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PRODUCT MANAGEMENT PERSPECTIVES ON STAKEHOLDER AND BUSINESS OPPORTUNITY ANALYSES IN THE FRONT-END OF PRODUCT CREATION

UNIVERSITY OF OULU GRADUATE SCHOOL;
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Abstract

Products have a significant and multidimensional role in business, whereas product management as a scientific field is still in its emergence. However, long industrial tradition positions product management as a holistic and complete business management of products at different levels throughout product lifecycles. The evolving business environment and external stakeholders influence the decision-making in product management. A commercially successful new product may necessitate as much as hundreds of new ideas and opportunities to be screened. Hence, decisions made in the front-end of product creation significantly affect the product cost and value throughout its lifecycle.

This dissertation aims to answer the question of how product management can analyse stakeholders and business opportunities in a systematic way in the front-end of product creation. The study follows a qualitative research strategy and a constructive approach along the research process. Four original publications focus on stakeholder business opportunity analyses; the first one analyses external stakeholders as a business ecosystem for collaborative product creation; the second assesses the influence of internal stakeholders in product creation; whereas the third and fourth articles focus on systematic ways to conduct business case analyses during product creation.

The systematic analysis of external stakeholders' business models is seen as a tangible way to perceive the business ecosystem. Salience assessment further helps to explain how the voice of stakeholders can be noticed by product management decision-making. Systemising the business case analysis procedure, including gathering, processing and integrating information from different knowledge and functional areas – customers, marketing, technical, financial and strategic – provides the rationale for product management to make well-informed go/no-go decisions and assurance for commitment towards funding and launching product creation projects.

Keywords: business case, decision-making, front-end, product creation, product management, stakeholder

Kinnunen, Tuomo, Tuotehallinnan näkökulmia sidosryhmien ja liiketoimintamahdollisuuksien analysointiin tuotekehityksen alkuvaiheessa.
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Tiivistelmä

Tuotteilla on merkittävä ja moniulotteinen rooli liiketoiminnassa. Tutkimusalana tuotehallinta on aikaisessa kehitysvaiheessa, mutta pitkä teollinen perinne asemoi tuotehallinnan kokonaisvaltaiseksi liiketoiminnan johtamiseksi käsittäen tuotteet kaikkine osineen läpi niiden elinkaarten. Jatkuvasti muuttuva liiketoimintaympäristö ja ulkoiset sidosryhmät vaikuttavat tuotehallinnan päätöksentekoon. Yhtä kaupallisesti menestyvää uutta tuotetta kohden yritys voi joutua käymään läpi jopa satoja uusia ideoita ja mahdollisuuksia. Samalla tuotteen luomisen alkuvaiheessa tehtävät päätökset voivat vaikuttaa merkittävästi tuotteeseen, sen arvoon ja kustannuksiin koko elinkaaren aikana.

Tämä väitöskirja pyrkii vastaamaan kysymykseen, miten tuotehallinnassa voidaan analysoida sidosryhmiä ja liiketoimintamahdollisuuksia systemaattisella tavalla tuotteen luomisen alkuvaiheessa. Tutkimus toteuttaa laadullista tutkimusstrategiaa käyttäen konstruktiivista lähestymistapaa tutkimusprosessissa. Alkuperäiset julkaisut keskittyvät sidosryhmien ja liiketoimintamahdollisuuksien analyyseihin. Ensimmäinen julkaisu tarkastelee ulkoisia sidosryhmiä liiketoimintaekosysteeminä yhteistyössä tehtävän tuotekehityksen kannalta, toinen julkaisu käsittelee sisäisten sidosryhmien tärkeyttä tuotteen luomisessa. Kolmas ja neljäs julkaisu keskittyvät systemaattisiin tapoihin toteuttaa tapauskohtaista liiketoimintamahdollisuuksien analysointia tuotteen luomisen alkuvaiheessa.

Analysoimalla systemaattisesti ulkoisten sidosryhmien liiketoimintamalleja voidaan konkreettisesti hahmottaa liiketoimintaekosysteemi. Sidosryhmien tärkeyden, salienssin, arviointi selittää, miten eri sisäisten sidosryhmien äänet otetaan huomioon tuotehallinnan päätöksenteossa. Systemaattinen menettely tapauskohtaiselle liiketoimintamahdollisuuksien analysoinnille tuottaa tiedollisen perustan tehdä johdonmukaisesti perusteltuja tuotehallinnan päätöksiä tuoteprojektien käynnistämisestä. Menettely kerää, käsittelee ja yhdistelee tietoja eri osa-alueilta, kuten asiakas, markkina, tekninen toteutettavuus, talous ja strategia.

Asiasanat: alkuvaihe, liiketoiminta, päätöksenteko, sidosryhmä, tuotehallinta, tuotekehitys, tuotteen luominen

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Oulu, June 2016 Tuomo Kinnunen

List of abbreviations

AHP	Analytic Hierarchy Process
DFX	Design for X
e.g.	exempli gratia
FE	Front-end
FFE	Fuzzy Front-End
NPD	New Product Development
PC	Product Creation
PM	Product Management
PDM	Product Data Management
PLM	Product Lifecycle Management
PPM	Product Portfolio Management
RPD	Rapid Product Development
RP	Rapid Productisation
RQ	Research Question

List of original publications

This dissertation is based on the following publications, which are referred throughout the text by their Roman numerals:

I Kinnunen T, Sahlman K, Harkonen J and Haapasalo H (2013) Business ecosystem perspective to new product development. International Journal of Business Development and Research 1(1): 6–22.

II Kinnunen T, Aapaoja A and Haapasalo H (2014) Analysing internal stakeholders' salience in product development. Technology and Investment 5: 108–115.

III Kinnunen T, Pekuri A, Haapasalo H and Kuvaja P (2011) Business case analysis in new product development. Global Journal of Management and Business Research 11(2): 49–56.

IV Kinnunen, T, Hanninen, K, Haapasalo, H and Kropsu-Vehkapera, H (2014) Business case analysis in rapid productisation. International Journal of Rapid Manufacturing 4(1): 14–27.

The author of this dissertation is the primary author in all the articles. He had the primary responsibility in planning the research frames and research processes and in coordinating the data collection, data analysis and writing of each paper. He wrote most of the text in each paper. The co-authors merely had supportive roles during the research process and writing of each paper.

Table of contents

1 Introduction

1.1 Background and research environment

Products have a significant and multidimensional role in business and they are incorporated in strategies, business plans and multiple business activities within enterprises, in business ecosystems and global business environment (Moore 1993, Porter 1985). Products must meet and satisfy various needs and requirements of multiple stakeholders, and these must be considered in developing, producing, selling, delivering, marketing, maintaining, disposing and recycling products (Ulrich & Eppinger 2008, Stark 2005). Product management has a long tradition in industries, for which and empirical literature suggests a holistic and complete business management of products in different levels – from product portfolios and platforms to product data and components – throughout the lifecycle (Haines 2009, Tolonen *et al.* 2015b). Nevertheless, the academic research on product management is limited and focused mainly on the aspects of marketing and creating products (Tyagi & Sawhney 2010).

Product creation literature emphasises the importance of new product development (NPD), that has been studied vastly since 1950s in the fields of marketing, operations management, innovation management, organisation theory and engineering design (Conway & Steward 2009). Product innovations are recognised as significant drivers of revenue growth and profitability (Patterson 1998, Cooper & Edgett 2003, Shapiro 2006). The drivers for product development stem from financial goals, strategy and business environment, marketing and customers, technology, internal push and resources, and supply chain stakeholders (Majava *et al.* 2013). However, product innovation efforts are much more likely to fail than to succeed (Cooper *et al.* 1999). For instance, one substantially new commercially successful industrial product may require even 300 ideas to be screened (Stevens & Burley 1997). Furthermore, NPD is challenged by shortening product-life cycles, increasing technical complexity and market uncertainties and rising cost of development (Bhaskaran and Krishnan 2009, Cooper 2001).

Evolving business ecosystems challenge the holistic management of products. The dependencies built trough everyday product decisions can shape the future of a company (Iansiti & Levien 2004a). This strategic relation is recognised in ecosystem research but the vital role of product management is not yet clarified. For example, evolving customer needs and emerging new requirements are often

considered as operational product management issues in practice (c.f. Hanninen *et al.* 2013b) without adequate and systematic analysis of potential strategic dimension or significant stakeholders. In addition, subjective preferences and coincidental knowledge of individual decision-makers may dictate the decisions as systematic management practices are often lacking (Eversheim *et al.* 2008). This indicates a research gap both in the role, and in the practices of product management in perceiving the stakeholders and analysing business opportunities for decisions made in the front end of product creation.

Product creation and product management among other business activities need to be aligned with the competitive strategy of a company to create and sustain competitive advantage (Porter 1985). It is an issue of business planning to ensure that target setting, priority setting, resource allocation and budgeting are aligned with the strategic objectives (Kaplan & Norton 1996). However, intended strategy is hardly ever realised as planned – some intentions stay unrealised while realisation combines deliberate and emergent strategies (Mintzberg 1994). Global business environment with evolving business ecosystems create lots of niche opportunities (Iansiti & Levien 2004a). Changes in strategic directions and emergent strategies may develop as a result of emerging opportunities, while product management faces and deals with these opportunities in relation to the products.

Corporate strategy deals with the expectations of owners in order to create wealth and value for shareholders (Johnson *et al.* 2005). Product creation as a business activity emphasises customer in order to satisfy customer needs and generate customer value (Cooper 2001, Lilien *et al.* 2002). Similarly, all issues within a company and the business environment originate from stakeholders – employees, investors, customers and users, regulatory authorities, partners, supply chain associates, or any other group that influence or is influenced by the company in question – also traditional management issues are stakeholder issues (Wood 1991, Clarkson 1995, Post *et al.* 2002). The basic stakeholder management question is on which stakeholders the management should pay attention to, and more specifically, how much importance and priority should be given to a stakeholder (Mitchell *et al.* 1997). From the product management perspective, a specific stakeholder management question can be formulated as: how the voice of stakeholders, not only customers, is taken into account in decision-making. It is known that decisions made in the early phase of product creation determine the majority of the product lifecycle costs and significantly affect product value, and therefore also revenue and profit potential (Bralla 1996). Little is known about involving multiple

stakeholder issues in the decision-making during the front-end of product creation (Driessen & Hillebrand 2013).

1.2 Objectives and scope

This research focuses on the field of product management. As a part of the constructive research effort the specific focus is on systematic and transparent practises to support well-informed decision-making to create shared understanding while avoiding subjective preferences and unnecessary ambiguity. The main objective of this study is to improve product management decision-making support by methods for stakeholder and business opportunity analyses relevant in the front-end of product creation. The research problem of the study is condensed into the following question:

- How can product management analyse stakeholders and business opportunities in a systematic way in the front-end of product creation?

There are several options to approach the research problem. At first, this study adopts the basic stakeholder management classification between *internal and external stakeholders* and approaches them with relevant stakeholder measures to support product management decision-making. Secondly, this study considers the business opportunities with regards to developing both *new and existing products* while approaching them through commonly adopted business case practices to support product management decision-making. As a result, the study as an ensemble consists of four perspectives that are selected in collaboration with practitioners to serve industrial needs: ecosystem perspective on external stakeholder analysis, salience assessment of internal stakeholders, and two systematic business case analysis procedures in product creation, one in new product development and the other in rapid productisation. These perspectives are further elaborated into four research questions (RQ) presented in Table 1.

Table 1. The research questions.

RQ#	Research question
RQ1	How can business ecosystem stakeholders be analysed for new product development?
RQ2	How can stakeholder salience be assessed in the early phase of new product development?
RQ3	How can business case analysis be conducted in a systematic way in new product development?
RQ4	How can business case analysis be conducted as a systematic procedure in rapid productisation?

These research questions aid to provide coherent answer to the main research question on how to analyse internal stakeholders, external stakeholders and business opportunities in a systematic way for new and existing products in the front-end of product creation. Each research question is answered in more detail by one correspondingly numbered original publication (see Table 2).

Table 2. Original publications in relation to the research questions.

Publication	RQ	Title	Journal
I	RQ1	Business ecosystem perspective to new product development	International Journal of Business Development and Research
II	RQ2	Analysing internal stakeholders' salience in product development	Technology and Investment
III	RQ3	Business case analysis in new product development	Global Journal of Management and Business Research
IV	RQ4	Business case analysis in rapid productisation	International Journal of Rapid Manufacturing

Product creation refers to any organisational and cross-organisational processes to create products, including new product development, incremental product development and productisation. Product management, understood as the complete business management of a company's products at all levels and across their lifecycles, is involved in, impacting and influenced by business decision-making of many levels. Reliable information of business consequences is needed for making informed decisions. In product management context, reliable information is produced by analysing data gathered from multiple sources and stakeholders. Nevertheless, maintaining a clear and up-to-date picture in an evolving business environment calls for systematic product management activities for analysing the stakeholder context as well as establishing criteria for and conducting business case analysis.

This study approaches two types of analyses that support business decision-making in product management. The articles I and II focus on stakeholder analysis. The first one focuses on broadest context of this study by providing exemplified description of a semiconductor business ecosystem for collaborative NPD and managerial use. The article I adopts the concept of business model as the key factor defining a business ecosystem as a constitution of stakeholders' business models and scope out any other stakeholder measures for practical reasons. The second article focuses on company context by assessing the significance and priority of internal stakeholders in NPD. The article adopts the concept of salience as a factor

that explains stakeholders' significance for product management. The articles III and IV focus on business opportunity assessment within product management of a company; the third one focuses on systematic way of conducting business case analysis as a part of NPD process and the fourth article explores systematic way to analyse business cases in rapid productisation to quickly respond to emerging sales opportunities. All the articles construct analysis frames as tools to support decision-making in product management in the front end of product creation. Altogether, the study as an ensemble explicitly links business case analysis and continue / no-go decision with the stakeholder context and consider the role of product management in managing multiple stakeholder issues in the decision-making during the front-end of product creation. The scope of the study and relationships between the research articles is illustrated in Figure 1.

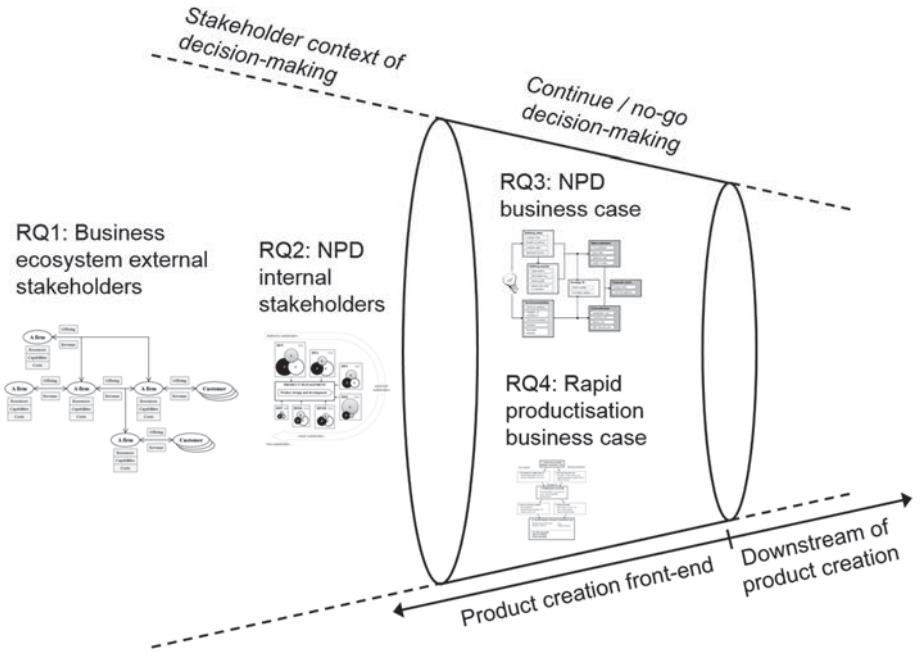

Fig. 1. The scope of the study and relationships between the research articles.

1.3 Research approach and process

A researcher must consider epistemological, ontological and ethical issues when clarifying the philosophical grounding of the research. These considerations include questions such as: How can one believe and know of reality based on scientific research?; How is scientific knowledge obtained and when is this knowledge scientific?; When does the researcher abuse his research object or act unethically against the scientific community?. (Lancaster 2005).

Epistemology concerns what constitutes acceptable knowledge regarding the social world in a discipline. One important aspect is the question of whether a natural science model of research process is suitable for studying the social world. (Bryman & Bell 2007). Ontology, on the other hand, concerns the nature of reality, where studied phenomena are understood to exist and how they relate to this reality. Ontology determines whether social entities are considered as objective and external to social actors or as built up from the perceptions and actions of social actors (Bryman & Bell 2007). Ontology can be seen to influence the choice of theory and concepts. (Anttila 2005, Harisalo 2008). The foundational assumptions of epistemology and ontology can be defined between two contrary or alternative positions as illustrated in Figure 2.

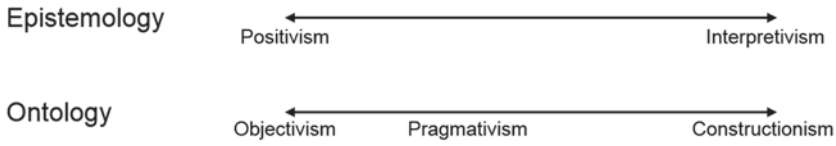

Fig. 2. Epistemological and ontological positioning.

According to Saunders (2007) epistemology can be roughly viewed along the axis of positivism and interpretivism. Hence, *positivism* is an epistemological position applied in natural sciences. Positivism presumes that business and management phenomena can and should be studied using principles, methods and objectivist approach of natural sciences. *Interpretivism* as a contrasting epistemology to positivism distinguishes the subject of socially constructed world – humans and institutions – as fundamentally different from the world of nature. Thus interpretivism presumes that a different logic of research process is required to study social phenomena of business and management. (Saunders 2007, Bryman & Bell 2007). This study is positioned towards interpretivism as product management

and product creation are human-centric activities within socially constructed reality of industrial companies (e.g. Haines 2009).

Ontology can be roughly viewed along the axis of objectivism and constructionism. *Objectivism* is an ontological position presuming that social entities can and should be considered objective entities as external realities that are beyond individuals' reach or influence. Objectivism perceives organisations as tangible objects, which have rules and regulations, and which adopt standardised procedures for getting things done. People are seen to be acting according to the standardised ways of organisation. In contrary to objectivism, the ontological position of *constructionism* challenges that people would be external realities and categories such as organisation and culture would be pre-given. Organisations are seen as worked at instead of being a pre-given structure. Thus, the social order may be negotiated and constantly evolving as agreements are continually being terminated, established, renewed, revised, and so forth. Furthermore, the order in organisations is accomplished in everyday interaction although the formal properties may constraint some individual actions. The intervening ontological position of *pragmativism* sees the research question as the most important factor in choosing the research philosophy. The researcher may choose viewpoints from both of the above mentioned positions in case the research question does not clearly support any philosophies. (Saunders 2007, Bryman & Bell 2007).

The theoretical and practical contexts of product management as approached in this research are positioned towards *objectivism*. This can be seen in the research objective to systematise product management methods in general. In addition, the underlying assumption is that companies are managed in a systematic way and apply formal product development processes. Despite formal processes and standardised procedures, the realm of product development in a company may be influenced significantly by certain people and company culture resembling more constructionism. This must be considered during the research process. Thus, the ontological positioning of this research is defined as *pragmativism* as it chooses viewpoints from both ontological positions.

This study applies qualitative research strategy for designing and conducting the research. Qualitative research strategy emphasises words rather than quantification as data, an *inductive* reasoning to the role of theory in relation to research, and do not apply natural science model, in particular positivism, to the research of socially constructed world. In inductive reasoning, findings are used to generate theory as opposed to deductive reasoning and testing theory. (Bryman &

Bell 2007). As an outcome of this research, the theoretical field of product management is elaborated.

The research design of this study follows constructive research approach. Constructive research emphasises theory and practice for solving particular and general problems, rely on construct, critical evaluation, demonstration of solutions, theoretical connection and general reflection through examination of the scope of application (Kasanen *et al.* 1993, Oyegoke 2011). The constructive research process includes the six phases presented in Table 3. The constructive research approach is flexible and allows the use of any generally acceptable research methods and tools for research process and validation. Co-creation with practitioners is embedded in the approach and it is advised to involve users of the construct – people and organisations – in the design and strategy for practical application. (Oyegoke 2011).

Table 3. Constructive research process in this study.

Constructive research process: (Kasanen *et al.* 1993)	Application in this study	Relevant (sub-) chapters
1. Find a practically relevant problem which also has research potential	The research problem is identified from industrial context and the research is carried out in collaboration with companies. The research gap in product management is identified also in the literature (e.g. Tyagi & Sawhney 2010, Driessen & Hillebrand 2013).	1 (1.2)
2. Obtain a general and comprehensive understanding of the topic	The study and each original publication embody this understanding from theoretical and practical aspects as well as through the research settings.	1, 2 (1.3, 2.1-2.4)
3. Design a construction or construct a solution	Each original publication creates a theoretical construction that reflects an empirical practice of product management.	3 (3.1-3.4)
4. Demonstrate that the solution works	Original publications present example case analyses and explain practical functioning of the constructions.	4.1
5. Show the theoretical connections and the research contribution of the construct	The theoretical connections are shown in chapter 2 and discussed in chapter 4.1. The research contribution is explained in chapter 3 and discussed in chapter 4.2.	2, 3, 4 (3.1-3.5, 4.1-4.2)
6. Examine the scope of applicability of the solution	Each original publication discusses the scope of applicability. The examinations are summarised in 4.3.	4.3

The research is designed and conducted in collaboration with practitioners, within real-life industrial context as a part of larger research and development projects. The research setting is influenced by the context providing certain benefits and

limitations – the real business context and true practical needs make the research more meaningful (Krishnan & Ulrich 2001), while findings tend to be closely related to the context and may not be easily replicated (Bryman & Bell 2007) – these are considered in detail in chapter 4.3. Each original publication I–IV follows the constructive research process in general and presents a construction that reflects the empirical practice that supports product management decision-making. The study as whole reflects the relevant decision-making by constructing and exemplifying means for stakeholder and business case analyses. External and internal stakeholder analyses explicitly exemplify the context of product management decisions while business case analyses illustrate the procedures preceding continue/no-go decision in the front-end of product creation.

1.4 Research methods and dissertation structure

The dissertation is a constructive research ensemble utilising mixed methods for data collection and analysis. The research methods are carefully selected in the realm of real-life industrial context for realising each original study presented in articles I–IV. Data collection and analysis methods include literature, survey, structured and semi-structured interviews, analytic hierarchy process (AHP), gathering and analysing documents, and observation. The quantitative methods, survey and AHP, were used to support qualitative research strategy and constructive research approach. The methods and data sources are presented per each individual study in Table 4, and through the following paragraphs.

Table 4. Data sources, data collection and data analysis in each original study.

Publication	Data sources	Data collection	Data analysis
I	Literature on semiconductor industry	Literature search	Qualitative and constructive case analysis
II	12 product management representatives in company A, company documents	Structured interview with pairwise comparisons, gathering documents, observation	AHP analysis, qualitative case analysis
III	21 product-related managers as survey respondents in company A, company documents	Survey, gathering documents, observation	Document analysis, quantitative analysis of survey results, qualitative and constructive case analysis

Publication	Data sources	Data collection	Data analysis
IV	Seven managers in six companies, companies' business case documentation	Recorded and transcribed semi-structured interviews, gathering documents, observation	Qualitative and constructive data analysis

The main data source are product related managers from companies operating in ICT industry. Company A is a large telecommunication and data networking system manufacturer. Other companies in IV are a large global mobile phone manufacturer, a large business and telecommunications' service provider operating in North Europe, a medium-sized product lifecycle management (PLM) solution provider operating globally, a medium-sized multinational IT and management consultancy company and a small business and IT consulting service provider operating internationally.

Article I was designed and conducted on the basis of desk research that provided a theoretical business model -based construction of business ecosystem stakeholder analysis. The use of that construction is exemplified by literature study and a constructive case analysis of semiconductor industry ecosystem. The case analysis reflects the global business environment where the company A is operating.

Article II integrates the concept of stakeholder salience (Mitchell *et al.* 1997) with AHP (Saaty 1980) constructing an AHP-based salience assessment framework. This framework was utilised in data collection by structured phone interviews with twelve managers responsible of products and/or their design in company A. The data consists 12 pairwise comparison matrixes (7x7) per each salience attribute – power, legitimacy and urgency – and confidential internal documentation describing the organisation, its operations and the product creation process as well as the objectives, roles and responsibilities of the selected internal stakeholders within the product process. Salience was compared between the selected internal stakeholders by relative scale 1–9, where quantitative data analysis followed AHP as described in detail in article II. The quantitative results of the AHP analysis were interpreted as a part of qualitative case analysis. These together illustrate the usage of the construction – AHP-based salience assessment framework.

Article III first creates a theoretical foundation of business case analysis in NPD, while the data collection and analysis include a survey in company A as the primary data source, supported by observations and analysis of confidential company documents – This includes a screening process description as a sub-process of product creation, a template, guidance and training material for business

case building and examples of documented business cases. The survey was sent to forty managers responsible of products and/or their design in company A. The respondents (N = 21) used five-level Likert scale for rating the importance of business case factors defined in article III, and the reliability of available information of each factor. The respondents also commented business case practice development through the open comments section of the survey. The results of the survey were used in qualitative case analysis that resulted in the construction – the procedure for business case building in the early phase of product development.

Article IV explores business case analysis procedure for rapid productisation. The study reflects contemporary phenomena raised by practitioners of company A: evolving customer needs and urgent requests call for product management attention and fast decision-making. This original paper studies related literature, while the data collection and analysis include semi-structured interviews, observations and confidential company documentations from six mature companies operating in the ICT industry. All the interviews were recorded and transcribed to facilitate thorough data analysis. The transcriptions and interview summaries were sent to the interviewees for their review to avoid any misinterpretations. The explorative nature of the original study guided the data analysis for constructing the procedure for business case building in rapid productisation.

The dissertation is an ensemble of four original studies, each of which present a construction that relats distinctively to product management decisions at the front end of product creation: Article I creates the construction for analysing business ecosystem and addresses its application to product creation by grounding semiconductor business ecosystem as the broad stakeholder network of company A; Article II creates the construction for assessing the importance of stakeholders while addressing its application in product management by classifying certain internal stakeholders of company A; Articles III and IV create business case procedures as exemplified tools for product management, addressing a key decision in the front end of product creation, namely the continue/no-go decision. Thus, the ensemble as a constructive research effort combines two kind of practices related to product management decision-making: the practises of explicitly analysing the stakeholder context and the business case practices to prepare continue / no-go decisions.

The compilation part of this dissertation is structured into five main chapters. The introduction chapter describes research background and clarify the research objective, scope, research questions and the research process. The chapter two presents theoretical foundation in the fields of product management, stakeholder

management and business planning and strategy. The third chapter presents and summarises research contributions from each individual study. The chapter four discusses theoretical and practical implications of the study as well as reliability and validity concerns, and states recommendations for further research. The research contribution and implications are summarised in the final chapter five. The compilation part ends in references and appendices. The original publications I–IV are reproduced after the compilation part.

2 Theoretical foundation

This study is initiated on three specific business and management fields seen as the fundamental theoretical knowledge areas for addressing the research problem of systematising product management decision-making in the front-end of product creation: product management (e.g. Haines 2009, Gorchels 2000, Stark 2005, Saaksvuori & Immonen 2008, Cooper *et al.* 1999, Tyagi & Sawhney 2010, Tolonen *et al.* 2015a), strategy and business planning (e.g. Mintzberg 1994, Porter 1985, Johnson & Scholes 2005, Iansiti & Levien 2004b, Moore 1993, Hamel & Prahalad 1994, Shafer *et al.* 2005, Osterwalder 2004, Teece 2010), and stakeholder management (e.g. Freeman 1984, Donaldson & Preston 1995, Mitchell *et al.* 1997). Further scoping of these theoretical fields was necessary to identify and select the key theoretical concepts as illustrated in Figure 3.

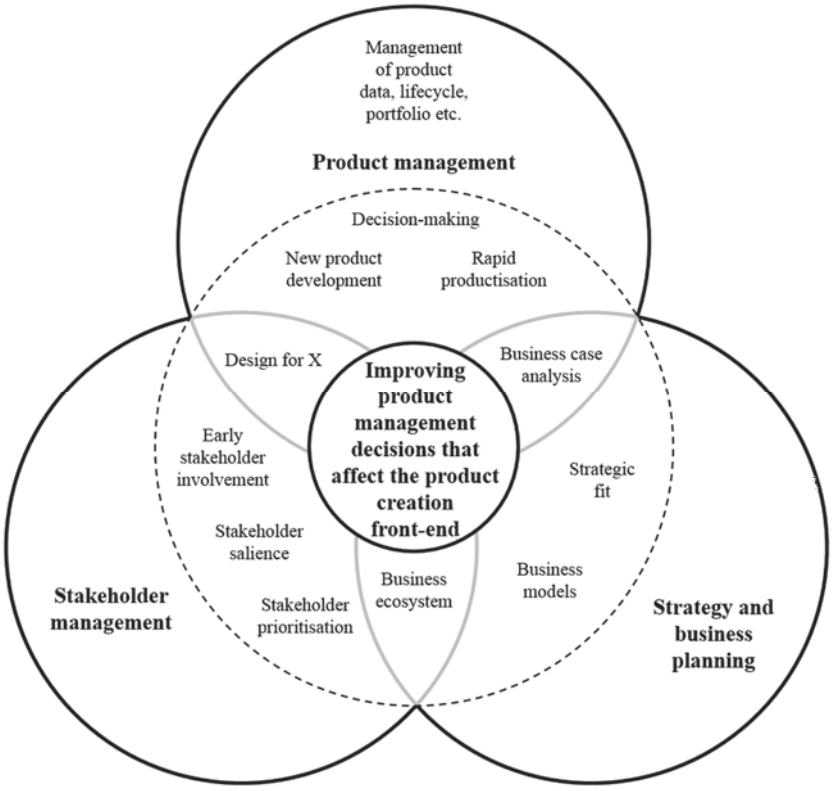

Fig. 3. Theoretical foundation of this study.

Literature on the selected theoretical fields and key concepts is presented in the next sub-chapters. The emerging theoretical field of product management have many other connecting theoretical fields that are scoped out from this study to avoid unnecessary broadening of the focus. For example, organisational culture and leadership (e.g. Schein 1985) and stakeholder integration and trust (e.g. Heugens *et al.* 2002) include relevant organisational and personal characteristics affecting the field of product management in general but not of key importance for systematising decision-making practices. In addition, information processing and IT tool integration (e.g. Silvola *et al.* 2011, Saaksjarvi & Immonen 2008), and product marketing (e.g. Henard & Slymanski 2001) can be seen as relevant for the topic but secondary in importance for addressing this specific research problem.

2.1 Product management

Product management is often practically understood as a set of tasks that a product manager needs to conduct. This refers to the operational level management of a product. A holistic approach, however, may see product management as a cross-organisational function that necessitates business planning also at a strategic level and concerns all products in all levels, from components and modules to product platforms, solutions and the entire range of products. For example, Pohl *et al.* (2005) define product management as planning, organising, executing, and controlling all the tasks that aim at successful conception, production, and marketing of the products offered by a company. In a broader context, product management can be seen as managing products, product data and product portfolio over the entire lifecycle including for example the creation, marketing, maintenance, and disposal phases of the products (c.f. Stark 2005). In fact, product management can be seen to emphasise the business aspects and can be seen as complete business management of products as Haines (2009) describe, 'business management at the product, product line, and/or product portfolio level'. The overall responsibility of a product manager is to integrate the various segments of a business into a strategically focused whole, maximising the value of a product by coordinating the production of an offering with an understanding of market needs. To accomplish this, a product manager needs a broad knowledge of virtually all aspects of a company along with very focused knowledge of a specific product or product line and its customers (Gorchels 2000).

Product management is defined in this study as **the complete business management of a company's products in all levels and across their lifecycles.**

The definition is inclusive covering different angles and levels of product management, such as product data and product lifecycle management as well as management of product platforms, product modules, individual products, product lines, solutions and product portfolio. Within a company, the responsibility for the product may change at different phases of the lifecycle (Stark 2005). Despite the context-specific arrangements on the product ownership and governance, product management function should be able to influence product-related decisions to ensure complete business management (Silvola *et al.* 2011) The highest level objective for product management is to maximise profit by increasing product revenues, reducing product-related costs, maximise the value of the product portfolio, and maximise the value of current and future products for the company, customers and shareholders (c.f. Stark 2005). The current academic research on product management is centred on product creation and mainly new products, excluding the management of existing products across their lifecycles (Tyagi & Sawhney 2010, Tolonen *et al.* 2015a).

Key terminology and concepts

In order to understand product management, it is necessary to start by defining the related terms and concepts. ISO 9000 standard defines the term *management* as coordinated activities to direct and control an organisation and the term *product* as a result of a process a.k.a. set of interrelated or interacting activities which transforms inputs into outputs (ISO 9000:2005). Thus, ISO 9000 definition for product management may be combined as coordinated activities to direct and control an organisation and a process which transforms inputs into outputs resulting in products.

Product can also be defined as something sold by an organisation (Ulrich & Eppinger 2008). Haines (2009) extends the definition to all goods, services and knowledge sold by an organisation, consisting bundle of attributes and being tangible or intangible. In this study, products are understood as not only something to be developed and sold but they are essentially objects of business across their lifecycle requiring business management through the lifecycle.

Product strategy is linked to, and its objectives are derived from the overall corporate strategy, marketing strategy and technology strategy (Trott 2012). Product strategy include competitive aspects – e.g. competitive advantage of products and technologies that guide product portfolio management and product creation.

Product portfolio is the total ensemble of company's products and may include diverse types of products – hardware, software, systems, services and documentation – which are connected to each other and the product items in different levels (Kropsu-Vehkapera & Haapasalo 2011).

Product plan identifies the portfolio of products to be developed by a company and the timing of their introduction to the market. The product plan may consist of new products, new product platforms, platform derivatives and incremental product improvements. The plan may be updated periodically e.g. once in a year. (Ulrich & Eppinger 2008, Trott 2012).

Product line is a grouping of products that serve similar markets, are produced via similar methods, or solve a particular type of problem (Haines 2009). Product line and product family can be used as synonyms (Pohl *et al.* 2005). In practice, a product family can be seen as a small product portfolio or a sub-portfolio.

Product platform is the set of assets such as components, sub-assemblies and modules that are shared across a set of products (Ulrich & Eppinger 2008). The use of product platforms enable cost-efficient development of a high product variety and/or fast development of product variants (Jiao *et al.* 2007). Product platform is often associated with modular product structure.

Technology means specific types of knowledge that is applied into something referring to the know-how of an organisation. Technology is often associated with science and engineering, but the processes enabling effective application, such as product creation, are important. (Phaal *et al.* 2001).

Product creation refers to any activities, organisational and cross-organisational processes to create products. *Productisation* refers to similar activities of combining something – e.g. software, service or technology – into a product like object that can be sold commercially (Harkonen *et al.* 2015). Product creation literature is emphasised in *new product development* (NPD) that is defined in this study as an innovation process to transform a market opportunity into a new commercial product (c.f. Krishnan & Ulrich 2001). Product creation activities also include *incremental product development* that focuses on adding or modifying something into existing products (Gautam & Singh 2008). *Rapid productisation* (RP), also known as rapid product development, is understood as a specific type of incremental product development addressing emerging sales opportunities (Hanninen *et al.* 2013b).

2.1.1 Decision-making

The role of product management culminates into the process of making product-related decisions. Some decisions are easy and do not impact many people or require lot of resources, while some decisions are very complex, have long-lasting impacts and require gathering, processing and analysing data and information from multiple sources (Haines 2009). The range of decisions that product management is engaged in starts from day-to-day issues and ends in deciding the strategic future paths for the offerings (Gorchels 2000). Furthermore, Gorchels (2000) argue that product managers should play a role in all product-related decisions throughout the product lifecycle, although specialists of different lifecycle phases may carry out many of those decisions.

Front-end activities and decision-making. Khurana and Rosenthal (1998) suggest that successful organisations follow a holistic approach in the front-end of product creation. This may include both individual and team activities in areas of minimising risk and optimising potential of the identified opportunities. In addition, the early prediction of product cost is needed (Newnes *et al.* 2008). Front-end decision-making may be seen as complete when a decision to continue or no-go is made, including potential commitment to funding and launch of a product creation project. (Koen *et al.* 2001).

After the front-end, product development research identifies decisions on setting up the development projects. These decisions can be classified into three levels: product strategy and planning; product development organisation; and managing a development project. The role of product management, as defined in this study, may be emphasised on the highest level, *product strategy and planning*, that typically include decisions about the firm's target market, product mix, project prioritisation, resource allocation, and technology selection. *Product development organisation*, the social system and environment in which a company's design and development work is carried out, deals with decisions like team staffing, performance monitoring, and investments in productivity-enhancing tools and processes for product development. *Managing a development project* deals with operational project management decisions such as the relative priority of development objectives, the major project milestones and prototypes, and means of monitoring and controlling the project. (Krishnan & Ulrich 2001).

When a product creation project is set-up, next decisions deal with concept development. Krishnan & Ulrich (2001) identify five basic decisions relating to concept development: 1) What are the target values of the product attributes; 2)

What will the product concept be; 3) What variants of the product will be offered; 4) What is the product architecture?; and 5) what will be the overall physical form and industrial design of the product?

2.1.2 Product portfolio management

Portfolio thinking guides to approach products as investments following the logic of managing financial assets. The aim of product portfolio management is to maximise the profitability of the product portfolio, find a balance with the range and the amount of products in a portfolio and to achieve alignment with the business strategy by adding new products to the portfolio, improving and modifying the existing products and removing obsolete or poorly performing products from the portfolio (Tolonen *et al.* 2014, Belliveau *et al.* 2004). Therefore, product portfolio management is essentially performed as an analysis and decision-making process. Product portfolio management applies generic portfolio management methods and techniques, including financial methods, strategic approaches, scoring models and bubble diagrams, and so on (Cooper *et al.* 1999, Cantamessa 2005).

The literature on product portfolio management is largely focused on managing new product portfolios and product creation projects while only few studies discuss management of the existing product portfolio (Tolonen *et al.* 2015a). The key issues in new product portfolio management entail strategic choices related to the types of products, markets and technologies, and the allocation of resources to achieve ideal balance on projects (Cooper *et al.* 1999). Product portfolio covering all lifecycle phases and different product levels aims to achieve an ideal portfolio balance. For example, many companies have shifted their product creation focus from disruptive NPD to incremental product development which may result in portfolio unbalance (e.g., Barczak *et al.* 2009, Cooper *et al.* 1999). The incremental development focus combined with the companies' revenue growth goal tends to overload product creation project portfolios. This result in a wide product variety and diverse product portfolios which are not often optimal for profit and business value due to increasing costs of production and supply chain, and reducing sales per variant (Tolonen *et al.* 2015a). In addition, high product variety also increases hidden costs such as the amount of administrative work required to keep product related data up to date (Stark, 2005).

Product portfolio management requires a holistic business management approach to achieve an optimally balanced product portfolio. As an effort towards

this goal, Tolonen *et al.* (2015a) suggest the use of key product portfolio performance focus areas including 1) the strategic fit, (2) value maximisation, and (3) the balance of the product portfolio. The strategic fit means ensuring the consistency and alignment of the product portfolio with the company's strategic goals. Value maximisation as a key performance focus area is often considered through sub-targets, such as return-on-investment, profitability, success, and business value. The product portfolio balance is to be considered across the different product levels and lifecycle phases as well as across organisational functions, such as marketing, product development and manufacturing (Cantamessa 2005).

Managing product portfolio requires certain portfolio mind-set and active grasp of decision making to direct which projects to fund, to what levels, and at what point in time. Effective portfolio decisions focus efforts on the right products, and allow agile decision making across the set of products. (Kester *et al.* 2011). However, any weak portfolio decisions can have remarkably negative impact if not managed effectively and harmonised with the company's strategy (Cooper *et al.* 1999). Even product termination decisions are essential for portfolio management, for example the decision to kill products that either are not expected to meet profitability target, or are no longer aligned with company strategy. Such termination decisions are necessary in releasing company's resources for other activities with higher profitability opportunities. Product termination as a part of portfolio management as well as product lifecycle management has proven as one of the most difficult management decisions to make (Balachandra *et al.* 1996).

2.1.3 Product lifecycle management and product data management

Product lifecycle management (PLM) is the cross-functional business information management of a company's products across their lifecycle, from the initial idea for a product to the market withdrawal and the disposal of the product (Stark 2005). By enabling better control over the product lifecycle, PLM may enhance the timing of product decisions to boost profit e.g. by accelerating new product introduction and by making timely market withdrawal of poorly performing products. *Product data management* (PDM) is closely associated to PLM concept but it can be seen as a narrower both in scope and in purpose as PDM is a set of tools and methods for managing product data in an effective way. (Saaksvuori & Immonen 2008).

In essence, PLM is about creating, preserving and storing information related to the company's products and activities to ensure the easy, trouble-free and fast

finding, refining, distributing and reutilising the data needed for daily operations in product and order-delivery processes. In practice, PLM is a compilation of business rules, methods, processes and guidelines built on a common product information model. PLM and PDM abbreviations also refer to an information processing system or a set of IT systems to manage product lifecycle and product data. Such a system include various product lifecycle management entities, typical examples being item management, product structure management, document management, configuration management, workflow and change management and file vault. (Saaksvuori & Immonen 2008).

Product data is no more limited to the product definition and the technical data serving the needs of product development. Instead, product data covers all product related information that is necessary to design, produce, sell, deliver, maintain and finally dispose of a product (Saaksvuori & Immonen, 2008). Thus, product data can be defined 1) to product master data used in business processes and operational and decision making systems and 2) to other general product data that defines how the product is to be sold, produced, and maintained (Kropsu-Vehkapera and Haapasalo, 2011). The general product data may be more informal and includes e.g. product specifications, technical drawings, functional models, manufacturing bill-of-materials, user guides, work descriptions and so on (e.g. Saaksvuori & Immonen 2008; Crnkovic et al., 2003; Zhang et al., 2004). Most product data is usually created as an integral part of product development activities, including systematic creation of basic product master data, such as product description; product item code; basic specification such as price, weight or supplier information; configuration options and product classification in information systems (Kropsu-Vehkapera & Haapasalo 2011, Zhang et al., 2004).

Practitioners convey product data as important for running the business while any shortcomings in business critical product data directly impacts the business performance (Kropsu-Vehkapera & Haapasalo, 2011). The data aspect can become even more critical if business processes rest on information systems. Thus, a company has to model its products uniformly to present them efficiently. General product structure is perceived as a way to model the products (e.g. Saaksvuori & Immonen 2008; Sudarsan et al., 2005) and it can be used to represent products in information systems (Forza & Salvador 2002). Product structure can be defined to represent the product, product data, product-related data and the relationships between the components (Saaksvuori & Immonen 2008). The product structure consists of various types of items for different needs, for example a sales item is seen as the highest level item that defines the product marketed to a customer, while

a deliverable item describes the product to be delivered to a customer, containing for example the product, accessories and user manuals (Jansen *et al.* 2005). In addition, there can be many sub-levels of items such as sub-modules, source codes, sub-assemblies and components.

2.1.4 Product creation

Product creation refers to any activities and organisational processes of creating products, not only totally new products. This study classifies existing product creation literature into new product development, incremental product development, productisation and rapid productisation.

New product development

New product development (NPD) is defined in this study as an innovation process to transform a market opportunity into a new commercial product (c.f. Krishnan & Ulrich 2001). NPD process is often structured by activity stages and a decision gate model (Conway & Steward 2009, Khrisnan & Ulrich 2001). Exemplified model of such NPD process is illustrated below in Figure 4. The content and the number of stages and gates can vary between companies and different projects, but the logic is always similar (Shepherd & Ahmed 2000, Ulrich & Eppinger 2008). For smaller projects the stages in process may be embed, while in larger projects more stages and controlling gates are used. Between the stages the project team undertakes pre-defined work, gathers needed information and does the data integration and analysis. The following gates are go/kill decision points where the deliverables from stages are presented and ideas are evaluated. The benefits of such processes are well known as they improve effectiveness and efficiency by shortening development times and increasing the output of successful products. (Cooper 2008).

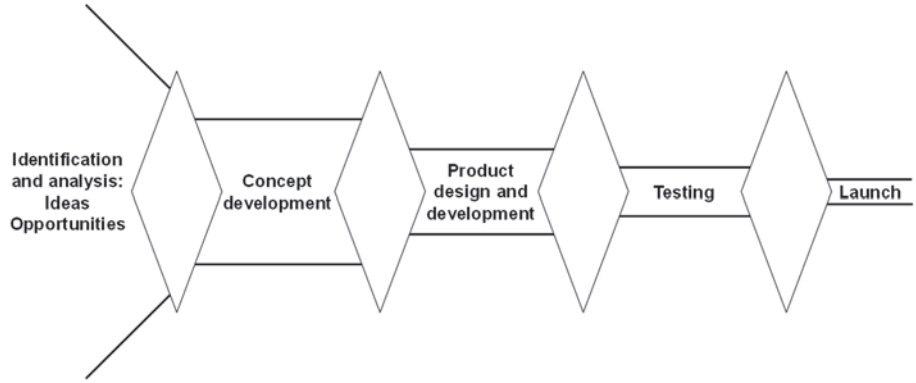

Fig. 4. A generic view on new product development process.

At first, a formal product development process, one that demands up-front homework should exist (Cooper & Kleinschmidt 2007), while the gates between the stages should be effective as firms nearly always have more ideas than available funding and people (Koen *et al.* 2001, Schmidt 2004, Toubia & Flores 2007). Secondly, there should be a defined strategy that sets goals for business's total new product effort and helps to focus and guide the limited resources (Cooper & Kleinschmidt 2007).

The early phase of NPD is also referred to as the *fuzzy front-end* (FFE) of NDP process where the main objects of the process are *opportunities* and *ideas* (Koen *et al.* 2001). Activities during the FFE aim at early reduction of technical and market uncertainty. Managers should ensure intensive, high-quality initial planning in the early phase of NPD to reduce uncertainties. Uncertainty reduction during the FFE affects the effectiveness and efficiency of NPD projects (Verworn *et al.* 2008). Front end activities needs to be aligned with the company's organisational capabilities and business strategy to ensure a constant flow of new products with added value to the corporation (Koen *et al.* 2001). Khurana and Rosenthal (1998) call for a holistic approach towards the front end, and indicate that effective integration of business strategy, product strategy and product-specific decisions are success factors also for the FFE when identifying new opportunities. Fuzziness and uncertainty seem to be reduced when using a systematic NPD process when opportunities and ideas can be addressed by early definitions of *product concepts*.

Too many projects are moved from idea to development without necessary assessments that would provide basic constraints for development and consider whether the idea is worth further development. The necessary up-front homework

tasks should include both marketing and technical assessments, and the voice-of-customer should always be taken into account. Then information should be integrated to financial and business analysis to determine the overall business rationale of the project. Early product definitions to clarify target market, benefits and positioning are also among the best practices together with self-evident quality of execution. (Cooper 2001, Cooper & Kleinschmidt 2007).

The later phases of NPD include for example product design and development, verification and validation, and launching (e.g. Shepherd & Ahmed 2000, Ulrich & Eppinger 2008). The later phases of new product development are laborious and need substantially more time and resources for projects, as well as a number of sophisticated methods and tools compared to the earlier phases (Ulrich & Eppinger 2008). Product design may involve design of mechanics, hardware, software, electronics and their integration in a way that provides customers value and makes the product efficient to manufacture and deliver (Otto & Wood 2001). Testing of such ICT system products may necessitate substantial allocation of project resources. In addition, a significant share of product life cycle costs are already determined by the decisions made during the early phases of NPD (Bralla 1996). Design for X (DFX) is a known approach for consider all different lifecycle aspects from the very beginning of the NPD process (Huang 1996). However, adequate implementation of DFX is a rather complex task (Huang *et al.* 2001, Meerkam & Koch 2005).

Incremental product development

Incremental product development means adding or modifying some features of existing products (Ulrich & Eppinger 2008). One of the main objectives of incremental product development is to make the product more attractive and valuable for the customers, to lead to increased sales and higher profits. When existing product design is modified to improve its perceived value, each change requires resource commitment. (Gautam and Singh, 2008).

Incremental product development is a largely studied and is an increasingly common practice in the development of software products, often referred to as release-based software development (Påhl *et al.* 2005). The early phase of incremental software product development includes constant activities of requirement screening and release planning (Aaramaa *et al.* 2013). Requirements originate from several sources such as users, clients, technologies, markets, standards and government; they come constantly at a high rate; and their screening

aims to quickly assess the value of these new requirements (Regnell *et al.* 2003). Requirement screening and release planning are essentially analysis and decision processes which play a critical role in the success of software product development (Aurum & Wohlin 2003). The requirement screening and selection may not be a straightforward task for product management since requirements are often incomplete at the beginning and relevant stakeholders may have differing expectations and priorities for the requirements (Aaramaa *et al.* 2013). The process of release planning aims at selecting and assigning features to be developed in a sequence of consecutive product releases within the existing development constraints such as time, resources and budget. A good release plan provides maximum business value through the best possible set of features that will be implemented in a right sequence of releases; and will satisfy the most important stakeholders; and are feasible in terms of available resources. (Ruhe & Saliu 2005). Incremental software development has top-down approach to product creation in which a minimum viable software product is developed and released at first and new features and requirements are added along each successive increment to increase the value of the product (Barney *et al.* 2008).

Productisation

In general, productisation refers to activities of manipulating something – e.g. software, services or technology – to make come up with a product, a.k.a. an object that can be sold commercially (Harkonen *et al.* 2015). Products exist to create customer value by satisfying customer needs and solving customer problems, while productisation emphasises the creation of tangible, and repeatable offerings that are efficient to produce and deliver, and are easy to sell, buy and use (Hietala, 2004; Simula, 2008). As synthesised from a rather scattered literature, Harkonen *et al.* (2015) define productisation to relate to 'the process of analysing a need, defining and combining suitable elements, tangible and/or intangible, into a product-like defined set of deliverables that is standardised, repeatable and comprehendible'. Productisation may either be simultaneous or partially overlapping activity with commercialisation, which is a clearly marketing-oriented activity compared to product-centric focus of productisation.

Rapid productisation

Changing markets, and even individual clients may require fast and controlled reactions from companies in relation to product creation and order-delivery processes (Saaksvuori & Immonen 2008). Rapid productisation, also known as rapid product development, is understood as a specific type of incremental product development that addresses unexpectedly emerging sales opportunities (Hanninen *et al.* 2013a). In comparison to incremental product development, rapid productisation is understood as a customer-initiated and sales-driven process where adding or modifying some features of existing products requires minimal engineering effort, and can be planned in short term with a predictable delivery time. (Hanninen *et al.* 2013b). The phases of rather straightforward process are exemplified in Figure 5.

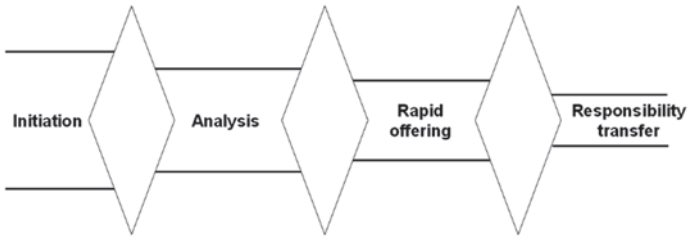

Fig. 5. Exemplified rapid productisation process.

Modularisation and modular product structure are seen as key enablers when responding to new customer requests by changing, or redesigning product modules on the fly (Kangas *et al.* 2014). Rapid productisation may provide merely cosmetic modifications, or a slightly re-defined products by using product bundling strategy (Docters et al., 2006). However, these small changes may affect not only product management, but also the delivery operations relevant to the product (Bernard *et al.* 2009). The standardised processes often cannot manage the customised products as such and additional work is needed in operations (Anderson *et al.* 2006).

Resolving customer specific product requirements through rapid productisation is a widely utilised industrial practice especially in business-to-business companies. However, research on managing variety at the business front-end is almost non-existent but fulfilling non-standard requests calls for mechanisms to provide rapid effective quotations, and capabilities to identify any constraints preventing a company to offer (Bramham *et al.* 2005). Managers often describe

rapid productisation as an ad-hoc procedure that is necessary to satisfy customers and to get new orders but may disturb other business processes. A more systematic procedure for rapid productisation could provide benefits and even competitive advantage for some companies (Hanninen *et al.* 2014).

2.2 Stakeholder management

A stakeholder can be broadly defined as any group or individual who influence or is influenced by a company (Freeman 1984). Besides the influence, a stakeholder should also have a specific stake, a potential benefit or harm, in the firm itself. Hence, it is the responsibility of management to make decisions by selecting activities and directing resources to gain benefits for stakeholders (Donaldson & Preston 1995). Stakeholders are commonly classified into internal and external, or primary and secondary stakeholders. More detailed classification is made based on functional roles into e.g. employees, investors, customers and users, regulatory authorities, partners, supply chain associates, local communities and citizens, private organisations and the government (Post *et al.* 2002). Stakeholder management is built on the relationships that an organisation has with other groups and organisations in the external environment. These groups and organisations influence the decisions made in the company, but the decisions also impact the environment. (Freeman 1984).

Developing and maintaining productive stakeholder relations is essential management competency for enhancing company's value creation capacity and improving its ability to respond to problems and challenges. Stakeholder management refers the development and implementation of organisational policies and practices that take into account the goals and concerns of all relevant stakeholders. (Post *et al.* 2002). Stakeholder management includes activities such as identification and analysis of stakeholders and communication with and influencing the stakeholders (Aapaoja *et al.* 2013). Stakeholder management strives to facilitate the understanding of how to manage stakeholders in invariably changing and unpredictable environments presuming that management function acknowledges the validity of diverse stakeholder interests and attempts to respond to them within a mutually supportive framework (Donaldson & Preston 1995). An essential managerial question is to which stakeholders should the management pay attention to, and to which not (Mitchell *et al.* 1997).

2.2.1 Stakeholder salience

The theory of stakeholder identification and salience propose that managers' perceptions of three key stakeholder attributes – power, urgency and legitimacy – determine the stakeholder salience, the degree to which managers give priority to competing stakeholder claims (Agle *et al.* 1999, Mitchell *et al.* 1997). The more salient stakeholder the more attention managers need to pay to them. Mitchell *et al.* (1997) have divided stakeholders into eight classes based on the salience attributes stakeholder possesses. Table 5 presents the classification and explains how each salience attribute – power (P), legitimacy (L), and urgency (U) – is interpreted when possessed by a stakeholder.

Table 5. Stakeholder salience classification (modified from Mitchell *et al.* 1997, reproduced by permission of SciRes).

Stakeholder classification		Description	Possessing salience attributes
Definite stakeholder "Highly salient"		… managers' have a clear and immediate mandate to attend to and give priority to that stakeholder's claim.	P, L, U
Expectant stakeholders "Moderately salient"	Dominant stakeholder	…'s influence in the firm is assured due to having legitimate claims and ability to act on these claims.	P, L
	Dependent stakeholder	…have urgent legitimate claims but depend upon others for the power to carry out their will.	P, U
	Dangerous stakeholder	… will be coercive and possibly violent.	L, U
Latent stakeholders "Lowly salient"	Dormant stakeholder	… have a little or no interaction with the firm.	P
	Discretionary stakeholder	… have no power to influence and no urgent claims.	L
	Demanding stakeholder	…'mosquitoes buzzing in the ears'	U
Non-stakeholders		… potential stakeholder or not stakeholder at all.	-

Power defines probability that a stakeholder can carry out his own will despite of resistance. The power can be coercive, utilitarian and/or normative in nature. Coercive power utilises the physical resources of force, violence or restraint. Utilitarian power means financial or material resources and normative power utilises symbolic resources (Mitchell *et al.* 1997, Etzioni 1964). Legitimacy is 'a generalised perception or assumption that the actions of an entity are desirable,

proper or appropriate within some socially constructed system of norms, values, beliefs and definitions' (Suchman 1995). Legitimacy can stem from individuals, organisations or society. However, a stakeholder with a legitimate claim may not be perceived as salient by management unless the stakeholder possess the power to enforce the claim. Urgency refers to the degree to which stakeholder claims call for immediate attention and it has two features: criticality and time sensitivity. The criticality is understood as the importance of the claim to the stakeholder, while time sensitivity means the degree to which delay in management attention to the claim or relationship is unacceptable to the stakeholder. (Mitchell *et al.* 1997). The impact can be assessed through the stakeholder identification and salience framework (Mitchell *et al.* 1997) that identifies the stakeholders to whom managers should pay attention.

2.2.2 Early stakeholder involvement

The early involvement of stakeholders, especially suppliers and customers, is recognised as an important and effective but challenging stakeholder management practice in product creation (Wagner & Hoegl 2006). The benefits of early involvement can be achieved through outsourcing and/or collaboration that enables gathering stakeholders' requirements and knowledge for product design. The benefits are realised in many ways as early stakeholder involvement lowers the likelihood of developing poor product designs, increase the likelihood of more effective design, may increase customer satisfaction as regards the function and usage of the product, and may lead to more efficient stakeholder operations. (Dowlatshahi 1998, Wagner & Hoegl 2006). As a result, early stakeholder involvement can improve the effectiveness and efficiency of product creation by reducing costs, shortening product development time, improving quality, and increasing value. The disadvantages of early stakeholder involvement include the risk of losing proprietary knowledge and internal competences, increased dependence on strategic suppliers, and enabling easier imitation by competitors (Ragatz *et al.* 1997, Mikkola & Skjoett-Larsen 2003, Handfield *et al.* 1999).

The early stakeholder involvement may range from consultation on design ideas to integrating stakeholders as fully responsible for the design of components, systems, processes, or services (Ragatz *et al.* 2002). The early involvement is, however, more critical for subsystem suppliers than those of single components, and for stakeholders holding critical knowledge and technology items related to the product (Handfield *et al.* 1999). In addition, stakeholders' roles and responsibilities

influence the level and time of involvement, while some stakeholders may be reasonable to involve also at later stages of product development (Monczka *et al.* 2000). A generalised statement on stakeholder involvement could read as: the more complex the product under consideration is, earlier the relevant stakeholders should be involved. This as the early stakeholder involvement enables procedures that are synchronised and carried out phase-by-phase. (Dowlatshahi 1998).

2.2.3 Design for X stakeholders

Design for X (DfX) methodology have been utilised in the manufacturing industry to address the different aspects of the stakeholders during early phase of product creation (Boothroyd *et al.* 1994). The informed decisions made early reduce need for changes in later stages, and help to reduce the total lifecycle costs (Lehto *et al.* 2010). DFX can be seen as a design philosophy or a set of tools and methods to consider certain lifecycle aspects and to reduce lifecycle costs of products (Bralla 1996). As a structured approach, DFX addresses systematically functional integration and enable capability creation in early product development. During the last two decades, the concept of DFX has evolved from Design for Manufacturing (DFM) and Design for Assembly (DFA) disciplines to cover tens of varying aspects, tools and methods (Chiu and Kremer 2011). The X stands for certain aspects or stakeholders in regards to a product and its lifecycle, production and supply chain to be considered during product design. For example, DFE as Design for *Environment* and DFT as Design for *Testing* cover the aspects of environment and testing, respectively. In this study, Design for X is approached as an organisational setting represented by diverse DFX stakeholders. DFX can be seen as a specific set of internal stakeholders with inherent intent to influence NPD from the very beginning. In a typical business context, design for X includes five to nine relevant aspects at a time to improve product creation (Huang 1996).

The employees representing DFX disciplines should aim at establishing themselves as influential, definitive stakeholders by using their knowledge to improve product design and development. Kochan & Rubinstein (2000) suggest three organisational and governmental features on how employees as stakeholders can contribute towards firm's success: 1) stakeholders need to add value to ongoing operations, 2) organisational processes and governance systems need to be adapted to complement the contributions of the stakeholders, and 3) stakeholder interests must be aggregated and conflicts managed effectively.

2.3 Strategy and business planning

Strategy defines the fundamental approach to the competitive advantage a company is pursuing, and provides the context for the actions to be taken. The three generic strategies are cost leadership – becoming the low-cost producer in the industry; differentiation – offering unique value in the industry in comparison to rivals; and focus – choosing a narrow competitive scope by selecting a segment or group of target segments in the industry and optimising strategy to serve them. (Porter 1985). Strategic agenda includes defining a unique position, making clear trade-offs and tightening fit while involving constant search for ways to reinforce and extend the company's position (Porter 1996). Strategic management can be thought to include three main elements: *understanding the strategic position*, which aims at identifying the impact on strategy of the external environment, a company's core capability and the expectations and influence of stakeholders; *strategic choices*, which include understanding the underlying bases of competitive advantage arising from markets, customers and the strategic capability of the company as well as the alternative directions and methods that strategy may develop; *and turning strategy into action*, which ensures that strategy is working in practice by structuring a company to support strategic performance and enable success as well as managing the changes required for strategy implementation (Johnson *et al.* 2005).

Strategy affects product management in several ways at different levels. The strategic vision may implicitly or explicitly outline the future picture of the company and its offerings, and the strategy may pursuit new markets, new technologies and new directions that need be addressed by product management and incorporated in the long-term product plans (Gorchels 2000). Generic strategies direct product management efforts to different directions, for example, cost leadership strategy guides to reduce product cost with the principles typical for DFX while differentiation guides to enhance product quality, features and deliverability (Porter 1985). Products are essentially involved both in the direction and the method of strategy development as the development directions can be broadly classified into protection, product development, market development or diversification while the development methods include internal development, mergers and acquisitions or strategic alliancing (Johnson *et al.* 2005). Thus, strategy affects strongly both the context and the focus areas of product management. Traditionally many successful technology companies invested heavily in and relied on the capability of internal product development but there has been a significant shift towards collaboration and strategic networking that is

identified especially in the field of open innovation (Chesbrough 2003). In short, open innovation is 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively' (Chesbrough *et al.* 2006).

Planning can be seen as 'a formalised procedure to produce an articulated result, in the form of an integrated system of decisions' where formalisation – systematisation of the phenomena under planning – means three things: to decompose; to articulate; and to rationalise the processes by which decisions are made and integrated in organisations (Mintzberg 1994). Business planning refers to the long-term planning process that integrates strategic and financial plans and ensures that target setting, priority setting, resource allocation and budgeting are aligned with the strategic objectives (Kaplan & Norton 1996). Long-term business success calls for effective decision making of product management concerning the entire portfolio of products and opportunities for new products (e.g., Tolonen *et al.* 2015b, Chao & Kavadias 2008, Cooper *et al.* 1999). Business planning is integral part of product management and relevant in many levels of decision-making from external and internal stakeholder contexts, product portfolios and product plans to the case-by-case decisions concerning opportunities and ideas for new products (Haines 2009).

2.3.1 Business ecosystem

Networked global business environment is increasingly studied utilising the concept of business ecosystem (e.g. Zarvić et al., 2012). In fact, product innovation activities may need diverse capabilities of tens of organisations globally, and the success depends on the performance of the entire business ecosystem (Iansiti & Levien 2004b). Product management research is also extended from a company-specific focus to integration of several actors (Leonard-Barton 1992; Mishra and Shah 2009). The issues addressed by this research include, for example, sharing costs, sharing risks, and sharing profits by collaborating with others, or outsourcing (Bhaskaran & Krishnan 2009; Chesbrough 2003). Business ecosystem approach is especially interesting from the product management perspective when dealing with product business opportunities that would necessitate changes in business, for example requiring new partners, or changing business models of the current stakeholders (e.g. Petrie 2012).

The ecosystem concept originates from biology and ecology but it has been recently utilised to describe specific type of business networks (Moore 1993). The

business ecosystem concept provides a rich analogy on the nature of business networks, despite the fact that biology and business do not share congruent scientific basis (Corallo 2007). Charaterically, such ecosystems have a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival (Iansiti & Levien 2004a). In a business ecosystem, companies co-evolve capabilities around new innovations while cooperative and competitive relations advance to come up with new offerings, to satisfy customer needs, and eventually discover innovations (Moore 1993).

Business ecosystem as conceptual approach emphasises network members' symbiotic, co-evolving relationships and dynamic nature of business networks (Hearn & Pace 2006). Ecosystem dynamics is based on co-evolutionary relationships of the members meaning that the relationships activate selective pressure on others influencing consequently on each other's evolution (Corallo 2007). Thus, business ecosystem evolves by competitive and cooperative interactions among its members. The members participate in an ecosystem for their own benefit and share the total value that the ecosystem creates. Each organisation adds its distinct aspects to the offering and value that the ecosystem generates (Camarinha-Matos et al., 2009).

Business ecosystem overlaps with several other business network concepts. For example, the concept of value chain means organisations that are horisontally linked to each other while the chain can be seen just as a set of sequential activities that are linked together via information and resource flows to produce value to customers. (Porter 1985). Alternatively, the concept of value network has the goal of providing value also for firms and societies participating in the network, not only for customers, while the resource and information flows are simultaneous and multidirectional (Parolini 1999; Bovet & Martha 2000). Therefore, a value network is seen as a web of actors rather than a funnel-like value chain. Such a network structure in where actors are linked vertically and/or horisontally through value exchange activities can be identified also from a business ecosystem. The structure of a business ecosystem is based on relationships and connections between the members, while the ecosystem operates through various roles played by the members (Iansiti & Levien 2004a). Moore's (1993) simple classification identifies the leader and followers or business partners as the members of a business ecosystem. The leader is a central ecological contributor for the followers who appreciate the leader because of its grip on customers (Moore 1993). Iansiti & Levien (2004a) describe four fundamentally distinct roles of business ecosystem members: a keystone, a classic dominator, a value dominator and a niche player.

2.3.2 Business models

Business model concept has been widely discussed and studied during the past two decades yet the concept lacks a unified taxonomy (Makinen & Seppanen 2007, Shafer *et al.* 2005, Osterwalder & Pigneur 2009, Klang *et al.* 2014). Table 6 presents a selected set of more detailed definitions illustrating also common elements of the concept.

Table 6. Business model definitions.

Source	Definition
Timmers (1998)	An architecture for the product, service and information flows, including a description of the various business actors and their roles; a description of the sources of revenues and potential benefits for the various business actors.
Chesbrough & Rosenbloom (2002)	A blueprint of how a network of organisations co-operates in creating and capturing value from technological innovation.
Shafer *et al.* (2005)	Representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network.
Osterwalder (2009)	A business model describes the rationale of how an organisation creates, delivers and captures value. The business model is like a blueprint for a strategy to be implemented through organisational structures, processes, and systems.
Zott & Amit (2013)	The business model describes the system of interdependent activities that are performed by the firm and by its partners, and the mechanisms that link these activities to each other.
Klang *et al.* (2014)	Business model concept is the constitution of (1) internal artefacts, which are primarily related to the internal sphere of the firm and do not directly influence its relationships with external stakeholders; (2) relational mechanisms, which influence the relationships between the firm and external stakeholders involved in its transactions; and (3) external stakeholders, which exist beyond the boundaries of the firm.

Klang *et al.* (2014) analyse the literature on business model concept along three dimensions: classification – academic debate on 'what is the business model, and what is it not?'; constitution – practitioners need for explaining 'what is the business model built of?'; and configuration – empirical observations on 'what does the business model look like from the inside?'. This study see the business model concept as a constitution and utilises that concept in analysing and describing a business ecosystem for managerial purposes. In this study, business model is understood as *representing a company's business logic and strategic choices for creating and capturing value in a value network* (Shafer *et al.* 2005, Osterwalder 2004, Teece 2010). Value creation refers to the assets, collaborative

processes and activities that a company performs to create value for customers and other stakeholders. Value capture refers to the individual company-level actual profit-taking a.k.a. how firms eventually pursue to reach their own competitive advantages and to reap corresponding economic returns in relation to the value they create. (Ritala *et al.* 2013, Shafer *et al.* 2005). Shafer *et al.* (2005) identified four common problems associated with creating and using business model as a tool: 1) flawed assumptions underlying the core business logic; 2) limitations in the considered strategic choices, 3) misunderstandings about value creation and value capture; and (4) flawed assumptions about the value network. These problems indicate the necessity to thoroughly think, formulate and test the key elements of business model which may be an ongoing effort following the making and implementing the strategy. Hamel & Prahalad (1994) gives four advisory questions to find opportunities to improve the existing business model: 1) which customers and needs an enterprise does not serve? 2) Is it possible to make profit from different points of value chain? 3) Could the customer needs be served better by different structure of skills and property? 4) Is business protected against 'new business rules'?

2.3.3 Business case analysis

Business case is a concept used for evaluating potential investments and selecting best investment alternatives (Keen & Digrius 2002, Reifer 2001). Business case analysis seeks to figure out the business reasons for why, or why not, a specific opportunity is worth the investment (Keen & Digrius 2002). The objective of business case analysis is to predict in a rational way the true business value of potential investment to support decision-making.

Business case analysis in product creation

Starting from the identification of opportunities and product ideas in the early phases of NPD process, product management activities are needed to reduce uncertainty concerning each opportunity, especially by studying value, feasibility, strategic fit and market potential of the product idea as well as the size of the investment and development effort (Otto & Wood, 2001). Business case analysis when conducted as a systematic procedure specifically aims at reducing that uncertainty. These aspects are apparently considered throughout the NPD process especially in gate criteria (Carbonell-Foulquie et al., 2004; Hart et al., 2003). The

early phase of NPD process is often engaged in both screening out the opportunities with weak business potential and prioritising opportunities with strong business potential. For example, Cooper (2001) defines the early phase as scoping consisting of a preliminary market, technical and financial assessment as well as a rudimentary check of the business rationale and financial prospects of an opportunity. These issues may be checked in the FFE of formal NPD process. For example, front end business case may be built based on the estimates of market potential, customer needs, investment requirements, competitor assessments, technology unknowns and overall project risks (Koen *et al.* 2001).

Cooper (2001) suggest that NPD business case analysis consist of three main tasks: 1) *Product and project definition* – Defining target customers and/or target markets and the product itself, including the benefits, features and initial design requirements; 2) *Product justification* – Reviewing financial, profitability and risk considerations as well as nonfinancial considerations, such as the strategic rationale, competitive advantage, leverage and market attractiveness to justify why should a company invest in the project; and 3) *Project plan* – Planning the schedule, the launch date and required resources – money, people, and equipment – and the responsible leader and team for conducting the project.

NPD business case combines information from different functions and knowledge areas, typically at least customer and market-related information, technical information and financial information as well as consideration of strategic alignment (Cooper 2001, Cooper 2008, Ulrich & Eppinger 2008, Carbonell-Foulquie *et al.* 2004). Thus an important precondition for smooth business case analysis is easy availability of existing information and knowledge in a usable form. This can be for example, past financial information, market reports and competitor analysis and existing product data. Otherwise gathering the data and information from similar or analogous products, or coming up with rough estimates for product layouts can be a laborious task. The cost data must be established considering the marketplace: e.g. unit costs and sales volume curves, dependence on other products or systems of the customers. (Otto & Wood, 2001, Asiedu & Gu 1998, Atzeni *et al.* 2010).

2.3.4 Strategic fit

In strategic management literature, strategic fit measures whether a firm's strategy is aligned both with organisational competencies and the external circumstances (Zajac *et al.* 2000). Porter (1996) identifies three types of fit: Simple consistency –

ensures that the competitive advantage activities cumulate and do not cancel themselves out; activities are reinforcing; and optimisation of effort – typically eliminating redundancy and minimising wasted effort e.g. through coordination and information exchange across activities. Competitive advantage depends on the entire system of activities that the strategy necessitates while the fit among activities may substantially reduce costs, increase differentiation, improve customer service or increase delivered value (Porter 1996).

In product management, strategic fit can be understood as a product, or an opportunity fitness for strategic objectives, capabilities and plans. Strategic fitness is identified as an important factor in determining new product success. Common ways to describe strategic fit include relatedness to strategy, strategic importance, fit with current strategic plan, alignment with firm's strategy, consistency with the firm's overall product plan and technology strategy, and importance of project to the strategy (Loutfy & Belkhir 2001, Lilien *et al.* 2002, Carbonell-Foulquie *et al.* 2004, Ulrich & Eppinger 2008, Cooper 2008).

2.4 Literature synthesis

Product management. The theoretical pinpoint of the thesis lies in the front-end of product creation. This is analysed by the product management function focusing on improving the decision-making support by systematic analyses of stakeholders and business opportunities, following the purpose of the main research question. The definitions for product and management by ISO 9000 as the common frame for standardised and systematised management, reveal an organisational decision making and product ownership dilemma between product management and project management. Typically product creation processes are carried out by project organisations responsible for the completion of explicit tasks and deliverables (Ulrich & Eppinger 2008). After the project is finished the project management and the project organisation is disbanded, but product management still continues running the business surrounding the product, which is just in the very beginning (Haines 2009). Given the fact that significant share of product life cycle costs are often determined by the decisions made during the early phases of product creation (e.g. Huang 1996, Bralla 1996), there is a systemic risk of sub-optimisation with the narrow scope of development at the expense of product value and costs throughout the lifecycle. As a consequence, the successful integration of product, project and business decisions can be seen as a major challenge that a company and the product management function must deal with (c.f. Mintzberg 1994). The key

theoretical concepts from the fields of strategic management and stakeholder management are reflected against the main objective – improving product management decision support in the front-end of product creation – and synthesised in Table 7.

Table 7. Synthesis of the key theoretical concepts.

Key theoretical concept	Synthesis of the key concepts in relation to product management decision-making that affect product creation front-end	Main references
Business case analysis	As a systematic procedure to analyse opportunities and ideas, business case supports making go/no-go decisions and commitment in funding and launching product creation projects.	Cooper *et al.* (2001), Koen *et al.* (2001)
Strategic fit	Products have a central role in executing strategy. Strategic fit is recognised as a significant factor in determining new product success and needs to be considered in product management decisions.	Porter (1996), Carbonell-Foulquie *et al.* (2004)
Business model	A product acts as a medium of creating and delivering value. Business model – the representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network – explains the enterprise context for product-related decisions.	Shafer *et al.* (2005)
Business ecosystem	Business ecosystem – a business network of dynamic nature with co-evolving relationships between participants – explains the external business environment for product-related decisions.	Hearn & Pace (2006)
Stakeholder prioritisation	Products have many stakeholders of varying importance and relevance. Identifying, mapping and prioritising stakeholders facilitate deciding which stakeholders' needs and requirements need to be considered in product creation front-end.	Donaldson & Preston (1995)
Stakeholder salience	Explains the fundamental question of stakeholders in a systematic way: which stakeholders deserve or require management attention, and which not.	Mitchell *et al.* (1997)
Early stakeholder involvement	The early involvement of stakeholders is recognised as an important and effective, but challenging management practice in product creation.	Wagner & Hoegl 2006
Design for X	A specific group of internal stakeholders that are involved in product creation and intentionally aim to affect the decisions made in product creation front-end.	Bralla (1996)

Strategy and business planning. The strategic choices reflect directly to product management function, especially to the field of product portfolio management concerning decisions of which markets, technologies and products to invest in (Cooper *et al.* 1999). Product management also plays a role in converting the strategy into action and balancing it with evolving environment (Johnson *et al.*

2005). For example, unexpectedly emerging opportunities may develop strategy to new directions as explained in emergent strategy concept by Mintzberg (1994). Overall, product management needs to be aligned with the strategic objectives of the company, and in product creation front-end this can be considered using the concept of strategic fit. For example, the cost leadership strategy guides product management to consider cost competitiveness as the determining factor of strategic fit in decision-making.

Stakeholder management. Product management deals with several groups and organisations, both within the company and in the external environment meaning that stakeholder management is often implicitly incorporated in product management. In fact, many stakeholders influence the decisions made in product creation front-end, but the decisions also impact the environment and stakeholders – potentially demanding product management attention (c.f. Freeman 1984). Besides the influence, a stakeholder is identified as having a specific stake, and will potentially benefit or harm by the product itself. Stakeholder management reflects product management in terms of developing and implementing such practices that take the goals, interests, needs and requirements of all relevant stakeholders into account (c.f. Post *et al.* 2002). Hence, an essential question for product managers is to which stakeholders they should pay attention to, and to which not (Mitchell *et al.* 1997). Product management function should acknowledge the validity of diverse stakeholder interests and form a mutually supportive framework to respond to them (c.f. Donaldson & Preston 1995) in order to manage stakeholder relations also in conflicting stakeholder issues.

Synthesis. Product management must deal with multiple stakeholder issues in the front-end of product creation. Stakeholders are commonly divided between external and internal. External stakeholders can be explained by using the concept of business ecosystem, which is often the actual context of product development activities in modern business (Iansiti & Levien 2004a). Also, the business model concept is adopted to explain the roles of external stakeholders within a business ecosystem resting on the idea that each business ecosystem is a composition of business models of its members, and vice versa. Hence, the role and position of each company within the ecosystem could be defined by studying their business models. Internal stakeholders are approached at a unit level, whereas unit is considered as a team, department or any internal group of people having a legitimate standing within the company by the concept of stakeholder salience (Mitchell *et al.* 1997). DFX stakeholders are selected for a closer look as a particularly interesting group of internal stakeholders since they are intentionally

involved in the early phase of product development (Bralla 1996). Business opportunities during the front-end of product creation are approached using the concept of business case analysis, both in new product development, and in rapid productisation. Rapid productisation is explored as a contemporary product management phenomena that reflects emergent strategy development in an evolving business environment (Minzberg 1994).

3 Research contribution

3.1 Business ecosystem analysis for new product development

The first article answers the first research question (RQ1). This article studies business ecosystem stakeholder analysis to aid collaborative new product development and ecosystem design. Collaborative new product development helps to share risks, and to increase the efficiency and effectiveness of the required activities. *An entire business ecosystem of relevant stakeholders is often required to carry out the NPD activities*. The stakeholder analysis and ecosystem description is built on the idea that firms compose a business ecosystem and their business models can be used to analyse the ecosystem in a systematic and detailed way. As the main contribution, this study constructs a business model framework for analysing and describing business ecosystems for new product development. This main contribution is illustrated in Figure 6.

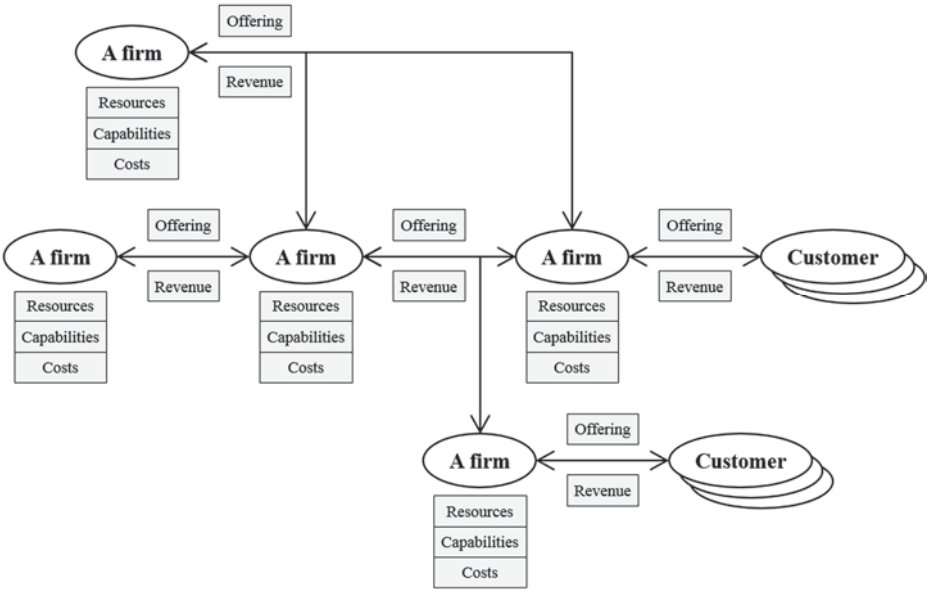

Fig. 6. Business model framework to describe business ecosystem stakeholders (Reproduced by permission of International Journal of Business Development and Research).

The business model elements, identified and synthesised from the literature, are stakeholders, value creation structure, offering, capabilities, resources, revenue, and cost. Systematic way of approaching business models can be seen to facilitate business ecosystem analysis from many aspects. Stakeholders – firms and customers – are connected to each other through relationships which are characterised by offering and revenue. Each offering describes value that a stakeholder creates and proposes together with its co-operators. On the contrary, revenue is value that a stakeholder captures from its customers. The value creation structure of a business ecosystem can be a chain, a network, or more likely a mix of these two. This is illustrated by the connections between all the ecosystem stakeholders. The position and the necessity of each actor for an ecosystem are changing over time. The position and the necessity are determined by the actor's resources, capabilities, offering and financial performance. The revenue gained by an actor must cover the costs of actor's resources, capabilities and upstream actors' revenue, in order to survive in the long run. Every business model element has its role in describing a business ecosystem. Ultimately, ecosystem business model might be described as a composition of stakeholders' business models as well as the ecosystem offering as a composition of stakeholders' offerings.

The constructed business model framework provides the ease of comprehension and facilitates analysing the roles of different stakeholders. This may enable managers to better prepare for risks and to understand business opportunities enabled by a product more swiftly. A business ecosystem description may also enable understanding potential success with different business models. The case study indicates that describing the semiconductor ecosystem via business model elements is a tangible way to perceive an ecosystem and the roles of different stakeholders.

3.2 Assessing internal stakeholders' salience in product development

The second article answers the second research question. This study utilises the concept of stakeholder salience for analysing stakeholders' influence on product management in product development context. The single case study assesses saliences of DFX stakeholders whose intentional aim is to improve product design in the early phase of product development.

The concept of stakeholder salience assumes that the influence of each stakeholder is sum of three salience attributes it possesses: power (P), legitimacy

(L) and urgency (U). Power defines the probability that a stakeholder can carry out his own will despite of resistance. Legitimacy is a perception that the stakeholder's actions of are desirable, proper or appropriate. Urgency refers to criticality and time sensitivity, the degree to which stakeholder claims call for immediate attention. Assessment of these three attributes enables classifying stakeholders into definitive, expectant, latent or non-stakeholders. Highly salient definite stakeholder has power, legitimacy and urgency in their claims meaning that product managers have a clear and immediate mandate to give priority to their claims. Non-stakeholder is not stakeholder at all, at least not yet. As the main contribution, AHP based framework for assessing stakeholders' salience is constructed and used in product development context. The results are illustrated in Figure 7 where DFX stakeholders are sequenced and their relative saliences are evaluated and visualised. Compared stakeholders are Design for Testing (DFT), Design for Assembly (DFA), Design for Packaging (DFP), Design for Serviceability (DFS), Design for Supply Management (DFSM), Design for Demand/Supply chain (DFDS) and Design for Environment (DFE).

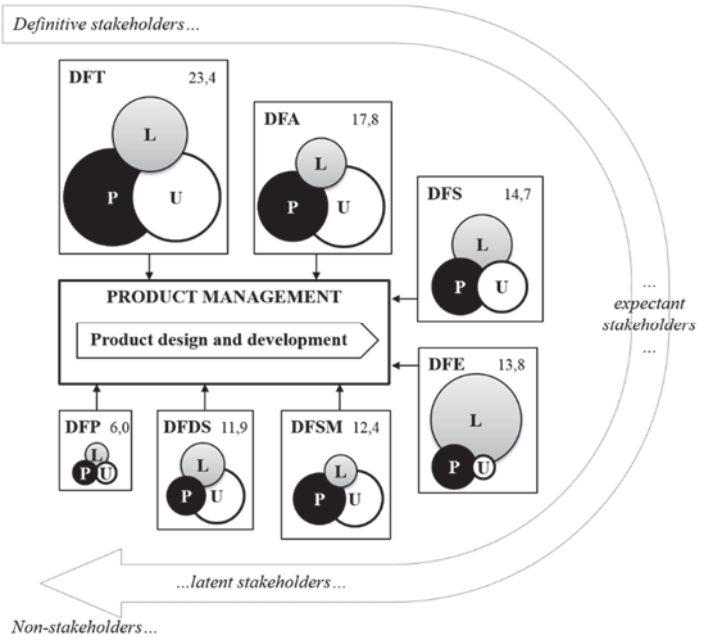

Fig. 7. Internal DFX stakeholder saliencies in the case study (Reproduced by permission of SciRes).

The results show that the product managers in the case company perceive DFT as the most salient DFX stakeholder for product development and DFP the least salient. The fourfold difference means that DFT has essentially higher salience. Data was collected by asking product managers to compare each DFX stakeholder against each other by each salience attribute P, L and U using relative scale from 1 (equal) to 9 (absolutely higher). Thus comparison matrices (size 7 x 7 in this study) were established for pair-wise comparisons and the results were analysed following the AHP method. The benefit of the AHP method is that the analysis includes the consistency ratio and guides to accept only consistent answers.

This study exemplifies the usage of AHP method in assessing stakeholders' salience but the results are not fully generalisable. After carrying out salience assessment a company may take corrective actions to increase or decrease the salience of specific stakeholder group, to disband an internal stakeholder group, to consolidate some stakeholder groups together, or to segregate a certain Design for X group into several groups. The unique approach of this study is to apply the stakeholder salience assessment framework in product development context. The framework and assessment procedures are applicable to be used also in other contexts and companies.

3.3 Business case analysis in new product development

The third article answers the third research question. This study approaches business case as a means of analysing product ideas and opportunities starting from the early phase of new product development (NPD) process. These business cases serve product management decision-making in selecting ideas and concepts for further development and committing resources to them. A systematic way to conduct business case analysis is built on four areas of gathering and processing information: market assessment, technical assessment, financial analysis and strategic fit. This foundation, identified from the literature, is illustrated in Figure 8.

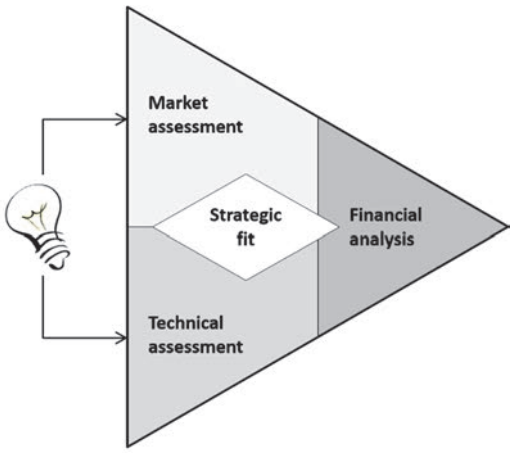

Fig. 8. A common foundation for business case analysis (Reproduced by permission of Global Journals Inc. (US)).

New product development is a context-dependent process taking place in companies and real business environments. Detailed content, extent and depth of business case analysis vary depending on many factors such as the field of business and development cycle times. As the main research contribution, this study constructs a business case analysis procedure which illustrates the logical flow of the analysis and exemplifies the content of NPD business case, see Figure 9. The creation of the procedure is motivated by true industrial needs as it is developed as a part of an effort to develop integrated information processing tool for product development process of the case company. The procedure refines the common foundation described above into seven distinct but interrelated parts of NPD business case analysis. The first four parts, defining value, defining market, figuring out technical feasibility and determining strategic fit, are the root of a product business case. The detailed analysis of these parts provides key assumptions and the rationale for each case. The financial analysis, estimating sales, costs and financial return, completes the procedure to business case analysis as they convert the case analysis into monetary terms and calculates the expected financial consequences of the case. The proposed business case analysis presumes other NPD tasks, such as defining the product and studying its feasibility, to be done previously to or simultaneously with building the business case.

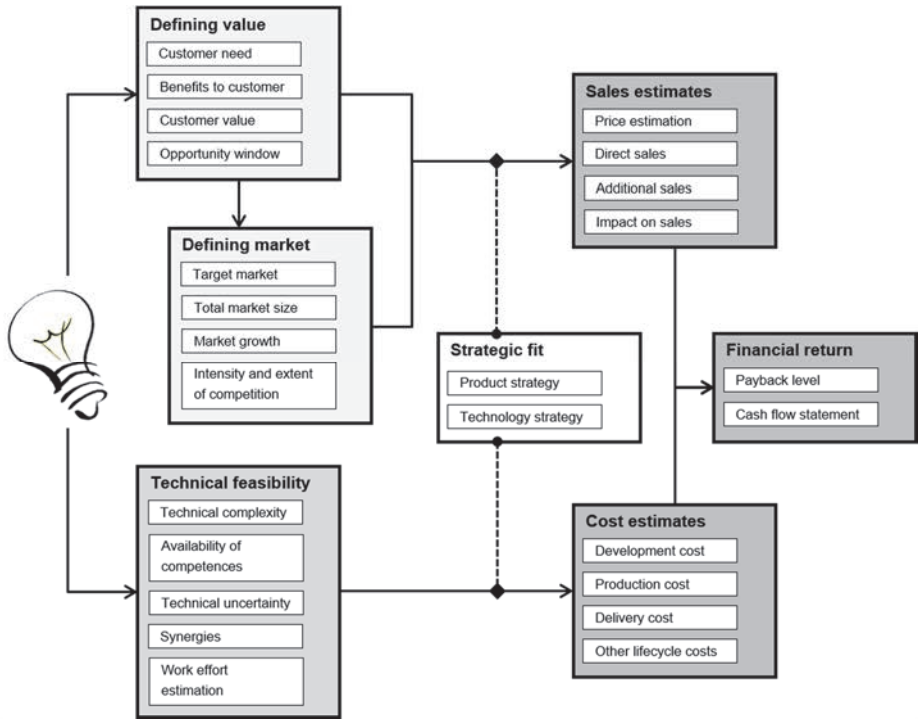

Fig. 9. An example of business case analysis procedure in NPD (Reproduced by permission of Global Journals Inc. (US)).

NPD business case analysis can be seen as a part of new product business planning continuum, where business potential of product ideas may be roughly and quickly assessed in the front-end of NPD; the business case of product concepts are analysed as accurately as possible for deciding whether to develop certain products, and a product business plan over its lifecycle is made after the development decision for launching and managing a certain product. All these business planning activities analyse same the business opportunities and face the same challenge of searching, accessing, gathering, processing and integrating data and information from multiple sources. Systematic analysis enables learning throughout the business planning continuum, and possibly, aids in developing more efficient business analysis or business intelligence tools integrated to both internal and external information systems.

This study provides a logical flow of essential tasks and steps for business case analysis in NPD. The systematic procedure can be used as a point of comparison in

any organisation aiming to implement or improve business case analysis in NPD process. The study is a theoretical construction that reflects the empirical practise of business case analysis.

3.4 Exploring business case analysis for rapid productisation

The fourth article answers the fourth research question. This study explores business case analysis procedure for rapid productisation. Rapid productisation is a customer-initiated and sales-driven product creation process to change, or redesign product modules on the fly. The need for rapid productisation arises unexpectedly and calls for fast reaction and decision-making. This kind of process may disturb other business processes, but is necessary to satisfy customers and to get new orders in certain situations. Exploring business case analysis is a part of an effort to rationalise and systematise industrial rapid productisation process and practises.

The systematic business case analysis procedure for rapid productisation, synthesised based on literature and analysis of six companies, is depicted in Figure 10. The procedure includes estimating revenue, analysing costs and determining strategic fit: whether the item has potential to be included in the product portfolio. The main tasks in the first phase are to estimate the revenue from the specific sales case and analyse the development and engineering cost of productisation. The item cost structure is analysed in the second phase as well as the market potential of items to be introduced in the portfolio. To complete the analysis, all the information and data is synthesised into a business case document. The document includes basic data, such as the price and the ready for delivery date for communication with the customer and sums of sales expectations and cost estimates to profit expectation.

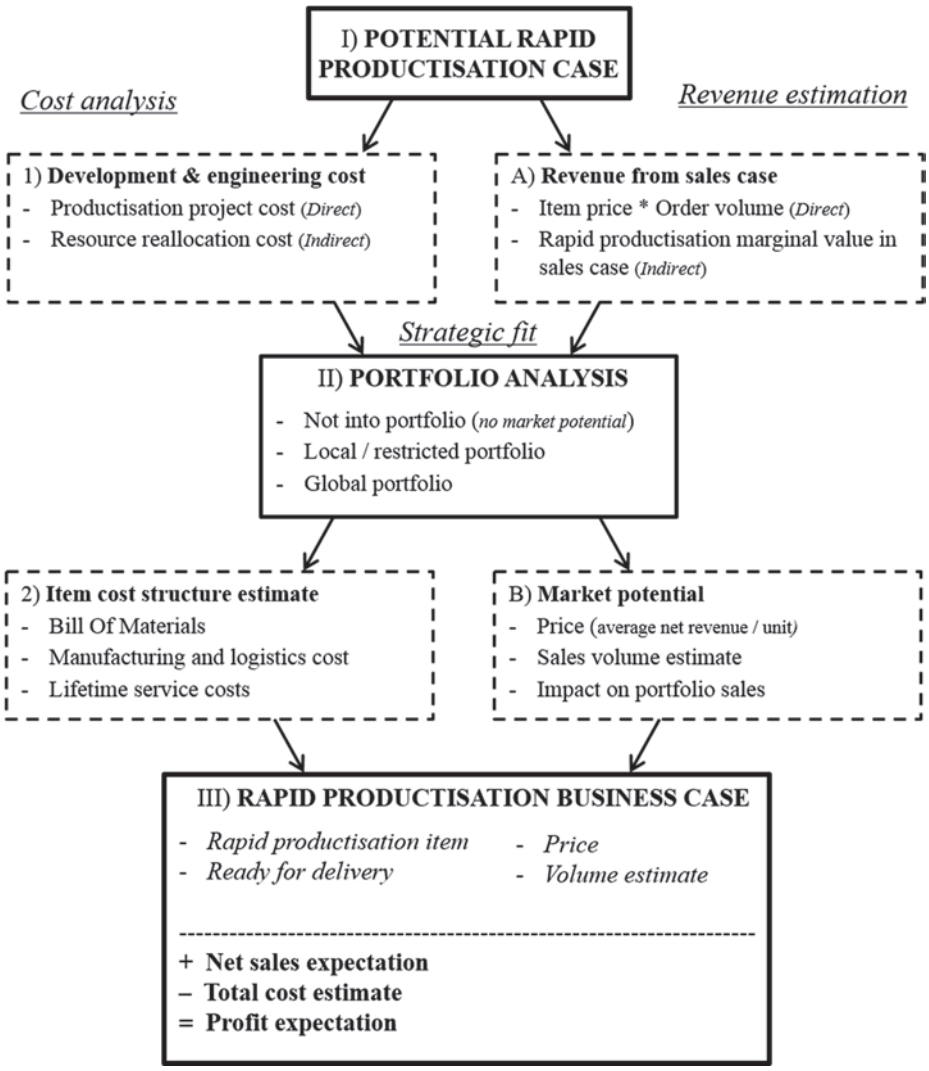

Fig. 10. An example of business case analysis procedure in rapid productisation (Reproduced by permission of Inderscience).

Business case analysis serves management to make well-informed decisions. In rapid productisation, decision-making culminates in two points: 1) whether to conduct rapid productisation case or not; and 2) whether to process rapid productisation item as a one-off sales case or aim at including the item in the product portfolio. The first decision is about weighing the value of the sales case

against associated costs. The portfolio decision follows strategic fit considerations and includes assessing market potential against total lifecycle costs. One-off sales cases may be processed as exceptional cases both in product development and in order-delivery processes, e.g. utilising an unusual engineer-to-order delivery mode or contract development. On the contrary, rapid productisation of portfolio items may follow formal product development process by bypassing unnecessary phases and tasks and speeding up the rest. However, the outcome may not differ from any other portfolio items from order-delivery process viewpoint.

In rapid productisation, business case analysis is a relatively straightforward task. In order to meet the explorative aim of the study; cost analysis, revenue estimation and strategic fit considerations are outlined as the main issues of such an analysis. The results of this study are applicable for the companies that apply mass customisation, face diverse customer needs and utilise a configure-to-order delivery mode to respond customer needs. The procedure may also be applicable to other similar contexts but cannot be generalised due to the exploratory nature of the study.

3.5 Results synthesis

Each individual study contributes to the understanding of how product management can systematically involve multiple stakeholders and analyse business opportunities in the front-end of product creation. The research contribution of each article is summarised in Table 8.

Table 8. Results summary.

RQ	Data	Method	Results
RQ1	Literature on semiconductor industry	Constructive research, literature study	The business model based framework to describe and analyse business ecosystems and to aid collaborative NPD and ecosystem design.
RQ2	12 pairwise comparisons in one company	Constructive research Analytic Hierarchy Process, document analysis	The AHP based framework for assessing internal DFX stakeholders' salience to guide product management.
RQ3	Survey data (N=21) in one company, company documents	Constructive research, survey, document analysis	A systematic procedure for business case analysis in NPD presents a logical flow of essential tasks and steps.

RQ	Data	Method	Results
RQ4	Interviews in six companies, company documents	Constructive research, semi-structured interviews, document analysis	A systematic procedure for business case analysis in rapid productisation to support fast reaction and decision-making.

Product creation is complex and collaborative effort demanding product management to deal with issues arising from various stakeholders. The constructed business model framework facilitates analysing the roles of external stakeholders for initiating and planning product creation projects. Describing business ecosystem systematically through stakeholders' business model elements may enable understanding business opportunities and potential success with different business models more swiftly. This positions evolving business environment and the need for ecosystem design to the context of product management, indirectly influencing the actual decision-making in the front-end of product creation. The original study II focuses on internal stakeholders' impact on product management decision-making by assessing DFX stakeholder saliences. The study points out moderate salience differences between DFX stakeholders but the variance in taking the voice of DFX stakeholders into account in product management decisions is comparatively low (c.f. Aapaoja *et al.* 2013). This indicates a relatively balanced situation in addressing issues of these stakeholders from the case company's product management viewpoint.

A commercially successful new product may necessitate even hundreds of new ideas and opportunities to be screened (Stevens & Burley 1997). This study considers business case analysis as a product management tool for effective screening and analysis of business opportunities. Business case analysis as a systematic procedure that strive to predict the true business value of potential investments. Such a procedure includes gathering relevant and trusted data and information, analysing this information in a rational way, calculating predictable business consequences and synthesising the results to a formal business case document. A major challenge is to determine the effort to be used in business case analysis and especially recognising the trade-off point after which gathering and analysing more information would certainly not change the continue/no-go decision. The results of individual studies are synthesised in Figure 11.

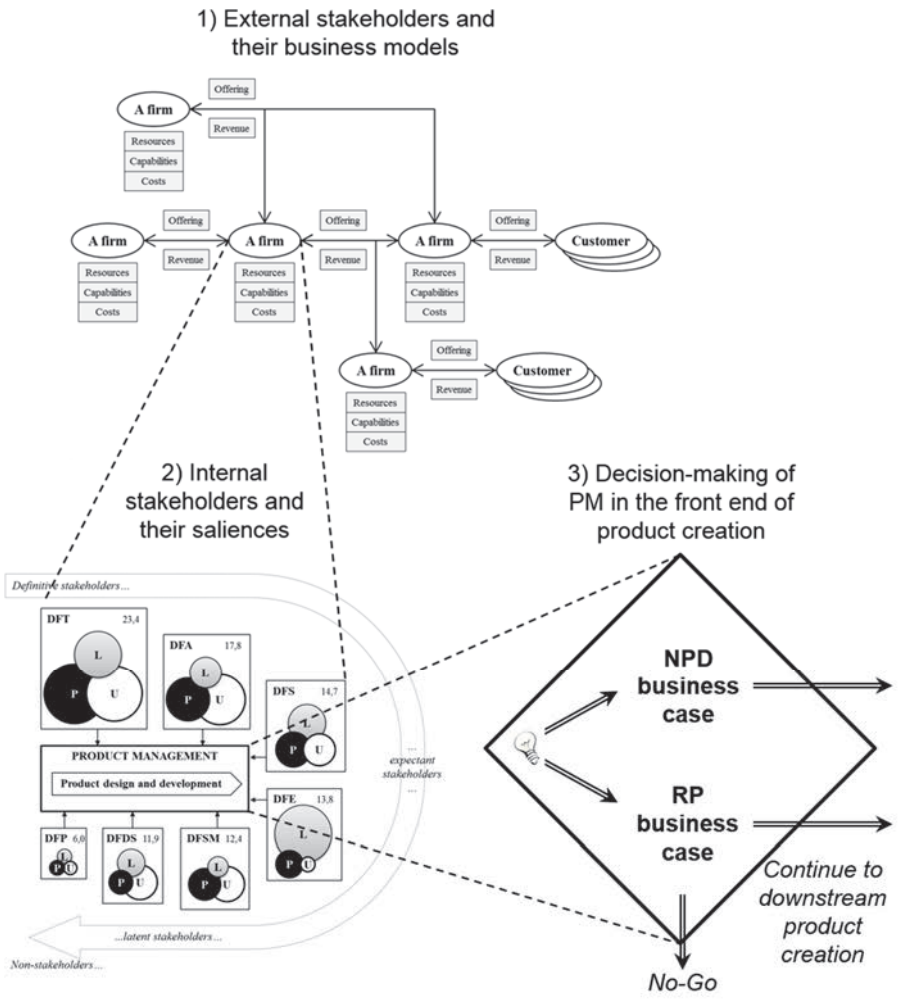

Fig. 11. Results synthesis.

Product management decision-making in the front-end of product creation culminates into the continue/no-go decision. The procedures constructed in this study illustrate a systematic way in making well-informed decisions. Product management is not an isolated area but cross-organisational activity to address multiple issues of different stakeholders. The stakeholders are informants and they are influencing and/or influenced by the decisions forming the decision-making context for product management in the front-end of product creation. The

synthesised result suggest that the stakeholder context – salient internal stakeholders, business interests of external stakeholders and evolving environment – should impact strongly the product management decisions. However, the decisions' potential impact on the stakeholder context is varying and necessitates case-based consideration as regards the strategic intent of the company and economic justification of each case.

4 Discussion

4.1 Scientific implications

The scientific knowledge on product management is somewhat limited and emphasises the importance of new product development and marketing. Stemming from the research on new product development (e.g. Cooper 2001, Ulrich & Eppinger 2008, Conway & Steward 2009), this study is positioned to the emerging field of product management research (e.g. Tyagi & Sawhney 2010, Tolonen *et al.* 2015a) and builds on the selected theoretical perspectives in strategy and business planning, and stakeholder management. As each individual publication focuses on different scopes in supporting product management decision-making at the front-end of product creation, Table 9 presents the scientific implications of the individual articles.

Table 9. Implications by the individual publications.

Article	Title	Implications
I	Business ecosystem perspective to new product development	An evolving business environment and external stakeholders influence the product creation and decision-making of product management. The systematic analysis of stakeholders' business models is a tangible way to perceive the business ecosystem and analyse the roles of different actors in the front-end of product creation.
II	Analysing internal stakeholders' salience in product development	DFX entails a stakeholder management mechanism to incorporate the voice of stakeholders in the front-end of product creation. Salience assessment explains how early involvement of stakeholders have succeeded in regard to product management decision-making.
III	Business case analysis in new product development	Decisions made in the early phase of product development significantly affect product cost and value throughout its lifecycle. Systemising a NPD business case analysis procedure, that includes gathering, processing and integrating information from different knowledge and functional areas – customer, marketing, technical, financial and strategic fit – provides the rationale for product management making well-informed go/no-go decisions and commitment to fund and launch product creation projects.
IV	Business case analysis in rapid productisation	Unexpectedly emerging opportunities are common in an evolving, unpredictable business environment and demand occasionally product management attention and decisions. Systemising a rapid productisation business case analysis procedure support product management making well-informed go/no-go decisions quickly whether to launch rapid productisation projects.

Stakeholder management, strategy and product management. This study considers a business ecosystem as the context of collaborative product creation in an evolving business environment and utilises the concept of business model – the representation of each firm's underlying core logic and strategic choices within a value network – as a tool to perceive the business ecosystem. This approach provides new perspectives for the scientific product management literature as the original construction in the article I indicates that product management's interaction with external stakeholders in product creation forms a complex and dynamic network of business relationships agreeing with Iansiti & Levien (2004b). The business environment influence decisions made in the front-end of product creation and vice versa. The business model element-based view on external stakeholders explicitly links product management with the strategy implementation and value co-creation within a business ecosystem. With regards to internal stakeholders, this study considers DFX as a stakeholder management mechanism to incorporate the voice of selected stakeholders in the early phase of product creation providing new and extensive perspectives to the work on DFX by Bralla (1996) and early stakeholder involvement by Handfield *et al.* (1999), and Ragatz *et al.* (2002). The original construction in the article II indicates that perceived stakeholders' saliences vary and salience assessment may explain how early involvement of stakeholders has succeeded. This study contributes to product management research by constructing systematic methods to stakeholder analyses. The study explores the theoretical field of product management as a mutually supportive decision framework to respond to interests of diverse stakeholders starting in the front-end of product creation, similarly as Donaldson & Preston (1995).

Business planning, business opportunities and decision-making. Decisions made in the early phase of product creation significantly affect product cost and value throughout its lifecycle. This study acknowledges, as a specific product management challenge, the case-by-case decisions about whether an opportunity or an idea is worth of launching a product creation project. The study considers business case analysis as a systematic analysis procedure to support case-by-case decision-making, conducted in the early phase of product creation under the responsibility of product management. The procedures presented in article III and IV verify the work of Otto & Wood (2001) and Cooper (2001) about the common ground of business case in product creation – customer, market, technical, financial and strategy considerations. In addition, the presented procedures support the findings of Khurana & Rosenthal (1998) and Koen *et al.* (2001) with regards to a holistic approach and formal procedures being needed in the front-end of product

creation including information sharing and integration thinking in relation to technical, market, strategy, financial and organisational issues. By constructing systematic procedures for business case analysis in product creation, this study contributes to the decision-making aspect of product management and emphasises the need to integrate regular, often rigid business planning practises and systems with case-by-case decision-making procedures. Systematic case analysis procedures illustrates the logic that may be further refined to become the basis of analysis tools to support decision-making of product management, considering also wider context, such as extended enterprise, business ecosystem and unpredictable business environment as suggested also by Krishnan & Ulrich (2001).

Stakeholder and business opportunity analyses. The results of this study shows that customer value and shareholder value are considered thoroughly in business case analyses by product management. Within a business ecosystem there are often many other stakeholders and stakeholder values relevant to product decisions. This study recognises the research gap in addressing multiple stakeholder issues in product creation, thus confirming similar findings by Driessen & Hillebrand (2013). Business opportunities are varying as measured by scale, scope, temporal and spatial dimensions. This study exemplifies product management business opportunity analyses regarding existing products and new products within a company. However, customer and shareholder value may not be maximised merely by creating a product within a company. Some opportunities would necessitate changes and updates in the business model of the company or its partners and some opportunities are related to the business ecosystem and its value creation. This study indicates that the strategic dimension of product management is inadequately addressed in current theory as regards the multidimensional role of the products in business.

4.2 Managerial implications

This study contributes to the product management decision-making, both in presenting systematic ways to explicitly analyse stakeholder context as the decisions' sphere of influence and in business case procedures to prepare well-informed continue / no-go decisions in the front-end of product creation. This guides companies in organising management of products and aligning product management decisions with the strategy implementation and systematic management of a company, and furthermore, as a part of collaborative product creation effort of an entire business ecosystem.

Stakeholders and product management decision-making. Identifying, analysing and prioritising stakeholders and their claims are incorporated as the basic elements of stakeholder management also in product management. Product management needs to understand the companies' position and role in the ecosystem in collaborative product creation. This study exemplifies a systematic way for analysing a business ecosystem as a constitution of stakeholders' business models. This provides product managers the rationale, a tool and a practical way to gain understanding on the role, resources, capabilities and the true business interest of each stakeholder within mutual product creation activities. Early involvement of some stakeholders, especially suppliers and customers, is identified as a significant practise for effective product creation. Companies applying DFX approach have nominated specific DFX representatives, such as design for testing and design for environment, to be taken into account by product management in the front-end of product creation. This study assumes DFX as internal stakeholders to be early involved and constructs an AHP-based salience assessment framework for management to use as a systematic method to analyse how well the early involvement has succeeded.

Business opportunities and product management decisions. Product management practices towards case-by-case decisions vary from "gut feeling" to thorough case analysis. The systematic business case analysis procedures constructed in this study facilitate product management in making well-informed go/no-go decisions about new opportunities and ideas. The procedures pay attention on what is the logic and the sequences of such an analysis, what data and information is needed, and how to conduct a business case analysis. However, this is not enough to make business case analysis an effective management practise in any company. Context-specific work is needed to ensure that necessary data and information is available, effortlessly accessible and up-to-date within an adequate scope and in a usable form. In addition, the amount of data and data sources may be large, and the management challenge may involve simplifying and even automating the ways of how data and information is gathered, stored, processed and integrated. Ideally, product management uses best available information and sound analysis as the basis of deciding whether to seize the business opportunity and start a product creation project.

The managerial implications can be condensed into a statement: this study stresses how significant it is for the product management to understand business interests and stakeholder saliences, and analysing business opportunities in a

systematic way to make well-informed decisions in the front-end of product creation.

4.3 Evaluation of the study

This study aims at understanding a particular phenomenon rather than generalising it, and hence the research can be considered to be qualitative. The constructive research approach was selected among a large variety of options for qualitative research due to the developmental purpose of the research and a close collaboration with practitioners. The purpose of the research has been approached from several directions with a holistic mind-set which has introduced some variety in methods that the complex phenomena requires. The study aims to improve systematic product management practises on analysing stakeholders and business opportunities. Krishnan & Ulrich (2001) argue that product development research must be tightly motivated by the needs of industrial practice since most knowledge about product development is hardly meaningful if disconnected from the real business context. This research is conducted in ICT industry with companies operating globally, and present in Finland. The studied issues have arisen from industry, motivated by true needs of companies and the research is designed and conducted in collaboration with companies and managers. Inherently, the context has impacted the constructs of the study. Research quality is important for designing, conducting and reporting scientific research and include evaluating the reliability and validity of the research (Bryman & Bell 2007). Along the research process, several concerns have been addressed and actions taken to ensure the research quality. Table 10 summarises the actions that were taken to increase and ensure the reliability and validity of each original study.

Table 10. Ensuring reliability and validity of each original study.

Article	Reliability	Validity
I	Transparent data collection and case analysis rooted in professional literature The other researchers reviewed and commented the data, data analysis and the research report	The research approach and the results were discussed with the supervisor, other researchers and practitioners The article passed double blind review process

Article	Reliability	Validity
II	Standardised data collection methods – structured interviews The data was recorded and stored and its consistency was checked following AHP The other researchers reviewed the data, data analysis and the research report	Data triangulation was used The data was handled with confidentiality and anonymity The research approach and results were discussed with the supervisor, other researchers and practitioners The article passed double blind review process
III	Standardised data collection methods – survey The data was recorded and stored The other researchers reviewed data, data analysis and the research report	Data triangulation was used The usage of the construction – business case procedure – was piloted in the case company The article passed double blind review process
IV	The same interview set-up and procedure was followed in every interview Two interviewers were present in each interview to improve objectivism The data was recorded, transcribed and stored to ensure thorough data analysis The interviewees and other researchers reviewed and commented the data, data analysis and the research report	Data triangulation was used The data was handled with confidentiality and anonymity to encourage honesty of interviewees The research approach and results were discussed with the supervisor, other researchers and practitioners The article passed double blind review process The data was handled with confidentiality and anonymity

The original studies and this compilation demonstrate data, collection and analysis methods to some extent aiming to make the research process transparent enough for their rigor to be assessed, and the rigor to be seen as adequate. The best attempts have been made to reach the research objective and use the appropriate methods. Theoretical background, research findings and the interpretations have been interconnected with each other to the extent of the author's ability. The theoretical significance is not coming from generating new theory but rather from extending the scientific body of the field of product management. Practical significance is achieved by presenting tools relevant for product management practitioners' use.

Reliability is concerned about whether the results of the study can be repeated if the same methods and procedures were to be followed, and also about the extent which data collection methods and procedures for analysis yield consistent findings (Saunders *et al.* 2007, Bryman & Bell 2007). Reliability is addressed in multiple ways along the research process, for instance, by utilising standardised methods for collecting data, recording and transcribing the interviews, using industrial product management experts as informants and ensuring anonymous data handling (Yin 1989). Each original study I–IV can be repeated in different context but the results,

especially the constructs, are likely to be somewhat different. That is due to the nature of socially constructed reality, meaning that this study is bounded to the temporal and social context in the past.

Validity is concerned with the integrity of the conclusions that are generated from a piece of research and addresses whether the findings are truly what they appear to be about (Saunders *et al.* 2007, Bryman & Bell 2007). Validity concerns are typically divided to three main types: construct validity, internal validity and external validity. *Construct validity* refers to establishing an appropriate research setting for the concepts being studied (Yin 1989). Throughout the study and individual studies I–IV, the data triangulation was addressed by using multiple data sources including interviews, companies' internal documents, surveys and meeting notes, and applied to verify the findings against several sources. In addition, construct validity was addressed through several iterations of designing the research and analysing the data with feedback from other researchers. *Internal validity* aspects consider causality that is not studied as such in this kind of constructive research (Yin 1989). Still, several issues were addressed to increase internal validity and the credibility of the research process. The informants were encouraged to be honest, and all research data was handled as confidential and anonymous. The informants were given a chance to check the analysis that was based on the data they had provided as well as the written reports. The research was designed as a joint effort and feedback from other researchers were utilised along the research process.

External validity refers the extent that the results of a study can be generalised, and whether the results are applicable in other contexts (Saunders *et al.* 2007). The generalisability of the results of this kind of qualitative and constructive research is challenging and very restricted as such, and mainly concerns the possibility to transfer the results and constructs into other contexts. This is considered also as the last step of the constructive research process as *the scope of applicability*. The constructs are clearly more applicable in companies and extended enterprises that are managed in a systematic way, apply formal product creation processes and acknowledge the role of product management. Still, several constraints can hinder the adoption and use of the proposed constructs and any new constructs will face mental resistance among managers (Oyegoke 2011). It is hoped that researchers and practitioners involved in product management can relate to this research work and its context in a way that enables application of the results in their own work. Application of the constructs is an empirical effort that necessitates careful consideration of context-specific factors.

4.4 Recommendations for further research

Emerging theoretical field of product management provide the multiplicity of further research opportunities. A critical review on the literature related to product management would be very valuable for positioning the field among existing theories and to setting the sustainable basis and frame for product management research. This study has constructed stakeholder and business opportunity analysis methods to support product management decision-making in the front-end of product creation and there is room to continue research efforts related to the systematisation of product management practises.

An interesting question is that what happens to product management when a company co-creates products in a business ecosystem. Further research may explore inter-firm and/or extended enterprise product management (Cantamessa 2005) related to, for instance, product knowledge (Distanont *et al.* 2012) or product portfolio (Tolonen *et al.* 2015b). Identification, analysis and prioritisation of stakeholders and their requirements may be a long-lasting challenge that is largely unexplored as product management research area (Driessen & Hillebrand 2013).

Further research on analysing business opportunities could include tool experimentations, in-depth case studies and longitudinal studies to the benefits and experiences of using business planning tools supporting case-by-case decision-making in real industrial product management context. Also a retrospective analysis of product management decisions and information used to make the decisions could reveal interesting insights. The research challenge is to gain understanding about how to effectively manage products, especially gather customer, market, product, technical, strategic information and knowledge to make well-informed decisions in the front-end product creation. This research challenge could be addressed also in business ecosystem or extended enterprise context.

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I Kinnunen T, Sahlman K, Harkonen J and Haapasalo H (2013) Business ecosystem perspective to new product development. International Journal of Business Development and Research 1(1): 6–22.

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