the findings of the study are discussed and compared with those of existing literature. Finally, recommendations for product innovation in the wood industry are presented and advice for further research is given.

5.2 Reliability, validity and limitations of the study

Research that cannot show that its methods and data are reliable and that its conclusions are valid is of little value. Silverman (2000, p. 175) defines validity as "...truth, interpreted as the extent to which an account accurately represents social phenomena to which it refers". Both internal validity (do the gauges used actually measure what they are intended to measure (Juslin & Lindström, 1998)), and external validity (to what extent are the results generalizable to the whole population (ibid.)), are relevant for this study. Merriam (1994, p. 177) identifies some important aspects to consider when discussing internal validity: information never speaks for itself – it always has to be interpreted; to measure an event without changing it is impossible; numbers, equations and words are abstract symbols of reality and are not the reality itself. Accordingly, the validity of interview-based research findings must be assessed through judgments of the validity of the researcher's interpretation of (people's) construction of reality. Accordingly, the challenge for a researcher doing interviews is to seek understanding of the interviewee and of his or her view on reality.

Reliability can be defined as "...the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions" (Silverman, 2000, p. 175). However, reliability is a somewhat problematic concept in social science. The challenge of ensuring the reliability of the methods used is, at least for the method of interviewing, related to the fact that "asking and answering any question can never be separated from mutual interpretations which are inherently local and non-standardizable" (Silverman, 2000, p. 185). Furthermore, according to Merriam (1994, p. 180), the basis of the concept of reliability is that there is one reality that would look the same if studied on repeated occasions. Because interview-based research, however, often deals with the interpretation of people's construction of reality, and because people's behavior is not static and their construction of reality is individual, there are no solid points of reference for repeated measurements for ensuring a reliable result (ibid.). Interestingly, some scholars consider this view as ruling out systematic research (Silverman, 2001, p. 226). However, instead of only defining reliability as congruence over repeated observations, one may find it useful to consider the reliability of the result by assessing the overall research methods and perspective of the researcher. For this to be possible, it is important for the researcher to give a detailed account of the research process (Merriam, 1994, p. 180).

Specific measures taken to strengthen validity and reliability, and the detailed limitations of this study, are reported in articles I, II, and III, and also partly in the method section of this thesis. In the qualitative study the main limitation is the risk of invalid interpretations of respondents' accounts, a weakness inherent in all interview-based research. In the quantitative studies, the main limitations concern the operationalization and measurement of constructs. Also, model specification (which variables and relationships to study) constitutes a limitation of the conclusions that can be drawn. Some complements to the discussion in the articles are given in the paragraphs below.

In both the qualitative and quantitative studies, product development in the wood industry is studied with the assistance of the resource-based view of the firm and the organizational capabilities approach. This framework is not used in its most rigorous form, with the detailed operationalizations of all its concepts, but is instead employed as a conceptual frame for structuring the data. The benefit of entering a research project with a certain degree of theoretical pre-understanding is that it allows the researcher to analyze the gathered data in a structured way, for instance to make comparisons with other research through the categorization of the data according to the proper

theoretical concepts and models. The drawback is that some information that emerges during the research project is filtered away and not further considered. The focus of the researcher is directed in a certain direction, which helps him or her to see the focal phenomena more clearly, but this hinders the discovery of unexpected information. To summarize, it is important to realize that the narrowing down, focusing and choices made according to the theoretical framework of the study also mean that this research and its results are only one way of looking at the topic of product development in the wood industry.

Data collection in this study relied on semi-structured and structured interviews with managers. The qualitative study (article I) is described as a study of managerial perceptions, and the findings are treated as what they are: the individual opinions of a deliberately chosen set of people. For questions about the structure of the product development process, key success factors, and product development barriers, much of the synthesis was left to the respondents. Because the interviewees were very qualified experts on product development, however, the validity of their accounts, and thus the findings of the study, can be expected to be high.

In the quantitative studies (article II and III), a more 'objective' approach to data was applied. Increased 'objectivity' was achieved by reducing respondents' input from narratives to quantified opinions about pre-given alternatives. Thus, if the constructs and their operationalizations gave a valid account of what they were intended to measure, and the respondents' opinions were reliable, valid conclusions about an 'objective' or 'non-subjective' reality could be drawn. However, because the data were based on individual opinions, it was still influenced by the interpretations, judgments and reliability of the respondents. Whereas factual data pose less of a problem in this sense, perceptual data are a bigger challenge. Podsakoff and Organ (1986) remind us about the problem of common method variance associated with the collection of perceptual data from key respondents (see section 3.3.3). Even if some procedural measures were taken in this study to decrease the effect of one of the sources of common method variance (the consistency motif) the risk of bias due to social desirability or cues in the stimulus setting still exists.

It can be argued that interviews can never produce anything but idiosyncratic and subjective data, and that conclusions about events external to the respondent based on this type of data are meaningless. There are, however, arguments that point in the other direction. Most questions used in the quantitative study are established operationalizations of the constructs they intent to measure (see details about the origin of the constructs and

their operationalization in article II and III). They have been developed, validated and used by many researchers over the years. Multi-item questions also provide a possibility for the control of reliability through confirmative factor analysis and the calculation of Cronbach's alpha. Furthermore, there is also evidence that conceptualizations may be shared among managers of different firms in the same industry. Managers share a common language and similar understandings of what the industry is and how it works (Alkbring, 2003; Pehrsson, 1990; Huff, 1982).

To summarize, it is important to adopt a humble perspective regarding the measurement of complex social phenomena through the use of structured self-report questions. In this study, measures were taken to improve the validity and reliability of data gathering but the reader is also encouraged to carefully evaluate the construction of the variables and the questionnaire as a part of the interpretation of the findings of this study.

5.3 Discussion of findings in the light of the literature and suggestions for further research

5.3.1 Drivers, strategic objectives, outcomes and antecedents of product development

The drivers, strategic objectives and outcomes of product development that were reported by the respondents in article I conformed relatively well to what could be expected based on existing literature and the present industry conditions. The lack of 'capability development' as an objective for starting product development projects in the investigated companies indicates a somewhat narrow product-market focus in their product development strategy.

The findings reported in article II suggest that the total share of SBUs in the Swedish and Finnish wood industry that were active in product innovation during 2002-2006 was 64%. This figure can be compared to the findings of the Swedish and Finnish CIS 2004 where, respectively, 39% and 34% of all industry companies were found to be active in product innovation during 2002-2004 (Statistics Finland, 2007; Statistics Sweden, 2006). With reservations to account for the possible effect of the identified underrepresentation of small sawmills and slightly different study units and time periods between this and the present study, the relatively large share of innovating SBUs found in the wood industry gives an indication of the increased interest in innovation even what is traditionally seen as a 'low-innovation' industry.

The findings reported in article II also suggest that organizational size and educational level among white-collar workers are two important facilitators of product development activity in the wood industry. These variables are also commonly mentioned in the literature (Hansen et al., 2006; Becheikh et al., 2006) and motivated mainly by better access to resources and more possibilities for innovation among large companies as well as better creativity and problem-solving capability among companies with well-educated personnel and a mix of academic- and experience-based competence. Among these factors, the possibility of increasing the share of academics in the wood industry might be considered the more interesting of the two. Low competence level among the personnel was also pointed out by respondents in the survey as one of the most important obstacles to product development. The need for more academics and the positive effects this could bring have also recently been discussed in the branch (Carlsson, 2008).

Some antecedents of innovation activity identified in other industries found, however, no support in the data. The unexpected results might be evidence of specific conditions typical for the wood industry. Regarding export share, for example, a common business model in the wood industry is selling commodity products in export markets via company-external agents (Hugosson & McCluskey, 2008). These agents handle direct communication with the customers and possibly work as filters or even obstacles for the flow of information from the market to the customer. In this way, the positive influence of a high export share on the flow of market information is reduced in the wood industry. This might explain the lack of influence of export share on innovation activity found in article II. In the same article, it was also shown that market orientation is of less importance for innovation activity. This is in conflict with the literature and also with the statements from managers in the qualitative study. One explanation for this contradiction might be that market orientation in a conservative industry (with conservative customers as well) might lead to a situation where the business unit gets stuck in gradual improvements of existing products instead of seeing new possibilities (Mohr et al., 2005, p. 116). Korhonen and Niemelä (2004) found in a study of the leading forest industry companies that “a strong customer orientation could counteract the innovation benefit resulting from improved internal information flow”, that is, being too focused on customers might hinder innovation and only produce the gradual improvement of existing products. Nevertheless, market orientation was acknowledged by the managers in the qualitative study as an important facilitator of product development. However, the managers in the qualitative study represented companies recognized as innovation leaders in

the industry. It is not implausible that these companies might also mainly have relationships with the innovation leaders among customers. Because these companies are focused on new solutions, close relationships with these companies might actually lead to new ideas instead of the improvement of past solutions. The structure and effects of market orientation are widely debated among scholars. It has, for example, been suggested by Narver et al. (2004) that a special form of *proactive* market orientation is needed, in which reaction to market events is complemented by proactive opportunity-seeking. This would then protect from passiveness and from restriction to incremental innovations. Furthermore, Atuahene-Gima et al. (2005) argue that the effects of market orientation on product development success are complex. The authors argue for a curvilinear relationship, in which a 'medium' level is to be preferred, whereas low and high extremes are seen as counterproductive. Another possible explanation for the lack of influence of these two well-known innovation antecedents is the fact that this study focused more on product innovation than other types of innovation, for example process and business system innovation (Hovgaard & Hansen, 2004). Factors found to have no influence on product innovation in this study might instead have an influence on other types of innovation in the wood industry.

5.3.2 The product development process and its key success factors

Managers' views on product development, as described in article I, showed that product development in their companies deliberately is carried out in a more unstructured, trial-and-error fashion than what is recommended in the literature (see, e.g., Cooper & Kleinschmidt, 2004). The opinions expressed by managers also give evidence of a close relationship between product, process and business model innovation. This is in line with some literature (Schilling, 2008, p. 45) but in conflict with an earlier study of innovation in the forest industry (Hovgaard & Hansen, 2004) which describe these types of innovation as more or less separate processes.

As was shown in article III, the sharpness of product concept definition and leadership strength has a positive influence on the success level of product development projects. This is not surprising. These two factors have consistently been pointed out by previous researchers, and also by the respondents in the qualitative study (article I), as important facilitators of success. It is assumed that these two factors decrease the feeling of discomfort among the personnel caused by the uncertainty of the innovation project, help with the prioritization of tasks, and also improve the coordination of work between company functions. The literature points out

the importance of careful pre-analysis work during the ‘fuzzy front end’ of the development process in order to arrive at a sharp, high-quality product concept definition before entering into the more costly development phase. An inadequate pre-analysis might lead to heavily changing goals during the project – something that can make initial investments obsolete, cause frustration among development team members and increase development time (Salomo et al., 2007). However, allowing no goal changes while development is underway may indicate a real rigidity of process management (ibid.). Furthermore, too much pre-analysis kills the energy of the project according to the respondents in the qualitative study. This contradiction points out the importance of balancing formality, structure and attention to detail with informality, flexibility and speed in wood industry product development projects. This challenge resembles the challenge of balancing or simultaneously conducting exploration and exploitation, as acknowledged by previous research (Trott 2005 pp., 77-78; Grant 2002, pp. 357-358). Closer investigations into how a high quality pre-analysis could be achieved while still maintaining creativity and energy in the project would be interesting for both academics and practitioners.

The fact that product advantage, the cross-functional composition of the development team and customer involvement did not have a significant influence (and that customer involvement in fact had a negative influence) on project success in the quantitative analysis reported in article II is, however, more surprising. Because these factors were acknowledged as important both by previous cross-industry research and by the respondents in the qualitative study reported in article I, a complex picture emerges. The lack of a positive influence of customer involvement, for example, might be explained by the fact that businesses are unaccustomed to cooperation with customers. As stated above, a traditional business model in the wood industry includes the sales of commodity products to export markets via company-external agents. To involve customers in development projects in an efficient way might require new ways of working and improved external communication ability among wood industry companies. For example, it has been shown that knowledge can be difficult to move from customer to supplier because of social embeddedness (Andersson & Dahlgvist in Håkansson & Johansson (eds.), 2001). Some sort of knowledge mediator might then be needed in the relationship (ibid.). It is not implausible that the companies in the wood industry are in a learning phase with regard to cooperation with customers. In this learning phase, customer involvement might, in fact, lower the effectiveness of the development process in the short term (Korhonen & Niemelä, 2004), but might also act as an

investment in improved relationships and mutual communication ability over the long term (as indicated by the respondents in the qualitative study reported in article I).

Significant correlations between independent variables in the quantitative data indicate complex relationships among project management variables. Especially important is the highly significant positive correlation between customer involvement and sharpness of product concept definition, which indicates the possibility of a two-fold influence of customer involvement on project success: A positive indirect influence through the positive effect on the sharpness of product concept definition (Cooper & Kleinschmidt, 1994; Thomke & von Hippel, 2002) and a negative direct influence because close cooperation with customers consumes additional time and resources. To summarize, the results of the qualitative and quantitative studies indicate a complex relationship between customer involvement and product development activity and success. Further case study research on producer-customer interaction during development work in the wood industry is therefore needed (see, e.g., Trulsson, 2008). Furthermore, the significant correlation between customer involvement and sharpness of product concept definition, and also among other project management variables calls for structural equation modeling analysis. Because this study had too few cases for this type of analysis, this could be a fruitful approach for future scholars utilizing datasets with a larger amount of study units.

The influence and lack of influence of some project management factors identified in article III were found to be valid under different degrees of product newness. Because scholars seem to agree that the moderating effect of uncertainty (as manifested, e.g., in product newness) on the relationship between project management measures and project success exists, this finding was surprising. However, product development in the wood industry commonly takes place within conventional technological and market bounds (see article I), and the moderating effects of product newness might therefore not be clearly visible in broad surveys of product development work in this industry. Research on project management – performance relationships in highly innovative wood industry product development projects, such as development of system solutions for wood-based multi-storey construction, is needed to examine this further.

Other key factors for successful product development, as perceived by the managers interviewed for article I, conform reasonably well to those that have been found by previous research both within and outside the forest sector context. Entrepreneurship (willingness to innovate and willingness to take risks, Naman & Slevin, 1993) and market orientation among the

personnel were, for example, mentioned as important facilitators of success in product development work in general. Studies of managerial perceptions in a neighboring process industry also based on natural resources – the food industry – also indicate the conformance of product development key success factors in that industry with the conclusions of general product development literature (Stewart-Knox & Mitchell, 2003).

5.3.3 Barriers to product development

The survey of perceived barriers to product development, in both the semi-structured (article I) and structured (article II and III) interviews with managers, showed that resource constraints, high pressure from daily operative work, and the ensuing difficulty in prioritizing development work are the most important barriers to product development in the wood industry. Although it is often mentioned, these factors are seldom described as the most important barriers in cross-industry investigation of innovation barriers. It seems, therefore, to be a factor that is specific to the wood industry.

In one of the seminal works of organization science, March and Simon (1958) acknowledge some of the basic challenges of the organization of human activity in formal organizations. In the case of organizational change, the authors pose that there are two basic factors that influence organizational members' choices regarding activities to engage in: time pressure and clarity of goals. The authors continue (1958, p. 185): "These propositions lead to a prediction that might be described as the "Gresham's Law" of planning: Daily routine drives out planning. Stated less cryptically, we predict that when an individual is faced both with highly programmed and highly unprogrammed tasks, the former tend to take precedence over the latter even in the absence of strong over-all time pressure."¹⁷ One conclusion based on this might be that it is typical for individuals in organizations to prefer short-term operative work over long-term innovative work. The authors point out that a set-up of specific organizational units for development work in which the agenda does not include operative work, or the sharpening of time pressure for innovative work because of the dysfunctionality of existing solutions (e.g. the break-down of a machine results in an urgent need to invest in a new one), might increase focus on

¹⁷ Gresham's Law is commonly stated: "Bad money drives out good." It is named after the English financier Sir Thomas Gresham (1519 – 1579), and originates in the observation that 'bad' coins (worn and torn) drove 'good' coins (not worn and torn) out of circulation in the marketplace because people had larger incentives to give 'bad coins' as payment or in exchange.

innovation. It is the belief of the author of this thesis that the barriers to product innovation in the wood industry are heavily connected to this “Greshams Law” of planning as described by March and Simon. The challenge for managers in the industry is to inspire people in their organizations to escape the short-term operative focus and develop new business models, preferably before the old ones ‘break down’. Further research about how to do this is an important task for researchers interested in the strategic and organizational challenges of the wood industry.

5.4 Implications for practitioners – recommendations for innovation management in the wood industry

5.4.1 Introduction

Factors that influence high innovation activity and effective product development are summarized below in the form of recommendations to practitioners. The recommendations are divided in two separate sections. The first deals with the first main objective of innovation management: to be more innovative, in this case to increase the product development activity in the company. The second deals with the second main objective of innovation management: to innovate more effectively, in this case reaching a higher degree of success for each product development project. The recommendations are based on a synthesis of literature on innovation management and the empirical findings of this study. The synthesis has led to conclusions about the prioritization of some specific key factors that seem to be especially important in the wood industry context. In this way, the general knowledge about innovation management has been adjusted to fit an application in this wood industry context.

5.4.2 Recommendations for increased product development activity

Business strategy

To increase product development activity, managers are advised to craft a business strategy that includes a commitment to technology, stresses the importance of product development and views it as a tool for competence development. The positive effects of product development on customer relations, investment in new machine equipment, company image, willingness to innovate among personnel, and knowledge related to markets and technology identified in article I are striking examples of such competence development.

Resources, capabilities and infrastructure of the company

Access to time and resources for development work is of the utmost importance for innovation activity. Difficulty in giving practical priority to development work was pointed out in article II as the most important barrier to product development. Promoting the prioritization of development work is a multi-faceted task for managers. One way is to ensure the existence of a product development function in the business unit. To save resources in smaller business units, this can entail setting up a part-time position rather than a full-time position or a whole department. To create scale advantages in development work, ensuring the sufficient size of the business unit and/or promoting cooperation with peers are important tasks. Ensuring that there is a certain amount of slack resources is, regardless of organizational size, rewarding for creativity. A flexible and informal organizational structure based on market segments rather than functions, as well as the set-up of a structured product development process is also an important measure to take.

Furthermore, it is important to increase specialization and professionalism among managers, strengthen internal and external communication skills and assure a well-educated staff with a diverse range of skills (which in most cases in the wood industry results in a need to hire more academics). The need for a well-educated staff was clearly demonstrated in article II. Low knowledge level among the personnel was pointed out as the second most important barrier to product development among innovating business units in this study, and the share of academics among white-collar workers in the business unit emerged as a strong driver of innovation activity.

The study shows conflicting results concerning the benefit and importance of a market-oriented culture in the business unit. In article II, it was shown that market orientation in the industry's business units is of less importance for their innovation activity. This is in conflict with the literature and also with the statements from managers accounted for in article I. The contradiction is believed to be due to the fact that most wood industry companies and their customers are conservative and that market orientation among the wood industry companies might lead to a situation where only gradual improvements of existing products are being made instead of new possibilities being seen. The positive influence of market orientation on innovation acknowledged by managers cited in article I might be due to the fact that these managers represent the innovation leaders in the industry and that those companies mainly have relationships with the innovation leaders among customers. Close relationships with this type of customer might actually lead to new ideas instead of improvements of past

solutions. Therefore, managers in the wood industry are recommended to put less emphasis on management measures that promote an orientation towards conventional and conservative customers and instead direct their focus towards the innovation-leading customers. Another path would be to put less emphasis on what customers *say* and look more to what they *do*, and then proactively evaluate the possibilities this creates.

As reported in article II, another well-known innovation antecedent, export share, showed no influence on innovation activity. This is believed to be connected to the loss of market information resulting from the traditional business model in the wood industry with agents or other middle-men as representatives in export business. Therefore, to get access to the potentially valuable and inspiring information flow from export markets, managers are advised to cooperate with middle-men that allow and encourage the presence of the company's personnel in the market or to build direct relationships with customers.

Finally, the cultivation of a learning-oriented culture in the organization is facilitated by encouraging vigilance, adaptability, receptivity and acceptance of risks among the personnel. This can be achieved by actively pursuing product development and, while so doing, showing tolerance for mistakes as long as lessons are learned from them.

Industry collaboration

Some barriers to product development identified in article I can be addressed through industry collaboration. Better knowledge about the properties and functionality of wood, better technology for wood processing and control of raw-material and production flow, and the development of proper product standards were all referred to by respondents as projects too large for a single company but well-suited for broad industry collaboration. Managers are therefore advised to promote such collaboration, for example through participation in research programs lead by universities or research institutes.

5.4.3 Recommendations for increased product development effectiveness

New product strategy

To increase the degree of success in product development projects, managers are advised to evaluate business opportunities and focus on those that combine high customer value and synergies with their existing resources and capabilities.

Resources, capabilities and infrastructure of the company

Managers are advised to apply an organizational structure based on market segments and to support development work and the risk-taking inherent in this process. For product development targeting new market segments (e.g., wood in multi-storey construction) or end-consumers (e.g., retail), or for those that include radical new technology or product functionality, knowledge and other resources for new product launch are very important. Flexible and versatile production equipment facilitates the important test production of new products. To combine flexibility and versatility with the ever important demand on efficiency might, however, be problematic. Cooperation with subcontractors during the test production stages could then be beneficial.

Organization of product development projects

As concluded in article III, product development projects should be well-defined and product development teams should be given autonomy and responsibility and be led by a strong and competent leader. The sharpness in product concept definition (the technical specifications, target market, and positioning strategy of the product) was shown in article III to be a strong driver of project success. The sharpness of the product concept definition depends on the quality of the pre-development analysis, so priority should be given to this important part of the development process. For the actual development work, one should assure that all steps of the product development process are included while still maintaining creativity and energy by running the projects in a rapid, informal and flexible way. Continuous evaluation through go/kill decision points helps to steer the creative work without applying rigorous control over the details. The use of a product development model such as the Stage-Gate model® (see section 2.3.3) can assist in the management of a project. It should not, however, be used as a rigid plan of action, but rather as a map that inspires and assists in the progress and evaluation of the project.

The findings of article III suggest a complex relationship between customer involvement in projects and project success. Even though the effect was somewhat uncertain, customer involvement showed a negative direct influence on project success. At the same time, however, customer involvement was strongly correlated with the number one driver of success – sharpness of product concept definition. Close customer relations were identified in article I as one of the more important key factors for success. One explanation for the differing indications regarding the influence of customer involvement might be that many wood industry companies are

unaccustomed to close cooperation with customers. This could be the result of a long tradition of sales of commodities without the need for cooperation in development projects. Thus unaccustomed, such cooperation might result in a lowering of the effectiveness of development projects if customers are involved. The implication could be that even though deep customer relations are worth striving towards, organizations with little previous experience with customer involvement should avoid too deep an involvement of customers in development projects until they have gradually built their customer relationship management capabilities.

Finally, key success factors such as the willingness to innovate among personnel, the capability of managing product development projects, and customer relations have been found in article I to be strengthened by repeated product development, so that a cumulative positive effect of continuous development efforts can be expected.

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