LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
Faculty of Technology Management
Department of Industrial Management

Antero Kutvonen

STRATEGIC EXTERNAL DEPLOYMENT OF INTELLECTUAL ASSETS

Thesis for the degree of Doctor of Science (Technology) to be presented with due permission for public examination and criticism in the Auditorium 1381 at Lappeenranta University of Technology, Lappeenranta, Finland on the, 19th of December, 2012, at noon.

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Supervisor Professor Marko Torkkeli
Faculty of Technology Management
Department of Industrial Management
Lappeenranta University of Technology
Finland

Reviewers Dr. Anna Trifilova
Department of Innovation Management and Innovation Economics
University of Leipzig
Germany

Professor Tõnis Mets
University of Tartu
Estonia

Opponent Dr. Anne-Laure Mention
Innovation Economics & Service Valuation Unit
Centre de Recherche Public Henri Tudor
Luxembourg

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ABSTRACT

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Globalization, pervasiveness of technology and ICT, and the buildup of information societies and policies have lead to a growing abundance of knowledge and highly educated labour supply that is distributed widely. These changes have shifted the foundation of competitiveness to valuable knowledge resources which are now distributed widely across the globe, across actors in the value chain and across educated individuals in multiple organizations. Against this backdrop, the paradigm of open innovation (OI) has emerged as a new response to managing the increased amount of boundary-spanning knowledge flows in and out of the innovation process. The outbound mode of open innovation, that is to say the external exploitation of knowledge assets outside of the firm's own products and services, has been the less-researched aspect of the concept and so far typically seen as concerning the out-licensing of unused technological assets to generate additional revenue. Given that open innovation is essentially a framework for the holistic structuring and management of cross-boundary knowledge flows to improve a firm's innovative performance, a close integration to corporate strategy seems imperative in order to fully benefit from it. Integrating open innovation to strategy leads to elevating its role from a fringe activity to a central innovation management issue that needs to be systematically managed. Building a structure that allows effective management necessitates linking open innovation activities to each phase of the innovation process. Previously, the connection between outbound OI and the earlier stages of innovation has not been studied. The thesis finds that connecting outbound OI to the entire innovation process of the firm, including the fuzzy front end of innovation, is critical for attaining strategic objectives and to the successful implementation and management of the activity. The practical purpose for the research is to enable companies to fully utilize their potential for outbound open innovation and to be able to implement and manage it from a strategic standpoint.

Keywords: Innovation, Innovation Process, Open Innovation, Strategy, Outbound Open Innovation, Fuzzy Front End

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Lappeenranta, December 2012

Antero Kutvonen

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LIST OF ABBREVIATIONS

ETC	External Technology Commercialization
FFE	Fuzzy Front End (of innovation)
IP	Intellectual Property
IPR	Intellectual Property Rights
NCD	New Concept Development
NIH	Not Invented Here
NPD	New Product Development
NSH	Not Sold Here
OI	Open Innovation
ONCD	Open New Concept Development
OOI	Outbound Open Innovation
R&D	Research and Development
SME	Small and Middle-Sized Enterprise
TCE	Transaction Cost Economics
VC	Venture Capital

PUBLICATIONS

The thesis consists of the introductory part (Part I) and the following publications (Part II). The publications comprising the second part of the thesis are listed below, summarizing the contribution of the author of this thesis and the acceptance procedure of each paper.

Publication 1

Kutvonen, A., Torkkeli, M. and Lin, B. 2010. Pre-commercialization activities in external exploitation of technology, *International Journal of Innovation and Learning,* Vol. 8, No. 2, pp. 208-230.

The author was responsible for the literature review study design and implementation in collaboration with the second author. The practical implications and conclusions were done by the author in collaboration with the third author. The original working paper was presented at the doctoral tutorial and was subsequently submitted to IJIL, where the full paper was accepted following a double blind review.

Publication 2

Kutvonen, A. and Torkkeli, M. 2010. Opening the Fuzzy Front-End of New Product Development: a Synthesis of Two Theories, *International Journal of Business Excellence*, Vol. 3, No. 4, pp. 415 - 432.

The author was responsible for the literature review in collaboration with the co- author. The concepts and conclusions presented were the responsibility of the author. The original working paper was presented at the Management of Technology seminar at LUT, and was submitted to and accepted by the journal, where the full paper was double blind reviewed.

Publication 3

Kutvonen, A. and Havukainen, K. (2011) Extending the Fuzzy Front End Beyond Firm Boundaries: Case Demola, *Proceedings of 4th ISPIM Innovation Symposium,* 29 November - 2 December 2011, Wellington, New Zealand.

The author wrote most of the paper and was solely responsible for literature review. The research design, data collection and analysis were done in collaboration with the second author. The paper was accepted to the conference after the double blind review of an extended abstract and presented at the conference session.

Publication 4

Kutvonen, A., Savitskaya, I. and Salmi, P. (2010) The Evolution of External Technology Commercialization Motives, *Proceedings of XXI ISPIM Conference*, 6-9 June 2010, Bilbao, Spain.

The author was responsible for literature review, data collection and analysis in collaboration with the co-authors as well as for formulating concepts and drawing conclusions together with the second co-author. The paper was accepted to the conference after the double blind review of an extended abstract and presented at the conference session. The publication is currently submitted to review process in the *International Journal Business Innovation and Research*.

Publication 5

Kutvonen, A. (2011) Strategic Application of Outbound Open Innovation, *European Journal of Innovation Management*, Vol. 14, No. 4, pp. 460-474.

The author was solely responsible for the paper. The paper was accepted to the journal following a double blind review process.

PART I: OVERVIEW OF THE THESIS

1. INTRODUCTION

1.1. Research background and motivation

Strategy and management theory typically follow current business phenomena and build theory to explain observations from markets. As they fundamentally originate from the markets, which are subject to continuous environmental and endogenous change, theories, especially those that explain competitiveness, need to adapt to shifts in the environment. As the changes to theory start to accumulate, they lead to what Kuhn (1962) described as paradigm shifts in science. The innovation management literature has recently experienced such a shift.

The 20th century until the mid 80s was likely the most 'closed' period in the whole history of innovation (Arora & Gambardella, 2010). Organizations favored large, heavily integrated organizational designs and a focus on the internal development of technology to compete with scale advantages (Chandler, 1990; Chesbrough, 2003). Each industry had its unique technology, and a certain technology was used in only one industry (Drucker, 1999). Competitive advantage was sought first through positioning the firm (Porter, 1985), understanding competitive dynamics (Chen, 1996) and the building of market barriers to sustain advantageous positions (Bain, 1956). Later, management turned to the resource-based view (Wernerfelt, 1984; Barney, 1991), which explained how to compete with the firm's unique bundle of internal resources. In terms of innovation management, key issues to consider were the fine-tuning of the internal innovation process (e.g. Cooper, 1988) and the management of product and research and development (R&D) project portfolios (Wheelwright & Clark, 1992).

Meanwhile, global megatrends, technology and the competitive environment were all subject to changes that altered the foundations of previously competitive strategies. Globalization led to increasing competition and complexity of the environment coupled with diminishing the ability of firms to control or predict change through the manipulation of market barriers. Pervasiveness of technology and global connectiveness through information and communication technology (ICT) resulted in the buildup of information societies, innovation policy interventions and a rapidly growing, widely-distributed abundance of knowledge and highly educated labour supply (Chesbrough, 2003; Dahlander & Gann, 2010). All of these changes shifted the foundation of competitiveness to valuable knowledge resources (Grant, 1996), which were now distributed widely across the globe, across actors in the value chain and across educated individuals in multiple organizations (Chesbrough, 2003). These changes influenced how firms competed and conducted their innovative activities. The change was soon reflected in the academic literature on strategy and innovation by increasing academic interest in alliances (e.g. Gulati & Singh, 1998; Kale & Singh, 2007), learning (e.g. March, 1991; Levinthal & March, 1993) and cooperative modes of competition and innovation (e.g. Dyer & Singh, 1998; Escher, 2001).

Finally, open innovation (OI) (Chesbrough, 2003) emerged as an umbrella term or framework (Lichtenthaler, 2011) for these developments, explicitly announcing the paradigm shift that

had taken place. Open innovation is founded on the notion that accepting and actively managing in and outflows of knowledge between the innovation process and the environment (Chesbrough, 2006) is the next step in improving organizations' capacity for creating and profiting from technology (Chesbrough, 2003). It involves both the inbound direction of external knowledge acquisition, where the innovation process is opened for external inputs, and the outbound direction of external knowledge commercialization[1], where knowledge assets are provided to the markets for additional profit (Gassman & Enkel, 2004). Open innovation thus results in faster development, added flexibility, higher cost effectiveness and new lines of profit for the company. The added challenge of managing external parties in the innovation process and of controlling the purposive knowledge flows to and from the innovation process implicitly calls for the tighter coupling of it to the corporate and technology strategy in the firm. However, in practice, most implementations, especially of outbound activities, are still done *ad hoc*. Furthermore, both the academic study and practical implementation of open innovation has been predominantly focused on the inbound mode, with outbound OI being more resistant to both implementation and research efforts (Enkel et al., 2009). A balanced view of OI requires more research into outbound open innovation, and its integration into strategy is required as well in order to fully realize the benefits of the activity.

This dissertation will connect outbound activities to the firm's technology strategy and provide a basis for the systematic implementation of outbound activities as a means to achieve strategic objectives. This will expand the strategic options available to firms in managing intellectual assets and enable them to properly implement and manage outbound open innovation in the context of their innovation process and their strategy.

1.2. Research gap and research objectives

Open innovation research is still at an early stage, regardless of strong academic roots in streams of literature such as alliances, transaction cost economics and dynamic capabilities, and several academic shortcomings still remain (Enkel et al., 2009; Elmquist et al., 2009; Lichtenthaler, 2011). The essential problems with the theory are related to the ambiguousness of the definition and which actions constitute 'open' business practice (Dahlander & Gann, 2010; Trott & Hartmann, 2009), which firms (and in which environments) should adopt it (Chesbrough et al., 2006) and finally, how to measure it (Enkel et al., 2009). Furthermore and partially due to the issues above, managerial problems with implementing the concept and managing openness arise as well. These problems mostly have to do with the difficulties of operating in knowledge markets (Arora & Gambardella, 2010) that arise from problems of valuating knowledge assets, searching for and trusting transaction partners (Kutvonen et al., 2010), and persistent market imperfections (Arora & Gambardella, 2010; Teece, 1998).

[1] Hereafter, the terms "external technology commercialization", "external technology/knowledge exploitation" and "outbound open innovation" are considered to be synonymous and interchangeable. It is acknowledged that the terms have certain nuance differences, however, these are inconsequential in the context of this thesis.

Further difficulties are encountered in organizing for openness within the firm in the form of *Not Invented Here* (Katz and Allen, 1982) and *Not Sold Here* (Chesbrough, 2003) mindsets. These result in other difficulties, such as missing management structures to counter these mindsets with incentives and to overcome excess fear of knowledge spillover. Many of these problems could be substantially alleviated by connecting OI to the regular activities of the firm, coupling it tightly to corporate strategy and managing it systematically (Kutvonen et al., 2010). Proper implementation of these 'cures' however still requires academic work, especially in regards to the outbound mode of OI.

The inbound mode of OI has been given more academic attention and it has been more widely implemented by companies in the last decade (Enkel et al., 2009). Meanwhile, firms are still struggling with implementing the outbound mode and the most popular academic papers on it have focused on case studies of selected industry giants, such as IBM, Texas Instruments, Lucent Technologies and Dow Chemicals (Arora et al., 2001; Grindley & Teece, 1997; Kline, 2003; Sullivan & Fox, 1996). These describe how those companies are reaping massive licensing profits by externalizing residual technology (Rivette & Kline, 2000). In contrast, most outbound OI is still conducted on a case-by-case basis relying on ad-hoc decision-making (as opposed to integrating OOI to the innovation process), because the role of the activity is typically minor for the companies. Connecting these activities to strategy is still uncommon and even so, it is limited to avoiding conflict with main activities, in other words reaching keep-and-sell scenarios (Lichtenthaler, 2008b); the viewpoint of using outbound open innovation to drive strategy is in effect unexplored.

Open innovation is essentially a theoretical framework for the holistic structuring and management of cross-boundary knowledge flows to improve a firm's innovative performance (Lichtenthaler, 2011). In order to fully benefit from it, a close integration into corporate strategy seems imperative. Thus, the first research gap is the theoretical disconnect between outbound activities (that are concerned with external deployment of intellectual assets[2]) and the technology strategy of the firm, and by extension, to the strategic objectives that are pursued. Integrating open innovation with strategy leads to elevating its role from a fringe activity to a central innovation management issue that needs to be systematically managed. Building a structure that allows effective management necessitates linking open innovation activities to each phase of the innovation process. Previously, the connections, especially those between outbound OI and the earlier stages of innovation, have not been studied, which impedes understanding the practical implementation of strategic outbound activity that constitutes the second research gap. The thesis will connect outbound OI to the entire innovation process of the firm, so that its implementation and management becomes feasible. From these, we arrive at the overall objective of the study.

The **main objective** of the dissertation is to advance the understanding of strategic external deployment of intellectual assets through developing the theory of outbound open innovation. The thesis adds to open innovation theory by clarifying the strategic motives of outbound

[2] Here defined to be valuable knowledge-based resources, both codified and tacit, that may be applied to create value. (See chapter 1.3.3.)

activities and the integration of outbound open innovation (OOI) with technology strategy (addressing the first gap) and with the innovation process, especially by establishing the link between OOI and the fuzzy front end of innovation (addressing the second gap).

The main research question (RQ) is *how can the organization achieve its strategic objectives by the external deployment of intellectual assets?*

The following sub-questions are introduced to logically structure the research effort:

RQ1 *How are outbound open innovation activities connected to strategic objectives on a theoretical level?*

RQ2 *How are strategic objectives pursued through outbound open innovation activities in practice?*

Research towards answering the two sub-questions is presented mainly in the publications, while the dissertation sets these in a larger context through discussing the main question and synthesizing the answer as a result of the entire research process. The practical purpose for the research is to enable companies to fully utilize their potential for outbound open innovation, and to implement and manage it from a strategic standpoint.

1.3. Scope of the research and definition of key terms

1.3.1. Scope of the research

The positioning of the research is presented in Figure 1. The thesis belongs to the management of technology doctrine, which seeks to inform firms on the value of technology for the firm and on the management of the technological fundaments of their business. Within this doctrine, it is more specifically nested in the domain of innovation management research and is a part of the newly emerging open innovation stream. The thesis seeks to connect open innovation with strategy research and deepen their integration, while contributing to each. Both strategy and the management of technology are a part of organizational and management studies.

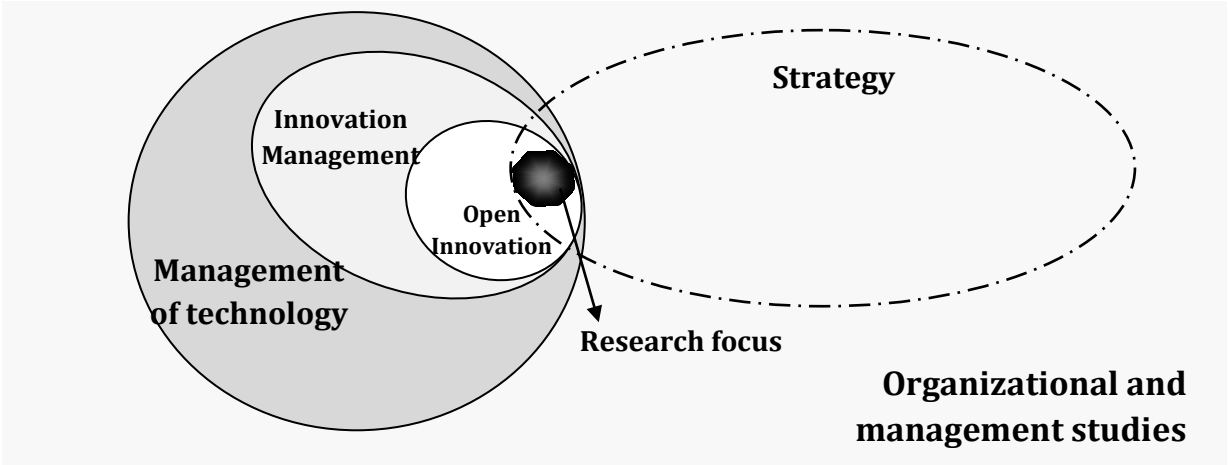

Figure 1. Focus area of current research of OI inside the environment

1.3.2. Innovation

The term 'innovation' is central to any academic work within the innovation management domain, and similarly to this thesis as well. While the research of innovation and its definition (e.g. Baregheh et al., 2009; Garcia and Calantone, 2001), application and impact on firms (e.g. Tidd et al., 2005), societies and the economy (e.g. Dosi, 1990) have been conducted as mainstream topics for nearly 80 years (since Schumpeter, 1934), no single widespread definition has universally been adopted (Baregheh et al., 2009).

Even if ambiguity exists, certain characteristics of innovation are generally agreed on. First, innovation may refer to both to the new products, processes or organizational setups, as well as to the process of purposeful change utilized to arrive at them. Secondly, innovation is universally linked to novelty (even if only novel to the people involved; Van de Ven, 1986) and beneficial change or renewal. Third, the innovation is distinguishable from an invention by its requirement for a successful application, as with Freeman (1982:7): "an *invention* is an idea, a sketch or model for a new or improved device, product, process or system" whereas "an *innovation* in the economic sense is accomplished only with the first *commercial* transaction involving the new product, process, system or device…" This demand for a (typically) commercial application of the new discovery situates innovations mainly in the domain of commercial environments and enterprises (Fagerberg, 2003). Furthermore, innovation is not restricted to being technological in nature or to result only in tangible artifacts (i.e. products), but may equally concern advancements to processes, modes of working or organization and ways to structure value generation and capture.

In this thesis, the term innovation follows the generally accepted characteristics broadly and refers to both the process of change leading from ideation and/or discovery of a need to the successful commercialization or application as well as to the outcomes of that process (e.g. tangible artifacts, practices, methods).

1.3.3. Intellectual assets

The term intellectual assets is neighbored by multiple alternate terms that are nearly synonymous, such as intellectual capital, intangible assets, knowledge assets or intangible resources (Martín-de-Castro et al., 2011). The research of intellectual assets was provoked by the initial finding that companies' market value consistently exceeded their book value, often in multiple-fold, also resulting in the initial definition of the term as being this gap between the two financial values (Galbraith, 1969; Sveiby, 1997). Later academic work further elaborated on the definition by connecting it more specifically to knowledge assets (Teece, 1998) and to the ability to create competitive advantage or generate value (Stewart, 1998).

Intellectual assets include tacit and explicit (i.e. codified and uncodified) knowledge (Nonaka and Takeuchi, 1995). Examples of codified intellectual assets include patents, copyrights and other forms of intellectual property, while tacit knowledge is for instance the specialized knowledge possessed by skilled individuals (Teece, 1998). Furthermore, intellectual assets may also, in certain cases, be embedded in technological artifacts or in innovation concepts and thus (partially) codified to facilitate transfer.

Within the scope of this thesis, intellectual assets are defined as valuable knowledge-based resources, both codified and tacit, that may be applied to create value. Due to the scope of the research, they mainly refer to technological knowledge, expertise and competence, including intellectual property rights (IPR), process knowledge and organizational or process innovation.

1.3.4. Strategy

Strategy is arguably the most influential area of research in management that, as a concept, has multiple definitions referring both to the process of strategizing as well as to the outcome of the process. Otherwise put, it is a statement of a plan of action that guides the activities of an organization as it pursues its fundamental goals. Johnson & Scholes (2002, p. 10) define strategy as "the direction and scope of an organization over the long term, which achieves advantage for the organization through its configuration of resources within a changing environment and to fulfil stakeholder expectations." The concept of strategy and the emphasis of what it fundamentally should concern have evolved as different advances in the academic literature have increased or waned in prominence. For instance, Porter (1979, p. 11) emphasizes the role of competition and the market-based view of strategy formulation in stating that "The essence of strategy formulation is coping with competition", while Grant (2006) provides with a more endogenous view, where strategy is concerned with planning how an organization or an individual will achieve its goals.

Overall, strategy is typically understood to be concerned with the pursuit of a set of goals originating from the fundamental purpose of the organization, which in the case of the commercial firm (the organization type that is in the focus of this thesis) is to generate profit. A strategy fundamentally serves to seek ways of securing sustainable competitive advantage, or from an academic perspective, of explaining why some firms perform better than others in competitive markets. In the context of the broad academic literature streams, strategy research thus has the role of connecting management theories (such as innovation management) to the fundamental economic theories, which explain how markets work, and through this connection explaining how firms profit.

In the scope of this thesis, strategy refers to the corporate strategy of commercial firms and strategic objectives are understood as non-pecuniary goals that improve the firm's ability to compete, generate or sustain profits over a longer time period. Therefore, the thesis does not point to the ability of certain management actions to directly result in competitive advantage, but to the ability of those actions to aid in the achievement of goals set in the corporate strategy process.

1.3.5. Fuzzy Front End

When looking at the process of New Product Development (NPD), the time and activities that precede any formal commitment of starting the development is referred to as the Fuzzy Front End, or FFE (e.g. Smith & Reinertsen, 1991). It precedes formal NPD processes such as Stage-Gate™ or Product and Cycle Time Excellence (PACE®) (Koen et al., 2001). Alternatively, the FFE has been depicted as an extension of the formal Stage-Gate process as

the “pre-phase zero, phase zero and phase one” phases (Cooper, 1997; Khurana & Rosenthal, 1998; Moenaert et al., 1995). The definitions of the FFE vary but in this thesis, the definition of Kutvonen and Torkkeli (2010) is used:

FFE refers to the early ‘ideation step’ (Cooper, 1993) *that precedes a structured NPD process and is concentrated on the generation, refinement and analysis of new concepts* (Koen et al., 2001) *arising from the identification of an unfulfilled market need and/or a (untried) technological opportunity* (Smith & Reinertsen, 1991), *and ending in an organizational commitment to advance and fund the concept to NPD or to discontinue concept development* (Khurana & Rosenthal, 1998). (p.421)

Based on prior works on the FFE and the nature of uncertainty, Zhang and Doll (2001) define the front-end fuzziness of NPD as the uncertainty of customers (portfolio, preference, life-cycle and volume fuzziness), technology (material, specification and supply fuzziness) and competition (competing product development and adoption speed fuzziness), which are the lead causes of the managerial difficulties associated with it. It is generally agreed by both managers and academics (Chase & Tansik, 1983; Cooper & Kleinschmidt, 1994; Rosenau, 1988; Smith & Reinertsen, 1991) that, of all the actions firms can take to improve their NPD process, those taken at the FFE give the greatest time savings or improvement in outcome for the least expense.

The early activities that constitute the FFE, according to Reid and Brentani (2004), are problem/opportunity structuring and/or identification/recognition (Leifer et al., 2000; Urban & Hauser 1993); information collection/exploration (March, 1991); and ‘‘up-front homework’’ (Cooper, 1996), whereas the later activities are seen as involving aspects of idea generation and concept development (Cooper, 1990; Urban & Hauser, 1993), continued information collection, and informal or prescreening (Crawford, 1980; Crawford & Benedetto, 2003), with possibly some initial fund allocation for exploring a new idea (Cooper, 1990; Cooper & Kleinschmidt 1986). Koen et al. (2001) structure the FFE activities in the New Concept Development (NCD) model with five elements (Idea genesis, Idea selection, Opportunity identification, Opportunity analysis and Concept & Technology Development) that have no preset order of execution and are coupled with the engine of leadership and organizational culture while surrounded by external influencing factors.

1.4. Outline and structure of the thesis

The structure of the thesis can be described through an input-output scheme (Figure 2). The first chapter sets the motivation for the study and identifies the problem area. The background for the research is presented along with definitions of the identified research gap, key terms and the delimitation of the scope of research.

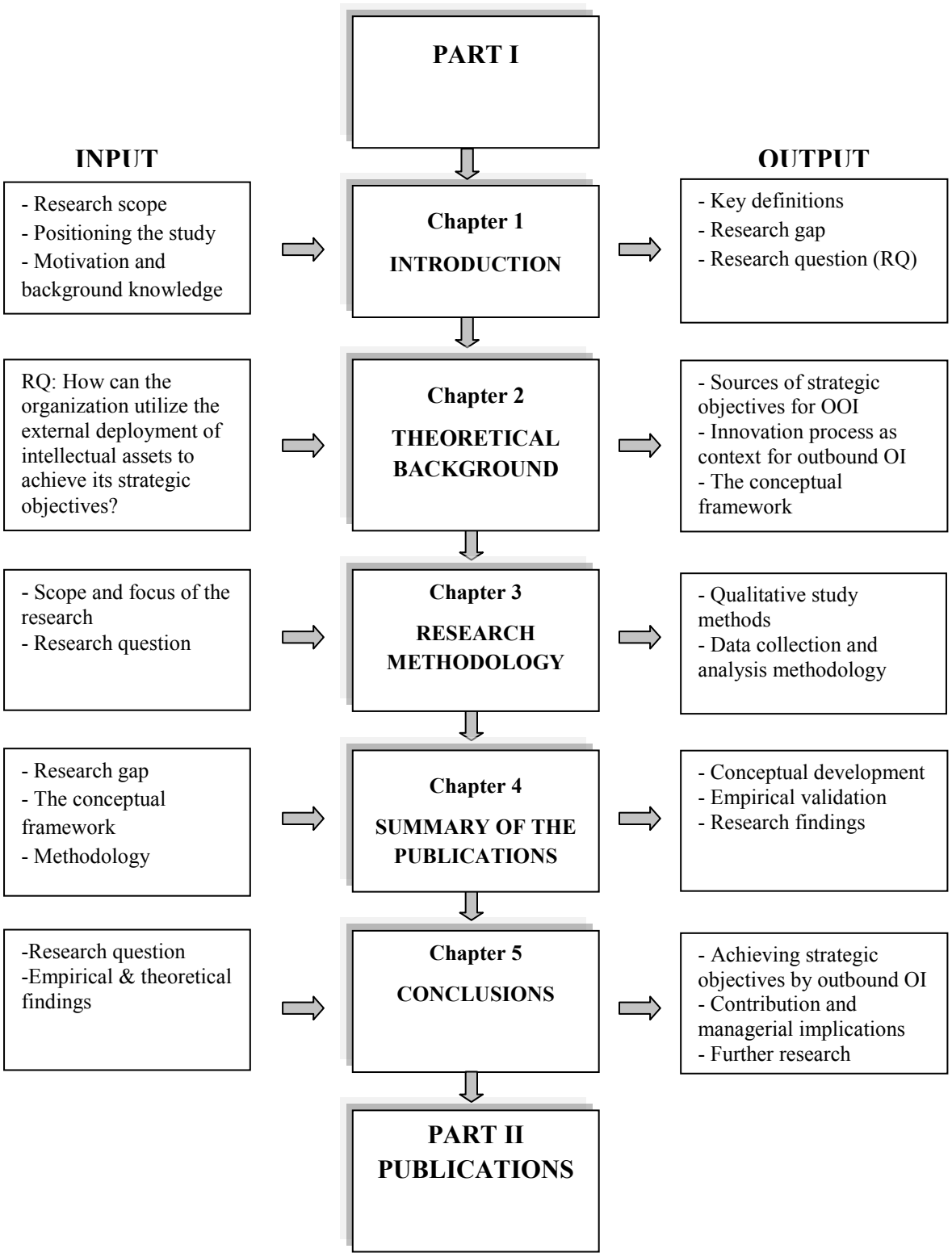

Figure 2. Structure of the thesis

The second chapter presents a literature review on the main theories that contribute to the conceptual framework and set the context for answering the overall research question in concert with the publications. This includes reviewing and summarizing literature on technology strategy, innovation process conceptions and open innovation. Technology strategy provides a connection point between non-pecuniary motives for open innovation and the technology and innovation-related goals of the organization, while innovation process literature informs the study about the context of innovation management in firms to establish grounds for implementing the presented open innovation activities. Finally, open innovation research is summarized to provide the state-of-the-art in management literature on the topic and contrast it to the novelty of the study.

Chapter three discusses methodological choices, as well as research design and implementation. Qualitative study is presented as the main method of research, along with associated data collection practices and principles.

The fourth chapter gives an overview of the publications comprising Part II of the thesis. The role of every publication is to advance the understanding of the phenomena addressed by main research question of the thesis a level further. Publications 1 and 2 focus on providing an initial outlook on the research problem and on the conceptual development of theoretical and managerial tools to address the research question. Following those, publications 3 and 4 present two complementary approaches to the empirical validation of the constructed concepts, while the final publication (5) summarizes insights generated during the process, thus concluding the research of the thesis.

2. THEORETICAL BACKGROUND

The theoretical background of the research builds on three main theories that together form the framework for the thesis. Strategic management of technology is reviewed to provide the link between the management of technology and the pursuit of competitive advantage at the firm level, in other words, to explain how innovative performance is related to setting and achieving strategic goals. Transaction cost economics, the relational view and resource dependence viewpoints are presented to give an overview of the traditional views within strategy research that explain the rationale behind collaborating with external parties in innovative activities. Technology marketing, which also originates from the management of technology literature, is presented as an antecedent theory to open innovation. This part of the theoretical framework seeks to establish the connection between innovation management and strategic decisions.

The second main theory covered is the innovation process that is at the core of innovation management theory (Van de Ven, 1986). Through reviewing innovation process theory, the evolution of the process understanding towards accommodating more collaborative innovation methods is presented, thus laying the foundation for connecting outbound open innovation to the regular innovative activities taking place in firms. The role of the innovation process theory in the thesis is to build a foundation for implementing OI on a practical level and to especially present the various stages within the popular process models in search of docking points for OOI. Fuzzy front end theory is covered in detail as it is seen as one of the most influential phases for innovative performance of the firm and because it shares a fundamental goal with open innovation in the management of NPD measurement error.

Finally, open innovation is presented with an emphasis on the outbound mode that is the focus of this thesis. The review of open innovation is focused on the main aspects of the theory of relevance to the topic of research: open innovation processes, connecting OI to strategy and its connection to the innovation process.

2.1. Approaches to the strategic management of technology

The common goal for strategic management has been to understand why some firms perform better than others and a variety of different theoretical frameworks have been created to explain the sources of sustained competitive advantage (Porter, 1985; Barney, 1991; Williamson, 1999). Prior to the mid 1980s, the tracks of technology and strategy management have been treated somewhat separately, but as the environment and the bases of competition have changed, strategy research has begun to more and more acknowledge the importance of knowledge and technology as fundamental sources of competitive advantage. The disruptive effect of technology on the effectiveness of established strategic planning practices (Mintzberg, 1994) academically led to embracing the resource-based view (Barney, 1991; Peteraf, 1993; Teece et al., 1997). The resource-based view basically explained performance differences through the heterogenous internal characteristics of firms (i.e. resource

endowments), which could both include technology and knowledge assets as well as allow for the purposive management of these resources. Another academic consequence was the emergence and rapid growth of the management of technology doctrine, which had a natural link to the strategy field through the study of technology strategy (e.g. Kantrow, 1980; Schumpeter, 1934; Steele, 1988). As technology and knowledge gradually became recognized as the primary sources of competitiveness, innovation management became arguably the most prominent stream of literature within the management of technology, while strategy researchers either continued work on the resource-based view track (Barney, 2001) or sought to establish new spin-off approaches (e.g. Grant, 1996; Teece et al., 1997; Sanchez, 2008) through criticism of the resource-based view and its shortcomings (Kortelainen, 2011). Strategy and the management of technology remained inescapably linked, but the link was often underutilized, especially with new innovation research approaches, such as open innovation.

The resource-based view provides the rationale for inter-organizational collaboration in terms of efficiency and effectiveness in resource and capability utilization. Production requires the combined application of multiple specialized resources (incl. knowledge), some of which may reside outside firm boundaries as well, in which case collaborative arrangements are one solution to acquiring them (Grant, 1996; Grant & Baden-Fuller, 2004). The notion that firms can, and often should, look outside their own boundaries for innovative inputs when developing technology has thus been long present in strategic management in various forms, such as research on joint ventures (Harrigan, 1988; Kogut, 1988), alliances (Doz, 1996; Gulati & Singh, 1998; Kale & Singh, 2007), dynamic capabilities (Teece et al., 1997, Teece, 2007) and organizational learning (March, 1991; Levinthal & March, 1993). The outbound mode of openness – the purposive release of knowledge assets to the environment – was touched upon only indirectly in the sense that collaborative arrangements often necessitated two-way knowledge flows, even if in these cases the typical prescription was to limit the outbound flow to a minimum (Khanna, Gulati & Nohria, 1998).

2.1.1. Transaction cost economics

The seminal authors writing on transaction cost economics (TCE) (Coase, 1937; Williamson, 1985) suggest that the two main governance modes through which to practice economic activity are markets and hierarchies. The basic rationale is that firms choose the governance mode that minimizes their sum of production and transaction costs in coordinating production and executing economic transactions. The fundamental question motivating the research of transaction cost economics is to explain why firms exist (Coase, 1937; Williamson, 1975) to which it offers the answer in the form of economizing on transaction costs.

The transaction costs are divided to *ex ante* (before contract) and *ex post* (after contract) costs. *Ex ante* transaction costs refer to the realized costs of drafting, negotiating, running and safeguarding an agreement or contract, whereas *ex post* costs include the costs associated with the misalignment of party interests with respect to the contract. These costs arise due to a) bounded rationality, b) opportunism, c) asset specificity, d) uncertainty, and e) the frequency of transactions (Williamson, 1985). Bounded rationality and opportunism are two

behavioural assumptions rooted in a strictly utilitarian view, where managers of firms pursue their own interests in the most economic way that they are cognitively capable. Bounded rationality implies that behavior is 'intendedly rational, but only limitedly so' (Simon, 1947: xxiv), while opportunism refers to seeking self-interest with guile. Asset specificity refers to investments made to support the transaction with an external partner being valuable in regard to that specific partner or transaction, potentially leading to interdependent relationships (Riordan & Williamson, 1985). Uncertainty (of the environment and the behaviour of the partner) adds to the need to invest in monitoring and control structures in contracting. The frequency of transactions naturally adds to the comparative cost of organizing via markets due to recurring contracting costs. When the transaction costs in a given activity are high, the firm should utilize its internal organization to minimize them. On the other hand, when transaction costs are low, it should buy the desired products and services from the markets. (Williamson, 1985)

TCE, similarly to the resource-based view (Barney, 1991; Peteraf, 1993), starts from the assumption that firms are heterogenous in regard to their assets and capabilities, but adds the notion that the ownership of productive (or innovative) resources is not necessary to gain value from them, but that access to the resource is sufficient (Lavie, 2006). It essentially introduced make-or-buy decision-making and firm boundary issues to the mainstream strategy discussion in a way that encompassed not only supply chain issues, but all facets of economic activity that firms engage in.

Collaborative arrangements (e.g., alliances and joint ventures) between firms can also be explained from a transaction-cost perspective as hybrid structures between markets and hierarchies (Williamson, 1999). As a hybrid form of governance they share some of the attributes of both markets and hierarchies and may potentially avoid or weaken the hazards of each (Park & Russo, 1996). Internal organization is often inefficient and costly in handling the economies of scale and scope required in many types of production (Kogut, 1988). On the other hand, buying inputs though market transactions is often not the preferred option either, because many types of modern production require more or less tacit knowledge, which is extremely inefficient to transfer through markets (Hennart, 1988; Park & Russo, 1996). Thus, various collaborative agreements are favored when transactions are frequent, the firms are dependent on other firms' inputs, and it is possible to share risks and knowledge (Blomqvist et al., 2002) or when there is a need to access resources that would otherwise be immobile (Lavie, 2006).

In addition, transaction cost economics is one of the influential antecedents to open innovation. Kortelainen et al. (2012) analyzed the boundary between TCE and OI from a dynamic resource-based view perspective (Diedrickx & Cool, 1989; Helfat & Peteraf, 2003). They argue that the inbound modes of OI directly connected to the firm's resource stocks are the traditional area of contribution of the TCE theory. This category of activities refers to buying or renting knowledge assets, either as technologies or modules that enable product features, as well as to the outsourcing of development activity to create new products. Inbound interaction directed at stocks can be used to achieve cost reduction in innovation by external technology acquisition or to quickly compensate for gaps in the company's internal

technology portfolio thus increasing flexibility, resulting in higher strategic agility (Doz & Kosonen, 2008). These types of motives have been a recurring element in open innovation studies as well in the form of decreasing cost, improvement of margins or profitable growth to name a few (Rigby & Zook, 2002; Chesbrough & Crowther, 2006; van de Vrande et al., 2009). Mitigating for the risk of innovating can also be essentially treated as a cost reducing motive in the transaction cost perspective. Having the option of acquiring assets from external parties for flexibility is linked to motives of expanding markets (e.g. Chesbrough et al., 2006; van de Vrande et al., 2009), withstanding environmental shocks (Miner, Amburgy & Stearns, 1990) or the management of dependence on others (Pfeffer & Salancik, 1978). While these motives are commonly referred to in the managerial logic of open innovation research, the true added value of open innovation beyond TCE logic is questionable in these cases. (Kortelainen et al., 2012)

Similarly to the previous, the outbound modes related to stocks also fit within the TCE logic, but with the important distinction that TCE focuses heavily on informing inbound decisions and indirectly *allows* for outbound modes of interaction, while open innovation theory and prescriptions treat both modes as equally important (Kortelainen et al., 2012; Lichtenthaler, 2011).

2.1.2. Relational view and resource dependence

Where the market-based view explained competitive advantage through advantageous market and industry positions defended by market barriers (e.g. Porter, 1985) and the resource-based view (Wernerfelt, 1984; Barney, 1991) shifted the focus to internal factors, the relational view (Dyer & Singh, 1998) takes yet another stance. Building further on the notion of accessing external resources through collaborative arrangements, the relational view argues that competitive advantage may originate from *interorganizational relationships* in addition to previously mentioned factors (Mesquita et al., 2008). The implication of the theory is that firms should place more value in the utilization and nurturing of relations with external partners. This constitutes a definite shift from the undersocialized, calculative stance of case-by-case evaluated transactions advocated by TCE to the direction of more sustained collaborative relationships over a longer term, which is better suited for understanding alliances and networked business models (Lavie, 2006). Dyer & Singh (1998) argue that separate competitive analysis for networked firms is necessary, as traditional strategic literature fails to describe competitive advantage in a networked environment due to the fundamental assumptions made in both theories and their strategic frameworks.

The essential claim is that in many cases, a firm's critical resources may span firm boundaries thus embedding them in interorganizational resources and routines. In these cases, there is a possibility to create relational rents (Dyer & Singh, 1998) leading to interorganizational competitive advantage. According to Dyer and Singh (1998), the generation of relational rents is only possible when certain preconditions are met. Relationships that are deep and committed enough to generate relational rents require both parties to make investments in relation specific assets that may be, for example, physical or human assets with asset-specifity characteristics. Value-generating relationships also involve substantial knowledge

exchange, which results in joint learning and the development of interorganizational knowledge-sharing routines that facilitate a more economic exchange of tacit knowledge. Provided that sufficient investments are made and routines are in place, the relationship allows for combining complementary, but scarce resources or capabilities, resulting in the joint creation of unique new products, services and technologies. Finally, the sustainability of relational rents is achieved through reaching lower transaction costs than competing alliance structures owing to more developed and effective governance mechanisms. (Dyer & Singh, 1998)

However, even though it is possible to create value by bundling complementary and supplementary resources in collaboration between partners (Das & Teng, 2000; Dyer & Singh, 1998), firm-specific resources and capabilities eventually dictate the appropriation of value in the markets. Thus, some firms are able to differentiate themselves from others that have been involved in the process of creating the value, which is critical to enabling coopetitive relationships (Ritala, 2010). In summary, the relational view adds the perspective of longer term or extensive arrangements to the understanding of collaboration and openness in innovative activity. Examples of this are sustained alliances and networked business models; the relational view can even be said to act as a precursor to subsequent ecosystem conceptions (e.g. Iansiti & Levien, 2004; Adner & Kapoor, 2010).

A further perspective on longer term collaboration is offered by the research into resource dependence theory (Pfeffer & Salancik, 1987), which can be understood as a complementary theory to the resource-based view (Barney, 1991) and the relational view (Dyer & Singh, 1998). The basic argument of the resource dependence theory (Pfeffer & Salancik, 1987) is that organizations must engage in boundary-spanning activities with their environment to obtain resources. Thus, the resource dependence theory explains the rationale behind interorganizational relationships via resources, similarly as the resource-based view explains the competitive advantage of a firm via resources. However, the resource-based theories of alliance formation have not always used the terminology and differentiated the theories appropriately. It should be highlighted that the focus of the resource-based view is internal, whereas, as Barringer and Harrison (2000) note, "resource dependence theory focuses exclusively on resources that *must* [*sic*] be obtained from external sources for an organization to survive or prosper." (p. 372)

According to Pfeffer and Salancik (1978), interorganizational relationships are formed either so that organizations can exert power or control over others possessing scarce resources or in an effort to fill a perceived resources need. The theory helps to explain asset complementarity as a reason for firms to enter interorganizational relationships (Barringer & Harrison, 2000). In particular, the lack of valuable resources is a valid motive in alliance and open innovation studies. Das, Sen and Sengupta (1998) studied upstream technology alliances and downstream marketing alliances and concluded that upstream alliances are more critical in relation to resource dependence and asymmetry inherent in the interdependence due to the limited number of potential partners available. These findings can be applied to open innovation as well by viewing inbound OI as being analogical to upstream technology alliances. Resource dependence theory focuses on the need for critical resources and the

necessity for social exchanges, and it emphasizes the environment or the social context thus extending the ideas of open systems theory (Katz & Kahn, 1978; Pfeffer & Salancik, 1978) leading to a different viewpoint than TCE. Supporting the viewpoint taken by resource dependence, Granovetter (1985) criticized the atomistic approach provided by TCE and other neoclassical theories and introduced the concept of embeddedness. Embeddedness denotes that organizations are embedded in networks of interdependencies and social relationships. Thus social theory was introduced to economic discourse, bridging sociology and neoclassical accounts by turning the make-or-buy question to make, buy or partner on sociological grounds. It is also worth noting that where other theories inform open innovation on the rationale behind collaborating with external partners, resource dependence sets out to manage inevitable interdependencies in order to minimize negative effects on competitiveness and flexibility. This makes it a useful theoretical approach to consider in terms of strategic conduct in open innovation, where maintaining strategic agility is of paramount importance.

2.1.3. Technology marketing

In the management of technology literature, the growing importance of technological assets to competitiveness also prompted enlarging the scope of research beyond the confines of the R&D function, as technology was increasingly seen as a prime concern of all levels of management. Among others, Tschirky (2003) advocated the view of extending the management of technology from the operational level to a core issue of both strategic and normative levels of management. This led to issues of innovation and technology being raised to general managers at all levels of the enterprise, and to promoting the role of technology in companies. Conversely, this also led to the role of all employees to play a part in contributing to the technology-based competitiveness of the firm, as well as to the formulation of technology strategies.

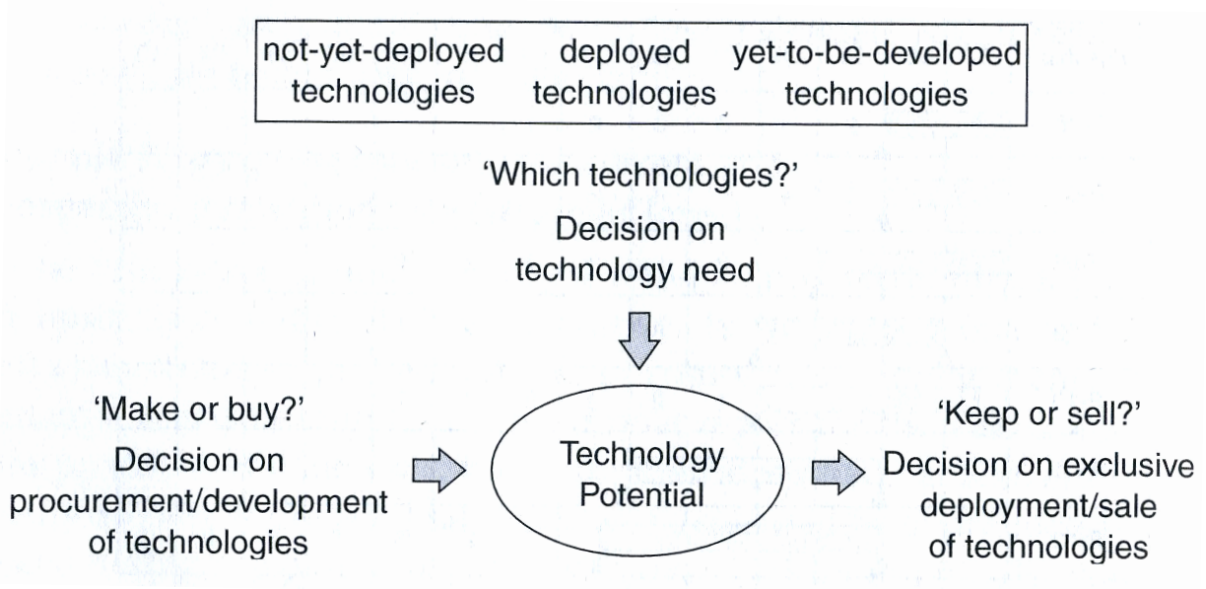

Figure 3. Trilogy of strategic technology decisions (Brodbeck et al., 1995, p. 108)

Engaging in strategic technology planning as a part of business strategy planning involved generating answers to three mutually complementing questions: 'Which technologies?', 'Make or buy?' and 'Keep or Sell?' Brodbeck, Birkenmeier and Tschirky (1995) coined this as the *trilogy of strategic technology decisions* (Figure 3), initiating thinking in the way of deep integration between strategy and technology that takes the opportunities available explicitly into account due to the existence of technology markets (Arora et al., 2001). Escher and Tschirky (2004) further developed the concept by analogously drawing on insights and concepts from the discipline of marketing. They reasoned that since the definitions of marketing (Kotler & Bliemel, 1999) already made the connection to acquisition and exploitation activities, and that knowledge markets could be seen as analogous to technology markets, the logical object of study would then be *technology marketing*. An illustrative list of analogies and differences identified between marketing and technology marketing is provided in Table 1 below.

Table 1. Basic differences between traditional marketing and technology marketing (Tschirky, 1998, p. 303)

Determining factors	*Traditional marketing*	*Technology marketing*
Purpose	Increase competitiveness Improve ROE	Optimize technology potential Set up alliances and networks
Target groups	Product, service, system user	CEO, CTO, R&D specialists Production management Original Equipment Manufacturers (OEMs)
Market segmenting (examples)	According to various criteria: geographic, geodemographic, psychographic, behavioural End users, product users, key and smaller customers	Technology products to be substituted Similar process functions New product and process functions Core competence strategies and readiness to outsource Production capacities
Marketing instruments: Market performance	Products, service and systems	Know-how, patents, prototypes, projects
Price and conditions	Price according to market rules	Case-specific pricing
Market administration	Advertising, purchasing, stimuli, sales	Reputation among specialists
Distribution	Distribution channels	Situation-specific technology transfer, conferences, technology broker
Body of knowledge	Marketing (and technology)	Technology and marketing

Furthermore, their work takes a unique perpective insofar as stating that "the task of technology marketing is to, explicitly and with equal weight, integrate acquisition and exploitation activities." (Escher & Tschirky, 2004, p. 239) Thus, the introduction of technology marketing may be seen as the first step in equally appreciating the role of outbound openness in firms' innovative processes and the potential synergies that it may bring.

Strong measures are required to enable the strategic management of technology marketing. Technology marketing happens in a very complex environment, must be done on persistently imperfect markets and can have potentially very significant effects on the competitiveness of the firm, in either direction (Escher & Tschirky, 2004). In addition to specialized tools that enable a sufficient level of technology intelligence to back up decisions, tight strategic integration is seen as a key requirement, as is evident in Figure 4 below.

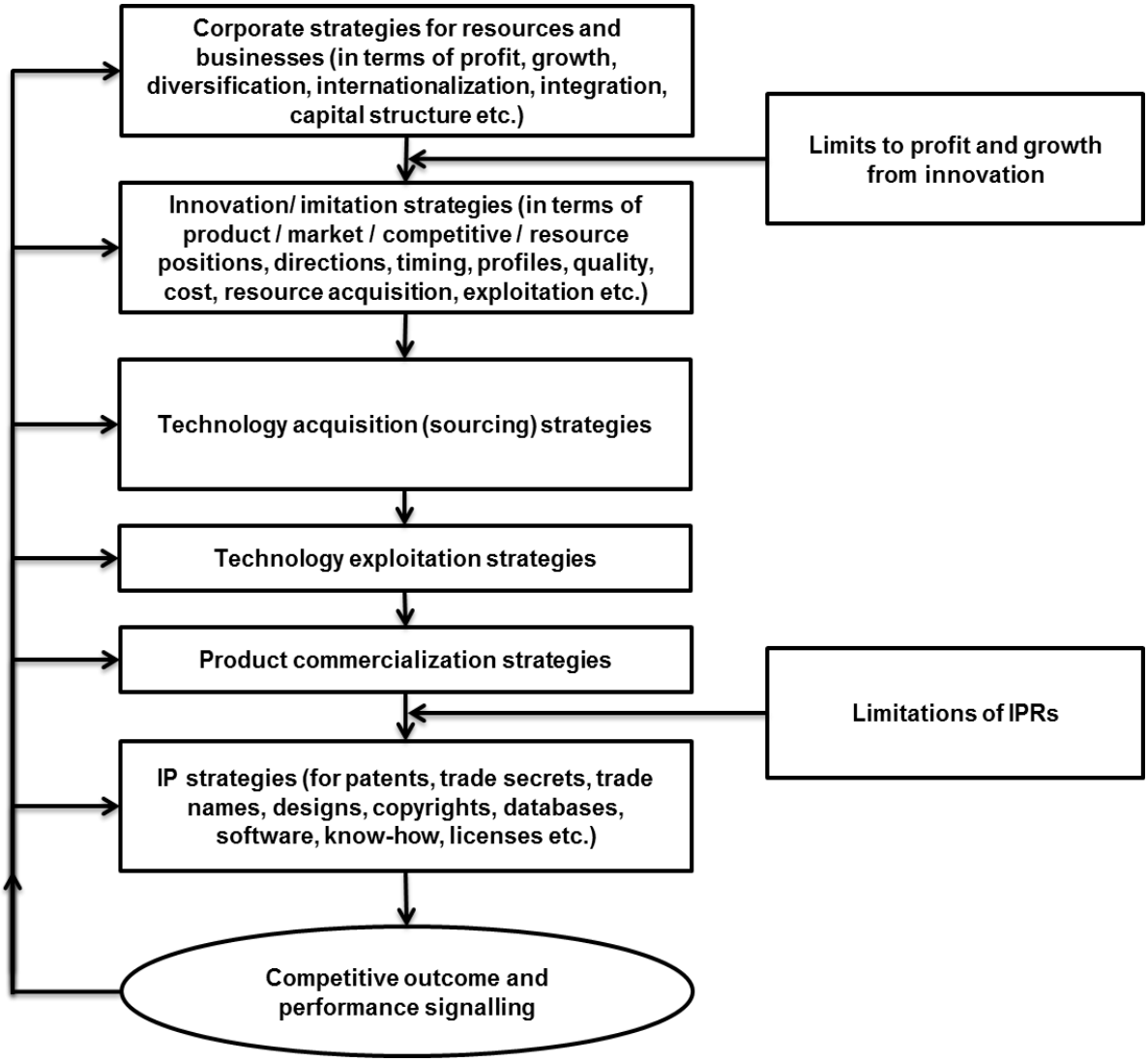

Figure 4. Types of management strategies for the technology based firm (Granstrand, 1999, p. 130)

Due to the challenges being qualitatively different in technology marketing than in traditional marketing and due to the central role of technology in determining competitiveness, Tschirky (1998) advocates founding a new organizational unit to manage the processes of technology marketing and technology strategy. Possible synergies in fields such as methodological know-how, networking, partner search competencies, negotiation know-how, transaction know-how, technology prizing and patent, licensing and contracting law further motivate grouping all technology marketing activities in a dedicated unit (Escher, 2001; Tschirky, 1998). While in some fields the synergies are more evident than in others, it can be said that practicing both sides of technology marketing (or open innovation; Lichtenthaler, 2011) would seem to enable the firm to develop a tacit, experience-based capability for managing technology transfer and its associated activities in general.

The process model of technology marketing (Figure 5) displays the interfaces of external entities as the 'Buy' and 'Sell' options (Escher, 2001). The decision of "Keep or Sell" is not entirely accurate, as often internal and external modes of exploitation do not exclude one another (Brockhoff, 1998; Ford, 1988).

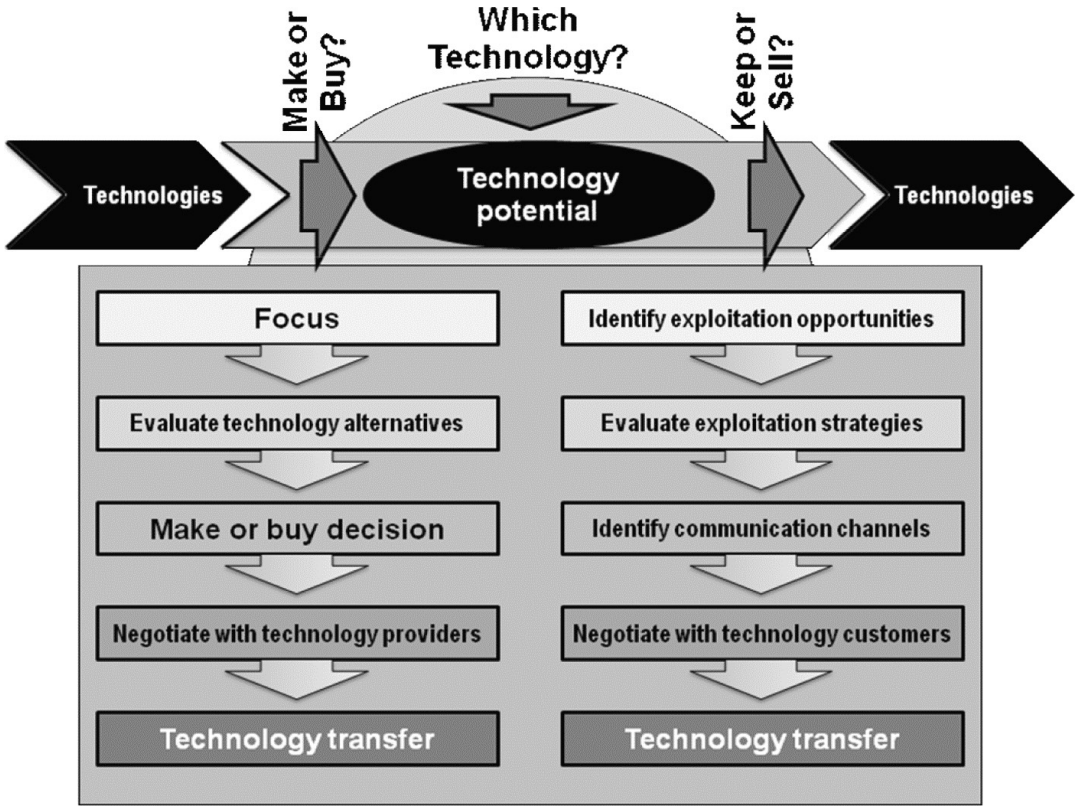

Figure 5. The process model of technology marketing (Escher, 2001)

Looking at the process from the outbound or exploitation side, five stages are presented by Escher (2001). First, the company chooses the technologies from its portfolio that are worth exploiting externally. The enterprise evaluates them in terms of technological attractiveness, strength and functional characteristics (that may reveal potential application domains). In the next stage, strategies for external exploitation are formulated and evaluated, which may include objectives such as profit, access to new capabilities and networks, learning effects in

R&D and setting industry standards. The third stage is finding appropriate channels for communication, which may be either passive (promotion channels; e.g., exhibitions and journals) or active (search channels; e.g., technology brokers and networks). Following this, negotiations are initiated with potential technology customers, where identifying the pricing and asymmetry of information are typical challenges. The final stage, that often receives too little attention from enterprises, is the actual technology transfer. The technology marketing process was later adopted into the open innovation literature in a similar form (Lichtenthaler, 2005).

2.2. Innovation process

2.2.1. Innovation process models and stages

Understanding of the innovation process has certainly come a long way since Usher (1929) noted that "our powers of innovation are mysterious and in their entirety inexplicable; but so too are other phases of the process of learning." (p. 9) However, already then, Usher made several observations regarding the innovative process that hold true today: that it involves both creative, unstructured elements as well as has a requirement for analytical, orderly processing of information and that it is fundamentally connected with the process of learning. Since then, these same notions have been incrementally refined and conceptualized by many academics.

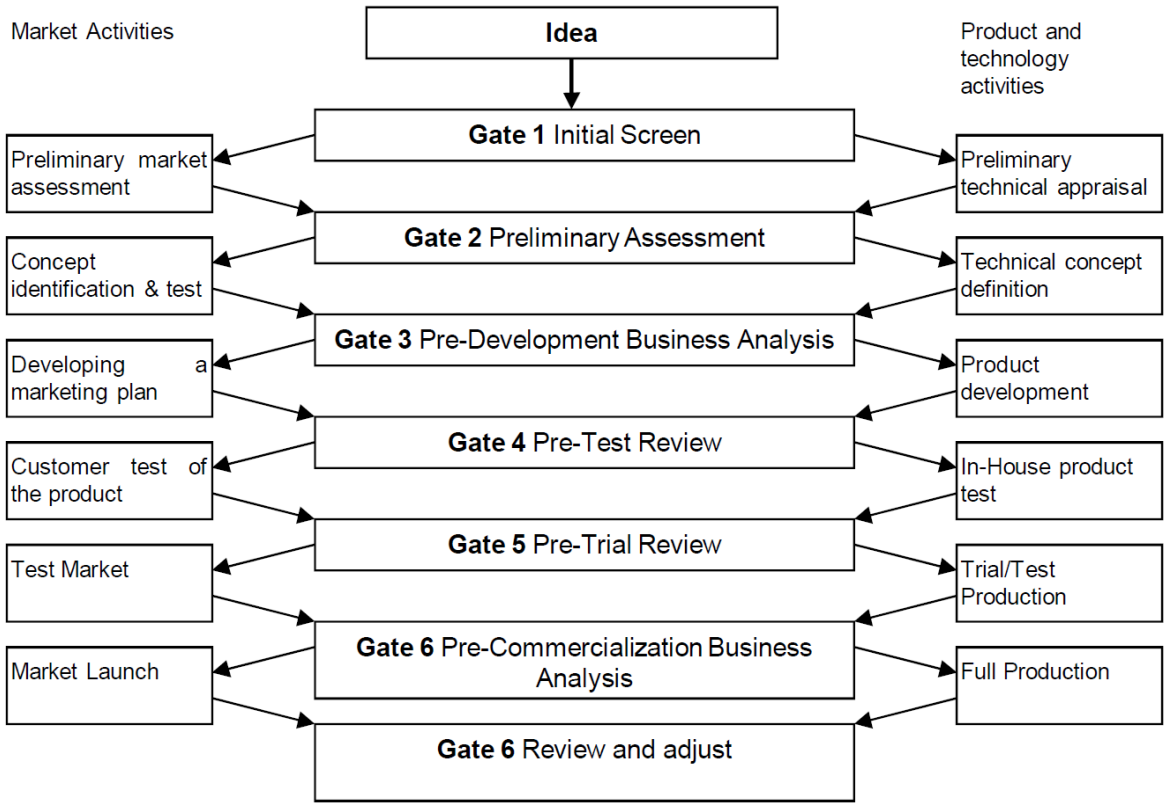

Figure 6. New product development with go/kill gates (Cooper, 1988)

The innovation process is usually divided into several stages, such as idea generation, idea screening and evaluation, development, testing and commercialization (following the activity-stage model introduced by Booz, Allen and Hamilton, 1982). Many formal models for innovation processes also include so-called gates between the different stages (see Figure 6; e.g. Cooper, 1988; 2001), in which a decision is made whether to continue the development process or not. In each stage, before the decision point, information is gathered in order to reduce uncertainty about both technological feasibility and the market potential for the product.

Roy Rothwell (1994) made a seminal contribution to describing innovation processes when reporting on the findings of the SAPPHO project. Rothwell contributed by providing five versions of the innovation process that were arranged as a linear evolution from first generation (1G) to fifth generation (5G). The first models were simple linear progressions starting from a technological advancement (1G) or a perceived market need (2G) all the way up to the market. The 3G model added a level of realism to the description of the process by coupling R&D and marketing functions, as well as including feedback loops, throughout the process (see Figure 7). It also became one of the widespread ways for companies to describe their innovation process, along with the Stage-Gate model (Cooper, 2001) and the "closed" innovation funnel (Chesbrough, 2003).

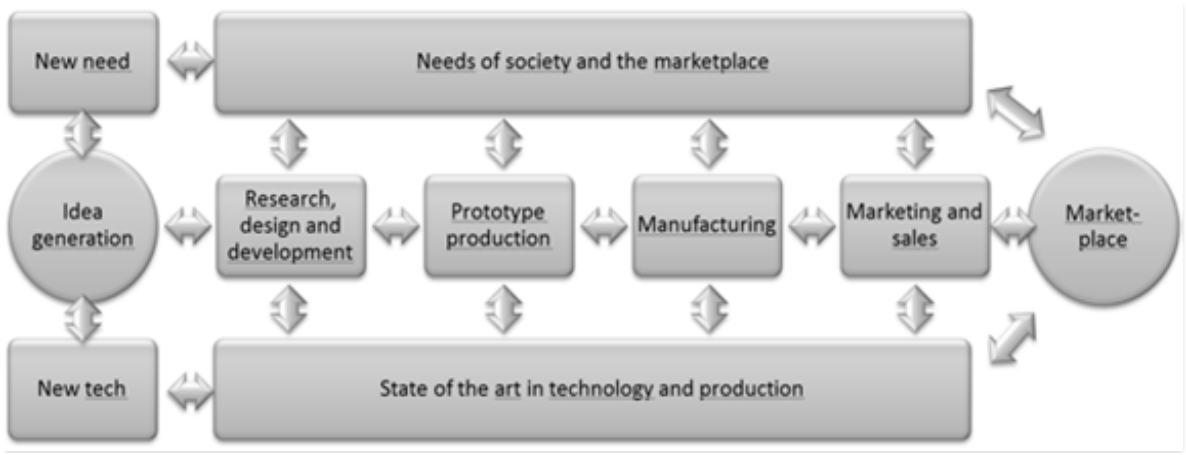

Figure 7. The third generation innovation process (Rothwell, 1994)

The fourth generation model was inspired by the innovation management practices of Japanese companies, where integration and parallel development processes were the essential additions to the previous model (Graves, 1987). The 5G model was only envisioned conceptually in Rothwell's (1994) work, where the essential evolution beyond the previous models was the influence of information and communications technology (ICT) ("electronic toolkits"), ever-increasing partnering arrangements and the central importance of achieving faster development speed. In hindsight, Rothwell's definition of the 5G model accurately pre-empted many features of the open innovation model of innovation, even if not at the same scale.

Looking at how companies implement these innovation processes, Van de Meer (2007) presented that in the normal evolution of innovation systems in companies, there are three

stages: natural innovation, systematic innovation with a closed system, and finally, systematic innovation with an open system. A modern innovation approach combines a good innovation climate (developed in stage 1) with a stage-gate methodology (perfected in stage 2) in an open-system approach (implemented in stage 3; Chesbrough, 2003; Van der Meer, 2007).

2.2.2. Fuzzy front end of innovation

As mentioned previously, when the process of New Product Development (NPD) is sliced into pieces, the time and activities that precede any formal commitment of starting the development is often called the Fuzzy Front End (FFE) (e.g. Smith and Reinertsen, 1991). It thus precedes a formal NPD processes such as Stage-Gate™ or Product and Cycle Time Excellence (PACE®) (Koen, et al., 2001). The FFE has also been depicted as an extension of the formal Stage-Gate process as the "pre-phase zero, phase zero and phase one" phases (Cooper, 1997; Khurana & Rosenthal, 1998; Moenaert et al., 1995). Kim and Wilemon (2002) define the FFE as the period between the stages when an opportunity is first considered and when an idea is judged ready for development. Figure 8 demonstrates the stages of the innovation process in which the fuzzy front end is highlighted. First, the idea is evaluated in an iterative process in phase I. The tasks of the second phase are the development of a more detailed product concept and the initial project planning. The output of the fuzzy front end is a detailed business plan, which is the basis for the decision on a business case. Then (if the concept passes the kill/go –gate) the actual development of the product starts in phase III (Herstatt et al., 2004).

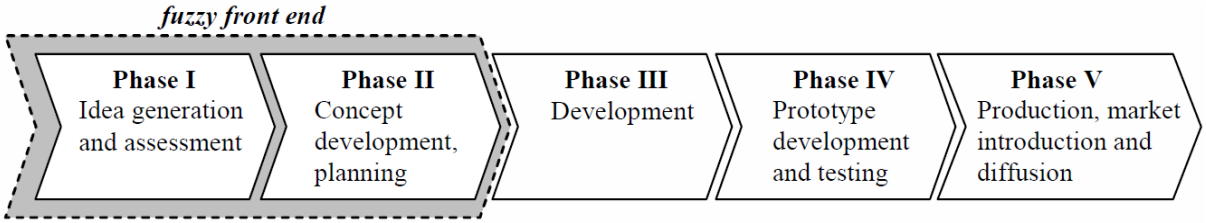

Figure 8. The fuzzy front end in the product development process (Herstatt et al., 2004)

According to Reid and Brentani (2004), the early activities are problem/opportunity structuring and/or identification/recognition (Leifer et al., 2000; Urban & Hauser 1993); information collection/exploration (March, 1991); and ''up-front homework'' (Cooper, 1996), whereas the later activities are seen as involving aspects of idea generation and concept development (Cooper, 1990; Urban & Hauser, 1993), continued information collection, and prescreening (Crawford, 1980; Crawford & Benedetto, 2003) with possibly some initial fund allocation for exploring a new idea (Cooper, 1990; Cooper & Kleinschmidt 1986). Koen et al. (2001) incorporate the FFE activities in The New Concept Development (NCD) model, which is described as a set of five elements (Idea genesis, Idea selection, Opportunity identification, Opportunity analysis and Concept & Technology Development) with no preset order of execution that are coupled with the engine of leadership and organizational culture and external influencing factors. The engine includes a culture that encourages innovation and creativity, early involvement of a business-executive champion, a collaborative culture that encourages knowledge creation, and leaders maintaining the

constancy of purpose and setting aggressive goals. The influencing factors consist of organizational capabilities, business strategies, the outside world and the enabling technologies that will be utilized (Koen et al., 2001).

The FFE is seen to be one of the most important determinants of NPD success, or as Zhang and Doll (2001) put it: most projects do not fail in the end, they fail at the beginning. Murphy and Kumar (1997) argue that the most important objective of front-end activities is to understand project requirements and that the reason why firms undertake predevelopment activities is to create a clearly defined product prior to development. This allows for a clearer understanding of development time, costs, required technical expertise, the right development team, market potential and positioning, risks, and organizational fit (Murphy & Kumar, 1997), or in other words, combating the inherent uncertainties or fuzziness of NPD. Based on prior works on the fuzzy front end and the nature of uncertainty, Zhang and Doll (2001) define the front-end fuzziness of NPD as the uncertainty of customers (portfolio, preference, life-cycle and volume fuzziness), technology (material, specification and supply fuzziness) and competition (competing product development and adoption speed fuzziness), which are the lead causes of the managerial difficulties associated with it. Over the past 20 years (Crawford, 1980) the view of managing front end uncertainties has revolved around advocating various approaches to implement more aggressive screening processes. There has been a notable string of literature, especially in the nineties (Khurana and Rosenthal, 1997; Moenaert, et al., 1995; Reinertsen, 1999), pertaining to this subject, most of it having to do with managing the uncertainties, speeding up the screening of ideas or attempting to provide structure to the seemingly chaotic, experimental and unpredictable phase of the innovation process (Koen et al., 2001). At that time, it was generally agreed by both managers and academics (Chase & Tansik, 1983; Cooper & Kleinschmidt, 1994; Rosenau, 1988; Smith & Reinertsen, 1991) that, of all the actions firms can take to improve their NPD process, those taken at the fuzzy front end give the greatest time savings or improvement in outcome for the least expense. In summary, the research on the fuzzy front end of innovation has described the struggle of NPD process managers in coping with increasing levels of NPD measurement error, which is the original field of contribution of open innovation as well (Chesbrough, 2003).

Both the theories of OI and FFE deal with issues central to success in innovation management and new product development. Inbound open innovation (i.e. tapping into the external technology base) provides the foremost overlap of the two theories as the fuzzy front end connects to the beginning of the development funnel (Chesbrough, 2003). Open innovation leverages the role of front end R&D by extending it to incorporate both the creation of knowledge as well as capturing it from the environment. Various FFE studies (e.g. Koen et al., 2001) already discussed the involvement of external parties prior to the era of open innovation. The potential of customer involvement in improving product concepts (Cooper & Kleinschmidt, 1987; Von Hippel, 1994) and as an information source critical to understanding of current and future customer needs, market size, and growth (Griffin & Hauser, 1992; Kim & Wilemon, 2002) were noted. However, as a whole, the wide majority of the FFE studies still retained a decidedly internal focus.

2.3. Outbound open innovation

2.3.1. The concept of open innovation

Chesbrough (2003) initially defined the concept of open innovation as a:

> *...paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open Innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model*. (p. xxiv)

The definition was founded on the movement of ideas across firm boundaries and included the ideas of equal weight to both inbound and outbound modes as well as the connection to business models, but it was not sufficient for academic purposes. The following improved version was introduced by Chesbrough (2006):

> *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.* (p. 1)

The revised definition thus allowed further (in fact, all) modes of knowledge exchange (from "ideas" to "knowledge flows"), the notion of intent ("purposive") and was more accurate with the purpose of the concept ("to accelerate internal innovation and expand the markets"), while remaining consistent with the original notion of the 'porous innovation funnel' (see Figure 9). With the revision, Chesbrough's definition of OI is the most popular, but still not uniformly accepted, with multiple variant definitions in use, resulting in the fragmentation of efforts and the rise of critical viewpoints (Elmquist et al., 2009).

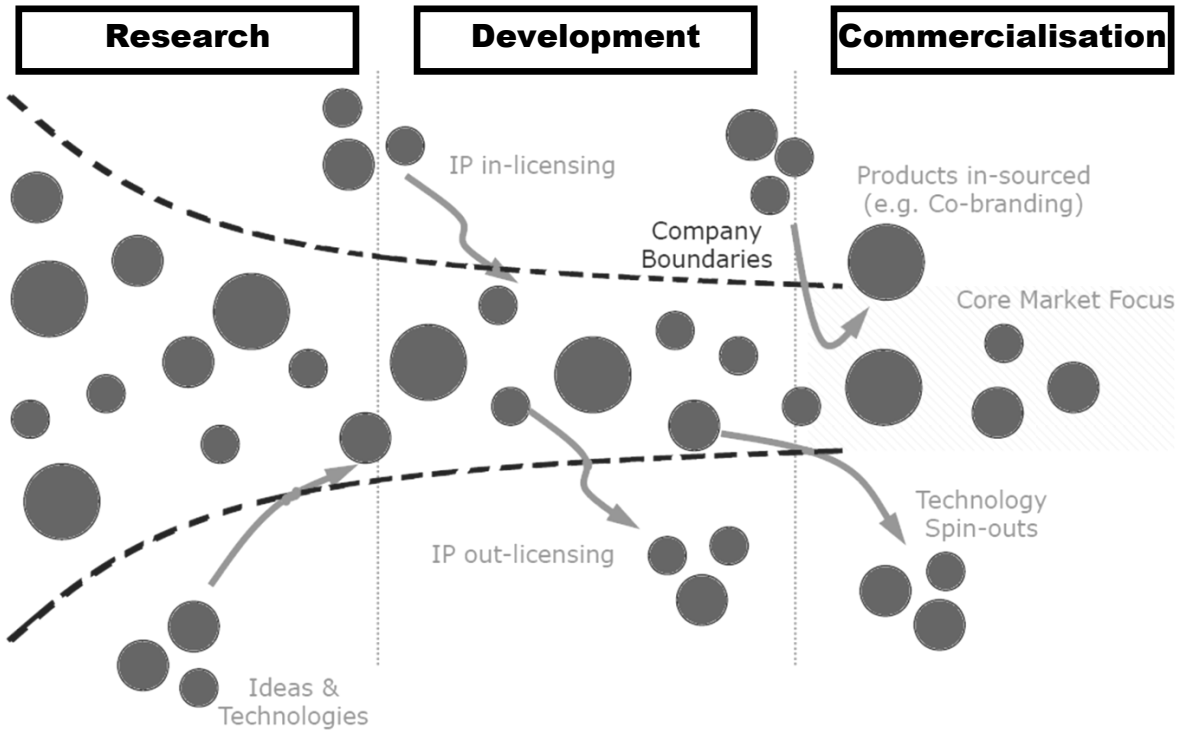

Figure 9. The open innovation funnel (Mortara et al., 2009)

While Chesbrough has provided the fundamental open-ended definitions that have succeeded in attracting the interest of both business leaders and academics, another interesting string of definitions comes from Ulrich Lichtenthaler (2005; 2008a; 2011). Starting with the need of a more operable definition, Lichtenthaler (2005) produced the following definition that closely resembles the concept of technology marketing:

> *Open innovation describes an organization's deliberate commercializing (exploitation) of knowledge assets to and / or acquisition from another independent party involving a contractual obligation for compensation in monetary or non-monetary terms.* (p. 233)

While the definition was more practically oriented, it had the fault of implicitly viewing open innovation as an *ad-hoc* activity that was rectified in the following definitions. In his next notable iteration (Lichtenthaler, 2008a) the notion of a systematic activity is invoked and open innovation is connected to certain capabilities implying both greater deliberation and a need for proficiency: "open innovation is defined as systematically relying on a firm's dynamic capabilities of internally and externally carrying out the major technology management tasks . . . along the innovation process." (p. 148) Finally, based on the cumulative knowledge of open innovation research, Lichtenthaler (2011) introduces his final definition of open innovation as "systemically performing knowledge exploration, retention, and exploitation inside and outside an organization's boundaries throughout the innovation process" (p. 77), thus combining the organizational boundary and knowledge flow focus from Chesbrough's definitions (2003; 2006) to his own capability-centered perspective.

The concept of open innovation explicitly considers the trend toward interorganizational innovation processes (Vanhaverbeke, Van de Vrande & Chesbrough, 2008) that has come about due to changes in markets (e.g. globalization, ICT, centrality of knowledge), which encourage seeking efficiencies through specialization and networked operation. As noted also in previous chapters, most of the ideas contained within the open innovation theory have surfaced already prior to Chesbrough's (2003) book, in fact, so much so that critical voices (Huizingh, 2011; Groen & Linton, 2010; Linstone, 2010; Trott & Hartmann, 2009; Dahlander & Gann, 2010) have questioned the novelty and added value of the concept. After all, open innovation draws on and partially overlaps with theories such as transaction cost economics (Williamson, 1985; 1991), absorptive capacity (Cohen & Levinthal, 1990), complementary assets (Teece, 1986), organizational learning (March, 1991), 'not-invented-here' syndrome (Katz & Allen, 1982), integration of customers in innovation process (co-creation) (Prahalad & Ramaswamy, 2004; Vargo & Lusch, 2004) and lead users (Von Hippel, 1986). Lichtenthaler (2011) addresses these criticisms and concludes that open innovation is distinguished from earlier approaches by three factors. First, OI assumes synergies between the in- and outbound modes and thus integrates inbound and outbound knowledge flows, whereas most of the earlier works typically focused exclusively on either one of the directions. Secondly, the additionality effect of internal and external innovation processes is emphasized, while previous research was raising the either-or question. Thirdly, OI seeks to research technology and innovation management issues in combination, instead of separating technology issues from innovation processes.

In summary, regardless of the exact definition, the open innovation concept includes the exchange of knowledge with the environment and both an inbound and outbound aspect, which refer to flows of knowledge to and from the innovation process, respectively. The benefits of opening up the innovation process are faster development, added flexibility, higher cost effectiveness and new lines of profit for the company. Open innovation is essentially a theoretical framework for the holistic structuring and management of the cross-boundary knowledge flows in order to improve a firm's innovative performance (Lichtenthaler, 2011). As inbound modes of openness have been subject to more academic research (both after and prior to open innovation introduction), the potential for the novel contribution of the OI theory concerns the outbound side, in addition to integrating separate literature streams and seeking synergies between different ways of governing innovation.

2.3.2. Open Innovation processes

Although the literature regarding different process models for open innovation is limited (Escher, 2005), some attempts at constructing explicit process descriptions with distinct steps have been made (Escher, 2005; Gassman & Enkel, 2004; Lichtenthaler, 2007b). One influential approach is the model of three core open innovation processes presented by Gassman and Enkel (2004) visualized in Figure 10.

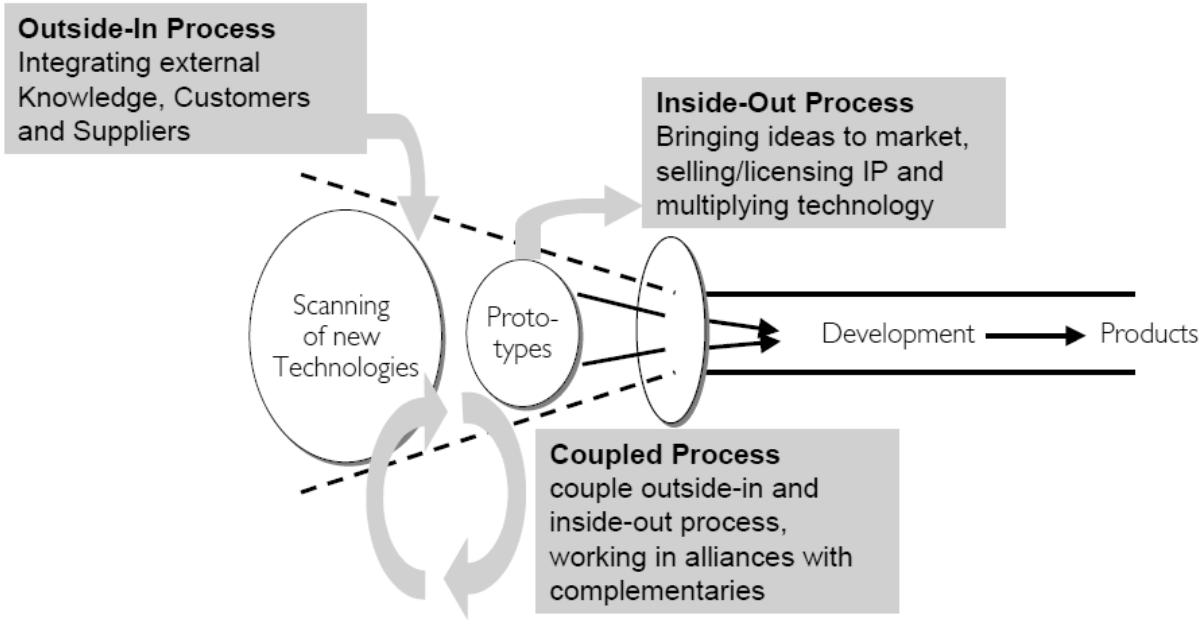

Figure 10. Three core open innovation processes (Gassman & Enkel, 2004)

The model can be summarized by the three innovation processes. The outside-in process entails the external knowledge acquisition to enrich the company's own knowledge base, as exemplified, for example, by Procter and Gamble's famous "Connect and Develop" – model (see e.g., Chesbrough et al., 2006; Huston & Sakkab, 2002). Second, the inside-out process, which represents external knowledge exploitation where the authors see earning profits, selling intellectual property (IP) and multiplying technology by transferring ideas to the outside environment as primary objectives. Third, the coupled process, which couples the previous processes by working in alliances with complementary partners in which give-and-

take is crucial for success. All of the three core processes represent an open innovation strategy, but not all are equally important for every company. Instead, each company consciously chooses a primary process, although it may incorporate aspects of the others as well (Gassman & Enkel, 2004). The processes defined by Gassman and Enkel (2004) do not explicitly separate different stages, but do identify similar tasks and challenges pertaining to them as in other literature (e.g. Escher, 2001; Lichtenthaler, 2005). It is also argued that the three core open innovation processes each require a different capability of the company (Gassman & Enkel, 2004): outside-in is associated with absorptive capacity (Cohen & Levinthal, 1990), inside-out process with multiplicative capability explained through technology transfer capability and proficiency in identifying partners and the coupled process is associated with relational capacity (Dyer & Singh, 1998).

Of specific interest to this thesis is the inside-out (outbound process), which has been studied especially by Ulrich Lichtenthaler (e.g. 2005; 2007; 2008b). Combining from previous process models of technology marketing (Escher, 2001) and open innovation (Gassman & Enkel, 2004) Licthenthaler (2007) presents a model (in Figure 11) that differentiates between the five stages in the outbound process: planning, intelligence, negotiation, realization and control.

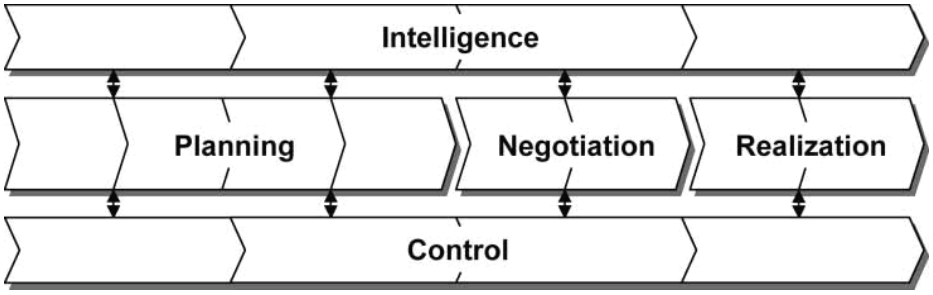

Figure 11. Sequential segmentation of the ETC process (Lichtenthaler, 2008b)

1. The *planning* stage can often be integrated into corporate strategy planning, as professional planning refers to a high-quality process of strategic planning, target setting, resource allocation and technology customer pre-selection. Proficient planning is necessary for limiting the potential negative consequences of outbound innovation; it is vital for building the firm's dynamic capability of outbound OI (Lichtenthaler, 2011) and for enabling the strategic alignment of outbound activities (Lichtenthaler, 2008b).
2. The *intelligence* stage comprises the scanning and monitoring of a firm's technological environment, with particular emphasis on the markets for technology. The evaluation of information needs and communication happens at this stage as well. The identification of technology commercialization opportunities usually presents a critical managerial challenge in leveraging technology externally (Lichtenthaler, 2007b; Enkel et al., 2009).
3. The *negotiation* stage is the one where the decision on transfer is done, provided that the firm has found potential customers at the previous stages. Proper negotiation is crucial to the success end efficiency of technology transfer. A sufficient level of

mutual trust and understanding is needed, as the exchange of highly confidential information is done at this stage, and the collaborative agreement is organized. The negotiation stage involves communicating the value proposition to the potential customer, which necessitates partial disclosure of the knowledge asset to be transferred, thus opening possibilities for opportunistic behavior. Additionally, the negotiation stage is also where the final valuation of the technology takes place and the price is agreed. The negotiations may go in a few rounds, involve third parties and last even over a year (Lichtenthaler, 2007b).

4. The *realization* stage is the one where the actual technology transfer happens. Proficiency at this stage refers to a high-quality execution of the design and implementation tasks. The transfer stage is often neglected by both parties, although thorough planning and detailed process mapping are necessary for its success. An important prerequisite for successful knowledge transfer is the absorptive capacity (Cohen & Levinthal, 1990) of the recipient, partly defined by the technological distance between the parties.
5. The final stage of *control* consists of the processes happening simultaneously through the whole external commercialization process from its planning stage. These processes secure the post-transfer activities, such as organizational learning and reflection (Kutvonen et al., 2010). The control stage includes the decision on when the transfer activities are to be redirected and when the process should be terminated.

Initially, the logic of outbound open innovation was only partially understood. Managers that were familiar with the concept based their understanding largely on popular academic papers on it that focused on case studies of selected industry giants, such as IBM, Texas Instruments, Lucent Technologies and Dow Chemicals (Arora et al., 2001; Grindley & Teece, 1997; Kline, 2003; Sullivan & Fox, 1996) and describe how they are reaping massive licensing profits by externalizing residual technology (Rivette & Kline, 2000). This focus on the short term monetary gains available by externalizing 'research waste' (or 'surplus' that was 'sitting on the shelf') was advocated by Chesbrough (2003) as well, which inadvertently lead to the implementation of and research focusing on mainly inbound processes instead of the balanced approach that OI had as a core strength of the theory. Thus, outbound OI research was connected predominantly with the out-licensing of technology and the role of intellectual property rights (IPR) became especially pronounced. Essentially, OOI was equated with out-licensing that aimed at generating higher returns from whatever IP portfolio the company had by generating licensing revenue and cutting IP maintenance costs (Megantz, 1996; Smith & Parr, 1993).

2.3.3. Open Innovation and strategy

The strategic (non-pecuniary) benefits of external exploitation have received relatively little attention and are considered secondary or complementary benefits even though they are frequently mentioned in open innovation research (e.g. Lichtenthaler, 2005; Arora et al., 2001). The intersection of strategy and outbound open innovation (e.g. Kline, 2003; Arora & Fosfuri, 2003) has mainly been in fitting the practice of external commercialization to the existing framework of corporate strategy; seeking a 'strategic fit' (Lichtenthaler, 2007a) by

offering guidelines to allow additional revenue generation without interfering with the development of the core business of the firm. While monetary compensation is indeed the objective in a vast majority of technology transactions (Rivette & Kline, 2000; Davis & Harrison, 2001), non-monetary incentives are arising, as markets of technology become more efficient (Arora & Fosfuri, 2003; Arora & Gambardella, 2010).

The integration of strategy and outbound open innovation can be characterized to be at one of three possible levels:

1. *Keep-or-sell decision*: Strategic alignment is sought after in an attempt to determine when it is beneficial to release knowledge assets outside instead of keeping them on the shelf.

The keep-or-sell decision is central to the deployment process. As in the acquisition process, this decision is made on both a strategic and on an operational level (Mittag, 1985; Birkenmeier, 2003). On a strategic level, the keep-or-sell decision sets the objectives of technology deployment activities, regulates timing issues, and identifies potential customers. This decision is based on an opportunity/threat analysis and determines the conditions and range for the preferred and acceptable outcome of subsequent technology deployment projects. The responsibility for controlling deployment projects and technology customer care are also assigned at this level. On the operational level, specific technology deployment projects are executed.

2. *Keep-and-sell scenarios*: Strategic fit has been attained at a high enough level, thus allowing situations where knowledge assets can be commercialized externally and in the companies own products and services simultaneously without conflict.

Lack of strategic planning regarding external exploitation is one of the fundamental reasons for the many problems (Enkel et al., 2009; Kline, 2003; Lichtenthaler, 2005) firms are encountering in their attempts at outbound innovation (Lichtenthaler, 2008b). In practice, external technology commercialization has been traditionally regarded as an *ad-hoc* activity (Tschirky et al., 2000), mainly the concern of the IPR department or portfolio managers. Technology deployment initiatives at this level require thorough coordination with the innovation activities of the company's strategic business units. OOI activities can occasionally support the overall business and product strategies, by conferring various non-pecuniary benefits, for instance through support for market entry through licensing or partnering (Escher, 2005). A rising number of technology-based enterprises take advantage of opportunities to utilize their technology assets by licensing out their technologies or founding entrepreneurial spin-off companies (Gassmann et al., 2003). All these initiatives require company-wide coordination in order to effectively time support activities and prevent the company from hollowing out the competitive advantages of its own business units (Escher, 2005). However, Lichtenthaler (2007) advocates that, provided sufficient strategic fit and integration with the firm’s internal innovation strategies and the corporate strategy, in other words an integrated knowledge exploitation strategy (Arora et al., 2001; Koruna, 2004), firms may ascend to a beneficial keep-and-sell scenario. The key to achieving high fit is to avoid

strategic conflict between the strategic goals of R&D and marketing, of the corporate and business unit and of knowledge and product business, which Lichtenthaler (2007) proposes to manage by collaboration, centralization and coordination, respectively.

3. *OOI driving strategy*: Outbound open innovation is systematically managed and integrated into corporate strategy and inputs from relevant intelligence and foresight instruments, which allows harnessing OOI activities as a means to directly pursue the strategic objectives of the organization while maintaining strategic fit.

The level of achievement which this thesis supports is extremely rarely seen in companies. The strategic objectives or incentives for external technology exploitation have previously been partially listed by various authors such as Teece (2000), Escher (2005) and Koruna (2004) to name a few, each having a different view on what constitute the primary strategic incentives for external technology exploitation. Motives for OOI also include non-strategic objectives: monetary benefits and compulsory externalization to comply to legal requirements, that is to say avoiding monopoly lawsuits. Lichtenthaler (2008b) divides strategic objectives into three groups: product-oriented, technology-oriented and mixed strategic objectives, and provides a visual overview (Lichtenthaler, 2007a) of which motives companies consider important in out-licensing (see Figure 12), signaling high interest for improving on the strategic alignment of outbound open innovation.

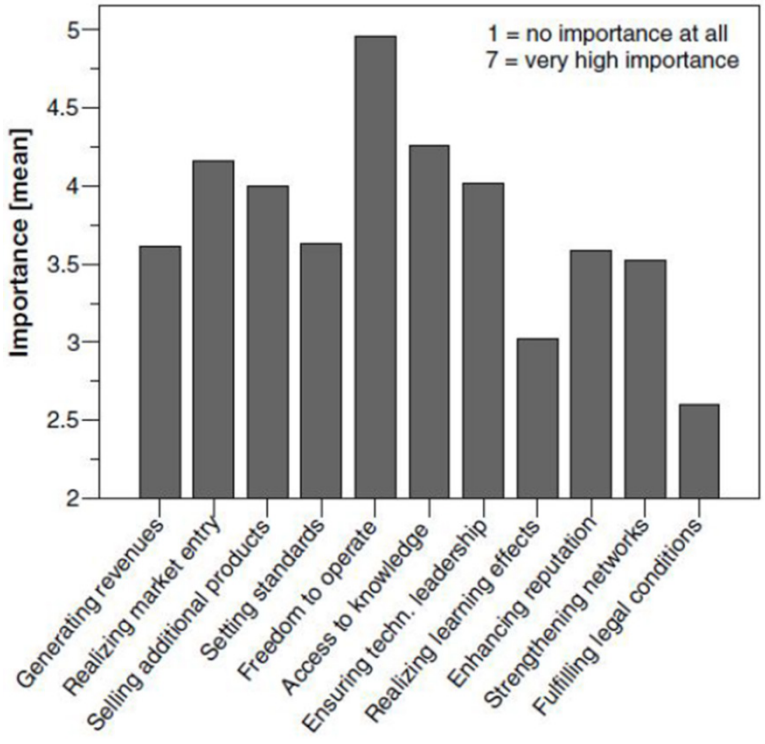

Figure 12. Importance of drivers for technology licensing (Lichtenthaler, 2007a)

2.3.4. Implementing outbound open innovation

While the capture or the acquisition of external technologies is commonplace today, the exploitation of technologies and of intellectual property (IP) outside the company is still infrequently observed (Athreye & Cantwell, 2007; Mendi, 2007; West & Gallagher, 2006). Measures grounded in the experience of a single company aiming for specific solutions for its individual set of problems is seen as a more effective, if not the only, way to facilitate successful external technology commercialization (ETC) implementation. This, in turn, has led to the emergence of several superficial case studies (Arora et al., 2001; Grindley & Teece, 1997; Kline, 2003; Sullivan and Fox, 1996; Chesbrough, 2007) that fail to properly address the need for a wider, integrated theoretical treatise of the subject. Implementing outbound open innovation successfully would mean advancing from the level of the occasional *ad-hoc* out-licensing of research surplus to a systematic management structure that is connected to innovation management in the organization.

The outbound process has been modelled and described independently of the general innovative activities (e.g. Escher, 2005) but without connection to innovation management processes it remains hard to implement for most companies (Enkel et al., 2009). The viewpoints of the keep-or-sell decision (Lichtenthaler, 2007a; Elmquist et al., 2009), the innovation process phases accommodating open innovation (Rohrbeck et al., 2009) and the strategic fit of ETC (Lichtenthaler, 2008b) have all been touched upon, but the interplay and interdependency between OOI activity and the innovation process has not been sufficiently studied to allow forming proper normative recommendations on implementation. As an example of the interrelatedness of the two, the early stages of the innovation process are characterized by much higher technical and market uncertainty, which leads to increased difficulty in valuating technologies that are still in the early phase of the process thus impeding the pursuit of monetary gains on knowledge markets in particular (Kutvonen et al., 2010). In fact, the levels of uncertainty and codification are key aspects in understanding the interplay of internal and external innovation management. The effect of uncertainty on the governance mode choice of interfirm relationships has so far been examined mainly in the context of technology acquisitions and R&D cooperation / alliances (e.g. Coles & Hesterly, 1998; Kogut, 1991; Lambe & Spekman, 1997; Robertson and Gatignon, 1998). Van de Vrande, Lemmens and Vanhaverbeke (2006) have also proposed that the level of uncertainty has an effect on governance mode for new business development: when technological and market uncertainties are high, firms are likely to use reversible governance modes with low levels of commitment (e.g. corporate VC investments and non-equity alliances) and move towards more hierarchical and less reversible governance modes only after R&D investments have decreased in uncertainty. Contrary to the traditional conception (e.g. Rohrbeck et al., 2009) that OOI concerns only the codified knowledge available at the end of the innovation process, ETC is not restricted to any specific phase of the innovation process, but instead is apparent in each, albeit potentially in different forms (Kutvonen et al., 2010).

Kutvonen and Savitskaya (2012) argue that, on a general level, the most essential problems impeding the adoption of outbound open innovation can be summarised to into a list of seven issues. The seven problems (indicated in *italics*) are both internal and external to the firm. The internal problems of the open innovation firm are the problems of *mindset* and *incentive*. The managerial problem of mindset (alternatively corporate culture, e.g., van de Vrande et al., 2009) has been present in open innovation since the founding literature of this research stream (Chesbrough, 2003). Its effect is most discernable in the classic 'Not Invented Here' (Katz and Allen, 1982) and 'Not Sold Here' tendencies (Chesbrough, 2003) in firms attempting to open their knowledge flows. The mindset problem has even recently been promoted as the central managerial challenge in the implementation of open innovation (e.g. De Man et al., 2008). Closely related is the problem of incentive, that is to say a lack of concrete management practice (or reward system) to support the grassroots employee's adoption of the concept. The internal problems manifest as fear of losing knowledge or control and incurring extra costs (Enkel et al., 2009) that in turn originate from a real problem of *spillover*. Outgoing spillovers can lead to the leakage of core technologies (Gans & Stern, 2003), lessening the rarity of the unique knowledge resource of the firm and resulting in the overall dilution of competitive advantage (Torkkeli et al., 2009). External problems include *imperfect knowledge markets* that persistently obstruct the *search and evaluation of potential partners*, retain the asymmetry of information between them and generally cause considerable uncertainty and *cost to the knowledge transactions* (Teece, 1998; Bidault & Fischer, 1994). Considering that the idiosyncratic nature of knowledge as a tradable asset (Arora et al., 2001) makes *valuation*, opportunity identification and value communication problematic (Kutvonen et al., 2010b; Kuo et al., 2011), it is no wonder that the implementation of the theoretically incomplete (Kortelainen et al., 2012) OI concept is struggling.

2.4. Conceptual framework of the thesis

The conceptual framework for the thesis (see Figure 13) is built on the complementarity of the three main theories in the context of the topic. The strategic management of technology contributes with some of the antecedent theories of open innovation (technology marketing, relational view and technology marketing) that still retain the explicit link to the achievement of competitive advantage on a well-founded theoretical level. Each of the sections within provides a different emphasis and answer the question of why a firm should cooperate in innovation processes or operate on the knowledge markets. Furthermore, each of the theories' main findings has later been adopted as part of the open innovation framework, testifying to the multiplicity of possible perspectives and motives for conducting outbound activities.

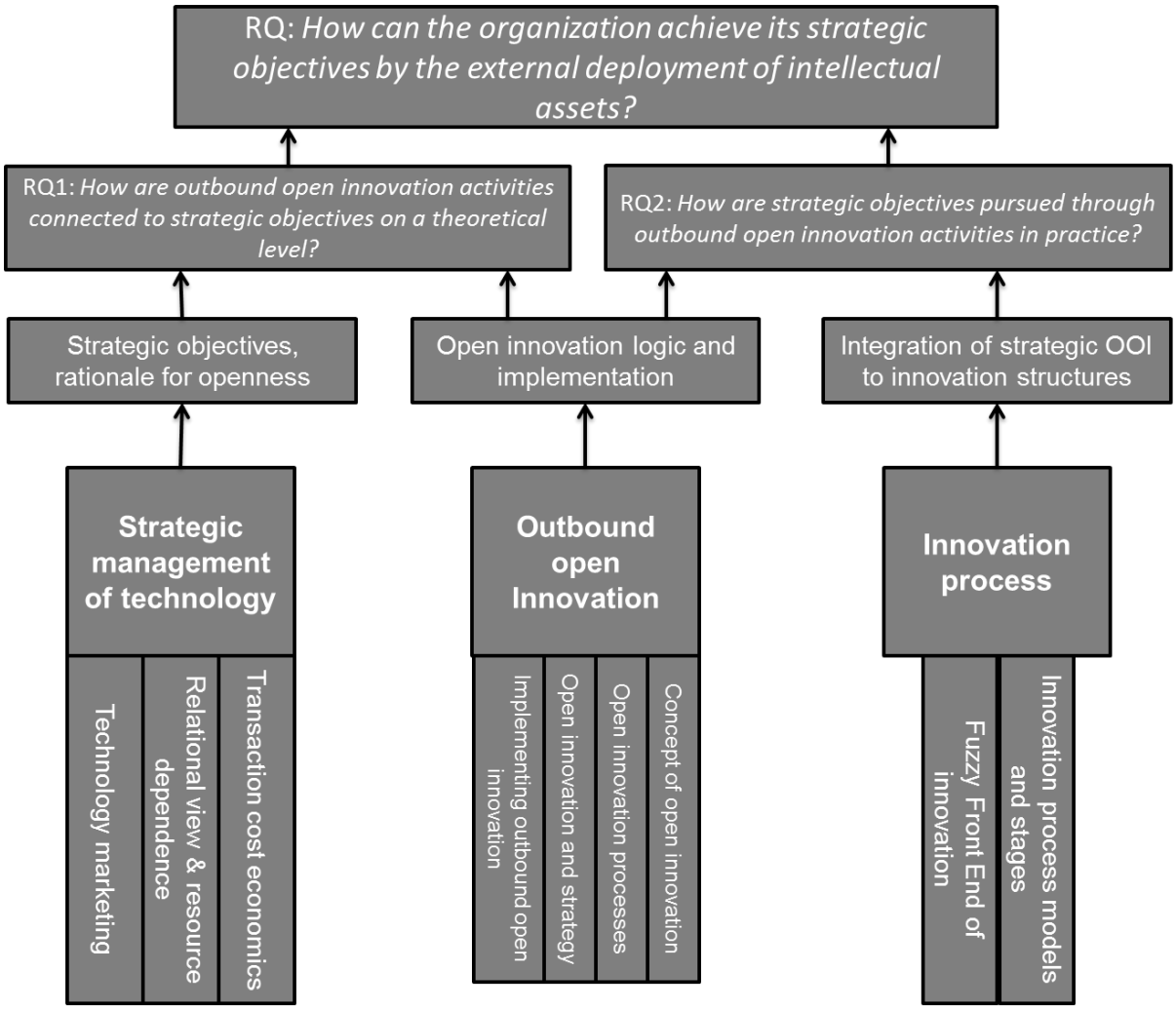

Figure 13. Conceptual framework of the thesis

Innovation process theory has progressed towards more and more collaborative processes that are opening up possibilities for further boundary-spanning knowledge flows. This should enable the natural connection of open innovation theory to the contemporary innovation processes in place at commercial firms so that the implementation of the new activities could be undertaken in an established context. The fuzzy front end was specifically interesting, since FFE research shares the objective of reducing NPD measurement error with open innovation and is also a phase where strategic technology decisions are first felt in an organization through the modification of screening criteria. The strategic management of technology and innovation processes are then connected via technology / innovation strategy, to which open innovation must be aligned or integrated in any systematic adoption of the concept.

By relying on the triad of complementary viewpoints, the thesis has sufficient grounds to establish the role of outbound open innovation in pursuing the strategic objectives of the firm and to address the challenges of concretely implementing such practices.

3. RESEARCH METHODOLOGY

3.1. Research approach

The research proceeded through five publications that focus on different aspects of the studied phenomenon. Figure 10 below describes the research design of the dissertation.

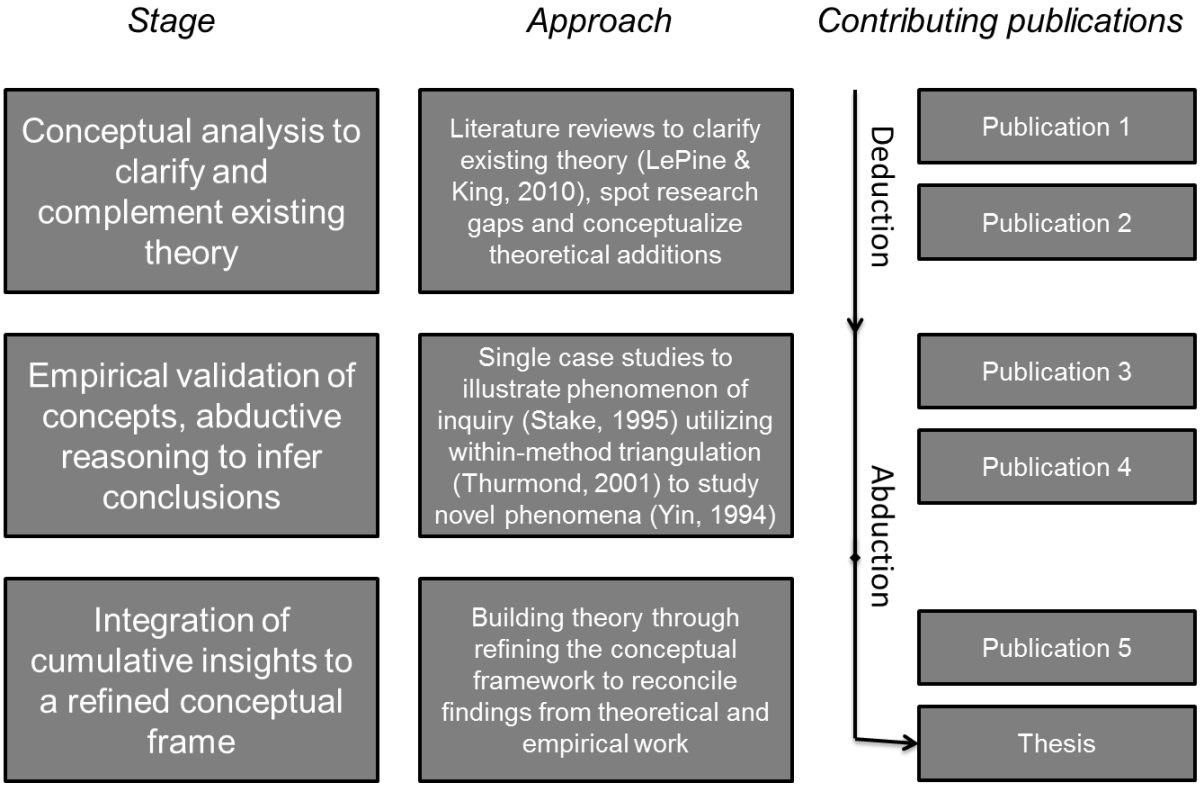

Figure 14. The research design

The progress throughout the research process can be simplified to three steps. Publications 1 and 2 are devoted to conceptual development, triggered by gaps from open innovation literature (LePine & King, 2010) where the contribution is deductively provided via conceptual development. The need of validating the developed concepts leads to publications 3 and 4, which further inform the development of the concepts through empirical study (Stake, 1995; Yin, 1994). This stage of research applied both deductive (theoretically-based) and the more inductive (empirically-based) research models common in social-science research (Eriksson & Kovalainen, 2008). Deductive research generally builds models, sets hypotheses based on the theory, and tests them on quantitative empirical data. Qualitative data (from publications 3 and 4) are used more inductively, even with the theoretical framework as the starting point, but with several iterative loops between analysis and theory in drawing conclusions. The methodological approach in publications 3 and 4 could be characterized as abductive, since the purpose of these publications was to compare existing theory in relation to empirical observations in order to identify relevant directions for future studies and theory development (Dubois & Gadde, 2002). Finally, publication 5 draws on the findings and cumulative knowledge of the previous works in presenting a refined concept of

the strategic application of outbound open innovation as the final research output to be included in the thesis. Given that the research process as a whole is characterized by the interplay of theory and empirical findings, and of deductive and inductive reasoning, the model could be termed as abductive (Eriksson & Kovalainen, 2008).

As Van Maanen et al. (2007) have noted, research rarely follows the ideal linear process of proceeding from identifying an interesting problem to formulating hypotheses, supporting them through data gathering and analysis to finally presenting verifiable conclusions. Nor has it been so simple with the research process of this dissertation either. Over the course of the research process, the findings from the research even resulted in restructuring the fundamental statement of the research gap and problem addressed. In publication 1 the focus was on seeking an explanation to the management challenges that companies face with implementing outbound OI and to the theoretical fragmentation of the relevant literature. Publication 2, on the other hand, was concerned with the seemingly independent gap of disconnect of outbound activities and the FFE stage of the innovation process. Performing the empirical research in publications 3 and 4 prompted a re-examination of the research object's definition and the interrelation of the research components. This led to the discovery of a connection between the FFE-centered research track and the management challenges in strategically managing the outbound OI activity, thus leading to the emergence of the eventual definition and scope of the thesis research and to the role of publication 5 as an integrative element. This approach closely resembles the practices of constructing synthesized coherence (Locke & Golden-Biddle, 1997) in uncovering and addressing undeveloped areas of research.

3.2. Data collection and analysis

3.2.1. Methods used

Table 2 more precisely summarizes the research design of the dissertation adopted in complementary publications in terms of reasoning logics, methods and analysis, as well as the data used in the publications. The characteristics of the research phenomenon, the amount of prior research about it, and the nature of research goals and objectives have guided the methodological choices of the dissertation. Open innovation as a field of study is relatively new and still seeking definition (Enkel et al., 2009; Elmquist et al., 2009), which limits methodological choices. As the theory is still developing rapidly, and stable constructs that would enable meaningful quantitative study are still unavailable (Enkel et al., 2009), open innovation research is still in the phase of theory development that favors use of literature-based conceptual development, explorative cases and other qualitative methodologies. Furthermore, qualitative methodology was deemed suitable for gaining higher credibility and persuasiveness through reflecting the deduced abstract models against real-life evidence (Graebner et al., 2012).

Table 2. Research design of the publications

Publication	Reasoning logic	Method and analysis	Data
Pre-commercialisation [*sic*] activities in external exploitation of technology	Deduction	Literature review and conceptual development	Existing theoretical and empirical research on external technology commercialization
Opening the fuzzy front-end of new product development: a synthesis of two theories	Deduction	Literature review and conceptual development	Existing theoretical and empirical research on fuzzy front end and open innovation
Extending the Fuzzy Front End Beyond Firm Boundaries: Case Demola	Abduction	Mixed method (primarily qualitative)	Interview data gathered from 21 semi-structured interviews; statistics and quantitative performance indicators of Demola
The Evolution of External Technology Commercialization Motives	Abduction	Qualitative, exploratory case study Within-case analysis	Interview data gathered from 6 semi-structured interviews with different managers
Strategic Application of Outbound Open Innovation	Deduction	Literature review and conceptual development	Existing theoretical and empirical research on outbound open innovation and strategy

The individual publications follow two different reasoning logics, deduction (publications 1, 2 and 5) and abduction (publications 3 and 4). The methodological approaches range from literature review –based conceptual development in the deductive research papers to qualitative, explorative case study (publication 4) and mixed-method research (publication 3).

3.2.2. Qualitative study

The qualitative research method was chosen as the primary one for the second stage in the research process (publications 3 and 4) and was implemented as an exploratory case study (in publication 4) analyzing the open innovation practices of firms in the innovation process context and complemented by quantitative data in the mixed-method study (publication 3) focusing on the validation of the Open New Concept Development (ONCD; theoretically developed previously in publication 2, see chapter 4.2) model implementation. The qualitative approach was justified for gaining a deeper understanding about the problem area, as case studies are the preferred strategy when the focus is on contemporary phenomenon within some real-life context (Yin, 1994). Cases in qualitative research are chosen on a theoretical basis and not for statistical reasons, given that the purpose is to develop theory and not to test it (Eisenhardt & Graebner, 2007; Yin, 2003).

The relative novelty of the open innovation theory and need for collecting primary responses to the stated research question were central motivators for method choice, as case studies are the preferred strategy when "how" or "why" questions are being posed and when the focus is on contemporary phenomenon within some real-life context (Yin, 2004). Eisenhardt (1989) describes case study research as a type of research that targets the individual situation and attempts to reveal an understanding of the multi-layered processes at work.

For conducting the case studies (in publication 4 and as part of the mixed-method study in publication 3) multiple sources of evidence were used (Yin, 1994), such as in-depth interviews, information presented on official company web pages and company-related publications. Descriptive empirical research was conducted by collecting data from secondary sources, such as the Internet, scientific and periodical publications, and specialized events. The case study in publication 4 was conducted by means of semi-structured in-depth interviews with the business-leaders in charge of innovation, cooperation and R&D in the case company, while the data for publication 3 was collected via 21 telephone interviews with contact persons responsible for 29 projects between Nokia and Demola in the years 2008-2011. The analysis began after all the data had been collected in order to preserve the integrity of replication logic (Eisenhardt, 1989; Yin, 1994; Ozcan & Eisenhardt, 2009).

3.2.3. Complementing research methods

In addition to qualitative study, the research design included deductive conceptual research based on literature reviews (Coughlan et al., 2007) in publications 1, 2 and 5, where the objective was to clarify and build theory, and formalize gaps to further guide research efforts. Traditional literature reviews are often criticized for being highly subjective by nature and lacking in rigor and wide coverage (Tranfield et al., 2003; Cooper, 2010), but when properly conducted they can constitute an objective, thorough summary and a critical analysis of the relevant available research and literature on the topic being studied (Hart, 1998). Literature reviews are utilized to aggregate large volumes of information from a wide range of studies into an accessible synthesis (Tranfield et al., 2003; McKibbon, 2006) and to highlight weaknesses and shortcomings in the existing body of knowledge (McKibbon, 2006). Literature reviews were targeted in the ISI Web of Science and Scopus databases to access high-quality journal articles which were complemented with books on specialized topics of relevance to the research questions. The selection of which sources to include was done based on analysis of titles, keywords and abstracts to determine relevance.

Publication 3 employed a mixed-method design in order to attain a richer understanding and a higher validity of the results. The primary qualitative analysis was supplemented with quantitative data from Demola general statistics that included performance indicators (e.g. number of new start-ups, successful projects and people employed) about Demola's overall operation in Tampere in the period of 2008 – 2011. The mixed-method approach included complementarity and triangulation purposes (Greene, Caracelli & Graham, 1989). Secondary qualitative data was gathered by reviewing the public information at the Demola website and success stories of Demola that further validated the findings. The data were analyzed individually by two researchers and results were then reconciled in joint discussion and analysis before presentation in the paper.

3.2.4. Quality of research

Conducting totally value-free research is not possible since the researcher's own ethics, assumptions and values inevitably influence it at some level. However, a researcher has to believe that he/she can with objectivity, clarity and precision, report on his/her own

observations of the social world including the experiences of others (Denzin & Lincoln, 2003). The transparency of the research process, especially in qualitative studies such as the present mainly is, holds an important position for reflecting the researcher's actions and giving the reader the possibility to make his/her own judgments about the results.

Relevant questions in qualitative research are to consider how we can be sure that the findings would be replicated if the study was conducted with the same participants and in the same context. Another relevant question concerns the question of how we can be sure that the findings are reflective of the subjects and the inquiry itself, rather than the product of biases and prejudices on the part of the researcher (Marshall & Rossman, 1999).

Different scientific paradigms use different ways to measure the quality of the study and value different dimensions in interpretation. The positivist paradigm argues that there is nothing specific in the qualitative research and thus it can be evaluated as quantitative research by using four criteria that are internal validity, external validity, reliability and objectivity (e.g. Denzin & Lincoln, 2003; Hammersley, 1992; Lincoln & Guba, 1985; Silverman, 2000). Yet, the post-positivistic paradigm among other paradigms proposes that a unique set of criteria in assessing qualitative research is needed (Lincoln & Guba, 2003). Lincoln and Guba (1985) suggest four criteria in assessing the quality of the study. These are *credibility, transferability, dependability* and *conformability*. Wallendorf and Belk (1989) added a fifth criterion for assessing quality called *integrity*. These five criteria are used in the subsequent discussion on the quality of the study.

Credibility (internal validity) refers to the extent to which the results are acceptable representations of the data. The means for achieving credibility in this study are the transparency of the research process and the utilization of multiple researchers in the analysis. Furthermore, all of the publications have been presented in scientific arenas, including scientific conferences and peer-reviewed journals.

Transferability (external validity) refers to the reporting; the results are presented to readers in such a way that it is possible to evaluate the applicability of the results in the reader's context. The external validity is regulated by the limitations of the study to a certain extent. As the study is empirically founded on two single case studies, the generalizability of the findings may be limited. However, the study is largely deductive, founded on quality inputs from literature, which have then been validated and refined in interplay with real-life case data, which adds to the plausibility of sufficient transferability.

Dependability (reliability) reflects the "stability" of findings, and would ideally require the replication of the results. In this study, dependability was achieved by recording the data collection process; all interviews are carefully stocked in their paper versions and the process was documented.

Confirmability refers to the results provided by the analysis of the data collected, and that those results can be compared to the interpretations of the other studies of the same phenomenon. In the case of this thesis, this was done to the furthest extent possible considering the limited availability of research on similar topics.

Methodological limitations of the study include:

- *Immature theory / concept of OI (newness):* As a nascent theoretical field, open innovation still has issues with the definition of the theory that lead to issues in measurement (Enkel et al., 2009). In short, there are not enough commonly agreed and defined constructs available to allow for a quantitative study of the subject. This was one of the reasons for adopting a qualitative research design for the thesis.
- *Theory-building focus:* As the thesis has a distinct focus on making theoretical contributions as the main results, the practical applicability of the findings and the concreteness of the resulting conclusions may be limited. The thesis attempts to counter this by focusing the qualitative research on issues of practical implementation that are then used for presenting practical implications in the concluding section.
- *Limitations for data collection:* The data collection is conducted in both cases in Finland, which may introduce issues of country-specific environmental bias (Savitskaya, 2011). However, in both of the cases the focal company in the study was a globally-operating enterprise, which should reduce this effect. On the other hand, this introduces the additional limitation of focusing only on large enterprises, thus bringing into question the generalizability of the results to SMEs. To counter this, the literature reviews conducted within the publications actively attempted to reflect the results on available findings from research concerning all sizes of firms.

4. SUMMARY OF THE PUBLICATIONS

4.1. Publication 1: Pre-commercialisation [*sic*] activities in external exploitation of technology

Objective

Publication 1 is an integrative literature review comprising multiple fragmented streams of research into a comprehensive approach to external technology commercialization. It provided the basis for the analysis of external commercialization of technology and introduced the concept of pre-commercialization phases of outbound open innovation as a key factor determining success in ETC activities. The review included a large scope of academic journal articles, as well as books on specialized topics, of high relevance to understanding outbound open innovation, the related challenges and the role of pre-commercialization phases.

Main contribution

The various process models for conducting ETC were presented and the individual process steps were detailed together with an account of the relevant challenges pertaining to each step. These individual challenges were further collated in order to explain the major common challenges of successful implementation of outbound OI approaches in commercial firms. The major challenges in the commercialization process mentioned in the literature both by researchers and practitioners are the identification of potential knowledge customers (identification phase), especially from outside the context of the commercializing firm, the actual transfer of knowledge (realization phase), due to its often tacit nature, sufficiently communicating the knowledge without exposing it (negotiation phase) and determining adequate compensation (planning and negotiation phases).

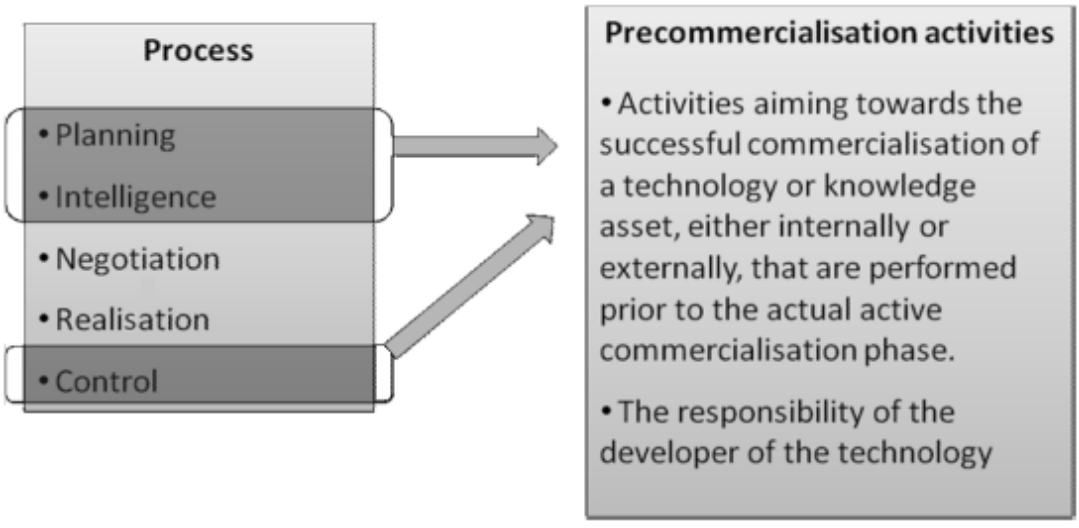

Figure 15. Positioning pre-commercialization activities in the external exploitation process (Kutvonen et al., 2010)

The majority of these challenges were seen to reside in what was termed as the *pre-commercialization phases* of ETC: planning, intelligence and control (see Figure 11). The publication offered to alleviate these challenges by proposing that firms should couple outbound activities more closely with corporate strategy, for example by means of a separate ETC strategy managed by a dedicated function in the organization, as well as by considering strategic value (as opposed to classic Discounted Cash Flow –based financials) through the use of real options, and finally to acknowledge the effect of building a dynamic capability to manage open innovation interactions with the environment.

The publication was one of the first to put an emphasis on the necessity of strategically managing the external technology commercialization process in order to overcome inherent challenges and gain competitive advantage, and noted the importance of pre-commercialization activities in doing so.

Role in the thesis

The publication provides the theoretical basis for treating the topic of outbound open innovation and initiates the research in the direction of connecting the activity to strategic technology management. It provides fundamental tools and concepts for conducting the remaining research and acts as a direct input to following publications 2, 3 and 4 and contributes to answering RQ1.

4.2. Publication 2: Opening the fuzzy front-end of new product development: a synthesis of two theories

Objective

Publication 2 set out to expand the understanding of outbound open innovation implementation by connecting open innovation and fuzzy front end innovation management literature streams. By integrating the two influential NPD management topics, publication 2 proposed a framework that improves the profitability of the product development process and helps firms proactively and strategically address in- and outbound flows of knowledge in their innovative activities. Prior to the research conducted in the publication, OOI was nearly exclusively understood as a part of the later innovation process stages and concerned only more codified forms of knowledge that could be readily monetized, such as patents and other highly-defined intellectual property assets. The paper reviewed literature on both FFE and OI theoretical streams and, based on the previous NCD model by Koen et al. (2001), conceptualized a novel framework, coined the Open New Concept Development (ONCD) model.

Main contribution

Both the FFE and OI theories are largely motivated by improving the profitability and effectiveness of new product development through the minimization of measurement error, in other words, false positives and false negatives (Chesbrough, 2004). Traditionally, all the efforts in the earliest innovation process phases are devoted to forcing the emerging technological opportunities to the servitude of a previously chosen application need. Typically, no external opportunities are considered for the concepts. The first proposition made was that adopting an OI viewpoint in FFE reduces unprofitable 'Kill' decisions through drafting pre-determined external application possibilities (or contingency plans) which increase the survivability of FFE concepts. This would then result in an increase in the commercial success rate of NPD processes. This opening of perspective may additionally reveal new possibilities, possibly even outside the firms' current business, thus supporting corporate renewal capabilities.

Table 3. How to deal with different types of concepts in the Fuzzy Front End

Technology Potential	*Fit to business model*	*Fit to core competences*	*Exploitation of concept*
High	High	High	Internal NPD
High	High	Weak	Partnership
High	Weak	High	NPD -> Ext. commercialization
High	Weak	Weak	Ext. concept expl.
Weak	Low / high	Low / high	Waste / dormant

Secondly, potential management guidelines were offered to help reduce concept waste (degree of false negatives) and improve the cost effectiveness of the front end of innovation. Key factors to consider for the external application of concepts are technology potential, fit to current business model and fit to technological competences, through the evaluation of which the potential for external use of concepts could be evaluated (an example is provided in Table 3).

The overall findings were summarized in the ONCD model (visualized in Figure 12) which updated contemporary innovation management practice by explicitly integrating open innovation on both in- and outbound modes into the fuzzy front end of the innovation process. The practical benefits for structuring the FFE according to the presented model included the previously mentioned, as well as an increased capacity for utilizing outbound open innovation practices for realizing strategic goals.

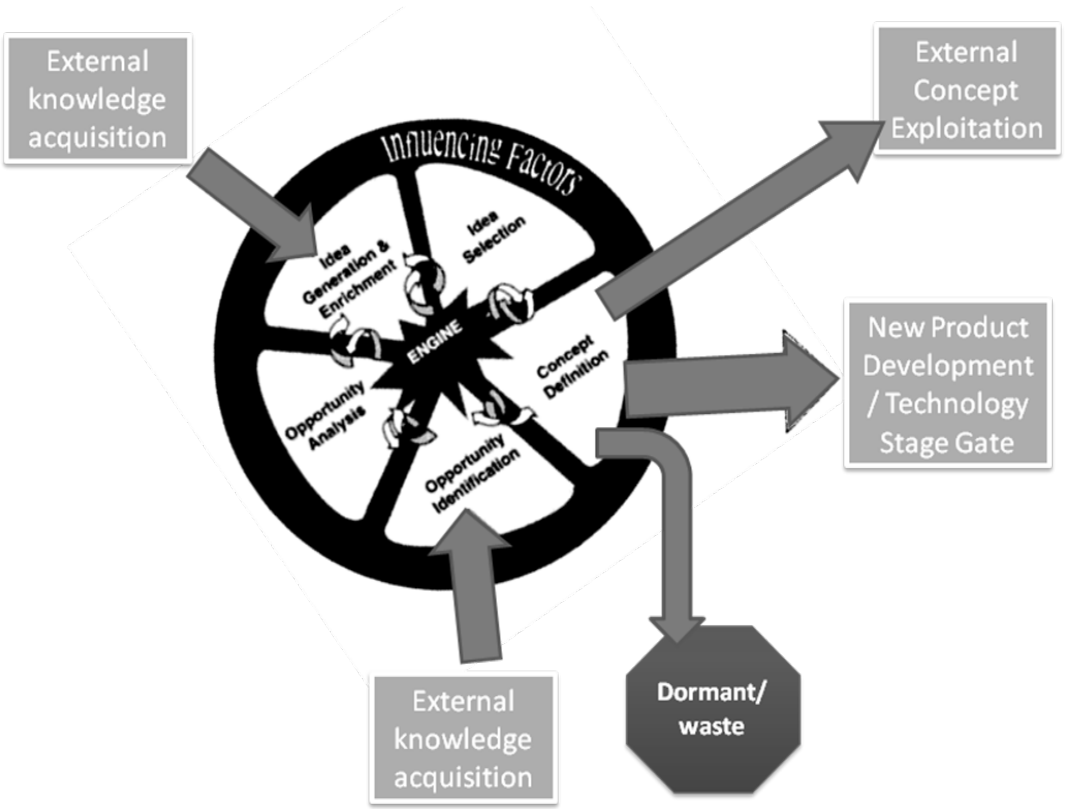

Figure 16. Open New Concept Development Model

Role in the thesis

The publication expanded on the initial ideas regarding the strategic purposing of outbound activities, and the proactive management and focus on pre-commercialization that were presented in publication 1. Establishing the connection between outbound OI and the earliest phases of the innovation process enables further research on the external exploitation of intellectual assets as a phenomenon concerning the entire innovation process. This is critical for strategic applications. The paper contributes to answering RQ1 and acts as a direct input for publication 3, where the conceptual model presented in this paper is validated empirically.

4.3. Publication 3: Extending the Fuzzy Front End Beyond Firm Boundaries: Case Demola

Objective

Publication 3 demonstrates a practical implementation of open innovation in the fuzzy front end by researching a method of academia-industry collaboration titled Demola. The research question concerned how open innovation could be integrated to the FFE efficiently, and in practice. As was conceptually shown in publication 2, the integration may improve the commercial hit rate of early NPD considerably. As the Demola method was studied from this

perspective, the paper also sought to explain how and why Demola works and how well it performs. The research built on the framework and literature review established in publication 2 and analyzed all the projects that took place between Nokia and Demola in the years 2008-2011 by applying a primarily qualitative study using a data set of 21 interviews that was mixed with supporting quantitative and secondary qualitative evidence.

Main contribution

The Demola innovation method incorporates open innovation into the fuzzy front end in a way that includes both in- and outbound modes, thus being one practical implementation of the conceptual model of Open New Concept Development. The open collaboration occurs between the focal company (its front end of innovation), the universities and the entrepreneurial teams of students, and the effectiveness of the method depends on the level of commitment and participation of each as well as on the alignment of expectations. Demola deals primarily with concepts that are from the company's viewpoint "on the fence" between acceptance and killing or including high uncertainty in their value. The Demola team generates information about the concept, reducing the uncertainty to a level where a more accurate evaluation may be done to determine the actual value. The core of the method is in the facilitation of the collaboration between entrepreneurial students, universities and established companies, which builds on the well-defined IPR rules setting a balanced and trust-inducing atmosphere. The newly established method still has some issues, mainly related to project management and not to the performance of the concept as such. The benefits and usefulness of Demola are clearly demonstrated in the high levels of innovativeness, the low cost (and risk) of operation and the ability to overcome FFE measurement errors by relying on openness.

The Demola projects undertaken with Nokia as a project partner had a comparable ratio of developments licensed back (89%) as in other Demola projects (93%). However, not all of the results of the projects studied were taken into use or developed further in Nokia even if they were licensed in. This was seen to result from, for instance, considerable strategic and organizational change at Nokia that coincided with the study period. Overall, by opening up the FFE by using Demola, Nokia was able to salvage a considerable portion of false negatives (or uncertain concepts) back into development instead of placing them on the shelf. Furthermore, the societal dimension of the method was also highlighted. Demola may constitute a cost-effective, novel way of facilitating self-employment as the student teams may found new start-ups based on the concepts with which they work. At the same time, it boosts corporate competitiveness, while providing companies with a convenient way for conducting corporate social responsibility action.

Role in the thesis

Publication 3 is one of the research steps concerned with the empirical validation of the theoretical advances in the thesis. It is directly linked to publication 2 and provides empirical support for the concept as well as presents one practical implementation of the conceptualized approach to early stage outbound OI in detail. As such, it contributes to answering RQ2 of the thesis. It especially elaborates on the issue of tying the open innovation approach to the contemporary innovation processes of firms, which is a key issue for successful implementation and management.

4.4. Publication 4: The Evolution of External Technology Commercialization Motives

Objective

Publication 4 set out to situate outbound open innovation activities to the innovation process of the firm in order to better enable the implementation of open innovation. The proposition was that, due to the lowering of uncertainty along the innovation process, a distinct pattern of evolution for the motives (pecuniary and non-pecuniary) of external technology commercialization would emerge. More specifically, the objectives of the study were to find out where ETC activities would be placed along the innovation process stages and how they could be managed in various stages to support strategic goals. A key issue was to examine the ETC decision in relation to the process stages: who is involved, the timing of the decision, how much planning is done, which motives are behind the decision and how the practical implementation of ETC takes place in a real business environment. The research was based on the concept of evolving motives developed in the paper and conducted through an in-depth case study of one multinational company that comprised of multiple interviews with persons in high level management positions. The publication thus sought to contribute to understanding the practical management of outbound open innovation activities, and to their strategic alignment with and integration into the existing innovation process in the firm.

Main contribution

Firstly, the empirical data clearly shows that ETC happens at each stage of the innovation process, and in different forms. The lowering of uncertainty along the innovation process leads to a distinct pattern of evolution of ETC motives at different innovation stages, generally from more strategic to pecuniary motives as the development goes forward (see Table 4). This finding is crucial for explaining why strategic motives have been less understood insofar as why outbound open innovation has primarily been associated in the literature to the later process stages thus skewing research results to emphasize the monetary value over the strategic value of the activity. The study showed that in the firm researched, long-term, strategic motives actually outweighed the monetary ones and that ETC was

considered primarily as a way to strategically leverage the technology / knowledge assets of the firm.

Table 4. The evolution of external technology commercialization motives

Process phase	*Typical modes*	*Typical motives*	*Reasoning*
Ideation	External concept exploitation, concept donation	Strategic, network / reputation building, creation of market ecosystems	Uncertainty is high; technology fuzzy and market potential (or even suitable markets) not apparent; IPR undefined; valuation difficult
Development	Joint development, collaborative arrangements	Learning from knowledge transfer, exerting control over environment, gaining access to new knowledge	
Testing	Cross-licensing, out-licensing	Multiplication of own technology (e.g. standard setting), guaranteeing freedom to operate	
Commercialization	Sell-off, out-licensing	Extra revenue	Uncertainty is very low; technology highly codified and business fore-casts highly accurate; valuation easy

As for the management of the outbound process, the case company viewed it as the domain of multiple departments and persons as opposed to a centralized activity. Furthermore, the person who ultimately decided on the external application of a given intellectual asset differed according to the stage of the innovation process that the asset was in at the time of the decision.

Role in the thesis

Publication 4 empirically links the outbound open innovation activity to all of the innovation process stages taking place at firms. It provides an example of the practical management of outbound OI to complement the theoretical perspective established in publication 1 and takes a detailed view to ETC decisionmaking within the firm. The study contributes to answering RQ2 of the thesis. The research helps to explain why strategic application of outbound OI necessitates accounting for OOI in connection to each of the innovation process stages, and not only at the later stages as early stages of innovation are more conducive of strategically motivated external exploitation. Thus it further establishes the relevance of the FFE-centered research track (publications 2 and 3) to the final publication (5) and to the outcome of the thesis.

4.5. Publication 5: Strategic Application of Outbound Open Innovation

Objective

The purpose of publication 5 was to study the strategic dimension of outbound open innovation, with a focus on identifying the strategic objectives for the external exploitation of knowledge. The study was performed as a literature review of scholarly works combining strategy and OOI, focusing especially on empirical observations. The review was complemented by further conceptualizing the strategic benefits attainable by the purposeful management of outbound open innovation. The research set out to balance the common viewpoint where the management of OOI is focused on capturing short-term monetary gains and minimizing negative impact on strategy with an approach where OOI acts as an enabler of further strategic flexibility and opens new options for strategy implementation.

Main contribution

The publication builds on challenging a set of implicit assumptions evident in the majority of outbound OI research. Many scholarly works on the topic see outbound activities concerning either only non-core knowledge assets or codified knowledge that is available only at the late stages of the innovation process. Furthermore, the dominant viewpoint is that OOI is an *ad-hoc* activity that is motivated by salvaging the residual value of NPD by externalizing technology assets that would otherwise be 'put on the shelf' due to a poor fit with the current business model. As a clear point of departure to this conception that originates from the original work by Chesbrough (2003) and to the use of terminology, such as keep-or-sell decision, OOI is viewed as a purposefully and systematically managed activity that may be deeply integrated into strategy to enable keep-and-sell scenarios as well as used to create new strategic business opportunities.

The publication presents the most comprehensive description of strategic objectives so far that they may be pursued by OOI along with several case examples drawn from the literature. The strategic objectives are classified into six categories, presented below in Table 5. The categorization and some of the objectives listed are novel additions to the current state-of-the-art. As a theoretical contribution, the paper provides a new viewpoint on the relation of strategy and outbound open innovation and seeks to broaden the applicability of OOI in the strategic management of technology by highlighting its significance as a tool for pursuing strategic goals. The managerial implication is that through systematic and successful management, OOI may be useful not only in generating revenue from residual technology, but also for gaining more strategic control over the company's future and its environment.

Table 5. The strategic objectives of external technology commercialization

Objective group	*Individual strategic objective*
Gaining access to new knowledge	Cross-licensing
	Entry into technological markets and networks
	Setting up listening posts for weak signals
Learning from knowledge transfer	Building dynamic capabilities
	Building reputation
	Learning from knowledge transfer
Multiplication of own technologies	Standard setting
	Profiting from network effects
	Geographical and product market expansion
Controlling technological trajectories	Controlling technological path dependency
External exploitation as a core business model	Actively developing for external parties
Exerting control over environment	Maintaining technological leadership
	Defensive out-licensing
	Creation of market ecosystems
	Guaranteeing freedom to operate
	Feeding entry barriers

Role in the thesis

Publication 5 builds on the conceptual development and empirical findings from previous publications and integrates these into a refined concept of the strategic management of outbound open innovation that is the foundation for the thesis. As the final publication, it distils the insight from the research process into a new viewpoint that challenges previous implicit assumptions of open innovation research and thus sets a foundation for overcoming challenges in implementing and managing outbound processes in firms. The connections between the outbound activities to the whole innovation process (including FFE) and systematic management practices rooted in the pre-commercialization stage are established as crucial for enabling deeper integration between OI and strategy. The paper provides the final input for answering RQ1 and distinguishes between the three levels of strategic integration of OOI: keep-or-sell (*ad-hoc* complementary revenue), keep-and-sell (minimizing strategic conflict) and OI as enabling strategic moves.

4.6. Overall

The thesis includes five scientific writings on outbound open innovation and strategic management. The research papers are interrelated and together provide a view of the research process, where three steps can be identified. Publications 1 and 2 are devoted to conceptual development, triggered by gaps in the open innovation literature. They lead to publications 3 and 4, which seek to validate and further inform the development of the concepts through empirical study. Finally, publication 5 draws on the findings and cumulative knowledge of the previous works in presenting a refined concept of the strategic application of outbound open innovation as the final research output to be included in the thesis. Figure 3 reflects the interrelations between the publications in this thesis.

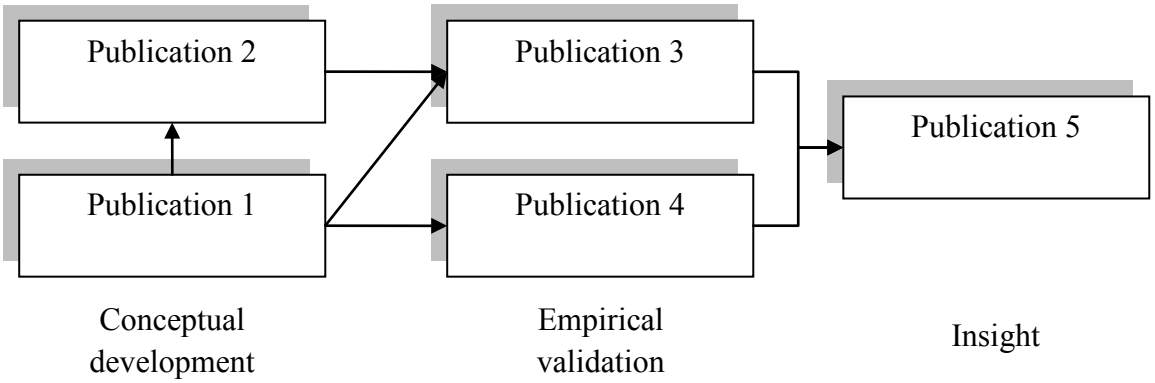

Figure 17. Content input-output based interdependencies between publications

From the figure, it can be seen that the line of inquiry proceeds along two tracks, both of which join at the last step. Publications 2 and 3 focus on the integration of OI into the FFE that is necessary in order to comprehend the strategic applicability and potential of OOI, as it is at that stage of the innovation process that the strategic motives for the externalization of intellectual assets are most pronounced. Meanwhile, publications 1 and 4 build understanding of the phenomenon at a more holistic level in the context of the entire innovation process. Insights from the research into both of these tracks have been essential to the formulation of the approach in publication 5.

All of the publications are summarized in the following Table 6.

Table 6. Summary of the publications and their main findings

	Publication 1	**Publication 2**	**Publication 3**	**Publication 4**	**Publication 5**
Title	Pre-commercialisation [*sic*] activities in external exploitation of technology	Opening the fuzzy front-end of new product development: a synthesis of two theories	Extending the Fuzzy Front End Beyond Firm Boundaries: Case Demola	The Evolution of External Technology Commercialization Motives	Strategic Application of Outbound Open Innovation
Research targets	Provide a comprehensive approach to ETC as basis for conducting analysis and introduce concept of pre-commercialization phases of OOI.	Connect OI and FFE theories. Improve NPD profitability and enable proactive and strategic management of in- and outbound knowledge flows in innovation process. Introduce ONCD model.	How can OI be integrated to FFE efficiently and in practice? Demonstrates the implementation of OI in FFE in the form of Demola innovation method. Evaluates the performance of Demola.	Situates OOI within the innovation process. In which stages of the innovation process is ETC done, by who and how is the ETC decision managed? Strategic value of the activity studied.	Study the strategic dimension of outbound open innovation. Identify strategic objectives for OOI and provide comprehensive list and categorization.
Method	Literature review	Conceptual	Mixed method	Qualitative (case study)	Conceptual
Data	Quality academic journals and books on specialized topics, searched by relevant keywords.	Quality academic journals and books on specialized topics, searched by relevant keywords.	21 telephone interviews; sample of 29 projects between Nokia and Demola. Quantitative indicators and statistics of Demola.	Single-case study with six interviews with managers. Secondary data from publicly available company documents.	Quality academic journals and books dealing with intersection between strategy and OOI, relevance determined by abstract.
RQ	**RQ 1**	**RQ 1**	**RQ 2**	**RQ 2**	**RQ 1**
Main Results	- Review of the main process models of OOI - Major common challenges of implementation - Importance of pre-commercialization phases - Need to couple OOI to corporate strategy - Value of strategic options - Building a dynamic capability for management	- Extending OOI to FFE leads to reduction of unprofitable 'Kill' decisions and higher success rate of NPD - Reduction in concept waste and better cost effectiveness - ONCD model, key factors to consider for externalization: tech. potential, fit to business model and core competence	- Demola as example of ONCD implemented; collaboration between firms, universities and students - Method reduces uncertainty in FFE and improves hit rate (less measurement error) - 89 % of projects licensed back in to Nokia - Societal benefits of OI	- ETC happens at each innovation process stage - Lowering uncertainty along the innovation process leads to a evolution of motives, from strategic to monetary - Strategic motives more important than monetary - ETC management decentralized, depends on process stage	- Challenges previous implicit assumptions and opens a new viewpoint - Comprehensive list of strategic objectives for OOI - Novel categorization and objectives - Strategic and systematic management of technology with OOI provides more strategic flexibility
Role in the thesis	Theoretical and conceptual basis for further research. Initiates research into strategic management of technology. Input for all remaining publications.	Conceptual input for publication 3. Contrary to established understanding, it proposes that FFE is an important stage for conducting OOI activities.	Empirical validation of ONCD model and its benefits presented in publication 2. Connects OI to the early innovation process phases. Input for publication 5.	Empirical validation and continuation of publication 1. Relevance of considering all process stages (incl. FFE) for strategic OOI research. Input for publication 5.	Concluding publication. Integrates findings of previous research to form a new concept of strategic OOI. OOI presented as potential enabler of strategic moves.

5. CONCLUSIONS

5.1. Answering the research questions

The thesis set out to connect outbound open innovation activities to the technology strategy of the firm and the objectives stated within on both theoretical and practical levels in order to answer the main research question of *how can the organization achieve strategic objectives by external deployment of intellectual assets?*

To answer the main question, the first task was to connect OOI activities to strategic objectives in order to answer sub-question 1 (*How are outbound open innovation activities connected to strategic objectives on a theoretical level?*). Integrating open innovation into strategy leads to elevating its role from a fringe activity to a central innovation management issue that needs to be systematically managed. Publications 1, 2 and 5 gathered theoretical viewpoints on the connection of strategy and outbound open innovation activity.

In *publication 1* it is proposed that the majority of the challenges experienced by companies with implementing and managing OOI are related to the pre-commercialization stages of the process, that is to say in planning, intelligence and control, all of which have a direct link with corporate strategy. Thus, strategically managing the outbound process is necessary for appropriating the potential benefits of outbound activities. These should be supported by assigning the task of maintaining the related strategy process to a dedicated management level within the organization, potentially organized in a cross-functional way, such as the *Technology Intelligence and Marketing* function advocated in technology marketing literature (Tschirky, 1998). Assigning clear roles for managing the technology and OOI strategy processes enables tighter functional integration between R&D, marketing and strategy levels, which is conducive of building dynamic capabilities for outbound open innovation (Teece et al., 1997; Lichtenthaler, 2011). This in turn enables learning (Kutvonen et al., 2010) and increases the efficiency of the activity. Furthermore, proper valuation processes should support the pursuit of strategic goals by introducing for instance real options-based valuation (Boer, 2000), which can account for non-pecuniary value in a comparative way in making keep-or-sell decisions.

Publication 2 adds to this by noting the importance of also considering the early stage of the innovation process, in other words the fuzzy front end of innovation (Koen et al., 2001), and the concepts therein as potential knowledge assets to leverage externally. Applying outbound open innovation to the FFE by processes conforming to the ONCD model (Kutvonen & Torkkeli, 2010) allows for the further improvement of NPD profitability and opens new options for proactively managing strategic in- and outbound flows of knowledge throughout the innovation process. The primary conclusion is that the management of outbound open innovation can only be proactive (and enable strategizing) if the decisions are already founded on preliminary analyses performed as part of the FFE activities in the innovation process. This approach sets a clear point of departure from traditional views on outbound open innovation that are predominantly focused on the externalization of assets available at the late stages of innovation where codification levels are more conducive of monetary valuation and trade on knowledge markets. It also impacts the FFE processes so that

screening process criteria need to be adapted to accommodate the benefits attainable through the external deployment of technological and knowledge assets in order to minimize concept waste.

Finally, *publication 5* establishes the theoretical connection by identifying a tentative, yet comprehensive list and the categorization of strategic objectives that may be pursued by outbound open innovation. Understanding the potential that OOI activities can have in attaining strategic goals and improving the competitiveness of the firm in the long-run enables further strategic flexibility and opens new options for strategy implementation. The publication also presents some tools to support strategic technology decision-making, such as integrated technology commercialization roadmaps (Lichtenthaler, 2008b) that essentially extend traditional technology-product roadmaps by adding the level of external applications to the picture (see Figure 18). A further conceptual tool to aid decision-making is utilizing the method of *functional markets* when envisioning the potential applications of new technology (Lichtenthaler, 2008b; Weiss, 2004). The basic notion of functional markets is to construct the application scope of a given knowledge asset in terms of functionalities instead of keeping with the traditional delineation based on industries and products (Weiss, 2004). Keeping with the conclusions of publication 2, both of these tools can be useful aids already in evaluating concepts in the FFE.

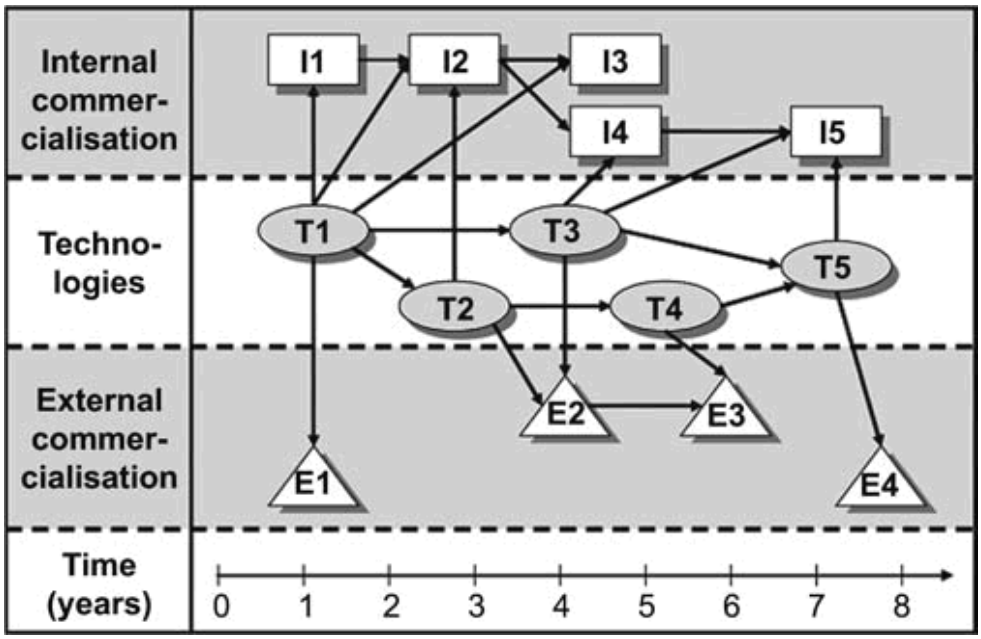

Figure 18. Example of an integrated technology commercialization roadmap
(Lichtenthaler, 2008b)

In summary, the strategic connection of outbound activities: requires dedicated management structures; is essential to learning from and improving on outward knowledge transfer; and in terms of the innovation process, starts with activities at the fuzzy front end and enables a firm to pursue a multitude of strategic options without necessarily impacting negatively on the core business, given that sufficient strategic fit is attained. The strategic deployment of

intellectual assets requires a systematic process, while putting into place supportive tools and processes, directing attention to the practical implementation and management issue.

The second sub-question to answer was focused on the implementation of the theorized approach, by asking *how strategic objectives are pursued through outbound open innovation activities in practice.* Building a structure that allows effective management necessitates linking open innovation activities to each phase of the innovation process. Previously, the connection between outbound OI and the earlier stages of innovation was missing. Through publications 3 and 4, the thesis connects outbound OI to the entire innovation process of the firm, so that its implementation and management become feasible.

In *publication 3* a practical implementation of outbound open innovation in the FFE is introduced in the form of an industry-academia collaboration method titled Demola. Demola is a method that allows companies to bring concepts that are most prone to NPD measurement error to a group of external students managed by a third party for further development towards a first prototype. As such, it gives an additional option for reducing the uncertainties related to a given concept by generating additional information for evaluation at minimal cost. The concept shows how a construct built fundamentally on a mutually beneficial standardized IPR framework may enable salvaging concept value while producing positive externalities in society as added entrepreneurship and granting students the possibility to work on real NPD processes. An additional property of the method is that it functions as a recruitment channel for the focal firm engaged in outbound open innovation, thus fulfilling a strategic human resource management role as well. Demola was shown to have a high success rate in companies in-licensing back nearly 90% of the concepts brought to it, thus avoiding costly accruement of false negatives.

Publication 4 adds to the understanding by examining the implementation of outbound open innovation throughout the entire innovation process and studying the interplay between innovation process stages and the structures and execution of the keep-or-sell decision-making in the case company studied. The primary finding is that OOI truly happens at each stage of the innovation process and validates the proposition that of all the decisions taken at various innovation process stages, the ones situated in the FFE are the ones with the highest potential for strategic impact. Further, it shows that, especially in the case of large global enterprises, the strategic benefits clearly outweigh short-term monetary benefits, thus updating the typical understanding of the role of outbound open innovation. It also details how open innovation may be decentralized across multiple departments and responsible managers in the corporate structure, provided that a degree of centralized control is maintained (in the case company, this was realized by higher management retaining the authority to make the final keep-or-sell decision in alignment with strategic goals of the company).

In summary, the practical implementation of the concepts follows the broad lines established through deductive reasoning in the theory-building publications. The main conclusions are that the entire innovation process is linked to outbound open innovation processes, and that the role of FFE-situated activities is critical for attaining strategic benefits. The link between

the innovation process stages and associated outbound activities is explained through the uncertainties of the knowledge asset to be deployed externally; innovations externalized at initial stages require more managerial attention and support but are more conducive to attaining strategic benefits. As the uncertainties recede and the technology becomes better defined and codified, it moves more and more towards the realm of knowledge markets and monetization, which is better explained also by the antecedent theories of OI, such as TCE.

From these viewpoints, we arrive at the end result of the study, which is discussed both in terms of theoretical and practical implications in the following section.

5.2. Theoretical implications

The theoretical implications are discussed in relation to the applied conceptual framework (Figure 13) and the theories within. A central antecedent theory of open innovation, *transaction cost theory*, informs the keep-or-sell decision on the grounds of economizing on the governance of innovative activities. However, it has a predominantly inbound focus, which restricts its application to the outbound modes of open innovation. Further, it applies mainly to codified knowledge assets and more predictable environments, and does not support dynamic, process-related outbound OI decisions as completely (Kortelainen et al., 2012). The TCE framework comes into conflict in situations where long-term strategic benefits are evaluated versus the potentials of short-term monetizing under conditions of high uncertainty. It is in these situations that this thesis adds to the explanatory power of the theory by proposing management structures able to more holistically consider the alternatives of internal and external exploitation through the application of real options, dedicated cross-functional teams and systematic strategic integration for example. Furthermore, TCE applies best to decision-making on a case-by-case basis, having a tendency towards pushing the organization away from the longitudinal purposive management of intellectual assets with the logic that successive case-by-case decisions of maximal economizing are the optimal route. This is a clear point of departure in the approach presented here that claims that only by sufficient foresight and holistic management, problems of partial optimization may be avoided and strategic benefits (and thus highest potential value from intellectual assets) achieved.

On the other hand, the *relational view* and *technology marketing* both take a longer time perspective in their rationale for collaboration in innovation. The relational view reasons that in order to gain competitive advantage from interorganizational relationships, bidirectional investments and learning are necessary. The findings of publication 5 in particular show however that the framework for managing the OOI activities presented here does not necessitate these elements, but instead advantages may be sought through opportunistic behavior on the knowledge markets, such as strategic out-licensing to divert competition. Technology marketing on the other hand, presents the claim that competitive advantage from openness is fundamentally related to functioning strategically on knowledge markets and benefiting from synergetic benefits between inbound and outbound as well as internal and external governance of innovation. These claims, however, have yet to be conclusively

proven by empirical evidence and are not fully reflected in the behavior of firms that typically seek predominantly inbound stances of openness. The framework here does not necessitate synergies in order to work, but rather posits that finding the proper balance and establishing the real value of synergies between the activities is a fruitful venue for future research. Another point of departure is that technology marketing focuses heavily on knowledge market operations, the prerequisite of which tends to be codified knowledge assets, thus pushing outbound openness to the late stages of the innovation process. In contrast, the thesis claims that the highest potential gains are achievable only when considering the entire innovation process, including the less codified assets at the FFE.

Traditionally *strategic management* in general has been based on long and thorough processes, where the objective was to find long term strategic commitments for the firm. Such an approach leads to an inelastic strategy process, focused on planning. This inelasticity has been a central point for criticism by researchers (e.g. Mintzberg, 1994; Doz & Kosonen, 2008a) who argue that such an approach is illogical in today's rapidly changing business environments. To compensate the high speed of change, the strategy process needed to become more lean and reactive to market changes and this applies more than most to the strategies of holistic technology exploitation, where preliminary planning must be complemented by a readiness to flexibly change course.

The contribution to the theories of *innovation process* and *fuzzy front end* is the explicit coupling of these innovation management theories to the open innovation concept. The most concrete update is found in the presented ONCD model that updates FFE management to involve both in- and outbound flows of knowledge as a central management issue. The simultaneous consideration of both internal and external opportunity requires organizational changes in introducing new roles and responsibilities (to cross-functional teams with a degree of centralized strategic guidance) as well as the application of supporting tools and processes (such as foresight, and integrated technology roadmaps).

Finally to the theory of *open innovation,* the main contribution is in understanding the potential of outbound open innovation in driving corporate strategy, in achieving strategic objectives and in connecting it to the entirety of the innovation process, thus departing from the classical view proposed by Chesbrough's (2003) innovation funnel, where inbound belongs to the early innovation stages and outbound is mainly concerned with externalizing codified assets available at the late stages. The thesis balances the research on open innovation by emphasizing the value of outbound activities and introducing them as a point of strategic relevance to an enterprise as opposed to being only a vehicle for the generation of value from residual technology. It furthers the connection between the literature streams of strategy, open innovation and innovation process management to provide an integrative viewpoint and a foundation for further research on the topic.

5.3. Managerial implications

The practical purpose for the research is to enable companies to fully utilize their potential for outbound open innovation and to be able to implement and manage it from a strategic standpoint. The managerial lesson to be drawn from the thesis is that being able to monetize residual value of shelved technology assets (and avoid negative effects on core business in doing so) is not sufficient for gaining competitive advantage from outbound open innovation. Thus, relying on prescriptions that solely build on governance perspectives inherited from TCE is insufficient. Instead of conducting sporadic case-by-case *ad-hoc* evaluations of which asset to externalize from the IP portfolio, managerial attention needs to be redirected at holistically managing open innovation implementation at a strategically-guided and strategically-integrated level. This requires reorganizing management structures to support the introduction of corporate strategic goals to guide OI and to incorporate the new options afforded by active external deployment into informing strategy.

Meanwhile, in order to implement this level of integration, the aspects of uncertainty and connection to innovation process stages, particularly the FFE, need to be considered. As the technological idea proceeds through the stages of the innovation process, uncertainty regarding technology lessens. Potential applications are easier to envision, and development costs and outcomes are suddenly easier to assess. Market uncertainties recede, making markets suitable for the technology to become apparent and give the possibility to more sharply define future volumes and lifecycle profits, distribution channels and other commercial aspects of the solution. The main conclusions for managers are that the entire innovation process needs to be linked to outbound open innovation processes, and that the role of FFE-situated activities is critical for attaining strategic benefits. This cannot be realized unless sufficient support is provided by the organization for decision-making and innovation processes, arming them with appropriate tools and tightly integrating them into the strategy.

5.4. Limitations and suggestions for future research

Open innovation research is still in an early stage, regardless of its strong academic roots in streams of literature, such as alliances, transaction cost economics and dynamic capabilities; several academic shortcomings still remain (Enkel et al., 2009; Elmquist et al., 2009; Lichtenthaler, 2011). The essential problems with the theory are related to the ambiguousness of the definition and which actions constitute ‘open’ business practice (Dahlander & Gann, 2010; Trott & Hartmann, 2009), which firms (and in which environments) should adopt it (Chesbrough et al., 2006) and finally, how to measure it (Enkel et al., 2009). As a result, managerial problems with implementing the concept and managing openness arise partially due to these issues as well. These problems mostly have to do with the difficulties of operating in knowledge markets (Arora & Gambardella, 2010) that arise from problems of valuating knowledge assets, searching for and trusting transaction partners (Kutvonen et al., 2010) and persistent market imperfections (Arora & Gambardella, 2010; Teece, 1998). Further difficulties are encountered when organizing for openness within the firm in the form of *Not Invented Here* (Katz and Allen, 1982) and *Not Sold Here* (Chesbrough, 2003)

mindsets and as missing management structures to counter these mindsets with incentives and to overcome the excess fear of knowledge spillover. Many of these problems could be substantially alleviated by connecting OI to the regular activities of the firm, coupling it tightly to corporate strategy and managing it systematically (Kutvonen et al., 2010), all of which are areas still requiring academic work beyond this thesis. As the strategic deployment of intellectual assets is possible only at high levels of proficiency in outbound open innovation, solving the fundamental theoretical and managerial problems is crucial for the wide-spread utility of the thoughts and concepts presented.

Furthermore, as the work was largely focused on building theory and developing concepts, one natural extension would be to engage in further empirical study by means of action research for example in implementing the concepts and practices in enterprises in order to discover whether there are additional, yet unidentified factors hindering the implementation effort.

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PART II: PUBLICATIONS

Publication 1

Kutvonen, A., Torkkeli, M. and Lin, B. 2010. Pre-commercialization activities in external exploitation of technology, *International Journal of Innovation and Learning,* Vol. 8, No. 2, pp. 208-230.

Pre-commercialisation activities in external exploitation of technology

Antero Kutvonen

Lappeenranta University of Technology,
Prikaatintie 9, FIN-45100 Kouvola, Finland
E-mail: antero.kutvonen@lut.fi

Marko T. Torkkeli

Technology and Business Innovations,
Lappeenranta University of Technology,
Prikaatintie 9, FIN-45100 Kouvola, Finland
E-mail: marko.torkkeli@lut.fi

Binshan Lin*

Louisiana State University in Shreveport,
One University Place, Shreveport,
LA 71115, USA
E-mail: binshan.lin@lsus.edu
*Corresponding author

Abstract: While external knowledge acquisition is well studied and understood, the external exploitation side of open innovation remains challenging. First we present the contemporary process models for external exploitation, describing the different steps along with relevant challenges and actions. Then, we identify major overall challenges in external knowledge exploitation and investigate limitations to applying open innovation approaches. Finally we find recurring themes in literature implying that pre-commercialisation phase activities may provide the critical support for successful management of external exploitation of non-core technologies. We conclude with implications for innovation and learning as well as the identification of promising further research avenues.

Keywords: technology transfer; external technology exploitation; open innovation; pre-commercialisation; external technology commercialisation; technology marketing; innovation; learning.

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Biographical notes: Antero Kutvonen obtained his MSc Degree in the field of Industrial Engineering and Management at the Lappeenranta University of Technology. He works as a Researcher at the Lappeenranta University of Technology research unit in Kouvola. Currently, he is preparing his PhD in Technology Management. His main research interests include innovation management, open innovation, regional innovation policy and knowledge management.

Marko T. Torkkeli is the Professor of Technology and Business Innovations at the Lappeenranta University of Technology in Kouvola, Finland. He has published in journals such as the *Int. J. Production Economics*, *Int. J. Foresight and Innovation Policy*, *Int. J. Technology Management* and *Int. J. Technology Intelligence and Planning*. He is a member of the editorial boards of the *Int. J. Services Science*, and the *Research J. Business Management*. He is a Visiting Researcher at INESC Porto (Portugal). He serves as the Director of Publications for the International Society for Professional Innovation Management (ISPIM).

Binshan Lin is the BellSouth Corporation Professor at College of Business Administration, Louisiana State University in Shreveport. He is a nine-time recipient of the Outstanding Faculty Award at LSUS. He has published over 200 papers in refereed journals since 1988.

1 Introduction and background

Since the 1990s there has been a substantial increase in technology transactions. This is due to the fact that many industrial firms have begun to actively use the external acquisition of technologies/knowledge as part of their business strategy (Granstrand et al., 1992). The external technology/knowledge exploitation, i.e., commercialising knowledge assets either exclusively or in addition to their application in a firm's own products or services, however, has been very difficult for most firms and only a few companies have managed to gain significant benefits by externally leveraging technology assets (Kline, 2003; Lichtenthaler, 2005). The difficulties are partly related to the various imperfections in the markets for knowledge, which means that companies need to develop their ability to manage the external exploitation of technologies/knowledge. Firms also need to consider external knowledge commercialisation more as part of their business strategy and as a proactive activity.

The perspective of actively managing the external exploitation of knowledge assets has been adopted in literature as well. The first studies in the 1970s – mainly in the field of technology management – primarily considered specific aspects, such as international licensing agreements. The term 'technology marketing' was also coined then by David Ford. After these early works there has not been a continuous research stream on this topic, however. The relevant literature is also highly fragmented: subtopics of the technology marketing include e.g., technology licensing, technology-based spin-offs, strategic alliances and joint ventures (Escher, 2005). There is hence a need to integrate the different streams of literature into a more comprehensive approach to external technology exploitation.

The main objective of this study is to conduct a literature review to integrate the relevant findings from the current stream of research for analysis of external

commercialisation of (non-core) technologies. We focus on pre-commercialisation phases and seek what is a common theme, if any. The selected focus here limits us to handling only the external exploitation of knowledge but not acquisition, thus possible forgoing the opportunity to see synergies between the two sides. Other limitations include a focus on the commercial firm, neglecting the cases of universities and other research institutes engaged in external exploitation of knowledge. The search for literature was focused on quality journals as well as some books on specialised topics, e.g., technology valuation, in order to provide for high-quality inputs. Keywords for scanning the literature were among others, external technology exploitation, technology marketing, licensing, external commercialisation and technology transfer. The paper is structured as follows. First we present the process models for external exploitation according to contemporary understanding, wherein the different steps of the process are described along with relevant challenges and the actions taken in every step. From here, we move to summarising what have been identified as the major challenges in external knowledge exploitation and investigate some limitations to applying open innovation approaches. Finally we address these challenges in the process basing on recurring themes in literature and pre-commercialisation phase activities that may provide the critical support for successful management of external exploitation of non-core technologies. The paper concludes with summarising the implications that this study holds for innovation and learning and identifying promising avenues of further research.

2 Process models for external knowledge commercialisation

The term external exploitation of technology is understood here as 'an organisation's deliberate commercialising of knowledge assets to another independent organisation involving a contractual obligation for compensation in monetary or non-monetary terms' (Lichtenthaler, 2005). This is synonymous with external commercialisation of knowledge, a term also widely used in literature, and a part of technology marketing, which additionally takes into account the external acquisition of knowledge (Escher, 2005). Even though the terms open innovation and technology marketing refer to both the external acquisition and exploitation, a clear distinction between the two should be made. As Table 1 portrays, they are very different sides of openness, with differing objectives, strategies and adopters.

Table 1 Different sides of open innovation

	External knowledge acquisition	*External knowledge exploitation*
Capabilities	Absorptive capacity	Technology transfer capability
Main objectives	Increase R&D efficiency by leveraging ext. knowledge	Increase innovative returns by exploiting knowledge externally
Example strategies	Fortify market position by multiple product launches	Standard setting

Pre-commercialisation activities are defined here as activities aiming towards the successful commercialisation of a technology or knowledge asset, either internally or externally, that are performed prior to the actual active commercialisation phase.

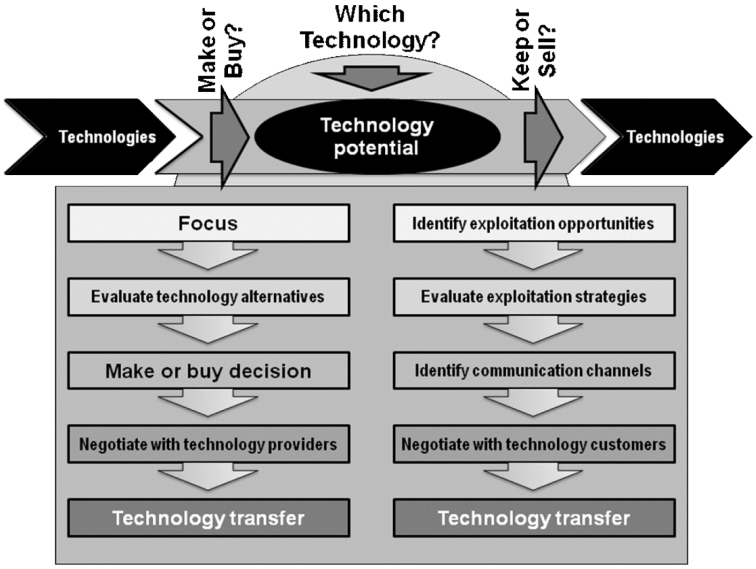
These include preliminary studies on technology viability in commercial terms preceding contact with actual clients, organisational and strategic steps taken with the primary objective of securing successful commercialisation and so forth. Pre-commercialisation activities are also always the responsibility of the developer of the technology and for a large part they are undertaken already during technological development.

Although the literature regarding different process models for external knowledge exploitation is limited (Escher, 2005), some attempts at constructing an explicit process description with distinct steps have been made (Escher, 2005; Gassman and Enkel, 2004; Lichtenthaler, 2007a; Prasarnphanich and Wagner, 2009). These process models have much in common and to an extent build upon one another with the model by Lichtenthaler (2007a) integrating the most essential features evident in the previous research into the subject. In this model some of the critical activities in the stages of planning, intelligence and control may also according to our definition be understood as pre-commercialisation efforts.

2.1 Integrated model of technology marketing

The model provided by Escher (2001) does not only take into account the external commercialisation of technologies, but rather invokes an integrated technology marketing view (see Figure 1). Technology marketing, which is described by the author as "a process to pursue normative, strategic and operational enterprise objectives concerning technology acquisition and technology exploitation markets", is chosen as a viewpoint by the assumption that considerable synergies exist between the acquisition and exploitation sides (Escher, 2001). Findings by an empirical study of 154 European companies provide support for this assumption as it is noted that external technology acquisition and exploitation appears to have a positive relation and that in opening their technology potential both ways firms have generally managed to attain above average operating margins (Lichtenthaler, 2008). Escher (2001) envisions possible synergies in fields like methodological know-how, networking, partner search competencies, negotiation know-how, transaction know-how, technology prizing and patent, licensing and contracting law. While in some fields the synergies are more evident than in others, it can be said that practicing both sides of technology marketing (or open innovation) would seem to enable the firm to develop a tacit, experience-based capability for managing technology transfer and associated activities in general. However, such an approach demands a high level of cooperation, usually characterised by a profound interaction between multiple parties over a longer period of time (Gassman and Enkel 2004) and thus is not suitable for all open strategies. The process model displays the interfaces to external entities as the 'Buy' and 'Sell' options (Escher, 2001). The decision of "Keep or Sell" is not entirely accurate as often internal and external modes of exploitation do not exclude one another (Brockhoff, 1998; Ford, 1988). Because of its integrative nature, the framework displays the also the process of external acquisition, which falls out of the scope of this paper and thus is not commented further here.

Figure 1 Integrated model of technology marketing



Source: Escher (2001)

In a first stage, the company has to choose from its technology portfolio the technologies that are worth exploiting externally. The enterprise has to figure out all thinkable application possibilities for each technology. After a short evaluation the attractiveness of the technology in promising application fields should be checked, where the author directs special attention to accounting for the transaction costs that can be considerable (Escher, 2001). In the next stage strategies for external exploitation are formulated and evaluated (see also Birkenmeier, 2003), which may include among others some of the following objectives: profit, access to new capabilities and networks, learning effects in R&D and setting industry standards (Escher, 2001). The third stage then is finding appropriate channels for communication, which may be either passive (promotion channels; e.g., exhibitions and journals) or active (search channels; e.g., technology brokers and networks) (Escher, 2001).

Next stage is initiating negotiations with discovered potential technology customers, where Escher (2001) identifies the pricing and asymmetry of information as the main challenges. Although the prizing of technologies can be difficult, the price expectations of the two parties should not diverge significantly if the technology selling firm has done a careful valuation of a technology in the beginning of the commercialisation process, i.e., in the pre-commercialisation phase. The valuation of technology is discussed in more detail later, in Chapter 6. The asymmetry of information, on the other hand, refers to a certain insight in a technology a potential customer needs in order to be able to decide whether the technology comes up to his requirements. Providing too much information to the potential customer risks disclosing critical parts of the solution that enable the potential customer to develop the solution at minimal cost without the need to engage in the transaction (Arrow, 1971; Escher, 2001). The final stage, that according to Escher (2001) often receives too little attention from enterprises, is the actual technology transfer. Here the absorptive capacity (Cohen and Levinthal, 1990) of the technology recipient and the commitment of both parties is the key to success.

2.2 Three core process model

Another model of depicting these open innovation approaches is the model of three core open innovation processes presented by Gassman and Enkel (2004). The model can be summarised by the three innovation processes. The outside-in process entails the external knowledge acquisition to enrich the company's own knowledge base, as exemplified by e.g., Procter and Gamble's famous "Connect and Develop" – model (see e.g., Chesbrough et al., 2006). Second, the inside-out process, which represents external knowledge exploitation where the authors see earning profits, selling IP and multiplying technology by transferring ideas to the outside environment as primary objectives. Third, the coupled process, which couples the previous processes by working in alliances with complementary partners in which give and take are crucial for success. All of the three core processes represent an open innovation strategy, but not all are equally important for every company, but instead each company consciously chooses a primary process although it may incorporate aspects of the others as well (Gassman and Enkel, 2004).

The processes defined by Gassman and Enkel (2004) do not however explicitly separate different stages, but do identify similar tasks and challenges pertaining to them as in other literature (Escher, 2001; Lichtenthaler, 2005). It is also argued that the three core open innovation processes each require a different capability of the company (Gassman and Enkel, 2004): outside-in is associated with absorptive capacity (Cohen and Levinthal, 1990), inside-out process with multiplicative capability explained through technology transfer capability and proficiency in identifying partners and the coupled process is associated with relational capacity (Dyer and Singh, 1998).

3 The five steps of external technology exploitation

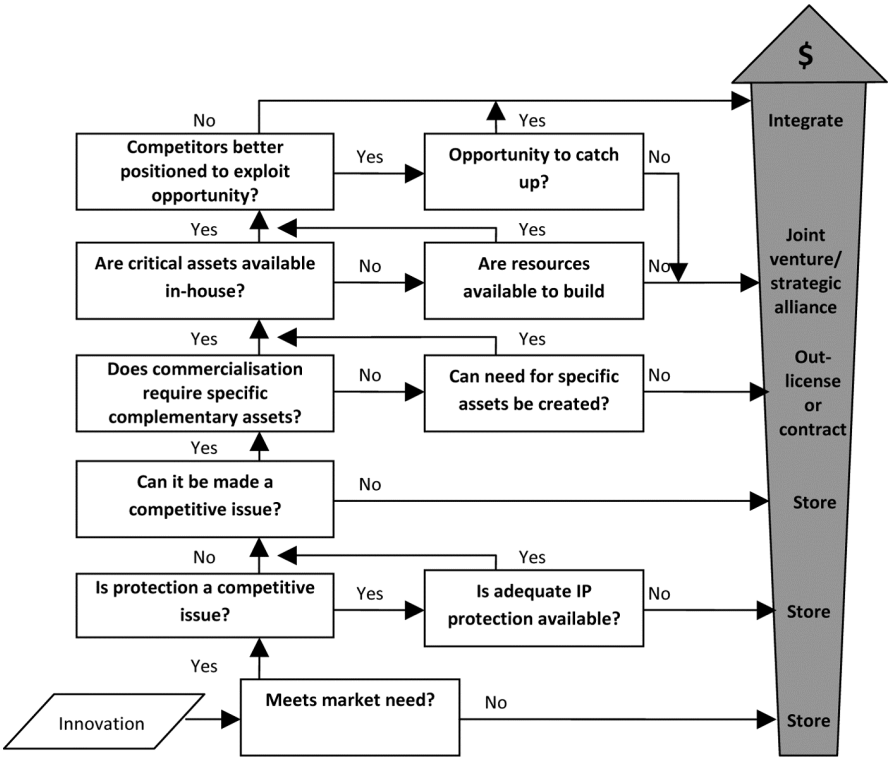
Lichtenthaler (2007a) has synthesised a five step process model based on literature (Escher, 2001; Mittag, 1985) to depict the process of external exploitation of technology and verified his findings via an empirical study of 152 industrial companies in Europe. The model is constructed to portray recurring propositions in various strands of literature and explicitly proposes the process to include the following steps: planning, intelligence, negotiation, realisation and control (Lichtenthaler, 2007a). It has to be noted that usually the process stages do not follow one another sequentially but iteratively with feedback loops, even though the process is presented as a sequential model (Lichtenthaler, 2007a).

3.1 Planning

The planning stage constitutes the interface between corporate planning processes and the planning of external technology exploitation. Prior research has shown that professional planning refers to a high-quality process of strategic technology planning, target setting, resource allocation and technology customer preselection (George and Farris, 1999; Lichtenthaler, 2005). i.e., before it decides to commercialise an innovation, a company must answer a set of questions that will help it determine both the mechanism to be used to convert the technology to cash and the degree of risk involved in successfully completing the cash conversion (see Figure 2). The actions taken in the planning phase are all pre-commercialisation activities in their purest form and critical to the subsequent

success of the entire external commercialisation process. In this configuration the conversion mechanisms of out-licensing, joint venture and strategic alliance are forms of external technology exploitation (Escher, 2005). Sullivan and Fox (1996) suggest that these mechanisms be applied if specific complementary assets are not required for commercialisation and if the critical assets or the resources to build them up are not available in-house.

Figure 2 The commercialisation decision process



Source: Sullivan and Fox (1996)

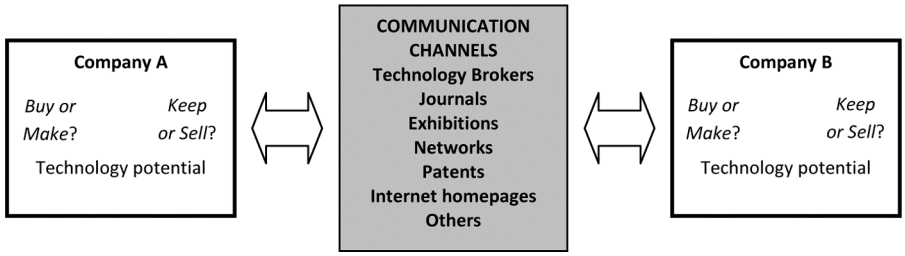
Due to the coordinating role of the planning stage, many firms have embedded it into their strategic technology planning processes by relying on integrated instruments, e.g., roadmaps (Kostoff and Schaller, 2001; Teece, 1998). If a firm decides to explore the possibilities of a particular transaction, it needs to set clear targets (George and Farris, 1999; Lorange and Roos, 1993). Then, the firm has to clarify which resources it may contribute to this technology transaction (Draulans et al., 2003; Grindley and Teece, 1997). Particular attention has to be paid to the risk of losing idiosyncratic competencies as a result of multiple outward technology transactions (Fosfuri, 2006; Kline, 2003). Afterwards, potential technology customers, e.g., licensees, have to be selected (Dyer et al., 2001). The planning stage is critical in securing strategic benefits, such as gaining access to external knowledge, setting industry standards, profiting from infringements of a firm's intellectual property, realising learning effects and guaranteeing "freedom to operate" (Grindley and Teece, 1997; Lichtenthaler, 2005; Rivette and Kline, 2000).

Firms that lack proficient planning processes are often unable to successfully align internal and external technology exploitation (Teece, 1998) and suffer from weak preliminary choice of the right technology customers, which substantially contributes to performance in outward technology transfer (Arora et al., 2001; Draulans et al., 2003). In addition, proficient planning is essential for limiting a priori potential negative consequences of outward technology transfer, e.g., strengthening competitors (Fosfuri, 2006; Kline, 2003). Lack of strategically oriented planning that leads to performing singular ad-hoc transactions incur significantly higher transaction costs.

3.2 Intelligence

Apart from identifying technology commercialisation opportunities, a professional intelligence process comprises the scanning and monitoring of a firm's technological environment, with particular emphasis on the markets for technology (Lichtenthaler, 2003). Additional tasks include prior identification of information needs and the subsequent information evaluation and communication (Brockhoff, 1991; Lichtenthaler, 2003). The firm selects appropriate communication channels for offering and promoting the technologies according to the formulated strategy to all possible suitable customers (see Figure 3). This can be done either actively (i.e., by identifying search channels) or passively (by identifying promotion channels). Besides traditional communication channels, such as journals, exhibitions and networks, there are also new internet based technology brokers like Yet2.com and Pl-x.com. In addition, many firms provide patents and technologies for potential customers through their own web pages. The performance of Internet-based technology brokers, however, is still extremely weak: In the year 2004 the most prominent internet broker, yet2.com, scored approximately ten technology transfers with a user base of 90,000 registered users (Lichtenthaler and Ernst, 2008). Finally, the stage also comprises the identification of potential risks and the analysis of a firm's environment, e.g., regarding competitors and customers on the markets for technology (Gerybadze, 1994; Makadok and Barney, 2001).

Figure 3 Communication channels for the promotion of technologies and search for customers



Source: Adapted from Escher (2005)

The intelligence phase is often considered to be the bottleneck of the external exploitation process. Due to imperfections in the technology markets, the identification of technology commercialisation opportunities, which is part of the intelligence stage, usually represents the critical managerial challenge in externally leveraging technology assets (Davis and Harrison, 2001; Escher, 2003).

3.3 Negotiation

The third step is the contact point with the customer and consists of negotiations with technology customers (provided that the firm has found potential customers) which will eventually lead to a decision on the technology transfer. In the negotiation phase the information produced by pre-commercialisation activities (e.g., documented technology valuation) begins to realise its value.

During professional prenegotiations, a firm attempts to get a clearer view of its compatibility with the potential technology customer, e.g., licensee (Avadikyan et al., 2001; Dyer et al., 2001) as well as evaluate the counterpart in an attempt to reach a sufficient level of mutual trust and understanding to allow exchange of highly confidential information during negotiations (Contractor, 1985). Eventually, a collaborative agreement is set up. The negotiation phase may have several rounds, include third parties (e.g., antitrust commissions) and last more than a year (Lichtenthaler, 2007a). The importance of the negotiations, aside from achieving favourable terms for both parties (regarding e.g., compensation), is underlined especially in cases where the objective is either bi-directional knowledge transfer, e.g., cross-licensing (Teece, 1998), or when attempting to set an industry standard through multiple technology transfer agreements (Lichtenthaler, 2005).

3.4 Realisation

Proficient realisation processes refer to a high-quality execution of the design and implementation tasks (George and Farris, 1999; Reid et al., 2001). Although this stage is often considered fairly straightforward by the involved parties, in practice it requires commitment of transfer-experienced scientists and developers on both the provider's side and the customer's side (Escher, 2001). Proficiently carrying out the design tasks involves a thorough planning of the technology transfer at an operational level and detailed process mapping to specify the implementation process with particular attention to potential interface problems and coordination requirements (Harmon and Ardishvili, 1997; Hoegl and Warner, 2005). Finally, it is essential to modularise a particular technology as far as possible to facilitate its subsequent transfer (Bozeman, 2000; Teece, 1998). As technological knowledge usually has to be tailored to the needs of the technology customer, the source firm often has to actively support the transfer process (Forrest and Martin, 1992; Teece, 1998). On the other hand, a high level of involvement also provides a learning opportunity to the technology provider as well.

The firm has an interest in actively supporting the transfer because a successful absorption of the knowledge at the recipient is critical for an effective technology transaction (Cohen and Levinthal, 1990; Martin and Salomon, 2003). Bi-directional technology transfer and performance-related forms of monetary compensation, e.g., running royalties in licensing agreements, are common (Powers and McDougall, 2006; Sherry and Teece, 2004) and may act as powerful incentives. Regardless of the exact form of agreement, full compensation is commonly tied with enabling the recipient to take full advantage of the transferred knowledge asset. It is also important to notice that if the technology buyer has a significantly lower level of technological know-how, the technology absorption capacity of the receiving partner will severely disrupt the transaction. This may be compensated by the seller providing information produced in the pre-commercialisation phase to the buying party during the negotiations to lower the

level of information asymmetry just enough to encourage transaction while maintaining the leverage in price setting.

There is also the issue of efficiency in the realisation processes, where the firm holds the objective of completing the transfer without having to shift excessive resources away from internal innovation processes (Escher, 2003; Lichtenthaler, 2005), although this does not seem to be a major concern for firms in general (Lichtenthaler, 2007a).

3.5 Control

There are many interdependencies between the control stage and the other process stages, particularly planning and intelligence (Dyer et al., 2001; Hoffmann, 2005), the two stages most prominently portraying the pre-commercialisation phase activities. In fact, the control stage is a mix between activities falling in and out of scope of the pre-commercialisation definition introduced earlier. Proficient control processes comprise the identification of information needs, information generation, information evaluation and information communication (Frishammar and Hörte, 2005; Lichtenthaler, 2005). Besides controlling the activities of the own firm, attention has to be paid to the technology customer's contribution (Bozeman, 2000; Yan and Gray, 1994). After generating information (Hoffmann, 2005; Makhija and Ganesh, 1997), its relevance has to be determined. Apart from evaluating the information, this assessment leads to organisational learning (Lichtenthaler, 2003). The control stage includes decisions on when the transfer activities are to be redirected and when the process should be terminated (Doz and Hamel, 1998; Hoffmann, 2005). Thus, proficient control exceeds the mere collection of internal pre-commercialisation data.

Enabling learning effects through careful analysis and documentation of the success factors of a completed transaction and accumulating experience is also an essential part of control stage operations (Lichtenthaler, 2007a). Over time, the accumulated experience coupled with good control mechanisms will lead to developing a dynamic capability of externally leveraging technology assets (Teece et al., 1997) and to shifting from ad-hoc activities to a strategic approach in external exploitation of knowledge (Lichtenthaler, 2007a). Thus, the control stage is vital for securing learning benefits typically associated with external exploitation of technology.

4 General challenges in managing external exploitation

External technology exploitation as such does not represent the core business of most industrial firms, and their prior experience is relatively limited (Teece, 1998; Davis and Harrison, 2001). Therefore, many firms do not achieve their external technology exploitation potential, i.e., the volume of technological knowledge that may be externally leveraged (Fosfuri, 2006; Sirmon et al., 2007). In many cases, firms are unable to simply see the potential of their shelved knowledge assets, were they applied in a domain other than their own core business, as was the famous case of the Xerox Palo Alto Research Center: unable to see the applicability of its seemingly useless (for the copier industry) technologies in the personal computing domain (Chesbrough, 2004). As knowledge has usually been embodied in products and services for its commercialisation, the markets for knowledge are imperfect (Arora et al., 2001; Caves et al., 1983; Gambardella, 2002; Teece, 1981). As knowledge is a highly

idiosyncratic good (Nonaka and Takeuchi, 1995; Teece, 2000), knowledge transactions are much more complex than transactions on the markets for most products and services (Arora et al., 2001; Guilhon, 2001a) and require specific skills of both the parties involved. Besides the challenges of actually transferring knowledge, the imperfections inherent in knowledge markets lead to appropriability issues and to high transaction costs (Brockhoff, 1992; Caves et al., 1983; Ford and Ryan, 1981; Guilhon, 2001b; Teece, 1981). All of this leads to firms experiencing knowledge transactions as too costly, both in terms of risk involved and plain resources spent on transactions. Bidault and Fischer (1994) further suggest that because of high transaction cost, uncertainty, and a limited number of partners with opportunistic behaviour technology trading frequently takes place within a previously formed network or parties that may be directly introduced through the network instead of so called open knowledge markets which may lead to sub-optimal transfer candidates being preferred (Torkkeli et al., 2009). Furthermore, the negotiation phase carries with it the risk of disclosing too much about the transferrable knowledge asset so that the buyer is able to produce a similar solution with minimal cost. This is especially problematic in the case of software companies, where the assurance of the code functionality would necessitate (partly) disclosing it, but the nature of the knowledge asset (high imitability, zero copying costs) effectively prevents the selling party from doing so.

Summarising from what has been presented earlier, major challenges in the commercialisation process mentioned in literature both by researchers and practitioners are the identification of potential knowledge customers (identification phase), especially from outside the context of the commercialising firm, the actual transfer of knowledge (realisation phase), due to its often tacit nature, sufficiently communicating the knowledge without exposing it (negotiation phase) and determining adequate compensation (planning and negotiation phases). It is notable that many of these issues take place in the pre-commercialisation phase.

4.1 Limits of open innovation approaches

While the contemporary literature in general openly embraces open innovation in a positive light, (e.g., Chesbrough, 2003, 2004, 2006; Chesbrough et al., 2006; Laursen and Salter, 2005; Sakakibara, 2003) touting it as a superior, if not the only way (see e.g., Huston and Sakkab, 2006) for firms to achieve long-term success in today's fast moving market environment, some critical viewpoints, although rare, may be found. Some recent studies have discussed the boundaries of the open innovation approach in general, as well as in the specific cases of external acquisition and exploitation of knowledge (Knudsen, 2005; Laursen and Salter, 2005; West, 2006). Applying concepts related to absorptive capacity, complementary resources, game theory and others, Torkkeli et al. (2009) defined some propositions outlining situations where open innovation practices are likely to produce value and where closed innovation might be preferable.

Similarly Gassman and Enkel (2004) have presented in their research requirements and limits for the successful emulation of the open innovation approach from the perspectives of process, capability and determinants and argue that aside from exploring the successful management of open innovation it is equally worthwhile to discuss whether the approach should be implemented at all in certain cases. They argue that a closed innovation approach might be better suited when the firm has low product modularity, the industry speed is low, tacit knowledge is not a critical requirement,

complexity of interfaces is low and no positive external effects may be realised through licensing (Gassman and Enkel, 2004). On the other hand, Lichtenthaler (2008) contradicts the traditional belief that industries affect the openness of companies and argues that the degree of openness is mainly determined by the strategic choice of the individual company.

5 Addressing challenges in precommercialisation phase

The essential managerial questions pertaining to external knowledge exploitation activities can be summarised to the following few points, which have not been comprehensively addressed in the present literature (Escher, 2005).

- What capabilities and/or attributes do firms need and what actions must they take in order to effectively and efficiently manage external knowledge exploitation?
- How can firms mitigate the accompanying risks, such as preventing leakage of core technologies and diluting their competitive advantage along with the rarity of their unique knowledge resources (Kline, 2003; Winter, 1995)?
- How can market imperfections, such as the asymmetry of information, be countered or taken advantage of?
- What kind of management structure and strategy is best suited to deal with the unique challenges of offering technologies in the market of knowledge?

We propose that some key elements to answering these questions are found in the pre-commercialisation phase. Essentially by concentrating on and developing the pre-commercialisation skills and capabilities a firm will be able to relieve some uncertainty about the process and also significantly lower transaction costs. By the words of Lichtenthaler,

> "technology transfer performance seems to be determined to a large degree by managerial activities that accompany the actual technology transfer, i.e., planning, negotiation and control." (Lichtenthaler, 2007a)

Furthermore, he states that most firms manage negotiation and realisation more professionally than planning, intelligence and control (Lichtenthaler, 2007a): the three essential phases of pre-commercialisation activities. Possible partial answers to the questions above have been collected from the literature. Specifically the suggested answers may be found through investigating the strategic connection of external exploitation and corporate business strategy (planning), knowledge brokerage (intelligence), valuation of technology (planning and negotiation) and dynamic capabilities (realisation and control).

Knowledge brokers, or innovation intermediaries, theoretically hold the possibility to combat problems in the intelligence phase. Firms may thus choose to rely on intermediary services to overcome difficulties in e.g., partner and application opportunity identification and valuation issues, instead of building on their own expertise (Birkenmeier, 2003); and considering their undeveloped skill in this activity, the collaboration with intermediaries appears to be a natural strategic move (Lichtenthaler and Ernst, 2008). Ideally, the use of intermediaries would help complement the firms'

abilities and lead to the creation of a market pull for the firm's knowledge, although with e.g., net-based brokers this is far from reality (Lichtenthaler and Ernst, 2008).

5.1 Approaches to a strategic external exploitation management

The existence of markets for technology increases the choice of strategic options for large technology-based firms. These firms are more likely to license their technologies to markets in which they own fewer market shares, to mainly foreign markets or to downstream markets that are highly competitive (Arora et al., 2001). On the other hand, smaller firms and technology-based start-ups take advantage of the increasingly effective markets for technology in order to specialise in technology development (Arora et al., 2001). It is proposed that especially research-driven companies with objectives like decreasing fixed R&D costs, branding and setting standards via spillovers would be inclined to implement strategies with an external exploitation focus (Gassman and Enkel, 2004).

In order to be able to handle multiple technology transactions successfully a coherent strategy is needed (Lichtenthaler, 2007b). The aim to reach an overall optimum on all transactions is essential because the local rationality of optimising the results of an individual transaction may have negative effects on other transactions due to potential – positive or negative – synergies (Dyer et al., 2001; Hoffmann, 2005).

The strategic issue refers to the decision of whether to commercialise a particular technology externally or not (i.e., keep-or-sell decision). There are several perspectives from which to approach the decision: among the most important things to consider are firm's complementary assets, transaction costs and appropriability regime (Lichtenthaler, 2007b). It is common that the decision can be made only after the intelligence and negotiation phases. Due to the high complexity and context dependency of the decision, it is difficult or even impossible to develop an overall external knowledge exploitation strategy. It is important however that this strategy is closely coordinated with corporate strategy and with internal knowledge exploitation strategies (Lichtenthaler, 2007b). When knowledge exploitation strategy is linked to business strategy new viewpoints open e.g., into the development and acquisition of technology:

> "A company must not base its development decisions on the projected returns of product sales alone. Instead, it should consider potential returns from the technology as a whole." (Ford and Ryan, 1981)

However, the primary function of the strategy is to enable identifying and seizing strategic opportunities and prevent strategic conflict between e.g., R&D and marketing strategies (Lichtenthaler, 2007b). A successful example of aligning external exploitation activities to overall corporate strategy is found in one of the most famous open innovation champions, IBM, that has successfully opened up its business model. Among the other great changes following a financial shock to their operations, IBM rethought its whole approach to managing intellectual property, effectively shifting from a completely defensive IPR strategy (protecting IP leaks) to an offensive one (aggressive out-licensing) (Chesbrough, 2007) where opening up the company's patent and technology portfolio was seen as a bold but necessary measure. A related considerable success was new semiconductor copper-on-insulator process technology that IBM, instead of traditionally setting up costly IP defenses, swiftly out-licensed to companies such as Intel, Motorola and Texas Instruments generating significant profits (Chesbrough, 2007).

Generally, the external commercialisation of a process or manufacturing technology (as opposed to new product improvements or technologies) is a risky and rare endeavour as such technology tends to be close to the core business of the firm and possessing a higher level of rarity and inimitability (Teece, 1998), since the customers do not get the chance to reverse engineer a process technology in the similar way as they would e.g., a new product. This translates into an opportunity to extract significant revenue from licensing, but also to a considerable risk of consciously diluting the competitive advantage of the firm: exposing to competitors a technology that would have been relatively resistant to attempts at imitation (Torkkeli et al., 2009). Thus, the success of the exploitation effort is critical, and as previously established, largely dependent on the quality pre-commercialisation activities (e.g., partner selection and control stage activities).

The diversity of the tasks inherent in the commercialisation process, performed by employees who specialise in certain tasks and are organised in particular units in a company-specific way (Dyer et al., 2001) creates a need for the coordination of the internal units. Moreover, the interfaces with the transaction partner, and perhaps with an intermediary, have to be managed. Various authors (Escher, 2003; Ford, 1985; Mittag, 1985) therefore propose a dedicated external technology/knowledge commercialisation unit which would specialise in the external technology exploitation process. The unit would focus on coordination requirements as well as supporting the managers or teams of individual knowledge transactions. Along the same lines, Tschirky (1998) conceptualised a dedicated organisational unit labelled "Technology Intelligence & Marketing Center (TIM)". He suggests that the unit would handle the realisation of the strategic tasks of external technology acquisition and exploitation. This unit would handle the essential tasks directly linked with technology marketing (or open innovation), such as technological intelligence and networking with relevant actors, elaboration of technology roadmaps and strategies (Escher, 2005; Tschirky, 1998). The empirical research done by Granstrand (1999) on 24 large Japanese corporations, such as Hitachi and Toshiba, showed some similar traits embedded into the functions of the corporate IP department.

5.2 Valuation of technology

A narrow financial approach to the valuation of technology is self-defeating. Real-world valuation is a blend of soft organisational issues, complex strategic questions and the analytical methodology of Discounted Cash Flow (DCF) (Boer, 1999). The valuation that ultimately matters (in internal decisions as well as external exploitation) is usually the one taking place in the marketplace, through negotiation between two or more parties (Boer, 1999). Thus the valuation of technology in external exploitation is always strongly linked to the interests of the potential technology 'buyers' and ultimately decided only in the negotiations between the parties involved in the transaction. Nevertheless, careful valuation of the technology with analytical tools in the pre-commercialisation phase, before engaging in direct negotiations with potential technology 'buyers' will provide baseline values to guide the compensation negotiations and may even provide an edge to the selling party during them. Thus, the determination of the value of a technology is done in two stages: the pre-commercialisation stage and the negotiation stage.

The precommercialisation phase technology valuation is based on various DCF analysis methods and performed iteratively throughout the development of the

knowledge. It should take into account different scenarios and options, which should be further elaborated by sensitivity analysis (Boer, 1999). When considering specifically the case of external exploitation, much depends on the identified technology customers as e.g., financial and strategic buyers have significantly differing valuations (Boer, 1999) (and willingness to pay) for the technology. Performing careful competitor analyses with an emphasis on the technological assets of the customers, that may be utilised as complementary assets (Boer, 1999; Teece, 1986) further adding the value of the technology to the customer, is a necessary step in determining the baseline 'price range' for the technology and in some cases, the appropriate form of external exploitation (e.g., license, sell-off), prior to negotiations. A well-founded pro forma DCF analysis may even be packaged with the technology to both justify and add value to the technology offering; the added value generated may be realised e.g., in evaluation fees as part of licensing negotiations even in the case of an eventually unsuccessful transaction (Boer, 1999). The traditional financial tools, like DCF methods, ignore some opportunities, such as the option to terminate, the options of making follow-on investment and the acceleration option, when estimating R&D projects. Another approach to assess technologies, which has gained a lot of detention in the literature, is real options (Boer, 2000). Naturally, these approaches are not exclusive but rather should be implemented complimentary to each other.

Apart from evaluating purely monetary gains the valuation has to consider the attainable strategic benefits from external exploitation scenarios discussed earlier which in many cases outweigh the direct financial benefits (Bidault, 1989). These benefits are very case-specific and evaluating them is mainly done in the planning phase through various foresight approaches, such as roadmaps and scenario planning, as explained previously.

Ultimately, regardless of the pre-commercialisation actions undertaken and their results, the final compensation is determined at the negotiations between the parties engaged in the transaction. Experience shows that the flexibility of the predetermined price is still notably large at this point (Boer, 1999), although preliminary valuation provides the selling party with powerful negotiation tools. The costs of the actual transaction (the knowledge transfer) also have to be figured in and cannot be precisely assessed before negotiating with the technology customer and gaining first hand information on e.g., their absorptive capacity and the amount of support they require of the seller during the actual realisation phase of the process. This is important as often e.g., license revenues do not cover the expenditures of the sell efforts (Escher, 2001).

5.3 Building dynamic capability through experience

Successfully managing internal technology exploitation, i.e., new product development, is often used as an example of a dynamic capability (Eisenhardt and Martin, 2000; Teece et al., 1997). The case is similar with external exploitation: by adapting a systematic process and realising learning effects based on prior experience, firms may reduce the transaction costs in the markets for technology (Cohen and Levinthal, 1990; Lane et al., 2006; Abrahams and Macmillan, 2009) and with experience develop a dynamic capability in external technology exploitation (Deeds and Decarolis, 2000; Teece et al., 1997). To realise learning effects and best accumulate organisational experience, many authors view the institutionalised approach of tasking a dedicated

external technology transaction unit with managing the learning process (e.g., Draulans et al., 2003; Dyer et al., 2001; Tschirky, 1998).

Lichtenthaler (2007a) confirms that even if outward technology transfer has only increased in recent years (Davis and Harrison, 2001; Kline, 2003) potential learning effects have already led to visible results. It is necessary to keep in mind that performance in external exploitation of technology depends also equally on the counterpart. Research into partner-specific absorptive capacity has shown that the similarity of managerial mechanisms between the technology source and the technology recipient positively affects performance (Lane et al., 2006; Wei et al., 2009). Absorptive capacity of the technology recipient in general has been identified by various authors (Escher, 2001; Lichtenthaler, 2007a) as one success factor as well as the deep commitment of both parties in to the transfer process.

6 Implications for innovation and learning

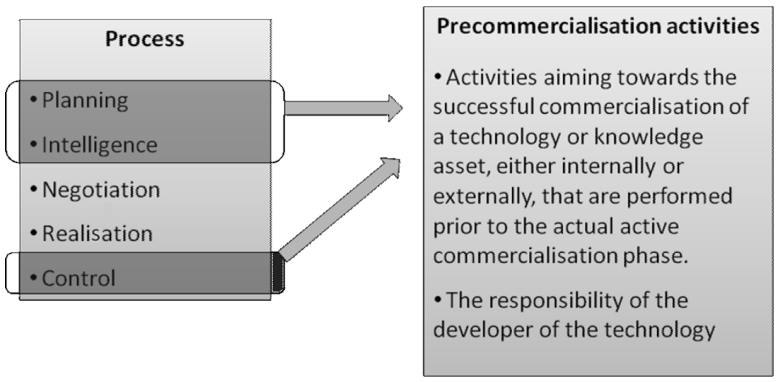
Many authors (e.g., Arora et al., 2001; Chesbrough, 2003, 2006; Chesbrough et al., 2006; Kline, 2003; Lichtenthaler and Ernst, 2009) seem to agree that a paradigm change towards open innovation is happening. Firms are opening up organisational boundaries and increasing flows of knowledge both in and out of the company are seen as the preferred way to cope with increasing pressures to innovate more efficiently and effectively. However, the knowledge markets are still imperfect and widespread, efficient practices for open innovation are yet to be established. The development of knowledge markets seems inevitable and eventually will force significant strategic imperatives on the various actors involved (Arora et al., 2001). Today, the acquisition of external knowledge can already be considered commonplace, even with numerous SMEs adopting this mode of openness (Kess et al., 2009; Shang et al., 2009) as well as industry giants such as Procter & Gamble, but the same is not true for the external exploitation of knowledge assets.

Even with all the open innovation buzz at the moment, most external exploitation benefits are still reaped only by companies utilising ‘research waste’, i.e., capitalising on the licensing of non-core technologies with little or no internal use or strategic value, as for example in the case of IBM (Gassman and Enkel, 2004). Other than that, the external exploitation is currently rare, mostly limited to few specialised SMEs, such as the specialised engineering firms in the semiconductor or chemical industries (Arora et al., 2001). One influential factor here may be the dimension of organisational innovation involved. In a general sense, the term ‘organisational innovation’ can be defined as the creation or adoption of an idea or behaviour new to the organisation (Daft, 1978; Damanpour and Evan, 1984; Damanpour, 1996). While the case of external knowledge acquisition may be relatively straightforward (Torkkeli et al., 2009) proficient execution of external exploitation may demand further organisational rearrangement (Granstrand, 1999; Tschirky, 1998). An example of organisational innovation in this context can be found at yet2.com (Lichtenthaler and Ernst, 2008) which is an organisation of a type that has not existed before the markets of knowledge have spawned into existence: the knowledge broker. Less drastic organisational innovations are abound as well, even overcoming the effect of the ‘Not Sold Here –Virus’ (e.g., Chesbrough et al., 2006) requires redefining the resident organisational culture. All the current open innovation champions, such as e.g., IBM and P&G, have experienced major

organisational innovation in creating their current open business models (Lichtenthaler, 2007). There is still fundamental room for further organisational adjustment or innovation, even in the pre-commercialisation phase: firms need to mold an environment that is more conducive to learning from an external exploitation scenario (or multiple instances of such). Once the markets develop further and encourage more external exploitation, understanding pre-commercialisation will become essential for managers.

Pre-commercialisation stage activities seem to play a critical role in the success of external knowledge exploitation. From what we have presented above we can summarise that even though according to Lichtenthaler (2007a) all process phases are critical to success, in most cases the determinants of external exploitation success can be found especially in the phases of planning, negotiation and control, of which planning and control are pre-commercialisation activities. Furthermore, companies are especially experiencing difficulty with handling the planning, intelligence and control phases, all the phases where pre-commercialisation activities take place (see Figure 4). Acknowledging the importance of pre-commercialisation can significantly boost the success of companies' external knowledge exploitation efforts, ultimately improving their innovation returns and also securing possible organisational learning benefits.

Figure 4 Positioning pre-commercialisation activities in the external exploitation process



Knowledge transactions with the external environment constitute a powerful environment for organisational learning especially in respect to the R&D departments involved. Traditionally learning effects have been primarily associated with the external acquisition of knowledge assets, or in other words the outside-in process. However, organisational learning is possible in all knowledge transactions, also in external exploitation, provided that proficient control stage activities are set in place (Lichtenthaler, 2003, 2007a). Proficiency in the control stage and the planning and intelligence stages to which it is inherently connected (Dyer et al., 2001; Hoffmann, 2005), or in other words proficiency in pre-commercialisation, to a large extent determines the possibilities to secure learning benefits from external exploitation. In an enterprise pursuing an open innovation strategy engaging in multiple knowledge transactions with external actors, the constant, close interaction of the R&D department with external parties provides a fertile soil for boosting idea generation, enhancing knowledge absorption and improving related processes. Gassman and Enkel (2004) refer to absorptive capacity (Cohen and Levinthal, 1990), relational capability (Dyer and Singh 1998) and multiplicative capability as the primary 'open innovation capabilities' that determine success in knowledge transactions

and also develop through accumulated experience in the various modes of open innovation implementation. This may be referred to as creating a dynamic capability for managing external knowledge transactions, the in- and outflows of knowledge assets productively.

Learning can be a primary motivator for a company to engage in an external exploitation process and the intentional building of a strategically relevant dynamic capability for managing external knowledge exploitation activities over time can be seen as one important goal of an aggressive external exploitation strategy. Dynamic capabilities such as this can lead to a sustainable competitive advantage by granting enterprises the ability to respond quickly to the rapidly changing environment (Lin et al., 2008). There is also some evidence that a strategy combining both external acquisition and exploitation would have synergistic benefits to the organisational learning and the building of dynamic capability for managing external knowledge transactions thus enabling an enterprise to reach higher margins with an open innovation strategy (Escher 2001; Lichtenthaler 2007a, 2008).

7 Discussion and further research topics

As the majority of all research in this area is concentrated on the perspective of the firm, external exploitation of knowledge in other organisations such as universities and research institutes has been somewhat neglected. Weger (1998) has explored the topic to some extent from the viewpoint of the strategic marketing mix and some works concentrate on industrial and state-run research institutes' spin-off practices (Granstrand and Alänge, 1995; Parhankangas, 1999) as well as those of universities (Ndonzuau et al., 2002). Additionally, some literature also exists under the wide topic of knowledge transfer, but considering the recent advancement of understanding this phenomenon time would be ripe for a integrative outlook on research-industry relationships and external knowledge exploitation in that field. An additional topic that needs further research is the knowledge transfer supporting pre-commercialisation activities that have been identified in this paper to be both the area in which companies are having difficulties as well as the area that has the greatest impact on the knowledge transfer performance. Additional interesting viewpoints that have been awarded little attention thus far would be concentrating on the synergies of external acquisition and exploitation, e.g., through the theory of dynamic capabilities, as well as the viewpoint of the technology intermediaries, i.e., knowledge brokers. One important and persistent gap in this research area is the scarcity of empirical studies and evidence pertaining to this phenomenon. Some studies have been conducted by e.g., Lichtenthaler (2007a, 2008) but these are by no means exhaustive and focused solely on the perspective of the industrial firm and thus we suggest gathering empirical evidence of research-industry relationships to support theoretical considerations as well.

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Publication 2

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Opening the fuzzy front-end of new product development: a synthesis of two theories

Antero Kutvonen* and Marko T. Torkkeli

Kouvola Research Unit,
Lappeenranta University of Technology,
Prikaatintie 9, FIN-45100 Kouvola, Finland
E-mail: antero.kutvonen@lut.fi
E-mail: marko.torkkeli@lut.fi
*Corresponding author

Abstract: Product development processes have been studied since the 80s and nearing 90s, academic attention turned to early phases of development, i.e., fuzzy front-end (FFE). Activities at the FFE are often chaotic and experimental with rather unpredictable or uncertain commercialisation future. Opportunities are raising, but a firm still cannot do all needed development and commercialisation actions for all potential technologies in-house. The theory of open innovation (OI) has tackled some of the emerged dilemmas by opening the borders of the company for knowledge and technology exchange. One of the fundamental notions therein is that technologies of little apparent value to your business may be highly valued outside your company. In our paper, OI and FFE theories are merged to introduce an open new concept development framework, leading to new discoveries in the relation between FFE and external technology exploitation. The framework helps organisations to improve their product development profitability by coping with in- and out-flows of technology.

Keywords: fuzzy front-end; FFE; external technology exploitation; open innovation; OI; new product development; NPD; external technology commercialisation.

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Biographical notes: Antero Kutvonen received his MSc in Industrial Engineering and Management at the Lappeenranta University of Technology. He works as a Researcher at the Lappeenranta University of Technology Research Unit in Kouvola, Finland. Currently, he is preparing his PhD in Technology Management. His main research interests include innovation management, open innovation, regional innovation policy and knowledge management.

Marko T. Torkkeli is a Professor of Technology and Business Innovations at the Lappeenranta University of Technology in Kouvola, Finland. He is a member of the editorial boards of the *Int. J. of Innovation Management*, *Int. J. of Services Science* and the *Research J. of Business Management*. He is a Visiting Researcher at INESC Porto (Portugal). He serves as the Director of Publications for the International Society for Professional Innovation Management (ISPIM).

1 Introduction

Companies must innovate, today and tomorrow: a constant stream of new applications, models, products and/or services is of paramount importance to maintaining competitive advantage. Approaching the end of the twentieth century however, innovative firms felt the pressure of escalating costs of developing new products and shortening product lifecycles that resulted in diminishing returns from development efforts. In a recent study, Silva et al. (2008) proved that the high innovation costs of today actually have a measurable, negative and significant effect on the innovation propensity for manufacturing companies. The new product development (NPD) process has been studied since the 80s (Cooper, 1985; Rosenau, 1988) and in the late 80s and early 90s early phases of product development, i.e., fuzzy front-end (FFE), became popular among academics (Khurana and Rosenthal, 1998). It was soon established that activities at the FFE of the product development process are often chaotic and experimental, with rather unpredictable or uncertain commercialisation future (Koen et al., 2001). Even if the process of internal FFE is studied thoroughly, an abundance of opportunities lays outside of the organisational boundaries. Open innovation (OI) theory proposes that one should open knowledge and technology borders of the company for idea exchange, both in- and outbound, because there might be a business model for the seemingly useless technology you are holding; or even someone holding a technology that you have been seeking to develop all along (Chesbrough, 2003c). In both theories there are implicit connections to each other and, while the research on external acquisition of knowledge does discuss boosting your front-end efforts by external inputs [e.g., via the popular case of P&G (Huston and Sakkab, 2006)], hardly any literature goes further in addressing the connections between the two theories. This is surprising, since before the emergence of OI, FFE was seen as the area where decisive performance improvements to new product (or innovation) processes could be made, whereas now the most potential and buzz is centred on OI practices.

In this paper, we introduce a framework for fully integrating the OI paradigm with the FFE of product development process. We review both theory of FFE and OI, analysing mutual and overlapping ideas of the theories. Then, we merge the theories into a framework, which would help a company to manage their innovation powered product development process. The framework is thus evaluated by how it can help companies to improve their product development profitability by coping with in- and out-flows of technology. In summary, the primary objectives of this paper are to investigate the applicability of the OI theories to the FFE of NPD, to provide a framework for strategic, proactive managing of in- and outflows of knowledge and further the contemporary understanding of FFE and OI theories. The focus here restricts us to the early phase of NPD and the managerial actions taking place there (as opposed to also addressing the more formal stages of the NPD process). There is a decisive emphasis on the inside-out mode of OI, i.e., the external exploitation of knowledge, as the outside-in, or external acquisition, is already more widely covered in the existing literature (e.g., Laursen and Salter, 2006; Lettl et al., 2006; Piller and Walcher, 2006) and also more prominently adopted in practice [e.g., according to Enkel and Gassman (2008) approximately 43% of companies have an in-licensing policy in place, while only 36% use an out-licensing policy to externally commercialise their technologies]. The external exploitation side has also been acknowledged as more lacking in recent literature reviews of OI (Enkel et al.,

2009; Lichtenthaler, 2005). Other limitations include a focus on the commercial firm, neglecting the cases universities and other research institutes engaged in innovative activities. The search for literature was focused on quality journals as well as some books, e.g., on OI, in order to provide for high-quality inputs. Keywords for scanning the literature were among others, FFE, OI, external technology exploitation, NPD and licensing.

The paper is arranged as follows. After the introductory section, we discuss about the OI perspective with main arguments on why and how it is relevant for modern companies. Then, the following section gives us a look into the FFE of product development process, where the literature on its benefits and challenges for an organisation are reviewed. After this the paper moves on to a synthesis of the two theories in the fourth section, where we develop a framework for OI applicability in the FFE of product development process to capture what we consider the primary implications of OI for managing the FFE. Finally, we conclude our study in the fifth and final section with a summary and some suggestions for promising avenues of future research.

2 An OI perspective

2.1 Challenges for the closed innovation model

The innovation models have been changing during the past decades, advancing through five distinct generations towards a more complex and connected picture (Rothwell, 1992). But still for the most part of the 20th century, even though companies realised the importance of flexibility and networking in R&D-operations, they kept their processes as a highly protected, secret business that was carried out all the way from beginning to end inside the company. The expression of 'the development funnel' is used to describe the transformation of an idea to a product or a service (Smith and Reinertsen, 1991). Innovations move through different stages from the idea creation to the launch phase. Later the funnel approach was connected to Cooper's (1990) Stage-Gate System. Here, R&D projects can only enter in and exit one way (Chesbrough, 2006a): companies believe that they have to do everything internally and a 'not invented here' (NIH) syndrome dominates the industrial R&D thinking. If a company had not developed the technology itself, how could it be sure that the technology is qualitative, operative and useful for it? (Chesbrough, 2003c) In the other side of the pipeline, firms tend to think that if the developed technology is not sold by us, why should we let anyone else sell it either. This phenomenon is known as 'not sold here' (NSH) virus (Chesbrough, 2003a). Chesbrough (2003c) refers to this traditional, and in many cases now outdated, model as the closed innovation model. The closed innovation approach worked well in the environment of the 20th century and it led many companies to success. Even in this day, the model goes well with some industries, like nuclear power and war industries, where control is in a critical position (Gassman, 2006).

Chesbrough (2003c) has identified four erosion factors that have compromised the effectiveness of the closed innovation model. The first factor is the increasing availability and mobility of skilled workers: the number of highly educated and trained people has grown significantly after the Second World War, and an increased labour market gives

well-trained workers an opportunity to shift from one company to another, or even start a company of her or his own with the help of a venture capitalist. The rise of the venture capital market is the second erosion factor. These two factors mentioned lead to the third: external options for ideas sitting on the shelf. The customers and competition have become more demanding to the point where a company cannot keep ideas on hold to eventually be established as technologies. If a company does not launch the technology, someone else will. The last erosion factor identified is the increasing capability of external suppliers with specialised suppliers gaining much more responsibility and participating more actively in the development processes of companies in a relationship of much deeper trust and collaboration than ever before. Academics and business people picked up on these events and a string of literature emerged, heralding a fundamental change in the innovation paradigm.

2.2 Introducing OI

A decade ago von Hippel (1994) suggested that companies should use external sources, customers, suppliers, universities and other companies, in their R&D activities. At the same time, Cohen and Levinthal (1990) empirically proved that firms have to learn from the environment. For doing that, R&D resources need to be allocated to developing and sustaining absorptive capacity as well. The importance of alliances and networks has been another popular topic of study in the 90s (see e.g., Gulati, 1998). Prior research has largely focused on external knowledge acquisition and the make-or-buy decision, i.e., whether to develop knowledge in-house or to acquire it from external sources (see e.g., Granstrand et al., 1992; Veugelers and Cassiman, 1999; Ferretti and Romano, 2006). Since the 1990s, scholars extensively studied various governance modes for external technology sourcing like strategic alliances, joint ventures, acquisitions (see e.g., Lambe and Spekman, 1997; Hagedoom and Duysters, 2002; Vanhaverbeke et al., 2002), or inward technology licensing (Smith and Reinertsen, 1991). Recently, moreover, other governance modes, such as the use of corporate VC investments to leverage external R&D, have been considered as well (see e.g., van de Vrande et al., 2006). The perspective of actively managing the external exploitation of knowledge assets has been adopted in literature as well. The first studies in the 1970s – mainly in the field of technology management – primarily considered specific aspects, such as international licensing agreements; later subtopics being e.g., technology licensing, technology-based spin-offs, strategic alliances and joint ventures (Escher, 2005). The term 'technology marketing' was also coined then by Ford (1985). After these early works, there has not been a continuous research stream on this topic, however.

Chesbrough (2003c, 2006a) brought together these emerging ideas, fundamentally different from the previous conceptions of how innovation works, in his theoretic model of OI. It builds on the basic assumption that the knowledge landscape has changed, announcing the business model instead of technology development prowess as the key success factor for an innovative business. The basic premise of the OI model is that by enlarging your 'research organisation' you may be able to tap into a much larger pool of ideas and find such ideas faster than if you limit yourself to the traditional, closed innovation model. Furthermore, you may benefit from 'dead born' ideas by utilising them outside the boundaries of your own firm, but within the business models of other firms, where these ideas may unfold their full potential. In Table 1, the basic principles of both closed and OI models are listed to highlight the difference between these two models.

Table 1 Contrasting the principles of closed and OI

Closed innovation principles:	*OI principles:*
The smart people in our field work for us.	Not all of the smart people work for us so we must find and tap into the knowledge and expertise of bright individuals outside our company.
To profit from R&D, we must discover, develop and ship it ourselves.	External R&D can create significant value; internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We do not have to originate the research in order to profit from it.
If we are the first to commercialise an innovation, we will win.	Building a better business model is better than getting to market first.
If we create the most and best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our intellectual property (IP) so that our competitors do not profit from our ideas.	We should profit from other's use of our IP, and we should buy other's IP whenever it advances our own business model.

Source: Chesbrough (2003b, p.38)

The intellectual property (IP) governed by a company, and previously considered primarily a defensive asset for raising competitive barriers and cementing the firm's position in the market, is now seen as growingly as a resource or commodity exploited much more diversely. As Chesbrough (2006a) sums up, OI is both a set of practices for profiting from innovation, and also a cognitive model for creating, interpreting and researching these practices. It offers guideline to perceive the prevailing innovation landscape. But even if openness in the innovation process is highly encouraged there will always be need for some closeness, too (Christensen et al., 2005; Torkkeli et al., 2009). Since the seminal works of Chesbrough, a broad awareness of OI and its relevance to corporate R&D has awakened. The implications and trends that underpin OI are now widely discussed in terms of strategic, organisational, behavioural, knowledge, legal and business perspectives, and its economic implications (Enkel et al., 2009).

Although much of the practice and literature of OI is revolving around the acquisition of knowledge assets, assuming that knowledge is widely spread, abundant and that even the successful innovators with big R&D resources have to look for the external sources of innovation (Chesbrough, 2006b), the interest in external knowledge exploitation (in terms of 'selling' or exchanging knowledge in the market) has also grown significantly (see e.g., Chesbrough, 2006b; Tschirky et al., 2004). A primary reason for this increased attention to the 'sell' side comes from the fact that markets for technological knowledge have developed and firms have more opportunities to leverage their technological assets (Arora et al., 2001). Various ways of externally exploiting knowledge include, but not limit to, selling of technologies and IP like patents, licensing-out, and collaborations in order to gain extra revenues. It may further be used to realise strategic benefits, such as establishing own technologies as industry standards (Gassman and Enkel, 2004; Lichtenthaler, 2007a). However, since selling of knowledge assets also has negative effects (e.g., the diffusion of competitively relevant knowledge, loss of control, heightened costs of coordination), firms are increasingly faced with a 'keep-or-sell' decision (Lichtenthaler, 2007b). The decision to adopt an active external exploitation

strategy means generating profits by licensing IP and/or multiplying technology, thus transferring ideas to other companies instead of the firm restricting itself to the markets it serves directly (Enkel et al., 2009).

2.3 Definition of OI

Even if there is a lot of discussion and literature in the recent years about OI, the exact definition of the concept may not be entirely obvious. Chesbrough (2003c) defines OI by the movement of knowledge across the boundaries of the firm (or organisation). This definition can be considered somewhat inconclusive; for instance, no innovation is created 'in a vacuum' so an influence of knowledge or information external to the organisation is always present and even companies with tight IP protection usually will ultimately 'leak' knowledge outside. Another definition is given by Lichtenthaler (2008) where OI is defined as "systematically relying on a firm's dynamic capabilities of internally and externally carrying out the major technology management tasks ... along the innovation process". Here, the notion of a systematic activity is invoked and OI is connected to certain capabilities implying both deliberation and a need for proficiency. Still the definition remains open-ended, offering little focus. Yet a further definition is provided by Chesbrough (2006a) defining OI as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". It should be noted, however that while this definition captures all instances of the paradigm of OI, such as the donation of intellectual property to the Open source movement in the software industry by e.g., IBM (Chesbrough, 2007), it indiscriminately takes into account all and any inflow and outflow of knowledge, such as e.g., a traditional customer satisfaction survey. When dealing in an interorganisational setting, we propose that OI could be more explicitly defined as follows:

> *OI describes an organisation's deliberate commercialising (exploitation) of knowledge assets to and/or acquisition from another independent organisation involving a contractual obligation for compensation in monetary or non-monetary terms.*

3 FFE of technology development

The FFE, a term first popularised by Smith and Reinertsen (1991), is considered to be the earliest stage of the NPD process and roughly is meant to denote all time and activity spent on an idea prior to the first official group meeting to discuss it, or what they call "the start date of team alignment". Other ways of thinking about this concept is understanding the FFE as the territory leading up to organisational-level absorption of the innovation process (Cohen and Levinthal, 1990), or refer to the efforts that precede a formally structured new product or process development (NPPD), Stage-Gate™ or Product and Cycle Time Excellence (PACE®) – process (Koen et al., 2001). There have also been attempts where the FFE has been depicted as an extension of the formal Stage-Gate process as the 'pre-phase zero, phase zero and phase one' phases by some authors (Cooper, 1997; Khurana and Rosenthal, 1998; Moenaert et al., 1995). Exact definitions vary, but in generalised terms the FFE, or synonymously front end of innovation (Koen et al., 2001), can be defined as follows:

> *FFE refers to the early 'ideation step' (Cooper, 1993) that precedes a structured NPD process and is concentrated on generation, refinement and analysis of new concepts (Koen et al., 2001) arising from identification of a unfulfilled market need and/or a (untried) technological opportunity (Smith and Reinertsen, 1991) and ending in organisational commitment to advance and fund the concept to NPD or discontinue concept development (Khurana and Rosenthal, 1998).*

The 'fuzziness' of the front end refers to the high degrees of technical and commercial uncertainty related with the concepts and ideas processed at that early phase, which also are a lead cause of the managerial difficulties associated with it. The primary interest in the area is motivated, aside from its unique nature in the innovation process, also by its immense effect on the success rate of new product and process development or as Zhang and Doll (2001) put it: most projects do not fail in the end, they fail at the beginning. Based on prior works on the FFE and the nature of uncertainty, Zhang and Doll (2001) define the front-end fuzziness of NPD as the uncertainty of customers (portfolio, preference, life-cycle and volume fuzziness), technology (material, specification and supply fuzziness) and competition (competing product development and adoption speed fuzziness). According to Smith and Reinertsen (1991), of all the actions firms can take to improve their NPD process, those taken at the FFE give the greatest time savings for the least expense. Managers and researchers alike claim that the benefits resulting from improvements in the front end are likely to far exceed those that result from improvements aimed directly at the design engineering process (Chase and Tansik, 1983; Cooper and Kleinschmidt, 1994; Rosenau, 1988). This is related to the relatively low cost of generating several potential ideas compared to the cost of actually implementing any one idea (Urban and Hauser, 1993). Several studies have indeed provided evidence of a link between new product performance and time spent on up-front activities (Cooper and Kleinschmidt, 1995; Kuczmarski & Associates, 1994; Urban and Hauser, 1993).

Scholars of NPD have discussed 'up-front activities' in a generic way for more than 20 years (Crawford, 1980). Especially in the 90s, there has been a notable string of literature (Khurana and Rosenthal, 1997; Moenaert et al., 1995; Reinertsen, 1999) pertaining to this subject, most of it having to do with managing the uncertainties, speeding up the screening of ideas or attempting to provide structure into the seemingly chaotic, experimental and unpredictable phase of the innovation process (Koen et al., 2001). Khurana and Rosenthal (1997), Moenaert et al. (1995), and Reinertsen (1999) have contributed to a better understanding of the FFE by examining key FFE issues and their particular impact on product innovation success. Specifically, Khurana and Rosenthal (1997) focused on the importance of structured strategy for dealing with new product opportunities at the FFE; Moenaert et al. (1995) examined the importance of communication at the R&D – marketing interface for ensuring better concept development at the FFE; and Reinertsen (1999) investigated the importance of optimising the FFE process by speeding up decision-making and screening. Eldred and McGrath (1997) also described a process (technology realisation and commercialisation, or TRAC) suitable for managing technical uncertainties in the FFE, but restricting to a technology development scenario. More recent research includes the attempt to reduce and explain the fuzziness of the front end by applying uncertainty theory (Zhang and Doll, 2001) as well as Reid and Brentani's (2004) distinction between the FFEs of radical and incremental innovation.

Reid and Brentani (2004) state that it is possible to distinguish early and late activities comprising the FFE, regardless of level of innovation (incremental or discontinuous), whereas Koen et al. (2001) describe the FFE as a set of five non-sequential elements with no preset order of execution. The early activities, according to Reid and Brentani (2004) are, problem/opportunity structuring and/or identification/recognition (Leifer et al., 2000; Urban and Hauser, 1993); information collection/exploration (March, 1991); and 'up-front homework' (Cooper, 1996), whereas the later activities are seen as involving aspects of idea generation and concept development (Cooper, 1990; Urban and Hauser, 1993), continued information collection, and informal or prescreening (Crawford, 1980; Crawford and Di Benedetto, 2003) with possibly some initial fund allocation for exploring a new idea (Cooper, 1990; Cooper and Kleinschmidt 1986).

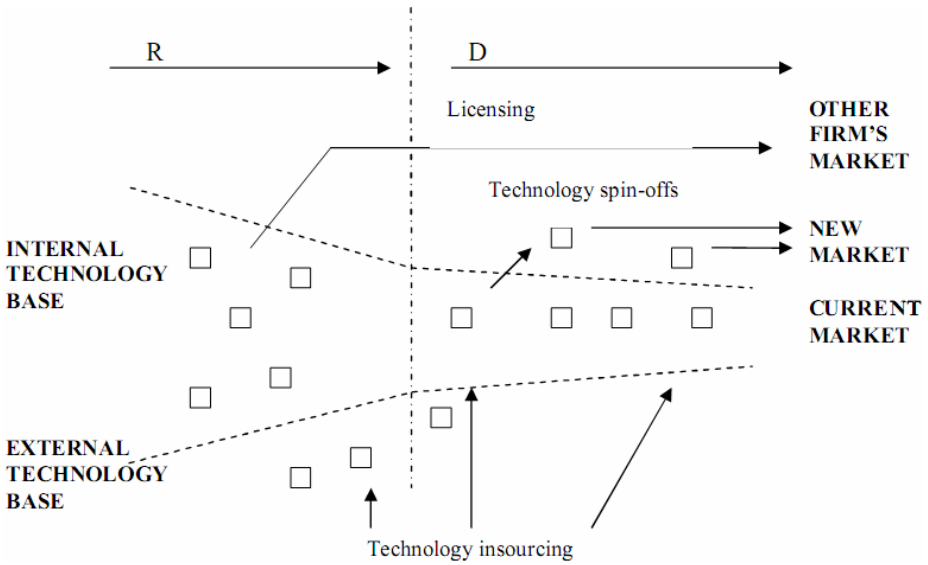
The FFE model that we will be confirming to in this paper is the new concept development (NCD) model introduced by Koen et al. (2001). The model consists of three key parts:

1 the five key elements (activities) in the FFE, namely idea genesis, idea selection, opportunity identification, opportunity analysis and concept and technology development

2 the engine which drives the above-mentioned elements and is fuelled by the leadership and culture of the organisation

3 the influencing factors, consisting of organisational capabilities, business strategy, the outside world (i.e., distribution channels, customers and competitors) and the enabling science (Torkkeli et al., 2009).

Figure 1 The OI model



Note: The dotted lines represent the firm boundaries in the 'development funnel', where the small squares represent product concepts.

Source: Chesbrough (2003b, p.37)

4 Synthesis of the two theories

4.1 External acquisition in the FFE

Both the theories of OI and FFE deal with issues central to success in innovation management and new product or technology development. Indeed, both have even been seen as the most promising avenues of research for boosting innovation success in their own time. These two theoretical models are however situated somewhat differently in respect to the entire innovation process of the organisation. In the literature of the FFE, it is often portrayed as one of three segments in a sequential process that depicts the innovation activities undertaken by the firm: FFE, NPD (e.g., Stage-Gate^{TM}) process, and finally commercialisation. In contrast, the OI model is often illustrated in connection with the 'development funnel' (depicting the NPD pipeline in the firm), as in Figure 1.

The FFE is situated at the leftmost side of the development funnel, so the foremost overlap of the two theories is to be found in acquiring external knowledge (i.e., tapping into the external technology base). Here, OI leverages the role of R&D. The researchers' job is transformed from only creating knowledge to also capturing it from outside the company. It comes as no surprise that this kind of application of the OI viewpoint to the activities of the FFE is indeed implicitly discussed in various FFE studies (e.g., Koen et al., 2001) and, to exacerbate, any use of e.g., lead user methods (von Hippel, 1994) can be considered conforming to the OI ideology. However, even here it is worthwhile to notice that even though the use of external knowledge is highly beneficial and crucial to the success rate of activities in FFE, the wide majority of the FFE studies still have a decidedly internal focus. OI studies (and practices) are often centred on external knowledge acquisition and cover the area extensively, but still hardly any explicit connection to FFE theories is drawn. A higher rate of interaction with the external environment can be applied both in opportunity identification (e.g., lead user methods) and idea generation (e.g., brainstorming together with trusted suppliers or investigating in-licensing options to fill technology gaps). Companies that have reached an even higher, sustained level of openness in their business model may be able to benefit from the external possibilities in opportunity and idea analysis elements of FFE as well, even partnering with competing firms in concept development entirely, when it makes business sense for both participants. A good example of a company mastering these principles is found in Procter & Gamble (Huston and Sakkab, 2006) and their Connect and Develop approach.

4.2 Connecting external exploitation to FFE

The external exploitation of knowledge, on the other hand, seems an entirely uncovered topic in the FFE literature. This was expected as well, as this 'inside-out process' of OI (Gassman and Enkel, 2004) is generally perceived as being more challenging for companies. Firms, excluding few OI exemplars such as IBM and P&G, are still finding it difficult to overcome both the inadequacies of the current technology marketplace and the NSH virus. Furthermore, the linear conceptual arrangement of the innovation process, where commercialisation and FFE are separated by the formal NPD process, found in much of the FFE literature also points towards difficulty in making the connection between FFE and external commercialisation of knowledge.

Does such a connection exist then? When assessing the potential of a new innovation, measurement errors in the FFE and its interface to NPD, *false positives* and *false negatives*, are paid attention in the OI model. Chesbrough (2004) especially refers to the false negatives, which are projects that companies abandon, because they seem to be unpromising and unsuitable to the firm's business model, although they hold tacit, inherent potential. To manage these measurement errors in conditions of high technology and market uncertainty, he proposes that companies adopt a new way to manage innovation, one that explicitly deals with the research waste generated by inevitable measurement errors. Furthermore, Lichtenthaler (2008) has found that firms being able to master both in- and outbound OI in general simultaneously are likely to enjoy synergistic benefits and hence we propose extending this notion to the front end as well.

We found that connecting the less explored external exploitation side (Lichtenthaler, 2004) of OI with the theoretical basis of the FFE leads to some interesting findings. While many of the prevalent pieces of literature regarding methods of increasing firm performance in the front end focus on ways to achieve faster kill decisions for ideas and opt for aggressive screening, applying the OI perspective would in some cases seem to provide additional justification for keeping ideas or concepts in further development and at the least provide alternate ways to deal with some of the ideas that face the kill decision and would otherwise be filed on the shelf as 'dormant' concepts, only never to be looked at again. Integrating practices from OI, previously associated only with the actual NPD phase of the innovation process, we managed to enhance the NCD model, originally presented by Koen et al. (2001), creating a new framework for managing activities in the FFE that is better suited to a firm that is embracing OI principles.

5 Resulting framework

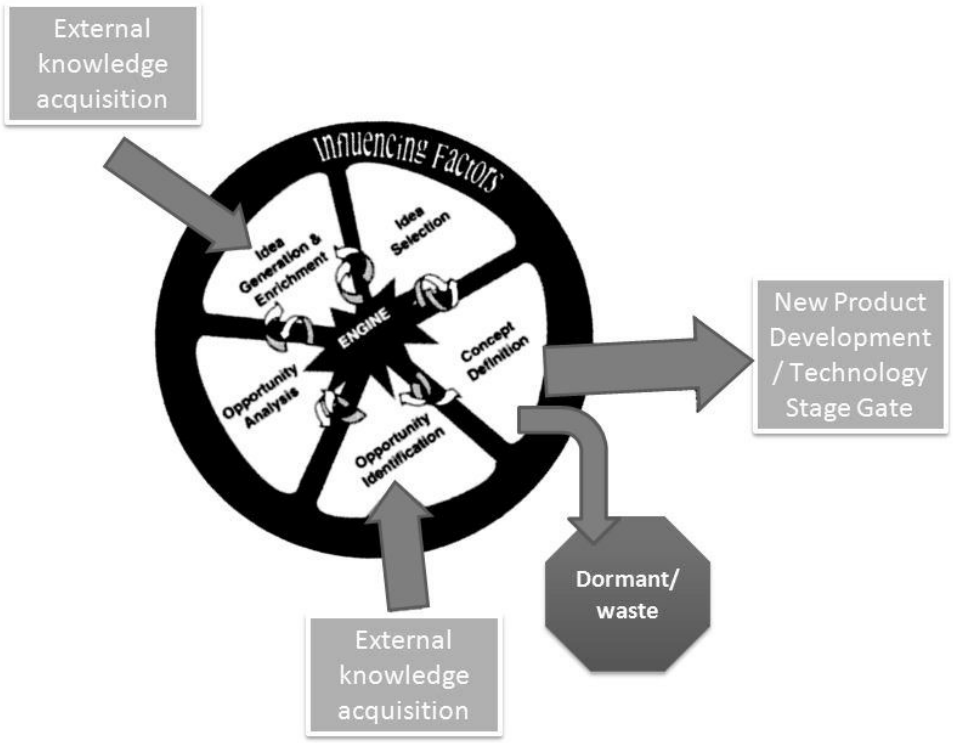
5.1 Framework of open NCD

As explained earlier the original NCD model introduced by Koen et al. (2001) consists of three key parts: The five key elements (activities) in the FFE, the engine of leadership and organisational culture which drives the elements and the influencing factors. The model is a fair summary of the FFE understanding developed in the 90s: a process for converting the needs of the immediate customer and the ideas generated from the internal technology base into product and service concepts for internal development. Updating the model with the OI understanding of 2003 (Chesbrough, 2003c), we include the external knowledge base as an input to the idea generation and opportunity identification elements, denoting the extended network for discovering needs and the additional boost in technological ideation coming from the external R&D organisation. What still needed to be added to come to a truly Open NCD model was the deliberate, pre-emptive consideration of external exploitation possibilities, i.e., external development, to connect the outbound OI mode to the concept development phase.

The framework of Open NCD is illustrated in Figure 2, below. The figure also shows the external knowledge acquisition side of applying OI by the arrows denoting the primary elements influenced in the FFE. In the common NCD model, the concepts have but two exits from the circle: continuing towards internal development, or being killed, leading them to be discarded as waste or stored as dormant concepts for an indefinite amount of time. Neither of the kill options salvages any of the resources put into

development of the concept, which is frustrating for the company. If we extend the OI ideology to the NCD model, some of the concepts may be salvaged through *external concept exploitation*, discussed in more length in the following sub-section, even if they are not suitable for internal development.

Figure 2 Applying an OI perspective to the NCD model



Source: Adapted from Koen et al. (2001)

5.2 Capturing concept value by open NCD

Firstly, we propose that *adopting an OI viewpoint in the FFE reduces unprofitable Kill decisions*. Most of the decisions taken in the FFE are performed under extremely limited information bases due to the inherent fuzziness (Zhang and Doll, 2001). In these circumstances, uncertainty about the future commercial prowess of a concept and its fit to the company's established business model and product line are critical points that often cause good project concepts to be killed, because scarce resources have to be administered to the projects that bring the most certain profits. These harsh criteria may be alleviated by already in the front end phase of development considering the possibility of complementary or entirely external commercialisation of the resulting product or technology. Furthermore, this may even lead to a fundamental change in the way a company operates: if it possesses a solid development capability to produce technologies sought after by the external actors, it stands a chance to reap great rewards by incorporating external exploitation aspects into its FFE concept evaluation criteria. The

often neglected option of externalising a certain concept in mid-development if internal development becomes unattractive lowers the risk involved in undertaking projects. If risk mitigation is the priority for the firm in undertaking Open NCD, it should pay special attention to external opportunity identification in the concept phase and maintaining close relationships in the networks where the technology can be marketed (Bidault and Fischer 1994; Torkkeli et al., 2009). This enables the firm to have a pre-drafted contingency plan to fall back on if the concept becomes unattractive to internal commercialisation during development. In other cases, the possibility of complementing commercialisation by own distribution channels by external non-competitive commercialisation, heightens the profit expectations of the concept, also helping to balance out the risks involved in development.

Secondly, being mindful of the opportunities in the external landscape *help reduce concept waste and improve NCD cost effectiveness by introducing a practice of external concept exploitation*. External concept exploitation may manifest in many ways, e.g., partnering with another organisation where the company would offer the developed concept and gain access to the partner's development skills and/or commercialisation channels, which ever being the restricting resource for continuing with internal development. Another possible way would be to let the employee(s) 'championing' the concept receive capital from a dedicated venture fund to find a working business model for it: if this succeeds the start-up may be spun back in. Such practices are already being adopted in select organisations, e.g., Deutsche Telekom (Rohrbeck et al., 2009). Opening concepts for external exploitation does not mean that all ideas will be salvaged: mediocre ideas will remain mediocre and still be killed as before. This only means that the novel, profitable ideas that you can't take full advantage of by yourself should not go to waste, or walk out with your brightest employees developing them.

Below is an example in the form of a table, Table 2, for how a firm might deal with some variant cases of technology concepts that come up in the FFE. There are a few points worth noting in the table. First of all, in addition to evaluating only the technology's potential itself, important considerations are also the fit to the business model as well as fit to the core competences of the company. Together, these provide some indication of overall strategic fit, although it is far from synonymous to actual strategic fit, which should also be considered as a separate point. Secondly, only those ideas that fit well with the business and which the firm is able to develop well on its own are taken into the internal NPD pipeline, just as in previous models. The key difference here is that only the models with weak inherit potential are completely discarded or set dormant. When the firm does not have the necessary core competences for a specific concept, but sees its value in complementing the current business model as significantly positive, it should opt to obtain a technology partner to assist in development; meanwhile also obtaining needed competences by learning effects in the course of cooperation. If the situation is the opposite, so that the development of the technology would be right in the company's core competence area (and indeed it might be the only company able to develop the technology so efficiently), but for some reason it does not fit into the current or planned business model, the company may opt to develop it for external commercialisation (by licensing or even outright sale of the technology to another organisation). If both areas are weak, but the technology holds great potential, it should be released to external concept exploitation, as described above. Still, these are not the only factors in play when deciding on external exploitation of knowledge assets, as no such decision can be made independent of the environment (Lichtenthaler, 2009)

Table 2 How to deal with different types of concepts in the FFE

Technology potential	*Fit to business model*	*Fit to core competences*	*Exploitation of concept*
High	High	High	Internal NPD
High	High	Weak	Partnership
High	Weak	High	NPD → Ext. commercialisation
High	Weak	Weak	Ext. concept expl.
Weak	Low/high	Low/high	Waste/dormant

5.3 Strategic leveraging of open NCD

Capturing strategic benefits from any external exploitation efforts requires certain internal competences, organisational mechanisms and a strategic alignment of the activities. Lichtenthaler and Ernst (2008) argue that despite potential synergies in achieving monetary and strategic objectives, external technology exploitation may be managed in relative isolation, but only if it is exclusively directed at generating revenues, e.g., optimising a firm's technology portfolio by commercialising residual technology (Davis and Harrison, 2001). By contrast, a more integrated approach is essential for achieving the strategic opportunities, e.g., ensuring freedom to operate (Grindley and Teece, 1997; Rivette and Kline, 2000).

Also in the FFE, OI practices need not and should not limit to pursuing short-term monetary benefits. In the modern landscape of innovative competition, knowledge is a highly valuable commodity that can be leveraged to provide longer term strategic benefits as well. Proactively managing knowledge in- and outflows in the earliest phases of product and technology development allows the company a multitude of new strategic options. Strategically managing the concept development and selection in the FFE can be done with the aim of producing knowledge that can be used to, e.g., attract access to sought after networks, to build skills and competence in new areas through leveraging external partners and even thus enabling the search for new business opportunities in markets outside the current business. Considering open opportunities broadens the opportunities available for the company increasing both the multitude and potency of the strategic options available (Kyläheiko et al., 2008) and providing the firm the ability to make a more informed and pre-meditated decision concerning them. Overall, the OI perspective and consideration of all the options available allows making a shift from a 'just profit' evaluation of the concepts to a more strategic, long-term control over the company's future.

Concept exploitation even on a large scale may be motivated entirely by potential strategic benefits and performed without monetary compensation. Consider the case of the Nokia Technopolis Innovation Mill. The Mill is a three-year partnership between Tekes (the Finnish Funding Agency for Technology and Innovation), Technopolis (a business environment service provider) and Nokia that offers a portfolio of hundreds of dormant Nokia concepts to start-up companies – for free. Furthermore, the offer is complemented by funding (8 million Euros have been set aside for this purpose only) and business development services to the start-ups willing and able to take up on Nokia's concepts (Nokia Conversations, 2009). In addition to the marketed corporate social

responsibility angle, the partnership stands to be beneficial to Nokia in other ways as well. Nokia is positioned to reap the strategic benefits of rapidly expanding its network of firms producing complementary product offerings and services, improving on its ability to pick up on weak signals and also externalising development of concepts that did not pass the harsh selection mechanisms at the company's front end; perhaps even creating candidates for future spin-ins.

6 Findings and conclusions

Traditionally all the efforts in the early development phases are devoted to forcing the emerging technological opportunities to the servitude of a previously chosen application need in a company or solving the technical difficulties involved. Meanwhile, little thought is given to the eventual commercialisation of the technology, and certainly no external opportunities are yet considered. We propose that this way of thinking is one of the causes that lead to the low commercial success rate of NPD processes. Instead the organisation could benefit from supporting the decision making in the FFE by thinking ahead in a few trajectories, starting from the emerging technological possibilities and ending in not only internal, but also external commercialisation opportunities. This opening of perspective may reveal new possibilities, possibly even outside the firms current business. This thought is examined and discussed more thoroughly with the use of the theoretical tools provided by FFE and OI literature. Researching the FFE theory (e.g., Koen et al., 2001), that was considered to perhaps hold the most promise in boosting the innovative processes of firms in the nineties, and the OI theory that is seen today as the new wave of cutting edge innovation theory that is in even touted as the superior model for current business (Torkkeli et al., 2009; Enkel, et al, 2009), we made interesting findings. It has already been established in literature that the theories indeed do have some overlapping ideas such as the utilisation of external innovation sources to boost innovativeness and idea generation. However, our primary findings reside in the much less explored area of external technology exploitation (Lichtenthaler, 2005) and its implications when combined to the FFE. Here, we introduced the notion of external *concept* exploitation (to distinguish from external *technology* exploitation) referring to the profitable externalisation technology or product concepts that have not yet qualified for the internal NPD pipeline.

In the modern innovation, landscape embracing the external options available in the front end of innovation will result in better cost effectiveness, better success rates and an increase in strategic options (Kyläheiko et al., 2008) available to the firm. We built upon the NCD model of FFE theory (Koen et al., 2001) and integrated practices from OI that have previously been associated only with the actual NPD phase of the innovation process (Chesbrough, 2006b) to build a new framework for managing the FFE in 'open' companies. The chief benefits of the proposed framework are reducing unprofitable Kill decisions in NCD, reducing concept waste, enabling external concept exploitation and increasing proactive, strategic management of FFE concepts.

Next, the model would have to be further validated with conducting an actual case study with a high-tech enterprise having sufficient knowledge resources and an accommodating organisational structure for implementing the framework. Thus, pairing commercial thinking with technology development in a real world environment at a very early phase would according to our theory potentially enable various benefits to the

organisation: improved hit rate for NPD, enabling early work on the business plan, shortening development time thus lowering total cost and even preparing contingency plans for commercialisation in case of technical difficulties or changes in the market.

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Publication 3

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Extending the Fuzzy Front End beyond Firm Boundaries: Case Demola

Antero Kutvonen*

Lappeenranta University of Technology, Kouvola Unit, Prikaatintie 9, 45100 Kouvola, Finland
E-mail: antero.kutvonen@lut.fi

Kai Havukainen

Tampere University of Technology / Nokia Corporation, P.O. Box 1000, 33721 Tampere, Finland
E-mail: kai.havukainen@nokia.com

* Corresponding author

Abstract: The paper demonstrates a practical implementation of open innovation in the fuzzy front end by demonstrating a method of academia-industry collaboration called Demola. With Demola a focal firm externalizes FFE concepts to an IPR neutral platform, where university students develop "from powerpoint ideas to prototypes". Following evaluation, concepts can be licensed back in by the firm and/or exploited independently by students, e.g. by forming start-ups. Demola is evaluated in terms of performance, experiences gathered and lessons learned with both quantitative and qualitative data concerning a sample of 29 Demola projects between 2008-2011. Demola proves effective in fast, cost-effective prototyping of ideas before deciding to continue development. The results indicate that NPD hit rate may be improved by opening the FFE and that Demola is a viable method for diminishing the number of false negatives in firms' NPD processes.

Keywords: Fuzzy front end, Open innovation, New product development, technology management, entrepreneurship

1 Introduction

Numerous examples have shown how prone firms' NPD processes are to generating false negatives where good ideas are wasted causing both societal and private losses (Chesbrough, 2003). Late 80s and in the nineties early phases of NPD, i.e. fuzzy front-end (FFE), became popular among academics (Eldred and McGrath, 1997; Khurana and Rosenthal 1998), although recently academic interest has shifted towards more collaborative approaches. Open Innovation and increased collaboration are seen as potential solutions, but practical implementation has proven difficult (Enkel et al., 2009). Few attempts have been made to bring integrated open innovation viewpoints into the FFE and the literature (e.g. Kutvonen and Torkkeli, 2010) remains at conceptual and theoretical levels without empirical evidence. In the current economic crisis societal challenges arise and bring escalating demand for fostering the development of new fast

growth, innovative SMEs to fuel stalling economies and for corporate actions of social responsibility.

The overall research question for the study is how can Open Innovation be integrated to the fuzzy front end efficiently, and in practice? In search for the answer we need to address multiple sub-topics and questions. How can the commercial hit rate for NPD be improved (i.e. false negatives avoided)? Provided that collaboration, or opening up, is key to this as recent literature would suggest, how can open innovation be practically implemented in FFE? We focus here on studying a potential candidate method for this called Demola. With the Demola method a focal firm opens up its FFE and provides concepts with high, but uncertain potential for development outside its boundaries to an IPR neutral platform, where skilled university students develop the concepts "from powerpoint ideas to prototypes". The concepts are then evaluated and can be licensed back in by the focal firm and / or exploited by the student team independently. The tool allows implementing external concept exploitation (Kutvonen and Torkkeli, 2010), i.e. open innovation in the FFE, while students get a chance to work with and form start-ups based on concepts relevant to industry interests. Finally, considering the Demola method as an implementation of open innovation principles in the FFE, brings the questions of how and why does Demola work and how well does it perform?

The paper brings attention to a sustainable innovation method that combines low costs and high performance. From the business point of view the capability to cope with in- and outflows of technology is improved. It provides means to implement OI within the extant innovation process and to improve the profitability and hit rate of NPD and innovation functions within the firm. Academically, the paper responds to the call for empirical research into open innovation, for building linkages between OI and other strands of innovation management and opens new interesting research avenues.

The research is structured as follows. We begin by reviewing the literature with a focus on combining FFE, OI and innovation processes. The resulting framework combines an integrated OI approach to the front end and is used to analyze the Demola innovation method. Demola is evaluated in terms of performance, experiences gathered and lessons learned with both quantitative and qualitative real-life data concerning a sample of 29 projects between 2008-2011 where Nokia has been the initiating focal firm utilizing Demola. Finally the empirical results are reconciled with the theoretical and conceptual understanding thus bringing forth conclusions and practical implications grounded in real-life data and discussed in relation to the challenges firms and societies are facing today.

2 Theoretical background

2.1 Open Innovation

The innovation models have been changing during the past decades, advancing through five distinct generations towards a more complex and connected picture. (Rothwell, 1992) The expression of "the development funnel", in which innovations move through different stages from the idea creation to the launch phase, is commonly used to describe the transformation of an idea to a product or a service (Cooper, 1990; Smith and Reinertsen, 1991). Here, R&D projects can only enter in and exit one way (Chesbrough, 2006a): Companies believe that they have to do everything internally. Chesbrough

(2003c) refers to this traditional, and in many cases now outdated, model as the closed innovation model, which is since compromised by four erosion factors: mobility and ready availability of skilled workers, availability of venture capital (utilization of ideas in start-ups), external options for shelved ideas and deeper collaboration with suppliers in development processes. All of these factors contribute to global spillover of technological knowledge, eroding the corporations' control over intellectual assets. Academics and business people picked up on these events and a string of literature emerged, heralding a fundamental change in the innovation paradigm.

Prior research in open innovation has largely focused on external knowledge acquisition (inbound open innovation) and the make-or-buy decision, i.e., whether to develop knowledge in-house or to acquire it from external sources (see e.g. Granstrand, et al., 1992; Veugelers and Cassiman, 1999; Ferretti and Romano, 2006). As an example, von Hippel (1994) suggested early on that companies should use external sources, customers, suppliers, universities and other companies, in their R&D activities. Since the 1990s scholars extensively studied various governance modes for external technology sourcing like strategic alliances, joint ventures, acquisitions (see e.g. Lambe and Spekman, 1997; Hagedoom and Duysters, 2002; Vanhaverbeke, et al., 2002), or inward technology licensing (Smith and Reinertsen, 1991).

The perspective of actively managing the external exploitation of knowledge assets (outbound open innovation, in terms of "selling" or exchanging knowledge in the market) has been adopted in literature as well with first technology management studies dating back to the 70s. Subtopics here have been e.g. technology licensing, technology-based spin-offs, strategic alliances and joint ventures (Escher, 2005). The term 'technology marketing' (Ford, 1985) also refers to similar concepts. After these early works significant research to this theme became scarcer, only to be picked up again later (especially by Ulrich Lichtenthaler, e.g. 2005; 2011) in the wake of Chesbrough's (2003) popular work on open innovation. Although much of the practice and literature focuses on inbound aspects (Chesbrough, 2006b; Enkel et al., 2009), the interest in outbound open innovation has also grown significantly (see e.g. Chesbrough 2003d, 2006b; Tschirky, et al., 2004). A primary reason for this increased attention to the "sell" is brought by the maturing of markets for technological knowledge, by which firms increasingly have multiple opportunities to leverage their technological assets (Arora, et al., 2001). Besides monetary gains, outbound open innovation may be used to realize strategic (i.e. non-monetary) benefits as well (Kutvonen, 2011).

Even if there is currently a lot of discussion and literature about Open innovation, the exact definition of the concept may not be entirely obvious. Chesbrough (2003c) defines Open innovation by the movement of knowledge across the boundaries of the firm (or organization). Another definition is given by Lichtenthaler (2008) where open innovation is defined as 'systematically relying on a firm's dynamic capabilities of internally and externally carrying out the major technology management tasks . . . along the innovation process.' Here, the notion of a systematic activity is invoked and open innovation is connected to certain capabilities implying both deliberation and a need for proficiency. Still the definition remains open-ended, offering little focus. Yet a further definition is provided by Chesbrough (2006a) defining OI as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively'. It should be noted, however that while this definition captures all instances of the paradigm of Open innovation, such as the donation of intellectual property to Open source in the software industry (Chesbrough, 2007), it

indiscriminately takes into account all and any inflow and outflow of knowledge, such as e.g. a traditional customer satisfaction survey. To reach an operable definition, we propose the following definition (adapted from Lichtenthaler, 2005):

Open innovation describes an organization's deliberate commercializing (exploitation) of knowledge assets to and / or acquisition from another independent party involving a contractual obligation for compensation in monetary or non-monetary terms.

2.2 Fuzzy front end of technology development

When the process of New Product Development (NPD) is sliced into pieces, the time and activities that precede any formal commitment of starting the development is often called Fuzzy Front End, FFE (e.g. Smith and Reinertsen, 1991). It thus precedes a formal NPD processes such as Stage-Gate™ or Product and Cycle Time Excellence (PACE®) (Koen, et al., 2001). There have also been attempts where the Fuzzy Front End has been depicted as an extension of the formal Stage-Gate process as the "pre-phase zero, phase zero and phase one" phases (Cooper, 1997; Khurana and Rosenthal, 1998; Moenaert, et al., 1995). The definitions of FFE vary but Kutvonen and Torkkeli (2010) define it by referring to earlier academic literature as follows:

FFE refers to the early 'ideation step' (Cooper, 1993) *that precedes a structured NPD process and is concentrated on generation, refinement and analysis of new concepts* (Koen et al., 2001) *arising from identification of a unfulfilled market need and/or a (untried) technological opportunity* (Smith and Reinertsen, 1991) *and ending in organizational commitment to advance and fund the concept to NPD or discontinue concept development* (Khurana and Rosenthal, 1998).

The FFE is seen to be one of the most important determinants of NPD success, or as Zhang and Doll (2001) put it: most projects do not fail in the end, they fail at the beginning. Based on prior works on the fuzzy front end and the nature of uncertainty, Zhang and Doll (2001) define the front-end fuzziness of NPD as the uncertainty of customers (portfolio, preference, life-cycle and volume fuzziness), technology (material, specification and supply fuzziness) and competition (competing product development and adoption speed fuzziness), which are the lead causes of the managerial difficulties associated with it. It is generally agreed by both managers and academics (Chase and Tansik, 1983; Cooper and Kleinschmidt, 1994; Rosenau, 1988; Smith and Reinertsen, 1991) that, of all the actions firms can take to improve their NPD process, those taken at the fuzzy front end give the greatest time savings or improvement in outcome for the least expense.

Scholars of NPD have discussed ''up-front activities'' in a generic way for more than 20 years (Crawford, 1980), generally advocating various approaches to implement more aggressive screening processes. Especially in the nineties, there has been a notable string of literature (Khurana and Rosenthal, 1997; Moenaert, et al., 1995; Reinertsen, 1999) pertaining to this subject, most of it having to do with managing the uncertainties, speeding up the screening of ideas or attempting to provide structure into the seemingly chaotic, experimental and unpredictable phase of the innovation process (Koen, et al., 2001). More recent research includes the attempt to reduce and explain the fuzziness of the front end by applying uncertainty theory (Zhang and Doll, 2001) as well as Reid and

Brentani's (2004) distinction between the fuzzy front ends of radical and incremental innovation.

The early activities, according to Reid and Brentani (2004), are problem/opportunity structuring and/or identification/recognition (Leifer, et al., 2000; Urban and Hauser 1993); information collection/exploration (March, 1991); and ''up-front homework'' (Cooper, 1996), whereas the later activities are seen as involving aspects of idea generation and concept development (Cooper, 1990; Urban and Hauser, 1993), continued information collection, and informal or prescreening (Crawford, 1980; Crawford and Benedetto, 2003) with possibly some initial fund allocation for exploring a new idea (Cooper, 1990; Cooper and Kleinschmidt 1986).

Koen et al. (2001) incorporate the FFE activities in The New Concept Development (NCD) model, which is described as a set of five elements (Idea genesis, Idea selection, Opportunity identification, Opportunity analysis and Concept & Technology Development) with no preset order of execution that are coupled with the engine of leadership and organizational culture and external influencing factors. This model has later been conceptually updated with the integration of OI themes by Kutvonen and Torkkeli (2010).

2.3 Open innovation in the fuzzy front end

Both the theories of Open innovation and Fuzzy front end deal with issues central to success in innovation management and new product or technology development. These are situated somewhat differently in respect to the entire innovation process of the organization. FFE is often portrayed as one of three segments in a sequential process that depicts the innovation activities undertaken by the firm: Fuzzy front end, New product development (e.g. Stage-GateTM) process, and finally Commercialization. In contrast the Open Innovation model is often illustrated in connection with the "development funnel" (depicting the NPD pipeline in the firm), as in Figure 1 below.

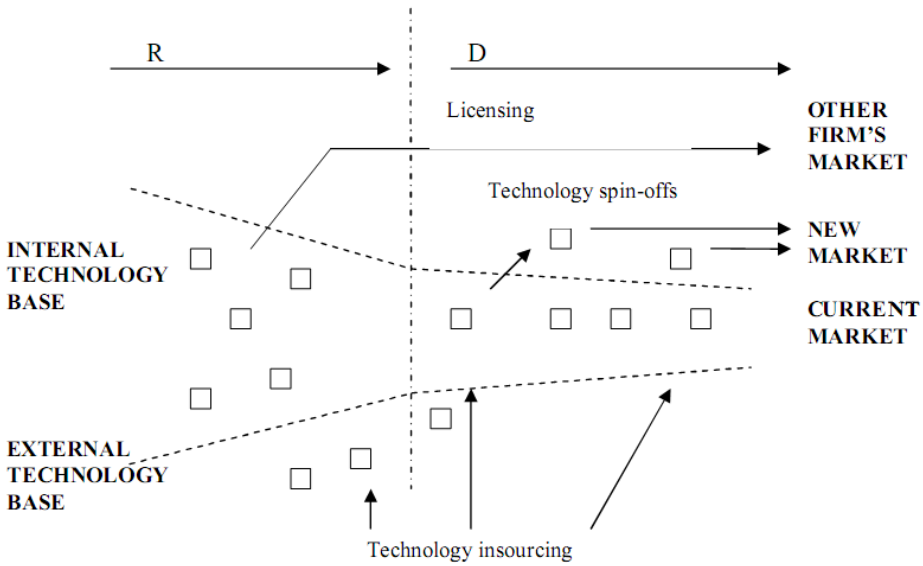

Figure 1 The open innovation model (Chesbrough, 2003b, p. 37). The dotted lines represent the firm boundaries in the "development funnel", where the small squares represent product concepts.

Inbound open innovation (i.e. tapping into the external technology base) provides the foremost overlap of the two theories as the fuzzy front end connects to the leftmost side of the development funnel. Open innovation leverages the role of front end R&D by extending it to incorporate both creation of knowledge as well as capturing it from the environment. This is indeed implicitly discussed in various FFE studies (e.g. Koen, et al., 2001) and, to exacerbate, any use of e.g. lead user methods (Von Hippel, 1994) can be considered conforming to the OI principles. However, while the use of external knowledge is highly beneficial to the success rate of front end activities, the wide majority of the FFE studies still have a decidedly internal focus. Open innovation studies (and practices) are often also centred on the inbound aspects and cover the area extensively, but still hardly any explicit connection to FFE theories is made. In terms of the NCD model (Koen et al., 2001), open innovation approaches can be applied both in opportunity identification (e.g. Lead user methods) and idea generation (e.g. brainstorming with trusted suppliers or in-licensing to fill technology gaps). Companies with routine open innovation practices may be able to open opportunity and idea analysis elements of FFE as well, such as with Procter & Gamble (Huston and Sakkab, 2006) and their Connect and Develop –approach.

Outbound open innovation in FFE, on the other hand, remains virtually untreated in the literature, with Kutvonen and Torkkeli's conceptual framework (2010) being the sole exception. One reason is found in the linear concept of the innovation process, where commercialization and FFE are separated by the formal NPD process. When assessing the potential of a new innovation, measurement errors (false negatives/positives) in FFE and regarding the entry of concepts to NPD are highlighted in the open innovation model. Chesbrough (2003d) especially refers to the false negatives, which are projects that companies abandon, because they seem to be unpromising and unsuitable to the firm's business model, although they hold tacit, inherent potential. To manage false negatives, he proposes that new ways to manage innovation are needed that explicitly deal with the research waste generated by inevitable measurement errors. Furthermore, Lichtenthaler (2008, 2011) has found that firms being able to master both in- and outbound open innovation simultaneously are likely to enjoy synergistic benefits.

3 Open New Concept Development

3.1 Framework of Open New Concept Development

Many of the prevalent pieces of literature focus on ways to achieve faster kill decisions for concepts in the front end and opt for aggressive screening. Applying OI with the Open New Concept Development (ONCD) framework (Kutvonen and Torkkeli, 2010) provides additional justification for keeping ideas or concepts in further development (potentially outside the firm) and offers alternate ways to deal with some of the concepts that could constitute false negatives in the traditional process (see figure 2 below). We apply the conceptual framework for evaluating a related practical implementation in form of the

Demola innovation method with the assumption that ONCD improves the firm's actual hit rate by more accurate screening of FFE concepts (especially false negatives) to development.

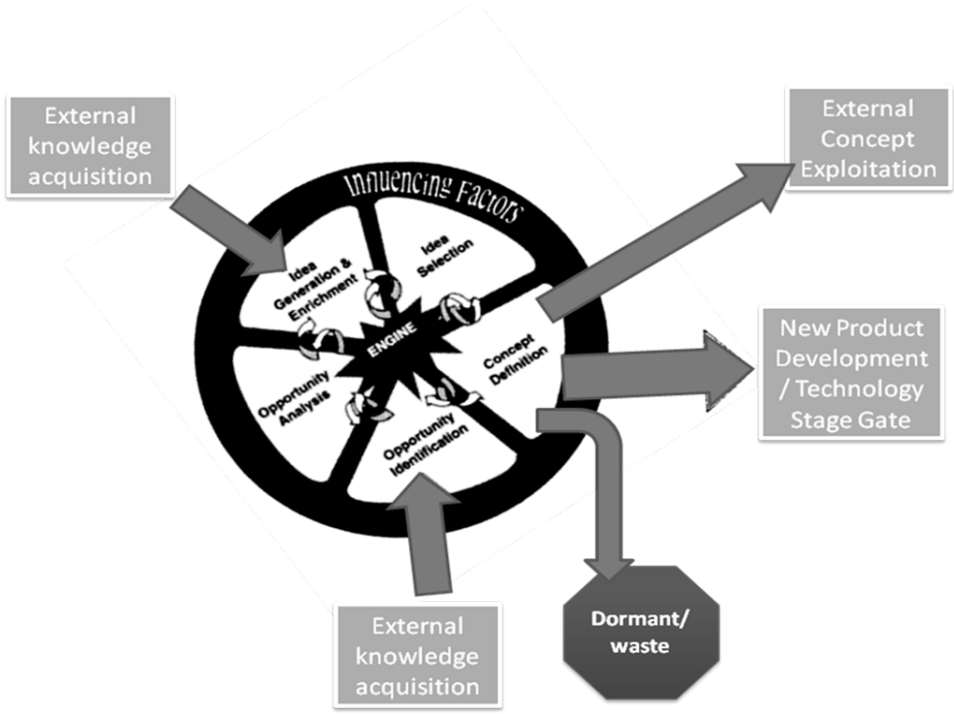

Figure 2 Open New Concept Development model (adapted from Koen et al., 2001 by Kutvonen and Torkkeli, 2010)

The ONCD model includes the external knowledge base as an input to the idea generation and opportunity identification elements to incorporate inbound open innovation approaches. It also connects the outbound open innovation mode to concept development by pre-emptive consideration of external exploitation possibilities.

In the common new concept development model the concepts either continue to internal development, or are "killed" by being discarded as waste or shelved for an indefinite amount of time. Neither of the kill options salvages any of the resources put into development of the concept, which is frustrating for the company. By the ONCD model, some concepts (i.e. false negatives) may be salvaged through external concept exploitation.

Full incorporation of open innovation to the FFE allows the firm to capture more of the value of innovative concepts and thus offers multiple advantages (Kutvonen and Torkkeli, 2010):

- Reduces unprofitable Kill decisions (i.e. false negatives): Highly selective FFE processes have a notable bias towards concepts offering more certain (but often lower) profits, which is emphasized in conditions of high uncertainty

- Offers lower cost development / commercialization prospects to balance cost-benefit assessments of concepts by including external development and exploitation options
- May allow higher revenue estimates through plans of complementary external commercialization
- Lowers risk of proceeding to development: outbound open innovation offers potential to salvage some value of concepts that are deemed unsuitable in mid-development – effectively providing 'contingency plans' for the technology
- Removes skill and capacity constraints of development: Alliances with external partners can be considered already in FFE as a means for obtaining necessary skills and/or engineering and commercialization resources to undertake projects
- Allows a higher degree of exploration: e.g. venture funding may be used as a tool to allow concept "champions" to pursue the idea externally in a start-up, from where it may be licensed or spinned back in if it proves successful (Rohrbeck et al., 2009)
- Enable pursuing strategic motives (Kutvonen, 2011): Achieving non-monetary goals by external exploitation necessitates a higher degree of strategic planning in technology management. These objectives may be e.g. corporate social responsibility and image building (e.g. the Technopolis Nokia Innovation Mill; Nokia Conversations, 2009), ensuring freedom to operate (Grindley and Teece 1997; Rivette and Kline 2000), standardization and such

Below is an example, Table 1., for how a firm might deal with some variant cases of technology concepts that come up in the fuzzy front end.

Table 1 How to deal with different types of concepts in the Fuzzy Front End

Technology Potential	*Fit to business model*	*Fit to core competences*	*Exploitation of concept*
High	High	High	Internal NPD
High	High	Weak	Partnership
High	Weak	High	NPD -> Ext. commercialization
High	Weak	Weak	Ext. concept expl.
Weak	Low / high	Low / high	Waste / dormant

Source: Kutvonen and Torkkeli, 2010

In addition to evaluating only the technology's potential itself, it is important to evaluate the fit to the business model as well as fit to the core competences of the company. Only ideas that fit well with the business and which the firm is able to develop well on its own are approved to the internal NPD pipeline. The key difference to prior FFE models is that in ONCD only the concepts with weak inherit potential are completely discarded or set dormant. When lacking necessary core competences, the firm may opt for partnering in development (by which needed competences may also be obtained by learning effects). If the technological competences fit, the company may develop the concept for external commercialization (by licensing or selling the outcome to another organization). If both areas are weak (or highly uncertain at the point of FFE) but the technology holds strategic potential, the idea should be released to external concept exploitation. It should be noted that also further aspects influence the decision (depending on the case) as no outbound open innovation decision can be made independent of the environment (Lichtenthaler, 2009).

4 Methodology and data

4.1 Methodology

The research applies a mixed method study design that employs both quantitative and qualitative methods to attain a richer understanding and a higher validity of the results. Qualitative data is gathered through interviewing informants connected with each of the Demola projects in the sample as well as representatives of the focal firm and Demola. Quantitative data comes from general statistics of Demola and include performance indicators (e.g. number of new start-ups, successful projects and people employed) about Demola's overall operation in Tampere in the period of 2008 – 2011. The mixed method approach incorporates complementarity and triangulation purposes (Greene, Caracelli and Graham, 1989). Secondary qualitative data is gathered by reviewing the public information at the Demola website and success stories of Demola that further validate the findings. The data were analyzed individually by two researchers and results were then reconciled in joint discussion and analysis before presentation in the paper.

4.2 Data

The research is focused on Demola projects originating from Nokia Research Center (NRC) concepts, i.e. where Nokia has been the focal firm that chooses and externalizes concepts for development in Demola. The authors received a list of all such project proposals between 2009 and 2011 and their respective company contact persons. The list contained 34 project proposals in total, of which 6 were still ongoing and therefore not considered in the present study. From the remaining 28 proposals we couldn't identify a company contact person in one case, and in two cases the contact person had already left the company and could not be contacted. In addition, while interviewing, one contact persons was able to tell about one of the first Demola projects from the year 2008, which was added to the sample. The total number of company contact persons interviewed was 21, and the number of project proposals, of which we were able to get information, was 26. Each of the interviewees was in a research-oriented position in Nokia, such as (senior) research engineer and research leader. These projects thus constitute a sample of

29 projects between 2008 and 2011. The interview was executed over telephone with a standard series of questions for gathering comparable, focused inputs. The following questions were asked from the interviewees:

- Was the project started in Demola?
- Was it completed?
- What was the duration of the project?
- Was the result of the project a demo, prototype, or something else?
- How well did the project meet expectations?
- Was the result of the project licensed to Nokia?
- Was the project or results used or developed further in Nokia?
- Was invention reports filed during or after the project in the project scope?
- Did the Demola team establish a company based on the project results?
- What were the lessons learned (about Demola cooperation) in the project?

The project specific interviews where complemented by interviewing a person in the Nokia Research Center and the head of Demola with open-ended questions regarding the key strengths, unique characteristics and advantages of the Demola method. Statistics about Demola performance were gathered from the Demola informant and concern the overall operation of the Demola method during its existence.

5 Open New Concept Development by using Demola

5.1 Demola method

Demola defines itself as an open innovation platform for students and companies (Demola, 2011). It was set up in the city of Tampere, Finland in 2008 to answer the need of bringing academia, industry, and students together. The initial project ideas and guidance come from project partners, i.e. companies. Students from local universities then form teams to work with the projects developing e.g. prototypes or demos. All IPR generated during the project belong to the student team. In the end of the project the project partner can acquire a license to the developments and reward the students for their work. Demola premises are located in an open working space, called New Factory, in the city centrum that provides an inspiring atmosphere for creative co-creation and new learning opportunities. New Factory also hosts another innovation method called Protomo that is an incubation environment for potential start-ups, including (but not limited to) those derived from Demola projects.

In addition to the “academic setup” described above, Demola also offers another option called “Innosummer”. According to the interviewed Demola representative, in Innosummer the students are recruited by Demola for the period of summer holiday, during which they participate in projects that are subcontracted by companies. These projects differ from academic Demola projects in the sense that companies pay for the development and therefore all IPR to the results are owned by them. During the Innosummer projects the developers work full-time whereas in academic projects the working time is typically about 10+ hours per week. In total the general Demola statistics until September 2011 indicate that so far 170 service and product prototypes have been developed by 850 students and 93% of the results are licensed back by the companies. In addition, 15% of the students have been recruited by the companies after the projects.

According to the Demola representative, the Innosummer projects have generally turned out to produce more inventions and startups than the academic ones.

According to an interviewed company representative, who is also one or the 'fathers' of Demola, a typical idea or concept that companies bring to Demola is a PowerPoint slide with few notes of what the company assumes the implementation of the idea could be or how it could be used. Such concepts are usually unproven from the company's project portfolio point of view, and therefore no resources have been allocated for their implementation. However, the same company representative added, the ideas that are brought to Demola have already been harvested from a larger pool of ideas and concepts at the front end, and are the ones that the company assumes to have potential or where the internal estimation of the actual potential is uncertain. In essence, Demola deals primarily with concepts that are from the company's viewpoint "on the fence" between acceptance and killing or including high uncertainty in their value. Thus, the companies opt for Demola to make a demo or prototype and reveal the actual value. As stated by the Nokia representative, "*the Demola projects may sometimes be fast-and- dirty work but at least they produce something concrete for further evaluation – not only another set of PowerPoints*".

5.2 Performance of Demola

Compiling the interviews with all the representatives of the Demola projects in our sample, we arrived at the following summarized results.

Out of the 26 concepts brought to the Demola platform by Nokia:

- 18 projects were started by Demola teams
- 17 projects were completed
- One project was terminated after 4 months due to the lack of evidence that the team would be capable of even meeting the minimum requirements
- 8 of the concepts failed to find a suitable project team from Demola
- The average duration for the projects was 5,5 months (varying from 4 to 6 months)

Of these 17 completed projects the outcome was as follows:

- 8 projects produced a demo (software or other construction), 8 produced a prototype of a product or service, and one produced an extensive study report
- 16 of the project results were licensed to Nokia according to the Demola principles
- 3 of the projects were considered to have performance "below target", 11 were "on target", and 3 were "above target"

Finally, the interesting part of the survey is how well Nokia was able to utilize the results of the Demola projects. Of the 16 licensed Demola project results:

- 11 remain so far unused by Nokia

- 5 has been used in Nokia for e.g. demonstration purposes
- 3 has been further developed in Nokia

Multiple interviewees noted that during the period of the sample Nokia Research Center faced major organizational changes, which also influenced the Demola projects. In 3 cases the interviewees mentioned that the changes were one of the key reasons why the company lost interest in the Demola project results. Also, in 3 further cases the interviewees estimated that there is potential, or a plan already exists for further internal exploitation of the project results, although the company hasn't yet taken further action.

Other interesting findings include that no startups were established by Demola teams based on the sample of projects studied. One invention report was made on the basis of an innovative discovery in one of the projects. Also, one of the project proposals that failed to find a team within Demola was eventually implemented by Nokia itself. A further result of the Demola cooperation was that Nokia hired one of the Demola students that had shown great talent as a developer in a project.

The interviewees were allowed to freely describe their conclusion of each the projects, from which we picked 8 themes, which were most frequently coming up in the comments. The themes are listed in table 2. as well as the number of positive and negative comments on each theme. Most themes on the feedback regarding Demola should be understood in terms relative to the expectation level of the company.

Table 2 Summary of Demola project feedback themes from interviews

Theme	*Positive comments*	*Negative comments*
Project management of the team	1	2
Project management of Nokia		3
Burden (time) to steer the team	1	4
Team competences	4	5
Commitment of the team members		3
Quality of the work	3	2
Enthusiasm, proactivity	2	
Innovativeness	5	1

By further aggregating from the comments, it is possible to identify three groups of feedback themes that characterize the experience of the informants with the Demola method. The first group highlights the strengths of Demola with themes that are nearly exclusively positive: Enthusiasm and Innovativeness. Secondly, there is the group where experiences on the themes were mixed: Project management of the team, Team competences and Quality of the work. Finally, the negatively tinted feedback themes are:

Project management at Nokia, Burden to steer the team and Commitment of team members.

6 Findings and discussion

6.1 Evaluation of the Demola method

The Demola projects undertaken with Nokia as a project partner had a comparable ratio of developments licensed back (89%) as in other Demola projects (93%). However, not all of the results of the Demola projects in our survey were taken into use or developed further in Nokia – even if licensed in. This may be due to several factors. First of all, the deliverable of the project may have failed to fulfil the expectations that the company had set to it in order to appropriately be able to evaluate the underlying concept, i.e. the deliverable fails to alleviate the initial uncertainty about concept viability. Further notions relate to the use of Demola for combating front end measurement errors. When the initial concept was considered for further development, but there was uncertainty regarding the evaluation, the Demola project delivery reveals it to be a false positive, i.e. not viable for development. On the other hand, although the deliverable may have fulfilled or even exceeded all the expectations, the company concludes upon evaluation that the product idea is not worth taking further (i.e. the original rejection of the idea was not a false negative). Lastly, in our survey we found out that in several cases the idea that the Demola team was working on was seen to be worth developing further but due to the changes in strategy or organization, the company lost interest to the subject.

The interviews indicated that in most of the projects the company representative didn't consider the Demola project to be a failure although its results were not actively used (only 3 out of 17 deliveries were considered "below target"). A partial explanation is that the projects were proposed by a research organization (Nokia Research Center) in which it is acceptable to fail (following prescriptions by creativity research, e.g. Amabile, 1998). The research organizations of companies are typically working in the very first steps of the innovation process, including the fuzzy front end, where a great number of ideas are evaluated in order to identify a handful of really potential ones. Therefore the contact persons with a research background easily consider eventually unused project results as a nice try instead of a disappointing failure. Considering the most evident successes from the Nokia-Demola cooperation, out of 18 initiated projects, three were approved for internal development. This suggests that by opening up the FFE by the use of Demola, Nokia was able to salvage a considerable portion of false negatives (or uncertain concepts) back to development, instead of placing them on the shelf.

Another viewpoint to the performance of the method can be found from the Demola platform itself. The students are paid only after the project has been completed, and the payment is subject to the company's willingness to license the results as well as to the quality of the overall project. This way of working differs from conventional subcontracting projects where the customer is typically paying regardless of the usefulness of the results – and therefore quality requirements for the outcome are generally higher. This would probably be the case also in Innosummer projects. In the academic setup of Demola the companies are not in the risk of losing their money at any point.

In order to succeed, companies that utilize Demola should be clear and realistic on their level of expectations and participate to the process accordingly. Firstly, the Demola personnel do not presently make very extensive analysis of the skills and motivations of the students. Therefore the team may contain a variety of talents – in good and bad (feedback on the theme of team competence was evenly split among the two). According to three of the interviewees, loose commitment was an issue with some of the teams and individual members could even drop off completely. It was also seen that when Demola work was connected to university courses that defined a solid schedule and milestones for the Demola project, the commitment of the team members – and their capacity to deliver – was significantly improved. Project management aspects in general were often brought up by interviewees. Several projects needed relatively lot of steering and guidance, as students are relatively inexperienced in product development and have a limited set of essential competences. Quality of the work received mixed feedback, where some of the project deliverables were considered to be lacking, while others exceeded expectations. The overall level of innovativeness and enthusiasm were seen as highly positive and made an impression on the interviewees. Several commented on the new ideas and suggestions provided by the students to be very useful and complementing internal ideas well. A testament to the performance of Demola is also the fact that only one of the 18 started projects was terminated prematurely that is exceptional for FFE projects.

In summary, Demola as an innovation method situated in the fuzzy front end has a number of unique features and advantages that make it advantageous for all involved parties. The core of the method is in the facilitation of the collaboration between entrepreneurial students, universities and established companies which builds on the well-defined IPR rules that set a balanced and trust-inducing atmosphere. While the newly established method still has some issues, they mainly relate to management of the projects and not to the performance of Demola as such. The benefits and usefulness of Demola is clearly demonstrated in the high levels of innovativeness, low cost (and risk) of operation and the ability to overcome FFE measurement errors by relying on openness.

6.2 Academic implications

The Demola innovation method incorporates open innovation to the fuzzy front end in a way that includes both in- and outbound modes, thus being one potential practical implementation of the conceptual model of Open New Concept Development (Kutvonen and Torkkeli, 2010). The open collaboration occurs between the focal company (its front end of innovation), the universities and the entrepreneurial teams of students and the effectiveness of the method depends on the level of commitment and participation of each. When all parties have agreed expectations for the collaboration and participate sufficiently, the outcome is greatly improved.

A characteristic scenario for the collaboration is one in which the focal company provides a concept that is subject to high levels of uncertainty thus increasing likelihood of front end measurement error (either false positive or negative). The Demola team is built around the concept from the student candidates coming in from the universities that provide a flexible and fast way to develop the concept to a working demonstration or prototype, while simultaneously generating new ideas for subsequent improvement. By this, the team generates information about the concept, reducing the uncertainty to a level where more accurate evaluation may be done to determine the actual value. Thus, Demola is ideally suited for improving the commercial hit rate of the NPD process by the

reduction of measurement errors and thus fulfils a goal common, and central, to both the theories of FFE and OI. The benefits of Demola are not limited to the focal company however, as also the student team has the chance to utilize the produced knowledge in a start-up company or be recognized for their talent, leading to employment. This makes Demola as a method interesting also for entrepreneurship and corporate social responsibility related studies. Furthermore, the method is notably effective, due to the well-defined IPR framework (avoids contractual costs of collaboration), the focus on the concepts pre-selected by the focal firm and the diverse set of skills and ideas of the students working on it. The example of Demola also shows how external concept exploitation may be applied to combating uncertainty in the front end, elaborating further on the conceptual ONCD model.

We found out that the FFE and NPD phases of the project partner (i.e. company) and Demola project team do not correlate completely. This is illustrated in Figure 3. From the project partner (focal firm) point of view the whole Demola project is for proving the concept, without any solid decisions to license the deliverable and continue the NPD process in-house, i.e. contained within their FFE. The Demola team may follow some of the development guidelines of the project partner (such as certain programming language in software development projects) but usually they are given a high degree of freedom in order to reach more innovative solutions. As the Demola team are not constrained by the typical process and guidelines of the company, the project deliverables may require extensive adaptation to the project partner's processes, even up to a complete recreation.

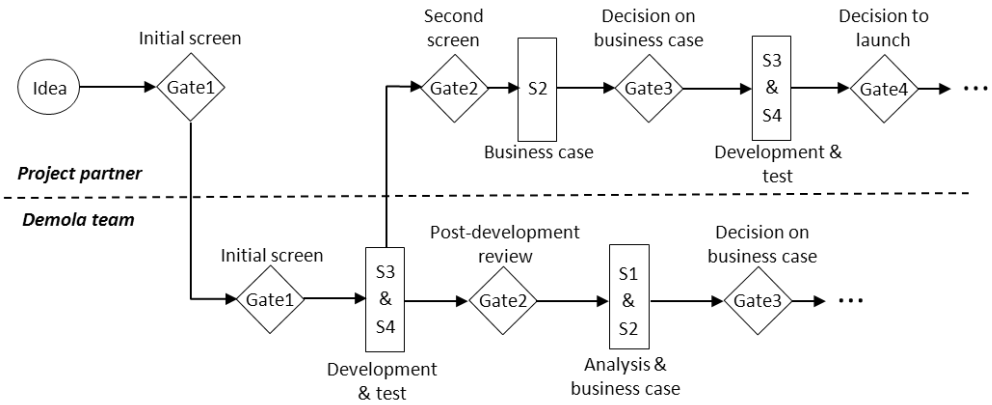

Figure 3 Parallel NPD processes of focal firm and Demola team

From the Demola team point of view the idea comes from outside, i.e. they experience inbound open innovation. Their FFE phase includes (in addition to agreeing in responsibilities and roles within the team) discussions with the company representative that deepens the team members' understanding about the requirements and target outcome of the Demola project. After this phase the Demola team enters into their post-FFE development. In the Demola environment the ramp-up of a project is easy and the implementation can start without much bureaucracy, much like in the case of agile start-up companies. This provides great flexibility compared to established organizations that need to decide how to focus their resources between different projects (Wheelwright and Clark, 1992).

At the end of the Demola project the deliverable along with its commercial and technological prospects are considered by both stakeholders. The Demola team considers whether it contains enough potential for building business on it and establishing a start-up. The project partner makes its own evaluation based on three options that the Demola method offers: to acquire a license to use the deliverable in its own business, to become a shareholder of the new company (if one is formed by the Demola team) or to abandon the idea altogether.

6.3 Limitations and discussion

Applying open innovation in the fuzzy front end by Demola can lead to a win-win-win situation for company, students (i.e. employment, own business), and academy (universities). The societal dimensions of the method are not to be neglected, especially considering the global financial developments in the last years. Societies are struggling to find new ways to revitalize economies and impose demands of corporate social responsibility on companies. While the concrete impact of Demola remains to be determined by further studies, it can already be said to contribute to solving this problem by offering a novel way of self-employment and corporate competitiveness at the same time by relying on open innovation.

The study has multiple limitations that breed further opportunities for research. Firstly, limiting ourselves to only Demola projects concerning one focal firm, Nokia, creates a considerable potential bias to the research. The inclusion of further companies, from multiple industries would bring additional insights and credibility. Also the time period of the study had an influence due to the heavy strategic and organisational restructuring taking place at Nokia at that time. However, it is worth noting that both Demola and a related method called Protomo are applied as tools to respond to the (localized) societal and economic distress that often accompany periods of restructuring. Still, it is reasonable to assume that under more stable circumstances more ideas from those in-licensed would’ve been approved for further internal use. To validate this assumption, more data is needed. A further restriction of the data set was limiting to academic Demola projects to provide for consistency and clarity. The other option of implementing Demola called InnoSummer would be an interesting object of study for comparing its performance against academic Demola. InnoSummer is reported to be more effective in producing start-ups and projects leading to protectable IP (inventions and patents) by more closely approximating a subcontractor relationship with the focal firm. To provide sufficient context and to understand the open innovation ecosystem surrounding Demola, researching the function of Protomo and the link that Demola has to this incubation environment would be crucial as a considerable number of projects end up being further developed in Protomo by the teams before founding a start-up. It stands to reason that the true performance of this method could then only be understood by looking at the complete picture of Demola, InnoSummer and Protomo and across multiple regions where they are implemented.

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The Evolution of External Technology Commercialization Motives

Antero Kutvonen*,

Lappeenranta University of Technology,
Faculty of Technology Management, Kouvola research unit,
Prikaatintie 9, FIN-45100 Kouvola, Finland.
E-mail: antero.kutvonen@lut.fi

Irina Savitskaya

Lappeenranta University of Technology,
Faculty of Technology Management, Kouvola research unit,
Prikaatintie 9, FIN-45100 Kouvola, Finland.
E-mail: irina.savitskaya@lut.fi

Pekka Salmi,

Lappeenranta University of Technology,
Faculty of Technology Management, Kouvola research unit,
Prikaatintie 9, FIN-45100 Kouvola, Finland.
E-mail: pekka.salmi@lut.fi

* Corresponding author

Abstract
In this paper we have presented the case study investigating the concept of evolution of external technology commercialization (ETC) motives. The theoretical proposition that the lowering of uncertainty along the innovation process would lead to a distinct pattern of evolution of external technology commercialization motives at different innovation process stages received some very encouraging support from the evidence collected. It was discovered that while ETC in early innovation phases tends to be strategic, towards the end monetary motives gain favour as valuation becomes easier. Thus we feel that the research merits continuation both in order to delve deeper into this phenomenon and to provide further validation to the anecdotal evidence presented here – that however does suggest that the concept is clearly apparent in the case of Company Ʊ.

Keywords: open innovation, external technology commercialization, ETC, case study, technology transfer, technology management, strategic motives.

Biographical notes: Antero Kutvonen received his MSc in the field of Industrial Engineering and Management at the Lappeenranta University of Technology (LUT). Currently, he is working as a researcher at LUT and preparing his PhD in Technology Management. He has published several journal articles with a focus on outbound open innovation. His main research interests include innovation management, open innovation, regional innovation policy and knowledge management.

Dr. Irina Savitskaya, is a post-doctoral researcher at Lappeenranta University of Technology, Kouvola research unit, Finland. She is conducting research and teaching in innovation management with particular focus on open innovation paradigm, and more specifically on the external environment determinants for Open Innovation implementation practices. Additional research interests include cultural aspect of innovation, regional and national innovation systems, emerging markets research, with focus in particularly on Russia, open innovation, and specifically outbound open innovation and cultural aspect of its implementation.

Pekka Salmi is a researcher in the Department of Industrial Management at Lappeenranta University of Technology. His research interests focus on innovation and technology management, knowledge management and interorganisational collaboration. He has presented his works in several forums in the fields of innovation and knowledge management, and organisation science.

1 INTRODUCTION

The outbound process has been modelled and described independently of the general innovative activities (e.g. Escher, 2005) but without connection to innovation management processes ETC remains a vague concept, hard to implement for most companies (Enkel et al., 2009). The viewpoints of the keep-or-sell decision (Lichtenthaler, 2007; Elmquist et al. 2009), the innovation process phases accommodating open innovation (Rohrbeck et al., 2009) and the strategic fit of ETC (Lichtenthaler, 2008) have all been touched upon, but still the literature falls short, considering the process phases a given attribute without examination on the mechanisms through which they affect e.g. the keep-or-sell decision or the mode of externalization. Thus, further research is needed in e.g. finding out where to place ETC activities in the innovation process (starting at the Fuzzy Front End / development / at the commercialization decision point), and how to manage them so that they support corporate strategy. Here we present a study grounded in the actual experiences of companies to shed light into the practical reality of the theorized management of ETC

activities: firms' motivation to engage in ETC, placing the ETC decision in the innovation process and the amount of planning involved.

Through investigating these factors via a case study, we aim to provide novel insights supporting a concept of the motives for external technology commercialization (ETC) being related to the phase of the general innovation process that the ETC decision is taken in. To investigate this, several sub-topics are covered: how do the outbound OI activities fit in to the pre-existing innovation process models employed by firms; who and at what phase of the process is responsible for the decisions and activities taken; what is the extent of non-monetary motivation and/or (long-term) planning behind an ETC decision in the firm. Based on this we then present a theoretical concept of evolution of ETC motives, which will be demonstrated through the case material.

The study is performed as an in-depth case study of one company, where persons in high level management are interviewed and the answers interpreted by a team of three researchers.

By our research, we extend further the understanding on ETC aspects such as: relation to corporate strategy or business goals, management practices, motives and fit into the innovation process models employed by the industry. The outcome will link the general innovation processes used in the industry, strategic considerations and ETC processes and management together to provide a more complete view, rooted in real-life experiences. Furthermore, the theoretical contribution to the academic literature will be a novel concept of evolution of ETC motives that further explains the aforementioned connections. For the managerial reader the paper will offer practical level experiences of implementing and managing ETC processes not separately but in concert with the innovation processes they have in place. Further it will help to understand how everyday corporate activities and ETC interact and how the timing of the keep or sell decision affects the range of choices and motivations available for a company.

2 EXTERNAL TECHNOLOGY COMMERCIALIZATION

Since the late 1980s there has been a substantial increase in technology transactions (Granstrand et al., 1992) and knowledge markets have continuously developed (Arora et al., 2001; Arora & Gambardella, 2010; Lichtenthaler, 2005). The external commercialization of technology assets goes beyond the sale of one's own products, processes and services. It includes conversion methods such as licensing, patent selling, technology spin-offs and technology induced strategic alliances (Escher, 2005). For this paper we use another stricter definition coming from Lichtenthaler (2005), where external exploitation (and synonymously external commercialization) of knowledge is defined as "*an organization's deliberate commercializing of knowledge assets to another*

independent organization involving a contractual obligation for compensation in monetary or non-monetary terms."

External technology exploitation as such does not represent the core business of most industrial firms, and their prior experience is relatively limited (Teece, 1998; Davis and Harrison, 2001). Therefore, many firms do not achieve their external technology exploitation potential, i.e. the volume of technological knowledge that may be externally leveraged (Fosfuri, 2006; Sirmon et al., 2007). In many cases, firms are unable to simply see the potential of their shelved knowledge assets, were they applied in a domain other than their own core business (Chesbrough, 2004). As knowledge has usually been embodied in products and services for its commercialization, the markets for knowledge are imperfect and therefore knowledge transactions are highly complex (Arora et al., 2001; Caves et al., 1983; Gambardella, 2002). All of this leads to firms experiencing knowledge transactions as too costly, both in terms of risk involved and plain resources spent on transactions. Empirical evidence on the challenges is provided by Enkel, Gassman and Chesbrough (2009) in a study with 107 companies, equally European SMEs and large enterprises. The study showed that there are significant barriers, such as the difficulty in finding the right partner (43%), imbalance between open innovation activities and daily business (36%), and insufficient time and financial resources for open innovation activities.

The external exploitation side has indeed been more resistant to implementation and research efforts (Enkel et al., 2009; Lichtenthaler, 2011) with most of the popular works popularizing this mode of Open Innovation by case studies of selected industry giants like IBM, Texas Instruments, Lucent Technologies and Dow Chemicals (Arora et al., 2001; Grindley and Teece, 1997; Kline, 2003; Sullivan and Fox, 1996), reaping massive licensing profits by externalizing residual technology (Rivette and Kline, 2000). The strategic, i.e. non-monetary, benefits of external exploitation have received little attention and considered secondary or complementary benefits even though they are frequently mentioned in open innovation research (e.g. Lichtenthaler, 2005; Arora et al., 2001; Dahlander and Gann, 2010). Most studies combining strategy to external exploitation (e.g. Kline, 2003; Arora and Fosfuri, 2003) adopt the viewpoint of fitting the ETC practice to the existing framework of corporate strategy seeking a strategic fit (Lichtenthaler, 2007) by offering guidelines to allow additional profit generation without interfering with the development of the core business of the firm. These studies have found that the lack of strategic planning regarding external exploitation is one of the fundamental reasons for the many problems (Kline, 2003; Lichtenthaler, 2005) in ETC implementation. Previously, most firms did not address these activities in a strategic and systematic way, but instead decided to commercialize particular technologies on a case-by-case basis (Tschirky et al., 2000).

2.1 A classification of incentives for ETC

We briefly review the literature regarding the strategic applications of external commercialization. Much of the literature (for a comprehensive review, see e.g. Escher, 2005) concentrates in exploring the basic strategic question at the heart of external technology commercialization, the keep-or-sell decision (Lichtenthaler, 2007; Elmquist et al., 2009).

The keep-or-sell decision is central to the deployment process. As in the acquisition process, this decision is made on both a strategic and an operational level (Birkenmeier, 2003, p. 135; Mittag, 1985, p. 178). On a strategic level, the keep-or-sell decision sets the objectives of technology deployment activities, regulates timing issues, and identifies potential customers. On the operational level, specific technology deployment projects are executed. Technology deployment initiatives require thorough coordination with the innovation activities of the company's strategic business units. External technology deployment activities can support the overall business and product strategies, by conferring various non-monetary benefits, e.g. support for market entry through licensing or partnering, learning curve effects and creation of monopoly positions by defensive out-licensing strategies, i.e. deviating competitors' R&D efforts (Escher, 2005, p. 99). A rising number of technology-based enterprises take advantage of opportunities to utilize their technology assets by licensing out their technologies or founding entrepreneurial spin-off companies (Gassmann et al, 2003, p.24). All these initiatives require company-wide coordination in order to effectively time support activities and prevent the company from hollowing out the competitive advantages of its own business units (Escher, 2005, p. 99). However, Lichtenthaler (2007) advocates that provided sufficient strategic fit and integration to the firm internal innovation strategies and the corporate strategy, i.e. an integrated knowledge exploitation strategy (Arora et al., 2001; Koruna, 2004), firms may ascend to a beneficial keep-and-sell scenario.

The incentives for ETC can be monetary, strategic or compulsory (such as a legal requirement to externally commercialize assets to avoid monopoly charges; Lichtenthaler, 2008). While monetary compensation is the objective in a majority of technology transactions, strategic incentives are arising as markets of technology grow more efficient. The strategic objectives or incentives for external technology exploitation have previously been listed as seen in table 1 by Kutvonen (2009), based largely on the works of e.g. Koruna (2004) and Escher (2005).

The wide variety of non-monetary incentives may be topically divided into 6 distinct groups of strategic objectives. The first group deals with applying external commercialization to advance the effectiveness and reach of outside-in open innovation activities. Bidault and Fischer (1994) suggest that because of high transaction cost, uncertainty, and a limited number of partners with opportunistic behaviour technology trading frequently takes place within a previously formed network or parties that may be

directly introduced through the network instead of so called open knowledge markets (Torkkeli et al., 2009). Firms may thus use ETC to trade one technology for another (if available in current networks) or seek entry to higher quality networks. Also, they may use knowledge transfer back to universities in order to set the direction of where the basic research is going (Savitskaya and Torkkeli, 2011; Coccia, 2008).

Table 1. The strategic objectives of external technology commercialization (Kutvonen, 2009)

Objective group	*Individual strategic objective*
Gaining access to new knowledge	Cross-licensing
	Entry into technological markets and networks
	Setting up listening posts for weak signals
Learning from knowledge transfer	Building dynamic capabilities
	Building reputation
	Learning from knowledge transfer
Multiplication of own technologies	Standard setting
	Profiting from network effects
	Geographical and product market expansion
Controlling technological trajectories	Controlling technological path dependency
External exploitation as a core business model	Actively developing for external parties
Exerting control over environment	Maintaining technological leadership
	Defensive out-licensing
	Creation of market ecosystems
	Guaranteeing freedom to operate
	Feeding entry barriers

Another group of objectives is centered on gaining long-term advantage by leveraging learning effects in their technology transfer activities. Each knowledge transaction can be realized as an organizational learning opportunity (Salmi and Torkkeli, 2009). Additionally, some authors (e.g. Gassman and Enkel, 2004; Kutvonen et al., 2010; Lichtenthaler, 2011) associate external acquisition and exploitation to certain (dynamic) capabilities, which may be built through practicing them in actual technology transactions.

Yet a further popularly cited group of objectives, multiplication of technologies, focuses on rapidly attaining a much larger penetration of the firm's technology in the target

market or markets than is possible by exploiting only internal commercialization channels. The obvious strategic goal here is standard setting, which is one of the most cited strategic motives (e.g. Conner 1995; Ehrhardt 2004; Gassman and Enkel, 2004).

The remaining three groups are more uncommon and do not share a similar wealth of company case examples as the ones above. Controlling technological trajectories to an extent is made possible by utilizing e.g. integrated technology commercialization roadmaps (Lichtenthaler, 2008) and well-managed networks of technology partners. There are even examples of firms, so called aggressive open innovators (Lichtenthaler and Ernst, 2009), that have adopted ETC as a core business model. Finally, there is also the group of highly strategic objectives characterized by a firm exerting control beyond its boundaries over the market environment. This group includes goals such as the maintaining of a technological leadership position by manipulating competitors' R&D by smart licensing, the proactive creation of market ecosystems by externalizing (even donating) enabling / supportive technologies or raising artificial entry barriers by strengthening a number of weak rivals against a more formidable opponent.

2.2 Uncertainty along the innovation process

Innovation process is usually divided into several stages, such as idea generation, idea screening and evaluation, development, testing and commercialization (following the activity-stage model introduced by Booz, Allen and Hamilton, 1982). Many formal models for innovation process also include so-called gates between the different stages (e.g. Cooper, 2001), in which a decision is made whether to continue the development process or not. The basic idea is that in each stage, before the decision point, information is gathered in order to reduce uncertainty about both technological feasibility and the market potential for the product.

Since the early stages of innovation process are characterised by much higher technical and market uncertainty, also the valuation of technology is more difficult in the beginning of the process. While new valuation methods for technologies and R&D projects involving high uncertainty have been developed in recent years (such as real options analysis; e.g. Amram and Kulatilaka, 1999), the fact is that technologies in the later stages of development are easier to valuate and, therefore, trade in the market for technologies. On the other hand, uncertainty is not the only factor affecting the tradability of technologies. For example, transaction costs for technology exchange are to a considerable extent determined by the clarity of property rights. That is, contracting is easier, and therefore less costly, when property rights are well defined (Arora et al., 2001). Moreover, a large tacit component of technological knowledge makes valuation difficult. Yet, both of these factors are related to the level of uncertainty of the innovation process, since it is often the case that technologies or knowledge assets at the early stages of the process are less codified (i.e., involve more tacit knowledge) and lack clear property rights.

The effect of uncertainty on governance mode choice of interfirm relationships has so far been examined mainly in the context of technology acquisitions and R&D cooperation / alliances (e.g. Coles and Hesterly, 1998; Kogut, 1991; Lambe and Spekman, 1997; Robertson and Gatignon, 1998). Recently van de Vrande, Lemmens and Vanhaverbeke (2006) have also proposed that the level of uncertainty has an effect on governance mode for new business development. By combining transaction cost and real options theories, the authors suggest, for example, that when technological and market uncertainty are very high (especially in the early stages of development process, where also real options reasoning is most useful), firms are likely to use reversible governance modes that involve a low level of commitment (e.g. corporate VC investments and non-equity alliances). After R&D investments have decreased in uncertainty firms will move towards more hierarchical and less reversible governance modes (such as equity alliances and acquisitions).

Since the level of uncertainty clearly has an effect on the valuation and tradability of technologies (or knowledge assets), we argue that it is a factor that should be considered in the context of ETC (and its modes) as well. In the following, we describe how external exploitation motives are related to uncertainty and the difficulty of valuation, and, therefore, to the stages of innovation process.

2.3 External exploitation motives along the innovation process

As the technological idea proceeds through the stages of the innovation process – here simplified to ideation, development, testing and commercialization – certain important factors change. Uncertainty regarding technology lessens, which is why potential applications are easier to envision and development costs and outcome are suddenly easier to assess. Market uncertainties recede, making markets suitable for the technology become apparent and give the possibility to more sharply define future volumes and lifecycle profits, distribution channels and other commercial aspects of the solution. The intellectual property rights become more attainable as the technology can be accurately described and the innovation isolated, whereby the codification of the knowledge leads to a heightened readiness for both sharing and protecting the IP. Finally, all of the above lead to a more realistic and ready valuation of the technology. All of these factors are crucial to the management of ETC and lead to the evolution described in table 2 below.

The amount of uncertainty associated with the innovation process phase affects the choice of ETC governance mode and also the range of motives available at a given stage. In the early phase of ideation, the extraordinarily high uncertainty makes valuation of an idea or concept exceedingly difficult and costly. Therefore this stage favours externalization modes such as concept donation (to trusted network partners) or even a systematic external concept exploitation practice (Kutvonen, 2009), where exact valuation is not as critical. Often the candidates externalized at such a phase are clearly

complementary to the core business of the firm and thus provide opportunities for e.g. creating market ecosystems or other strategic endeavours.

Table 2. The evolution of external technology commercialization motives

Process phase	*Typical modes*	*Typical motives*	*Reasoning*
Ideation	External concept exploitation, concept donation	Strategic, network / reputation building, creation of market ecosystems	Uncertainty is high; technology fuzzy and market potential (or even suitable markets) not apparent; IPR undefined; valuation difficult
Development	Joint development, collaborative arrangements	Learning from knowledge transfer, exerting control over environment, gaining access to new knowledge	
Testing	Cross-licensing, out-licensing	Multiplication of own technology (e.g. standard setting), guaranteeing freedom to operate	
Commercialization	Sell-off, out-licensing	Extra revenue	Uncertainty is very low; technology highly codified and business forecasts highly accurate; valuation easy

ETC arrangements in the development phase often can be categorized as joint development projects or other such collaborative agreements, where both parties have identified that the technological idea has inherent value and are able to share the risk caused by uncertainties. Furthermore, the motives in engaging on such collaborative relationships often involve a desire to learn from the partner organization and potentially to benefit from specialized knowledge that the partner may have.

Once the technology nears the commercialization threshold and enters testing phase, the uncertainties involved have already reached a fairly low level, enabling a clear picture of the potential of the technology both in- and outside of the organization. As the IPR issues become more defined, companies become aware of needs to e.g. license to guarantee freedom to operate, or able to identify plentiful opportunities to multiplicate the technology by reaching a keep-and-sell scenario.

If a developed technology ends up to be externalized in the commercialization phase, it is truly seen as a non-core surplus asset from the source company's perspective. At this phase the technology has already lost some of its novelty value and is commonly an ETC candidate due to being picked by portfolio managers for sell-off. Highly codified (i.e. patented) and easily priceable technology as a tradable asset also eases the common challenges of communicating the technology to potential buyers and locating such buyers in the first place as well as lowering the costs of the actual technology transfer involved. Thus, these instances are financially viable candidates for a source of extra revenue.

3 METHODOLOGY AND DATA

3.1 The company description

The firm examined in ETC context operates in the process industry and is one of the leading companies in its field (referred to as 'ʊ' hereafter). ʊ currently employs more than 20,000 people worldwide and has production plants in more than ten countries. The company comprises of three business groups/areas and each of these basically has its own R&D department. The management of the research centres is centralised, however, as they operate under the research technology and development (RTD) unit. The coordination of innovation management, in turn, is under a separate unit that is responsible for development of new businesses. From the organisational point of view, the manager of this unit coordinates all innovation-related activities in the company, but there are also around 30 innovation agents that are responsible for innovation management in their units. The objective of this kind of coordination is to ensure a broad enough scope of innovation management in the company.

3.2 Research methodology and data collection

We adopt a qualitative case study method due to the fact that the nature of our research work is to a large extent exploratory. Since in the current paper there is only a single case company, we use within-case analysis, which means that the collected data will be compared to the theoretical framework in order to identify particular similarities and differences (Yin, 1994).

As the primary data collection method, we use personal interviews. From the company ʊ *(Upsilon)*, we have interviewed the six business leaders of related to innovation processes units, as the one in new businesses area, IPR, technology management, strategy management. The research questions were formulated on the basis of the theoretical framework and the interview protocol consisted of a set of structured, open-ended questions asking the interviewees to describe e.g. the organisation of and the company strategy on innovation, objectives and barriers to ETC, and different forms of

ETC that have been used. The interviews, which were recorded with permission granted by the respondents, lasted in average about 90 minutes and were later transcribed into verbatim notes for the purpose of making a detailed analysis of the answers.

In addition to the interviews, we have also collected secondary data for our case study by examining annual reports, company presentations, press-releases and other publicly available documents from and about Company Ʊ. Various documents related to the company's new innovation activities and business ventures, in particular, have been a relevant source of secondary data.

4 RESEARCH AND INNOVATION AT COMPANY Ʊ

Promoting innovation plays an important role in Company Ʊ strategy. Besides new products, technology and related improvements, new business models and practices are also included in the framework of innovations. Company Ʊ has just last year defined a new innovation strategy that is currently being implemented across the organization. Besides new products and processes, innovation management is targeted at new business creation within the company. In-house R&D is strengthened with a wide range of joint research projects with suppliers, customers, universities and other companies in the industry. In 2009, the R&D expenditures equalled 0.5% of total sales.

Open innovation plays an important role within general innovation management of the company. Outside-in processes are represented to a wider extent; however inside-out open innovation is also becoming more common practice. Innovation management and research functions are located everywhere in the company – research is conducted at departments but it is centrally managed. The main goal of centralized innovation management is to make sure, that innovation processes are happening everywhere in the company; the operative work is then done inside the business units by the local innovation managers.

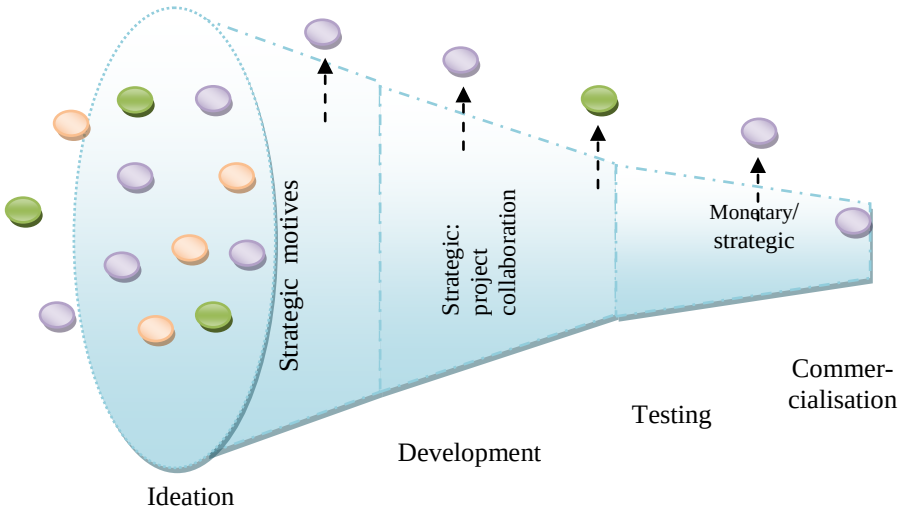
4.1 Outbound open innovation in R&D funnel

The innovation process at Company Ʊ can be conditionally divided into four bigger stages: ideation, development, test-phase and commercialisation. The outbound open innovation activities exist to a different extent at each of these stages, as demonstrated in Figure 1.

The innovation process starts with the idea emerging in the mind of employee, who would offer it for development. In addition to more traditional routes, there is also an intranet tool in the company to support idea sharing by all employees and it is aimed at facilitating ideas collection throughout the company. The brand new idea would go through assessment of its fit to company business model, goals and strategy. In case the

fit to the current business targets is not found the idea might be a candidate for being offered to the external market. Most often the recipients of the idea in such a case would be closely collaborating suppliers, who would develop this idea into a product beneficial for Company ʊ in future. In case of probable fit to current business, the idea will proceed further through the innovation funnel and a business study is typically conducted and the idea then moved forward to an early research stage. However, ETC is not very active at this ideation (i.e. Front End of Innovation) as there are extensive uncertainties in play, the outbound process is not completely clear in this phase and the complexity of setting the price for the idea will also be a hindrance. Most importantly, as the technological and market uncertainties are great at this phase identifying an ETC objective that would justify undergoing the demanding process of externalizing the idea is very difficult.

Figure 1. The innovation process and externalization motives at Company ʊ



At the following stage the opportunity of further development of idea will be identified and first development done prior to final decision-making. At this stage the continuing development gradually lowers uncertainty and may expose the misfit of an idea to current business and the idea might still go to the external market.

Having stayed inside the company a more suitable idea will be developed further. As development process continues, some research inevitably becomes unwanted surplus. The intent in Company ʊ is that surplus will not become research waste, but it will be spotted from development portfolios and receive a chance for life within different company, which more often than not is the joint research partner in the development.

The pre-commercialisation phase will include testing, where even the technology developed for few years within the company may leave it and go to the external market. In some of the ETC success stories from this stage of the innovation process a technology developed up to test-phase was sold out after being identified as being too far from the core businesses. The externalized technology resulted in the creation of a hospitable market situation for the subsequent launch of products that were closer to the core of Company Ʊ and benefited from this externalized complementary technology. What is more, selling out this technology created a positive impact in appearance of a new sub-industry and a new company in the area and meanwhile made market entry for Company Ʊ's products considerably easier.

4.2 Commercialisation modes and decision making

Since ETC does appear at different stages of innovation process, different departments share responsibility of initiating and handling the ETC process at Company Ʊ. There is a clearly felt difference on the efforts required to getting a technology to external commercialisation through e.g. selling it out at the later stage, compared to commercialising it externally at the ideation stage. One of the primary reasons stated was that the valuation of the technology (i.e. setting the price) is more precise at the later stages of development and yet another is that doing ETC with patented knowledge is seen as being more comfortable. Hence, at the earlier stages sell out is less likely to be the mode for ETC than at the very latest phases of the innovation process. Additionally, since the different modes depend on the stages of product development, the responsibility of different actors varies as well at the different stages of the process. ETC at the ideation phase will be basically the responsibility of the unit; however the R&D department of a given unit is likely the source and owner of the idea at that point. And then throughout developing the technology, responsibility will shift also to the R&D departments. Coming closer to the end of development process, the new business development unit will assume charge of any ETC activities. In some cases business groups and their business managers will be responsible for ETC process. The proposal of externally commercializing a certain knowledge asset can principally be done by anybody in the company; however it is more common that a team responsible for research and project portfolio management will make the initiative whereas the decision on it will be done by a dedicated technology management team, consisting of one person at top-management position plus 6-7 experts. The ETC Decision is always made taking into account the company's strategic goals and intent. Hence it is possible to state that the ETC practices are integrated into everyday routines of many departments in the company.

From the common modes for ETC, Company Ʊ has been involved in e.g. out-licensing deals, selling technology and even donating it. However, at the moment selling of a non-core idea or technology is the most commonly applied mode. Licensing deals

happen to smaller extent, but Company Ʊ is specifically targeting to increase the amount of those.

Donation of technology patents is not too common in Company Ʊ, but it does happen within certain collaboration projects. For Company Ʊ, Goodwill can also in some cases constitute a sufficient motivation to donate technology (it is worth mentioning, that Goodwill is calculated and mentioned even in their annual report). Nevertheless Company Ʊ admits that donation is seen as one of the most difficult modes of ETC as it is impossible to know what would happen with donated idea/technology. The reasoning behind the statement is that having received it for free, the recipient may not be that careful to utilise it quickly and properly, leading to potentially reduced or uncertain benefits for the technology source company.

5 THE EVOLUTION OF EXTERNAL TECHNOLOGY COMMERCIALIZATION MOTIVES

> "[When] we have developed technology and we won't use it by ourselves, of course we hope that our partners will utilise it and somehow it will benefit us. If it is new technology maybe we can be the first ones and maybe the only ones who can use this technology".

The informant in Company Ʊ confirms what was theoretically proposed above (Table 2, section 2.3): that the motives are different throughout the innovation process stages of technology development (and change through ideation to commercialisation cycle (see Figure 1). The ideation phase was described as being riddled with uncertainties, thus making for a difficult environment to seek ETC objectives and determine any price – thus Company Ʊ resorted to externalizing ideas and concepts at this phase to its closely collaborating suppliers in hopes of this resulting in improved offerings to them. Also the ideas were employed in a strategic way by donation to a pursuit of goodwill. These findings fit well within the theoretical proposition made.

The development phase was characterized by heavily networked development initiatives, with universities, suppliers, customers and other network partners, where externalization was often base on predefined contractual terms, which may be interpreted as a means to reduce the effect of uncertainties. In the test phase, the pursuit of technology lock-ins and standard setting was present, but also a more commercially oriented view of preparing the market for upcoming offerings and even seeking out monetary cash-outs for non-core assets. In the commercialization phase, the emphasis

was clearly in establishing new businesses by selling out, seeking monetary returns by out-licensing and cutting costs of IP maintenance and goodwill loss by occasional donations. Overall, the evidence seems to support the proposition of a clear evolution, but more empirical research is needed before making any concrete conclusions.

Motives to engage in ETC

ETC is a challenging practice for businesses, so the motivation to it and the possible benefits should be sufficiently strong for a company to get engaged. For Company Ʊ, the motives for ETC can be conditionally divided into monetary (getting financial benefits) and strategic (goodwill & creating a positive image of the company at the market, getting collaboration partners, creating industry standards, preparing market for innovation and meeting other long-term goals) motives, which goes in line with the theory-derived classification for the motives (Table 2).

For the company in case, goodwill can emerge as a surprisingly powerful motivation in cases when the new business creation in the area (and new working places) will allow compensating for a publicly unwelcomed action, such as a factory closure. Company Ʊ sees monetary motivation as a secondary objective, and the long-term profits brought about by applying strategic motives are more highly valued. The pure monetary goal would be mainly applied for out-licensing and other operations with patents.

The ETC process in Company Ʊ most commonly originates from a technologically driven standpoint. As the corporate R&D activities constantly produce a steady stream of ideas that enter the innovation process, centralized controls are in place and technology portfolio managers bring forward candidates for externalization. Because of the nature of R&D performed in Company Ʊ (e.g. often close to the manufacturing process of core business), the external parties best positioned to take advantage of the technological surplus are the trusted suppliers with whom much of the technology transfer takes place

6 CONCLUSIONS AND FURTHER RESEARCH TOPICS

In this paper we have presented the case study investigating the concept of evolution of external technology commercialization motives. The theoretical proposition that the lowering of uncertainty along the innovation process would lead to a distinct pattern of evolution of ETC motives at different innovation process stages received some very encouraging support from the evidence collected. Thus we feel that the research merits continuation both in order to delve deeper into this phenomenon and provide further validation to the anecdotal evidence presented here – that however does suggest that the concept is clearly apparent in the case of Company Ʊ.

The proposed concept and findings presented here point to further implications for understanding external technology commercialization. First, we validate our proposition that ETC is not restricted to any specific phase of the innovation process, but instead is apparent in each, albeit potentially in different forms. This provides interesting contrast to findings by Rohrbeck et al. (2009) where ETC activities were found only coupled together with outside-in activities in certain phases of the innovation process. This indicates a need for further studies encompassing cases from further industries and environmental contexts. Second, some notions could be drawn regarding the organization of the ETC function in the company, namely that ETC is the domain of multiple departments and persons as opposed to being a completely centralized activity within the firm. However, since the evidence is restricted to one company this can only be taken as an indication of a possible way to organize the function and not necessarily the prevalent or most efficient one. The third ETC aspect touched upon is the weight of short vs. long-term objectives in making the ETC decision. Here divergent from the focus or implicit attitude of most outbound open innovation research, we find that strategic objectives actually outweigh the monetary benefits and that ETC is first and foremost considered as optional strategic leverage for the technology / knowledge assets of the firm.

Due to our paper dealing with the ETC activities originating from the innovation process stages, certain interesting topics were necessarily left untouched. Currently the paper has focused on the externalization processes originating from a discovery of knowledge assets suitable for externalization, i.e. technology-driven ETC. The reverse case of need-driven ETC – starting from identifying a business need that can best be served by applying ETC – is theoretically foreseeable as well and is in fact suspected to be the common case in e.g. cross-licensing arrangements. Investigating how widespread such an approach to ETC is within industrial firms would be an exciting issue for further research.

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Strategic application of outbound open innovation

Antero Kutvonen

Kouvola Research Unit, Lappeenranta University of Technology, Kouvola, Finland

Abstract: This paper aims to examine the strategic dimension of outbound open innovation (OOI) with a focus on identifying strategic objectives for exploiting knowledge externally. It reviews the literature, presents a list of strategic objectives, and introduces a novel categorization. A literature review of works combining strategy, and OOI leads to conceptualizing an array of strategic benefits including novel concepts. The review focuses on the empirical observations reported by previous research and discussing the non-monetary objectives and incentives for engaging in outbound OI, or in other words, the potential that outbound OI has in creating strategic business opportunities. The paper presents the most comprehensive description of strategic objectives that may be pursued by OOI, with several case examples. Objectives are classified to six categories: gaining access to new knowledge, multiplication of own technologies, learning from knowledge transfer, controlling technological trajectories, external exploitation as a core business model and exerting control over the market environment. Whereas the common viewpoint in connecting between strategy and OOI is to minimize the negative impact, while retaining monetary benefits, this paper views OOI as an enabler of further strategic mobility and flexibility. The categorized list of strategic objectives also includes some novel additions to current understanding. For the manager, acknowledging the external opportunities for a firm's knowledge assets allows shifting from "just profit" externalization to a more strategic control over the company's future and its environment.

Keywords: Outbound open innovation, Strategy, Open innovation, External commercialization, Technology management, Innovation, Management strategy

About the author: Antero Kutvonen obtained his MSc degree in the field of Industrial Engineering and Management at the Lappeenranta University of Technology. He works as a Researcher at the Lappeenranta University of Technology Research Unit in Kouvola. Currently he is preparing his PhD in Technology Management. His main research interests include innovation management, open innovation, regional innovation policy and knowledge management. Antero Kutvonen can be contacted at: antero.kutvonen@lut.fi

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Introduction

Open Innovation has been a hot topic in technology management research since the early works of Chesbrough (2003), heavily leaning on the external knowledge acquisition side, both in practice and theory (e.g. Laursen and Salter, 2006; Lettl et al., 2006; Piller and Walcher, 2006). The external exploitation side, or outbound open innovation, has been more resistant to implementation and research efforts (Enkel et al., 2009) with the notable exception of Ulrich Lichtenthaler and his pioneering work with external technology commercialization (e.g. Litchtenthaler, 2005, 2007b; Litchtenthaler and Ernst 2009). Most of the popular works popularizing this mode of OI display case studies of selected industry giants, like IBM, Texas Instruments, Lucent Technologies and Dow Chemicals (Arora et al., 2001; Grindley and Teece, 1997; Kline, 2003; Sullivan and Fox, 1996), reaping massive licensing profits by externalizing residual technology (Rivette and Kline, 2000). The strategic, i.e. non-monetary, benefits of external exploitation have received relatively little attention and considered secondary or complementary benefits even though they are frequently mentioned in open innovation research (e.g. Lichtenthaler, 2005; Arora et al., 2001). Most studies combining business strategy to external exploitation (e.g. Kline, 2003; Arora and Fosfuri, 2003) adopt the viewpoint of fitting the practice of external commercialization to the existing framework of corporate strategy seeking a strategic fit (Lichtenthaler, 2007a) by offering guidelines to allow additional profit generation without interfering with the development of the core business of the firm. These studies have found that the lack of strategic planning regarding external exploitation is one of the fundamental reasons for the many problems (Kline, 2003; Lichtenthaler, 2005) firms are encountering in their attempts at outbound innovation (Lichtenthaler, 2008a). In practice, external technology commercialization has been traditionally regarded as an ad-hoc activity. Previously, most firms did not address these activities in a strategic and systematic way, but instead decided to commercialize particular technologies on a case-by-case basis (Tschirky et al., 2000). The inverted viewpoint of investigating the new strategic directions opened by exploiting the options awarded by an active external knowledge deployment focus is still a persistent deficit in strategy and open innovation research with only few works (Koruna, 2004; Lichtenthaler, 2008b) touching on the subject. E.g. Lichtenthaler (2007a) has identified the strategic perspective of external exploitation as an area awarding further research. Thus, the aim of this paper is to examine the strategic dimension of external knowledge exploitation with a focus on identifying the strategic directions or objectives made available by active engagement in external exploitation. The research is conducted as a literature review, pulling together the various works in the field regarding the interplay of strategy and external exploitation and conceptualizing an array of strategic, i.e. non-monetary, benefits that may motivate firms to engage in the practice of external knowledge exploitation.

The search for literature utilized ISI Web of Knowledge and Scopus databases and was focused on quality journals in order to provide for high-quality inputs, while the selection of

articles was done on the basis of relevance determined from the abstracts. Keywords for scanning the literature were open innovation, outbound open innovation, external technology exploitation, technology marketing, licensing, external commercialisation and strategy.

External exploitation of knowledge

Since the late 1980s, there has been a substantial increase in technology transactions, due to the fact that many industrial firms have begun to actively use the external acquisition of technologies/knowledge as part of their business strategy (Granstrand et al., 1992). Following a decade later, the trend of external exploitation of knowledge emerged and has seen constant growth as knowledge markets continuously develop (Arora et al., 2001; Lichtenthaler, 2005). Knowledge itself has become the economic good (Granstrand, 2000), despite remaining a critical and highly strategic, VRIN-attributed (Barney, 1991) resource for the firm. Next, the general theory of external knowledge exploitation is briefly summarized.

External deployment of technology

The commercialization of technology assets goes beyond the sale of their own products, processes, and services. It also includes conversion methods such as licensing, patent selling, technology spin-offs, and technology induced strategic alliances (Escher, 2005). One definition for external exploitation of knowledge according to Chesbrough (2006) is “the use of purposive outflows of knowledge to expand the markets for external use of innovation”. The definition is very broad, offering little focus but also allowing for phenomena such as open source software to be accounted for. For this paper we use another stricter definition coming from Lichtenthaler (2005), where external exploitation (and synonymously external commercialization) of knowledge is defined as “an organization’s deliberate commercializing (exploitation) of knowledge assets to another independent organization involving a contractual obligation for compensation in monetary or non-monetary terms”.

Although the literature regarding different process models for external knowledge exploitation is limited (Escher, 2005), some attempts at constructing an explicit process description with distinct steps, have been made (Escher, 2005; Gassmann and Enkel, 2004; Lichtenthaler, 2007b). These process models have much in common and to an extent build on one another with the model by Lichtenthaler (2007b) integrating the most essential features evident in the previous research into the subject. The model proposes the process to include the following steps: planning, intelligence, negotiation, realization, and control (Lichtenthaler, 2007b). It has to be noted that usually the process stages do not follow one another sequentially but iteratively with feedback loops, even though the process is presented as a sequential model.

Challenges faced by firms

External technology exploitation as such does not represent the core business of most industrial firms, and their prior experience is relatively limited (Teece, 1998; Davis and Harrison, 2001). Therefore, many firms do not achieve their external technology exploitation potential, i.e. the volume of technological knowledge that may be externally leveraged (Fosfuri, 2006; Sirmon et al., 2007). In many cases, firms are unable to simply see the potential of their shelved knowledge assets, were they applied in a domain other than their own core business, as was the famous case of the Xerox Palo Alto Research Center: unable to see the applicability of its seemingly useless (for the copier industry) technologies in the personal computing domain (Chesbrough, 2004). As knowledge has usually been embodied in products and services for its commercialization, the markets for knowledge are imperfect (Arora et al., 2001; Caves et al., 1983; Gambardella, 2002). As knowledge is a highly idiosyncratic good (Teece, 2000), knowledge transactions are much more complex than transactions on the markets for most products and services (Arora et al., 2001) and require specific skills of both the parties involved. Besides the challenges of actually transferring knowledge, the imperfections inherent in knowledge markets lead to appropriability issues and to high transaction costs (Brockhoff, 1992; Caves et al., 1983; Ford and Ryan, 1981). All of this leads to firms experiencing knowledge transactions as too costly, both in terms of risk involved and plain resources spent on transactions. Bidault and Fischer (1994) further suggest that, because of high transaction cost, uncertainty, and a limited number of partners, with opportunistic behaviour technology, trading frequently takes place within a previously formed network, or parties that may be directly introduced through the network, instead of so called open knowledge markets, which may lead to sub-optimal transfer candidates being preferred (Torkkeli et al., 2009). Furthermore, the negotiation phase carries with it the risk of disclosing too much about the transferrable knowledge asset so that the buyer is able to produce a similar solution with minimal cost. This is especially problematic in the case of software companies, where the assurance of the code functionality would necessitate (partly) disclosing it, but the nature of the knowledge asset (high imitability, zero copying costs) effectively prevents the selling party from doing so (Kutvonen et al., 2010).

Recent empirical evidence is provided by Enkel et al. (2009) in a study with 107 companies, equally European SMEs and large enterprises. The study, undertaken in 2008, showed that risks such as loss of knowledge (48 per cent), higher coordination costs (48 per cent), as well as loss of control and higher complexity (both 41 per cent) are mentioned as frequent risks connected to open innovation activities. In addition, there are significant internal barriers, such as the difficulty in finding the right partner (43 per cent), imbalance between open innovation activities and daily business (36 per cent), and insufficient time and financial resources for open innovation activities.

The importance of pre-commercialization activities

Pre-commercialization activities are defined as "activities aiming towards the successful commercialization of a technology or knowledge asset, either internally or externally, that are performed prior to the actual active commercialization phase" (Kutvonen et al., 2010). These include preliminary studies on technology viability in commercial terms preceding contact with actual clients, organisational and strategic steps taken with the primary objective of securing successful commercialization and so forth. Pre-commercialization activities are also always the responsibility of the developer of the technology, and for a large part, they are undertaken already during technological development. In the external exploitation process model, some of the critical activities in the stages of planning, intelligence, and control may be understood as pre-commercialization efforts (see Figure 1).

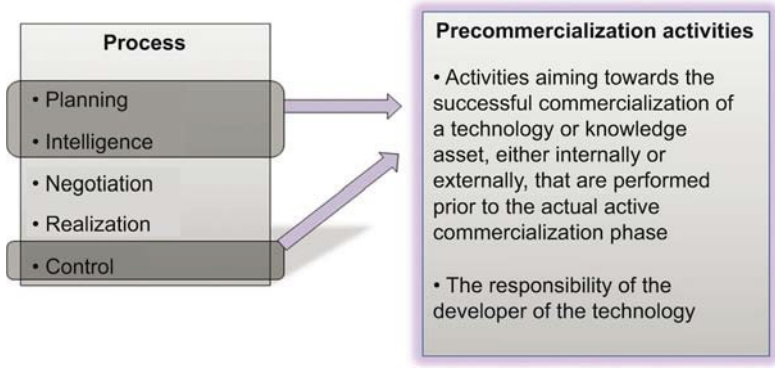

Figure 1. Positioning pre-commercialization activities in the external exploitation process

Pre-commercialization stage activities seem to play a critical role in the success of external knowledge exploitation. Even though according to Lichtenthaler (2007b) all process phases are critical to success, in most cases the determinants of external exploitation success can be found especially in the phases of planning, negotiation and control, of which planning and control are pre-commercialization activities. Furthermore, companies are especially experiencing difficulty with handling the planning, intelligence and control phases, all the phases where pre-commercialization activities take place. Acknowledging the importance of pre-commercialization can significantly boost the success of companies' external knowledge exploitation efforts, ultimately improving their innovation returns, and, also securing possible organisational learning benefits. Possible pre-commercialization phase activities to respond to the challenges, faced by firms, include, e.g. involving knowledge brokers and cultivating technology network relationships (intelligence), conducting a careful valuation of the technology in preparation of the negotiations (planning and negotiation), and integrating exploitation to corporate strategy, to methodically leverage external exploitation of knowledge assets (planning) (Kutvonen et al., 2010). Active engagement, in outbound open

innovation in the pre-commercialization phase, is found in practice as well. An example can be found in the bio-pharmaceutical industry where exploitation efforts may start already before the pre-clinical tests (Chiaroni et al., 2009).

Also in the fuzzy front end, open innovation practices need not and should not limit to pursuing short-term monetary benefits. In the modern landscape of innovative competition knowledge is a highly valuable commodity that can be leveraged to provide longer-term strategic benefits as well. A complete integration of the open innovation perspective into the technology strategy would entail the opening of the New Concept Development process in the Fuzzy Front End (Koen et al., 2001). Proactively managing knowledge in- and outflows in the earliest phases of product and technology development allows the company to strategically leverage a multitude of new strategic options and allow balancing external and internal exploitation optimally.

Integrating external exploitation to business strategy

We briefly review the literature regarding the connection and integration of external exploitation to business strategy. Much of the literature (for a comprehensive review, see, e.g. Escher, 2005) concentrates in exploring the basic strategic question at the heart of external knowledge exploitation, the keep-or-sell decision. Lichtenthaler (2007a) also approaches the issue from the perspective of finding strategic fit in the keep-or-sell decision and presents two tools for the strategic management of exploitation efforts (Lichtenthaler, 2008a), namely the open technology roadmap and the functional market concept. An additional tool is found in the open new concept development process in the form of external concept exploitation.

The keep-or-sell decision is central to the deployment process. As in the acquisition process, this decision is made on both a strategic and an operational level (Mittag, 1985, p. 178; Birkenmeier, 2003, p. 135). On a strategic level, the keep-or-sell decision sets the objectives of technology deployment activities, regulates timing issues, and identifies potential customers. This decision is based on an opportunity/threat analysis and determines the conditions and range for the preferred and acceptable outcome of subsequent technology deployment projects. Responsibility for controlling deployment projects and technology customer care are also assigned at this level. On the operational level, specific technology deployment projects are executed. Technology deployment initiatives require thorough coordination with the innovation activities of the company's strategic business units. External technology deployment activities can support the overall business and product strategies, by conferring various non-monetary benefits, e.g. support for market entry through licensing or partnering, learning curve effects and creation of monopoly positions by deviating competitors' R&D efforts (Escher, 2005, p. 99). A rising number of technology-based enterprises take advantage of opportunities to utilize their technology assets by licensing out their technologies or founding entrepreneurial spin-off companies (Gassmann et al., 2003, p. 24). All these initiatives require company-wide coordination in order to effectively time support activities and prevent the company from hollowing out the competitive advantages of

its own business units (Escher, 2005, p. 99). However, Lichtenthaler (2007a) advocates that provided sufficient strategic fit and integration to the firm internal innovation strategies and the corporate strategy, i.e. an integrated knowledge exploitation strategy (Arora et al., 2001; Koruna, 2004), firms may ascend to a beneficial keep-and-sell scenario.

While firms are accustomed to using integrated planning instruments for strategic technology planning related to technology- and product-related issues, these instruments have an inherent restriction to only considering internal exploitation options. Lichtenthaler (2008a) proposes an extension of the roadmap methodology (Kostoff and Schaller, 2001) to be extended to include external exploitation opportunities, resulting in an open technology roadmap. A visualization of such an open technology roadmap is provided in Figure 2 (Lichtenthaler, 2008a).

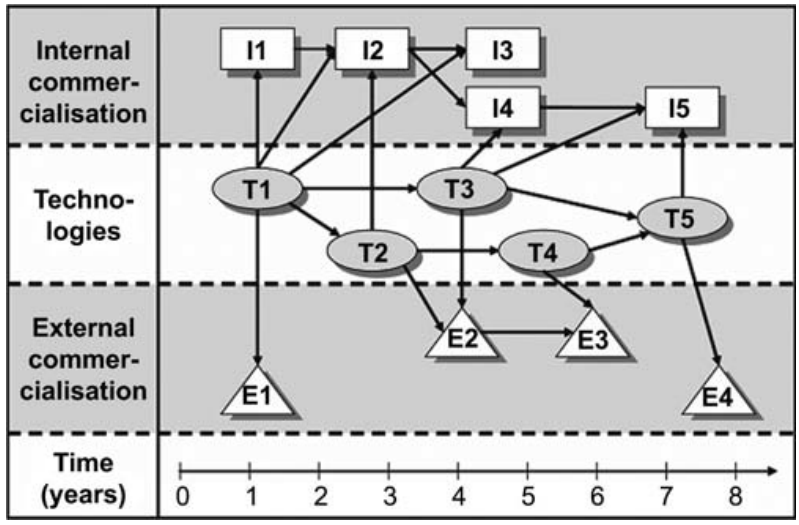

Figure 2. Example of an integrated technology commercialization roadmap

This extended roadmap shows relevant technologies (T1-T5), their internal exploitation (I1-I5), i.e. product applications, and their external exploitation (E1-E4), i.e. external technology commercialisation projects (see Figure 1). This integrated technology commercialisation roadmap visualises the links across the technologies, across the internal commercialisation projects and across the external commercialisation projects. Moreover, it displays the connections between the three levels. While E1, for instance, represents an out-licensing agreement for a single technology, E2 refers to a collaboration, which involves the technologies T2 and T3 and which leads to a new collaboration E3 incorporating the technology T4 (Lichtenthaler, 2008a). As a further tool to facilitate strategic thinking,

Lichtenthaler (2008a) proposes a conceptual method of functional markets. Largely basing on earlier research by Weiss (2004), the concept describes a potential method for answering some of the problems predominant in the intelligence phase activities of external technology exploitation. It is suggested that the firm should start investigating technology exploitation possibilities by reviewing its portfolio of technologies and matching them to external opportunities by scoping the search by functional thinking (i.e. determining what the basic functions of the technology may be) instead of conforming to a common industry and technology based boundary set.

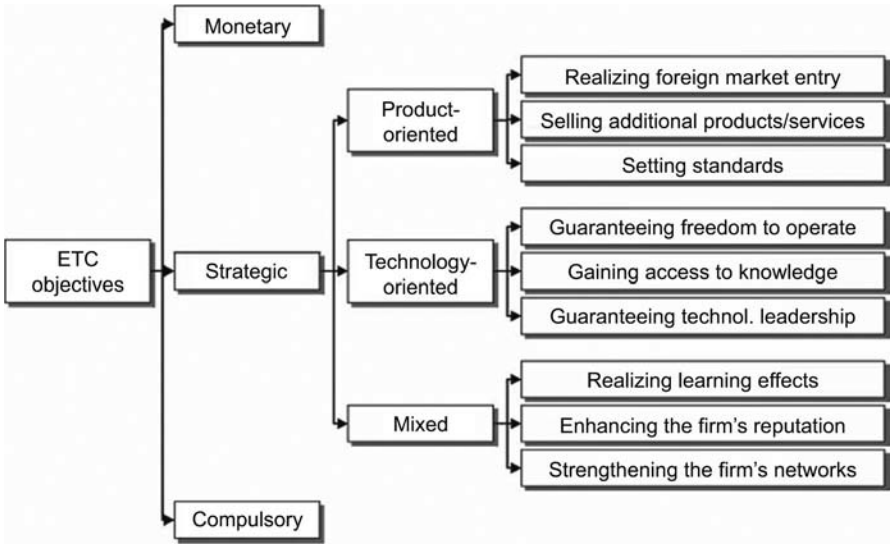

Figure 3. Overview of the systematization of external technology commercialization objectives according to Lichtenthaler (2008c)

Another conceptual method that should be used in conjunction with the two already discussed, is the practice of external concept exploitation in the open New Concept Development process. The notion of external concept exploitation (to distinguish from external technology exploitation) refers to the profitable externalization of technology or product concepts that have not yet qualified for the internal new product development pipeline. A well established front end process a considerable amount of ideas are refined into concepts with preliminary business plans, application descriptions and a variety of attached information, thus these concepts carry an inherent value even if they are not eligible to pass the super-selective screening process in place in modern companies' front ends. These concepts may be used to attain strategic benefits in a similar way as technologies that are in mid-development. The pre-emptive consideration of the external options available for the

promising concepts in the front end of innovation will result in better, cost effectiveness, better success rates, and an increase in strategic options available to the firm.

Non-monetary incentives for engaging in external exploitation

The open innovation perspective and careful consideration of the various external opportunities for a firm's knowledge assets allows making a shift from a "just profit" externalization of technologies to a more strategic, long-term control over the company's future and its market environment. While monetary compensation is indeed the objective in a vast majority of technology transactions (Rivette and Kline, 2000; Davis and Harrison, 2001), non-monetary incentives, are arising as markets of technology, grow more efficient (Arora and Fosfuri, 2003). The strategic objectives or incentives for external technology exploitation have previously been listed by various authors such as, e.g. Teece (2000), Escher (2005) and Koruna (2004), each having a different view on what constitute the primary strategic incentives for external technology exploitation. In Figure 3, an overview of different external technology commercialization objectives is provided by Lichtenthaler (2008c).

Figure 3 also includes the non-strategic objectives: monetary benefits and compulsory externalization to comply to legal requirements, i.e. avoiding monopoly lawsuits. The strategic objectives are divided into three groups: product-oriented, technology-oriented, and mixed strategic objectives. However, the objectives displayed in the figure do not constitute an exhaustive listing and thus this paper aims to extend this listing by taking a different classification, which is summarized in Table I. In the following sections, the various strategic motives are grouped into six different categories by the general overbearing motive, each with one or more distinct strategic benefits that may be the objective of a firm engaging in external technology exploitation.

Gaining access to new knowledge

The fast technology cycles evident in today's innovation landscape frequently make acquiring key technological knowledge externally an imperative. The first commonly acknowledged (e.g. Escher, 2005; Lichtenthaler, 2005) strategic objective for external knowledge exploitation is gaining access to another company's technology portfolio (Grindley and Teece, 1997; Rivette and Kline, 2000). The aim in this activity is to engage in reciprocal licensing agreements, i.e. cross-licensing, in this way applying external exploitation to forward external acquisition efforts. These kinds of licensing agreements are fairly common, especially in certain specific industries, e.g. semiconductor business (Grindley and Teece, 1997).

A related but distinctly different strategic objective is the usage of knowledge assets to gain entry in technology markets and networks (Davis and Harrison, 2001). Here the objective is also partly to facilitate external acquisition, but the primary goal is to solidify the firm's position in a desirable technology network building a strategic advantage for serving

upcoming technology transaction needs as technology trading frequently takes place in specific partnerships and networks as opposed to a global open marketplace (Bidault and Fischer, 1994). Each subsequent successful transaction lowers the transaction costs of following transactions, provided that the initial transaction is successful (Chesbrough and Schwartz, 2007). An example of pursuing such a strategy is Telefunken's decision to license out its PAL colour television patent, whose prime function in a first step was gaining allies and strengthening the firm's networks (Bidault, 1989). Proactive firms may also be interested in setting up relevant networks to pick up on weak signals in strategically interesting markets, in which case the strategic objective can be stipulated as networking to form relationships with firms acting as "listening posts" on potentially desirable markets (where the firm itself is not active).

Table 1. The strategic objectives of external technology commercialization

Objective group	Individual strategic objective
Gaining access to new knowledge	Cross-licensing
	Entry into technological markets and networks
	Setting up listening posts for weak signals
Learning from knowledge transfer	Building dynamic capabilities
	Building reputation
	Learning from knowledge transfer
Multiplication of own technologies	Standard setting
	Profiting from network effects
	Geographical and product market expansion
Controlling technological trajectories	Controlling technological path dependency
External exploitation as a core business model	Actively developing for external parties
Exerting control over environment	Defensive out-licensing
	Creation of market ecosystems

	Feeding entry barriers
	Maintaining technological leadership
	Guaranteeing freedom to operate

Source: Kutvonen et al., 2010

Multiplication of own technologies

The basic premise of multiplying a technology through external commercialization is a simple one: the firm needs to rapidly attain a much larger penetration of its technology in the target market or markets than is possible by exploiting only internal commercialization channels. The obvious strategic goal here is standard setting, which is one of the most cited strategic benefits sought after by external exploitation (e.g. Conner, 1995; Ehrhardt, 2004; Gassmann and Enkel, 2004). A well-known example of such practice is the Motorola case of promoting the GSM standard by aggressive out-licensing (Kline, 2003): By licensing GSM technology widely, the company was able to offset its own cost of development while generating significant new revenues. Strategic licensing allowed Motorola to essentially tax its competitors for their help in building the industry. A variant of standard setting is the objective of promoting network effects for a technology, which may even be a powerful enough incentive to freely reveal the IP in question as a publicly available good (Von Hippel and von Krogh, 2006).

Another commonly acknowledged strategic objective in this category is expanding to completely new markets, in terms of geography (Adam et al., 1988; Koruna, 2004) and/or product categories (Koruna, 2004). Examples of this long known practice of geographical expansion by external commercialization are the international licensing agreements between the dominant chemical companies in the first half of the twentieth century (Arora et al., 2001).

Learning from knowledge transfer

Each knowledge transaction can be realized as an organizational learning opportunity, regardless of the direction of transfer (i.e. in- or outbound), and may lead to a compression of the firm's learning curve (March, 1991). Additionally, some authors (e.g. Gassmann and Enkel, 2004; Kutvonen et al., 2010) associate external acquisition and exploitation to certain (dynamic) capabilities, which may be built through practicing them in actual technology transactions. By adapting a systematic process and realizing learning effects based on prior experience, firms may reduce the transaction costs in the markets for technology (Cohen and Levinthal, 1990; Lane et al., 2006) and with experience develop a dynamic capability in external technology exploitation (Teece et al., 1997). To realize learning effects and best accumulate organisational experience, many authors view the institutionalized approach of

tasking a dedicated external technology transaction unit with managing the learning process (e.g. Draulans et al., 2003; Dyer et al., 2001; Tschirky, 1998).

Another strategic objective loosely related to this category is building reputation. By actively and participating in technology markets by commercializing technology to other (preferably well-respected) as a firm with strong technological capability, thus attracting more and better candidates for further technology transactions, both in- and outward (Rivette and Kline, 2000; Stuart, 1998).

External exploitation of knowledge may act as a powerful tool of organizational learning, provided that proficient control stage activities are set in place (Lichtenthaler, 2003, 2007b). Proficiency in the control stage and the planning and intelligence stages to which it is inherently connected (Dyer et al., 2001; Hoffmann, 2005), or in other words proficiency in pre-commercialization, to a large extent determines the possibilities to secure learning benefits from external exploitation. The knowledge transactions may be leveraged to learn from areas outside the firm's own business, i.e. for building skills and competence in specific technological or application areas.

Controlling technological trajectories

For an organization well endowed in the use of integrated technology commercialization roadmaps (Lichtenthaler, 2008a) or similar strategic planning tools, external commercialization may be used to provide additional flexibility in planning technological trajectories. Theoretically, a firm may be thus able to advance along an identified technology trajectory with a higher degree of control even advancing past a certain technology step (that the firm finds unattractive) to the next level of technology (providing higher strategic and/or profit expectations). On a related note, Von Hippel and von Krogh (2006) in their study of free revealing of technologies, i.e. releasing proprietary knowledge, publicly available without compensation, found that one motive for giving out technology, is to have others improve on it, so that the original inventor may utilize these developments, and apply them commercially, on the basis of, e.g. scale benefits.

External exploitation as a core business model

The existence of technology producing firms with high development capability but low capacity for internal commercialization has been previously theorized and according to empirical evidence (Lichtenthaler and Ernst, 2009), such firms (so called aggressive open innovators) do exist, but they are a distinct minority. It is reasonable to assume that firms having a strategic focus in relying heavily on external commercialization channels both exist, and will grow in number with the development of a functional technology market (Arora et al., 2001). Examples for this strategic orientation, companies such as British Technology

Group, CSE M, Generics, and Rolic run technology deployment as a main business. This means that these companies generate a main portion of their sales through technology deployment methods such as licensing their technologies to third parties or spinning off technology projects (Escher, 2005).

Business models are not static however, as evidenced in the case of Millennium Pharmaceuticals, where the company used a business model entirely dependent on out-licensing arrangements with established industry giants, such as Pfizer, to eventually evolve to a company capable of becoming a direct and successful competitor in an industry characterized by massive barriers of entry (Chesbrough and Schwartz, 2007).

Exerting control over the market environment

A profoundly strategic category in leveraging external technology exploitation is the exertion of control over the market environment. This refers to the group of individual strategic objectives defined by the firm's intent to exert an element of control outside its own boundaries.

According to Koruna (2004), a company may guarantee its technological leadership by means of technology licensing. This surprising objective may be achieved in two ways. First, a powerful company may license its technology in a particular field to its major competitors to direct their focus in inventive activities on other areas, leaving the particular technology field to the company. A well-known example of this strategy is Canon, which successfully licensed out its laser jet technology to direct competitors and kept its leading technological position (Koruna, 2004). Another strategy is to license out a specific technology to competitors, focusing their activities on it, whereas the licensing firm itself concentrates on another technology, which represents a different market segment or which is superior in the long term (Davis and Harrison, 2001). Thus, a company may restrict itself to an attractive market segment, reducing other firms' intentions to develop substitutes for the relevant technologies. This strategy was applied by Xerox, which successfully licensed its electrofax technology and maintained its leading position (Chesbrough, 2002).

Other distinct strategic objectives falling to this category are the creation of supportive market ecosystems by encouraging complementary product and service production. This objective may potentially have the added benefit of cultivating potential future spin-ins. The example here is the recent case of the Nokia Technopolis Innovation Mill (Nokia Conversations, 2009), where Nokia leverages its residue concepts together with a business incubator and public funding body to rapidly generate a large number of start-up growth companies in adjacent business areas.

The most well-known strategic objective here is guaranteeing the "freedom to operate", i.e. avoiding patent infringement in industries with high technological overlap and rapid development cycles (Teece, 1998), by using knowledge assets as bargaining chips (Hall and

Ham Ziedonis, 2001; Reitzig, 2003) in cross-licensing arrangements with select competitors. Another possible way to leverage external technology exploitation is to raise entry barriers to formidable competitors by supporting a base of weaker firms with generous licensing arrangements, thus lowering the overall attractiveness of the market in question.

Conclusions

The ongoing development of knowledge markets (Arora et al., 2001) and firms' proficiency in knowledge transactions will continuously generate more external technology exploitation. Also, firms are starting to employ external exploitation in a strategic and systematic way, instead of making ad-hoc decisions on technology exploitation case-by-case, as has previously been the trend (Tschirky et al., 2000). These developments made the time ripe for conducting a literature review on the strategic deployment of external knowledge exploitation. First, we established a basic understanding of the external technology exploitation concept, the process and the associated difficulties most commonly faced by firms today to set the context for understanding the strategic options opened by such an activity. Then connecting external exploitation with business and technology strategy, the keep-or-sell decision was discussed along with some tools that are essential in order to pursue significant non-monetary benefits through the strategic planning of external knowledge exploitation activities. Finally, in section 4 we reviewed and complemented the literature, creating a list of distinct strategic objectives that may be the target of a firm engaging in external knowledge exploitation activities with the aim to secure long-term benefits. These were classified in six differently themed groups of objectives: gaining access to new knowledge, multiplication of own technologies, learning from knowledge transfer, controlling technological trajectories, external exploitation as a core business model and exerting control over the market environment. By this categorization, this paper managed to put together the most comprehensive description of the various strategic objectives that may be pursued by outbound open innovation, along with case examples for several distinct objectives. This paper serves as a literature review and reference to the leading works in the area of strategic outbound open innovation, integrates many previous findings and is seen to help answer the ever-growing need for further knowledge regarding successful, sustainable and effective technology management in an open innovation environment.

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