Strategic Reorientation of Industrial R&D Towards Commercial objectives

Organisational Implications for Dynamic Management of Technology Transfer and Innovation Transfer in Global Competitive Business Environments

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In an effort to leverage R&D knowledge asset and to create more value from industrial R&D in today's increasing liberalized and globalising business environments, some corporations adopt a strategic reorientation of their industrial R&D organisation towards commercial objectives. This study suggests that while such a strategic reorientation has a catalyst effect on technology transfer, it poses challenges with respect to the management of the demand and supply of technologies and innovations in dynamic relationships between industrial R&D and its customer's organisations. The findings reveal that technology transfer augmented with innovation transfer is a prerequisite for value creation from R&D investment in global competitive environments.

Introduction

According to studies on competitive advantage (Porter, 1985; Hamel and Prahalad, 1994), firm's that outperformed their competitors often derive their success from innovation and in many cases such innovation is technology based (Chiesa, 2001). Recognizing the crucial role of R&D for the development of technology competence (Hamel and Prahalad, 1990) required for their innovation purposes, corporations around the world have built and continue to build industrial R&D organisations. Industrial R&D can be defined as a variety of activities based on scientific and engineering disciplines, with the aim of creating new knowledge or exploiting existing knowledge cleverly (Roussel et al, 1991; Chiesa, 2001). For decades corporations have operated their industrial R&D organisations based on a cost-centre model (Roussel et al, 1991; Ganguly, 1999). This means that each year a corporate budget is allocated to industrial R&D to fund research projects (Billings et al, 2001). In this context the R&D strategy is defined as a set of R&D projects required to achieve fixed objectives in terms of technology competence acquisition as formulated in the corporate technology strategy (Chiesa, 2001). The knowledge generated by the cost-centre industrial R&D organisation involves technologies that are transferred to manufacturing for production. Within traditional concepts of R&D management, commercial exploitation of technologies has not been considered part of the activities conducted by industrial R&D.

While studies have largely covered the subject of making industrial R&D more effective through alignment with business needs, the traditional cost-centre model for managing industrial R&D has not been sufficiently questioned in the light of the today's increasingly liberalised and globally competitive business environments (Bowonder and Richardson, 2000; Kikkeri, 2000; Mahendra and Douglas, 2000). Especially less attention has been paid to the management of technology transfer in a context whereby the scope of activities of industrial R&D organisations shift to include commercial exploitation activities in order to successfully leverage the R&D knowledge assets. This study focuses on the understanding of the impact of a strategic reorientation of industrial R&D towards commercial objective on cross-industry management of technology transfer and innovation transfer. Central to this study is the synergistic approach between learning activities and exploitation activities (March, 1991) in relation to value creation by industrial R&D pursuing commercial objectives. In essence, innovation transfer is identified as a missing link in previous technology frameworks (Porter, 1985; Hamel and Prahalad, 1994; Chiesa, 2001). In the following, a brief review of the literature of the management of the generations of R&D is presented. Based on evidences from the field in the liberalised and strong competitive telecommunications service industry in Europe, challenges and opportunities of a shift of industrial R&D to commercial objectives are discussed. Further, a proposed theoretical framework is presented for a dynamic management of the demand and the supply of technologies and innovations at strategic level whereby on the one hand technology transfer is supportive of learning dynamics and on the other hand innovation transfer is supportive of commercial exploitation dynamics. Finally organisational implications address the imperative for building and managing demand and supply

organisations for technologies and innovations with particular attention to cross organisation processes as well as cross industry processes. Due to the explorative nature of this study, directions for future research are presented in conclusion.

Historical background of the management of industrial R&D

Over the past decades the management of industrial R&D has gone through a number of significant changes as described in the management of the "generations" of R&D (Roussel et al, 1991; Rogers, 1996; Miller & Morris, 1999; Chiesa, 2001). Roussel et al (1991) described the first, second and third generations of R&D management philosophy. In the 1950s through the1960s, the first generation was driven by intuition and intellectual curiosity. It was felt that creativity must not be fettered, and the results of research were unpredictable. So a fixed percentage of the turnover of a corporation was allocated to corporate R&D to spend on research projects of its own choice (Billings et al, 2001). The first generation builds from a technology competence approach to technology strategy formulation and subsequently to R&D management (Hamel and Prahalad, 1994; Chiesa, 2001). Supporting a technology competence approach to the management of R&D within firms, Hamel and Hamel (1994) argue that the turbulence and rapid change of markets, industry boundaries, customer needs as well as products have led to the view that these are not the appropriate reference points for developing the right technology for the firm's competitive advantage.

In the 70s through the 80s the second generation of R&D management decreed that no R&D would take place unless a customer in an operating division or business unit was prepared to pay for it (Ganguly, 1999). While the rigorous financial "rate of return" discipline has its virtues, the problem with the approach pursued in the second generation of the management of R&D was that only short-term research activities were generally funded, and research activities which might lead to the creation of a new businesses or protect against long-term business problems faced a lot of resistance in getting funding. The second generation is based on a market positioning approach that is covered by Porter's work on competitive strategy and competitive advantage. According to Porter (1985, 1998), technology is a determinant of the industry structure and therefore affects the profitability within the industry. As apposed to the technology competence approach by Prahalad and Hamel (1990), the market positioning approach advocated by Porter builds from the assumption that if a technology doesn't fit the industry's or the organisation's value chains, then it may reduce the profitability of the whole industry and therefore decreasing the profitability of the innovating firm in the long-term. This assertion may provide a justification for the reluctance of executive in funding research activities aimed at producing new technologies for long-term competitive advantage. The market positioning approach is also called the incremental view whereby the financial discipline tends to be overdone as strong emphasis on minimising risk may reduce R&D reward (Ganguly, 1999).

In the early 1990s, the third generation of R&D management emerged, advocating a purposeful R&D based on a partnership between R&D managers and general managers in the business side of the corporation to jointly explore and determine technology portfolio decisions. The objective being to minimize the risks and to share the reward of purposeful R&D project portfolio (Roussel et al, 1991). The third generation of R&D management is an attempt to integrate the technology competence approach and the market positioning approach to R&D management. Miller & Morris (1999) addressed the concept of the fourth generation of R&D management. They argue that the core of the R&D activity is innovation, the management of innovation being based on defining values as perceived by customers. The firth generation of R&D management emphasizes the value of knowledge asset for the business performance (Rogers, 1996). It builds from the idea of a cross-boundary and collaborative nature of innovation in symbiotic networks environment.

The theories of the management of the generations of R&D as elaborated in previous studies provide a thorough understanding of the various activities involved within R&D as well as the frameworks developed so far to strategically create value from R&D. These frameworks are based on the cost-centre idea of R&D whereby the objective of R&D is limited to the development of technology competence for long-term competitive advantage. In this case, industrial R&D is responsible for the development of the technology and not for its commercial exploitation. In terms of technology transfer, industrial R&D is the passer, manufacturing is the receiver of technology for production purposes whereas marketing and sales within the corporation are responsible for revenue generation.

However, current theories of the management of the generations of R&D have not considered the notion of technology transfer based on a shift of industrial R&D towards commercial objectives in the context of increasing globalisation and liberalisation of economies around the world. The observed contemporary phenomenon in this study is a strategic reorientation of corporate R&D towards commercial objectives pursued in early 2000 by some corporations such as the UK based British Telecom Group and The Netherlands based KPN as an attempt to create more value from their R&D organisations.

Managing industrial R&D differently in a global competitive environment

In the late 90s as the British Telecom Group in the UK and KPN in the Netherlands were entering an era of increased competition in their home markets following

the liberalisation of the telecommunications service industry in Europe, the value created by the corporate based industrial R&D organisations of these two corporations were subject of scrutiny by corporate executives. During a restructuring programme started in April 2000 at the British Telecom Group with the intention to improve the financial viability of the corporation that was facing falling revenues from its traditional telephony and the pressure to reduce its debts, it was clear to R&D directors and senior R&D managers that the corporate R&D organisation would not continue to exist as a cost-centre funded from a corporate budget. They undertook an initiative to determine the future position of the corporate R&D organisation that led to the creation in 2001 of a new R&D organisation called BTexact Technologies. The newly created R&D organisation was to operate as a business pursuing commercial objectives alongside other lines of business within the BT Group.

Around the same period in 2001, the management board of KPN decided that R&D will no longer be part of the core activities of the corporation. Subsequently, the management of KPN Research re-branded KPN Valley was assigned the task to develop a vision of the future of R&D organisation outside of the corporation. This led to the outsourcing of KPN Valley to TNO in 2003. The newly created industrial R&D organisation re-branded TNO ICT in 2005 combines research activities and commercial exploitation activities. While there have been some resistance within the organisation against the outsourcing and the shift to commercial objectives, the management board of TNO ICT successfully got the support of employees who understood that there were no future for industrial R&D within the KPN corporate boundaries.

After decades the British Telecom Group and KPN adopted a strategic reorientation of their R&D organisations towards commercial objectives. Rather than relying solely on corporate funding for research, R&D directors and other senior R&D managers at both the British Telecom Group and KPN believed that augmenting research activities with commercial exploitation activities will positively impact the ability of their R&D organisations to create more value through revenue generation for supporting a self-financing of a substantial part of their research activities. R&D directors and senior managers acknowledged that this new vision of how to manage corporate R&D was born from the need to survive in the context of increased competition in the telecommunications service industry in Europe and financial restrictions applied at all levels within their corporations. Godell et al (2001) suggests that corporations in the telecom service industry in Europe should abandon vertical integration (Hagel III J. and Singer M. 1999) to move to horizontal structure in order to be capable to address their innovation and competitiveness problems. In the suggested horizontal structure, R&D activities and the supply of technology expertises should be opened up to other external innovating companies. This view is consistent with the proposed open innovation paradigm by Chesbrough (2003). Furthermore, industrial R&D within the corporation should compete with peers external to the corporation for the supply of technology expertise on a commercial basis. This means a shift of corporate based industrial R&D organisations to commercial objectives in order to leverage value from its R&D knowledge asset. However, the shift of corporate industrial R&D organisations to commercial objectives poses a number of challenges both from the business viewpoint and from the technology viewpoint. These challenges were acknowledged by R&D directors and senior R&D managers at BTexact and at TNO ICT.

The challenge of shifting to commercial objective

Challenges from a business viewpoint:

Creating value as perceived by cross-industry stakeholders

Much of research activities conducted within industrial R&D organisations aims at extending the frontier of existing technologies and creating new knowledge that ultimately lead to a paradigm shift on the business side of the corporation in terms of revenue generation. Traditionally, industrial R&D has tend to limit the user group of its technologies to the business units within the corporate. For example technologies developed until the early 2000 at BTexact in the UK and at TNO ICT in the Netherlands were oriented for use only by lines of business within the British Telecom Group and the lines of business within KPN in the telecom service industry, respectively. When these industrial R&D organisations shifted to commercial objectives, they discover that they couldn't sell their technology expertise to customers in other industries without customizing them. This means that on the one hand, the perception of the value of technologies and innovations was limited to the demand of the lines of business within the British Telecom Group and within KPN; on the other hand, the supply of the technologies was limited to a single corporation within a single industry. The lack of cross-industry thinking in commercial exploitation of technologies developed within corporate R&D has led to untapped opportunity gap to create value. However, to successfully supply technologies and innovations that strategically fit the demands in the marketplace, industrial R&D organisations have to address the challenge of understanding of the notion of value creation as perceived by its stakeholders (Freeman, 1984) in a cross-industry commercialisation approach. Essentially, industrial R&D organisations shifting to commercial objectives face the challenge to create a new market space (Kim and Mauborgne, 2001) for themselves outside the corporation where they used to operate as cost-centre.

Balancing short-term and long-term competitive advantage objectives

As competition is heightening due to increased globalisation and liberalisation of economies around the world, the strategic agenda of executives within corporations tends to be dominated by the need to improve customer loyalties and winning back customers who move to competitors. A pitfall of shifting industrial R&D to commercial objectives is that an industrial R&D organisations could end up supplying incremental technology and innovation solutions that satisfy the short-term objectives of executives within customer organisations and loosing opportunities to make real difference through disruptive technology solutions. Conversely, the literature reveals that a pitfall of a cost-centre based industrial R&D organisation is that it tends to focus too much on new technologies and neglect the short-term business needs. While pursuing commercial objectives, industrial R&D organisations need to effectively address the challenge of balancing both short-term and long-term competitive advantage objectives of their customers in order to supply technologies and innovations solutions that strategically fit their demands (Ganguly, 2000).

Challenges from a Technology Viewpoint:

Achieving rapid deployment of technologies

In the 50s through the 80s as well as in the early 90s when economies in Europe were largely protected by government's legislations, national companies such as former PTTs used to exploit telephony services in a monopoly market. The pace of the development and introduction of new technologies was determined by one or few companies. In this context, it took many years to deploy a new technology in the marketplace because there was no pressure from competitors. For example the deployment of the ISDN technology for digital telephony services by KPN the incumbent in The Netherlands took at least 5 years in 90s. As speed is increasingly becoming an important strategic force in global competition, corporations are becoming more interested in rapid deployment of technology from day one when they decide to launch innovations in the market. The need for rapid deployment of technologies is associated with the need of firms to effectively exploit the technology before its becomes obsolete. Cost-centre based industrial R&D that used to focus on technology competence as a strategic force needs to shift their focus to address the challenge of rapid deployment of technologies.

Delivering interoperable technology solutions across different industries

The evolution of software design has led to the convergence of different technologies such as Internet technologies, fixed network telephony technologies, mobile network telephony technologies. These converging technologies have enable innovative services that turn out to be complex in the deployment phase but also in the maintenance phase after the introduction of these services into the marketplace. For example KPN, the largest Dutch telecom operator has launch in 2006 an innovative service called "InternetPlusBellen". The service is based on the integration of internet technologies and fixed network technologies. Shortly after the introduction of the service, customers experienced several times a lot of noise during their telephone calls and in some case the service was not even available due to service failure. In response KPN couldn't indicate the cause of the service failure and it took a couple days before repair activities were completed. Such a service failure due to the complexity of the innovation, refers to the critical impact of interoperability of technologies. As innovations are increasing based on the convergence and the integration of different technologies, the demands is also increasingly shifting towards the demand for the delivery of interoperable technology solutions. Different pieces of technologies are generally supplied to customer's organisations by different parties. Industrial R&D need to address the challenge of delivering interoperable technology solutions that strategically will fit an heterogonous technology environment in demand organisations of customers across different industries.

Opportunities when moving away from the cost-centre idea of industrial R&D

Considering the challenges they had to address in order to successfully transform the Research Labs of the British Telecom Group into a revenue generation organisation, and more specifically the skills deficiency in relation to the exploitation of Intellectual Property, R&D directors and senior R&D managers engaged a partnership with IPValue, a specialised organisation in the commercialisation process of Intellectual Property. The objectives being to quickly assess the market potential of the patent portfolio of BTexact as well defining the value propositions. Joe Zier, the president of IPValue in 2002 indicated that there was a huge potential in what they have found at BTexact as he commented: "In today's environment, when companies have cut costs to the bone and tried to find new ways of generating incremental revenues, Intellectual Property represents the single largest opportunity for companies to generate bottom-line profits. Intellectual Property commercialisation is the hidden treasure just waiting to be discovered in every company that invests in R&D".

The case study suggests that BTexact had successfully transformed itself into a cash-flow positive industrial R&D organisation in 2002, within two years after it was launched as a separate line of business within the British Telecom Group. Some example of successful commercial exploitation of BTexact's Intellectual Property include the payment of a license fee by Broadwing Communications, Inc to BTexact following a settlement of its litigation based on its patents covering

methods of making fibre-optic cable installations by a technique known as the "blowing" of the fibre-optic cable (PR Newswire, December 4, 2003); the sale of BTexact's voice activity detector (VAD) patent to LG Electronics Inc (*PR Newswire, May 29, 2003)*; the licensing of several BTexact patent on GSM technologies to Samsung Electronics Co., a Korean-based electronic equipment manufacturer (IP Value, April 20, 2004). In addition to commercial exploitation of Intellectual Property, BTexact realised that untapped opportunities resided in its on-the-shelf technologies and IT skills. In collaboration with the lines of business of the British Telecom Group that include BT Global Services and BT Wholesale, BTexact packaged its on-the-shelf technologies and skills to upgrade their portfolio ICT services but also to sell directly to external customers through technology consulting services.

The management board of TNO ICT had focused on the opportunity to improve internal efficiency. In the period from 2000 to 2002, the R&D organisation reduced its operational expenditure by 50%. This was largely the result of the reduction of wasted resources and partly the reduction of head counts. Rob Langezaal, the acting managing director of TNO ICT in 2003 stated that after a successful cost reduction phase, the R&D organisation was in good shape to focus its attention on the exploitation of on-the-shelf technologies, generating more revenue and growth while maintaining an efficient organisation. The current managing director of TNO ICT, Gerard van Oortmerssen, stated in our interview in 2005 that the organisation was acquiring new customers aside the lines of business of KPN that remained the largest customers. Subsequently, the organisation was generating new revenues from commercial exploitation of its technology portfolio augmented with consulting services.

This study reveals that the cost-centre idea of industrial R&D is not necessarily the best approach for managing industrial R&D in the today's competitive business environment driven by globalisation and liberalisation. Locked into the cost-centre model for decades, BTexact and TNO ICT have experienced that a large portion of their technologies concentrated in their patent portfolio for example have remained on-the-shelf rather than being transferred to the marketplace for production purposes or the creation of new businesses. Furthermore, BTexact and TNO ICT realised after the strategic reorientation that customers do not need technologies per se. Instead they need innovations that is the conversion of technologies into new product and services or improved existing products and services. In this context industrial R&D need to provide guidance to intelligently deploy technologies and support customers in adapting to the faster evolution of technologies that impact their businesses. As an augmented capability to research, commercial exploitation appears to generate opportunities for effective transfer of technologies and innovations from the lab to the marketplace. The strategic reorientation of industrial R&D towards commercial objectives as demonstrated at BTexact and TNO ICT suggests a re-conceptualisation of the demand and the supply of technologies and innovations at strategic level. Such a re-conceptualisation is needed to harness commercial capabilities consistently with research capabilities in order to capitalise on opportunities of moving away from the idea of R&D and to sustain value creation over time. Commercial exploitation activities is no longer perceived at BTexact and at TNO ICT as inconsistent with research activities or as activities that might stifle the creativity of researchers.

Re-conceptualisation of the demand and the supply of technologies and innovations at the strategic level

The proposed solution approach with respect to the re-conceptualisation of the demand and the supply of technologies and innovation in this study is based on a review of current corporate technology strategy frameworks in relation to a strategic reorientation of industrial R&D towards commercial objectives. Current corporate technology strategy frameworks have emphasized the need for a corporation to formulate a corporate technology strategy for long term competitive advantage. However, these frameworks tend to be rigid as they delineate the focus of a technology strategy around technology competence accumulation. Technologies and innovations are not recognized as two distinctive components of the demands. The findings from the case studies suggest that value propositions need to be formulated to capture the technology demand and innovation demand distinctively. The first focuses on the learning needs of the organisation and the second focuses on the commercial exploitation needs of the organisation. The supply of technologies and the supply of innovations should fit the demand of technologies and the demand of innovations, respectively. While current technology strategy frameworks (Little, 1981; Porter, 1985; Hamel and Prahalad, 1994; Hax and Majluf, 1984, Foster, 1986; Chiesa, 2001) are applicable in industries or within corporations where a cost-centre model of R&D is used to support the funding decisions and the R&D budget planning in static approach to the demand of technologies, we believe that they do not apply for an industrial R&D organisation pursuing commercial objectives. The latter is confronted with a more dynamic nature of the demand and supply of technologies and innovations. This view is supported by Rob Langezaal, the former managing director of TNO ICT, who commented about the supply and demand relationships between TNO ICT and its customer's organisations during our interview saying that: "Our customers determine to a large extent what we do. We try to meet with the top management of our customer's organisations and potential customer's organisations on a regular basis throughout the year to discuss their demands and determine what we can supply to help them create value for their own customers. In our interactions we focus on the needs of our customers or

potential customers relating to their daily business operations. The issue at stake involves continuous innovation with areas where we can help our customers to improve their existing services or develop new services as derivatives of our on-the-shelf technology competence. We also focus on discontinuous innovation opportunities with a strong business potential we believe our customers should consider based on emerging technologies. Such as in other businesses, we need to articulate our value propositions that fit the value perception of our customers or potential customers in order to gain their trust each time we want to sell our technology and innovation solutions".

Industrial R&D organisations pursuing commercial objectives are constantly looking for opportunities to use their on-the-shelf technologies in commercial exploitation activities on the short-term and simultaneously conducting research with long-term objectives. Essentially such an industrial R&D organisation attempts to integrate (Hax and Majluf, 1984) learning dynamics and commercial exploitation dynamics. This calls for our proposed theoretical framework for managing dynamic demand and supply of technologies and innovations at strategic level in global competitive business environments.

Proposed theoretical framework for a dynamic management of demand and supply of technologies and innovations

Central to the proposed framework is the notion of value creation based on the idea of synergistic perspectives between learning and exploitation within an industrial R&D organisation and between that industrial R&D organisation and its stakeholder's organisations. The concept of value has been widely used in management studies and may be differently understood (Coetzee, 2004). In this study, "value" refers to the resulting experience of stakeholders (Lanning, 1998), following their interaction with industrial R&D organisations. Value propositions consist of the entire set of resulting experiences that the industrial R&D organisation cause its stakeholder to have (Lanning, 1998). The identification of potential value propositions and the selection of superior value propositions are the fundamental purposes of the value creation strategies whereby generally conflicting objectives of learning and exploitation are reconciled. Further, as the fit between the demand and the supply is crucial for successful technology transfer and innovation transfer, we suggest that the value creation strategy on the demand side should be congruent (Nadler and Tushman, 1997) with the value creation strategy on the supply side.

Value creation strategy on the demand side: It answers the question of what stakeholder's organisations of an industrial R&D organisation need from technology (Abetti, 1989; Prahalad, 1997) and innovation (Teece, 1997; Porter, 1998; Rice et al; 2001) perspectives to successfully compete in the today's increasing liberalised and globalising business environment. The interdependent constructs at the core the value creation strategy on the demand side are the technology demand strategy and the innovation demand strategy. The *technology demand strategy* is designed around the value propositions supporting adaptive learning dynamics. It stresses the ability of the organisation to understand the impact of technology evolution (Foster, 1986; Burgelman and Rosenbloom, 1997) for its current businesses and potential new businesses; and to assimilate the required knowledge including skills throughout the organisation. The value propositions embodied in technology demand strategy serve for the purpose of guidance in adaptive learning dynamics (Lyles and Schwenk, 1992) based on a deductive strategic thinking that is supportive of the absorptive capacity within customer's organisation and favour the exploitation of knowledge around existing key technologies on the short-term within a time horizon of 6 months to 1 year.

Our findings suggest that when customer's organisations of industrial R&D pay attention to emerging technologies, they try to make sense of technologies they will exploit on the long-term within a time horizon of 2 to 5 years. The focus is largely put on exploitation opportunities and less on exploration. In this context, their objective is to gain the understand of when they need to assimilate a particular technology to create value from it before it becomes obsolete. The issue at stake is the need of strategic technology roadmap (Phaal, 2005) as part of the technology demand strategy. A strategic technology roadmap stipulates when existing core capabilities (Leonard-Barton, 1992; Prahalad, 1997) reflecting the technology competence of an organisation need to be upgrade or replace by new ones. These technology-based core capabilities as represented in such a strategic technology roadmap are supported by value propositions that are formulated around the supported functionalities the technologies, the speed of the deployment of technologies, the interoperability of technology solutions as well as their relationships with innovations. The technology demand strategy aims at achieving a successful transformation of the technology infrastructure of the customer organisation for innovation objectives. It is our believe that competitive advantage goes to firm's that are able to choose the right set of technologies amongst the breadth of technologies available around the world and assimilate them through well orchestrated adaptive learning dynamics in collaboration with industrial R&D organisations and other knowledge organisations such as universities. In this case, the technology demand strategy is considered in this study as an alternative to the traditional corporate technology strategy (Hax and No, 1991; Gomery, 1992; Hamel and Prahalad, 1994; Chiesa, 2001) that tends to focus essentially on technology competence accumulation for competitive advantage in the long-term with a time horizon 5 to 10 years, without articulating value propositions on the short-term including the need for

rapid deployment of technologies for commercial exploitation.

As innovation is concerned with the conversion of inventions (technologies) into commercial products, services or production processes (Roberts, 1998), the *innovation demand strategy* is designed around value propositions supporting commercial exploitation dynamics. The value propositions embodied in the innovation demand strategy articulate the value as perceived in the marketplace and feed the technology demand strategy. The innovation demand strategy is identified as augmenting the technology demand strategy of the customer organisation, providing strategic guidance for a successful deployment of technologies for continuous and discontinuous innovations. It fulfils a bridge function between the technology within the organisation and the dynamic marketplace where business models are fast changing and value chains as well as industry structure are continuously reconfigured following shorter lifecycles of technologies (Edelheit, 1998), in the today's globalizing world where technologies are rapidly moving from the stage of being disruptive to the stage of being obsolete (D'Aveni, 1994). Consistent with the shorter lifecycles of technologies, innovation lifecycles are becoming shorter. For a successful deployment of technologies, a strategic innovation roadmap as part of innovation demand strategy needs to be developed. It needs to be congruent (Nadler and Tushman, 1997) with the strategic technology roadmap. The strategic innovation roadmap describes the relationships between the various innovation capabilities relating to skills, processes, service portfolio, speed, cost, business modelling for example. The innovation demand strategy is supportive of the transformation of the business model of the customer organisation with respect to its commercial objectives. The lack of an innovation demand strategy may lead to the lost opportunities to successfully exploit a technology that turns out to be of high value in the marketplace as competitors successfully deployed it.

Our findings suggest that strategic forces that simultaneously need to be addressed from an innovation demand strategy with respect to continuous and discontinuous innovations include customer loyalty, profit, speed, cost, quality and growth for example. Value propositions embodied in the innovation demand strategy should be underpinned by these strategic forces. The value creation strategy on the demand side is then formulated on the basis of a trade-off between the value propositions embodied in the technology demand strategy that emphasize adaptive learning on the one hand and the value propositions embodied in the innovation demand strategy that emphasize commercial exploitation on the other hand. In the meantime, the value creation strategy on the demand side need to be congruent (Nadler and Tushman, 1997) with the value creation strategy on the supply side.

Value creation strategy on the supply side: It answers the question of what an industrial R&D organisation needs from technology and innovation perspectives in order to successfully compete in an increasing globalising business environment whereby corporations are no longer relying solely on their internal corporate R&D organisations (Chiesa et al, 2004) to fulfil their needs for technologies and innovation solutions. According to the concept of the cost-centre model of industrial R&D supported by previous studies (Roussel et al, 1991; Miller & Morris, 1999; Ganguly, 1999; Chiesa, 2001) industrial R&D competes with peers in the research community based on technology competence accumulation and scientific ratings. The notion of value related to the generation of knowledge are not necessarily related to commercial exploitation as it is usually considered as being the responsibility of the business side within the corporation. This view does not hold in the context of the strategic reorientation of industrial R&D towards commercial objectives. Therefore, a value creation strategy of an industrial R&D organisation should address the challenge of competing not only in the research community on the basis of technology competence but also in the marketplace on the basis of commercial achievements where technologies are successfully deployed in supporting continuous and discontinuous innovation solutions for customer organisations. For this reason, the value creation strategy on the supply side as defined in this proposed framework consists of two constructs, namely the technology supply strategy and the innovation supply strategy.

The technology supply strategy is concerned with creative learning dynamics (Lyles and Schwenk, 1992), mainly oriented towards knowledge exploration through inductive strategic thinking within organisations such as industrial R&D organisation. It builds on the imperative to permanently question the assumptions of the existing knowledge asset in order to generate disruptive technologies or to leverage existing technologies for continuous and discontinuous innovations (Miller and Morris, 1999). Essentially the value propositions embodied in the technology supply strategy should be aligned with the value as perceived in the demand side by stakeholder's organisations (Sanderson and Uzumeri, 1997). Rather than being just a description of research themes and research objectives in terms of the technologies or in the broader sense the knowledge that is intended to be generated, the technology supply strategy defines the connection between the technologies being developed and the needs from the viewpoint of the transformation of the technology infrastructure of customer's organisations. The strategic technology roadmap that should be part of the technology supply strategy provides an understanding how technologies are combined in a time horizon in order to fulfil the demand for interoperable technology solutions by customer's organisations.

Therefore a key aspect of the value proposition of the technology supply strategy shifts from the idea of supplying proprietary technology solutions to lock the market based on a "not invented here syndrome" to the

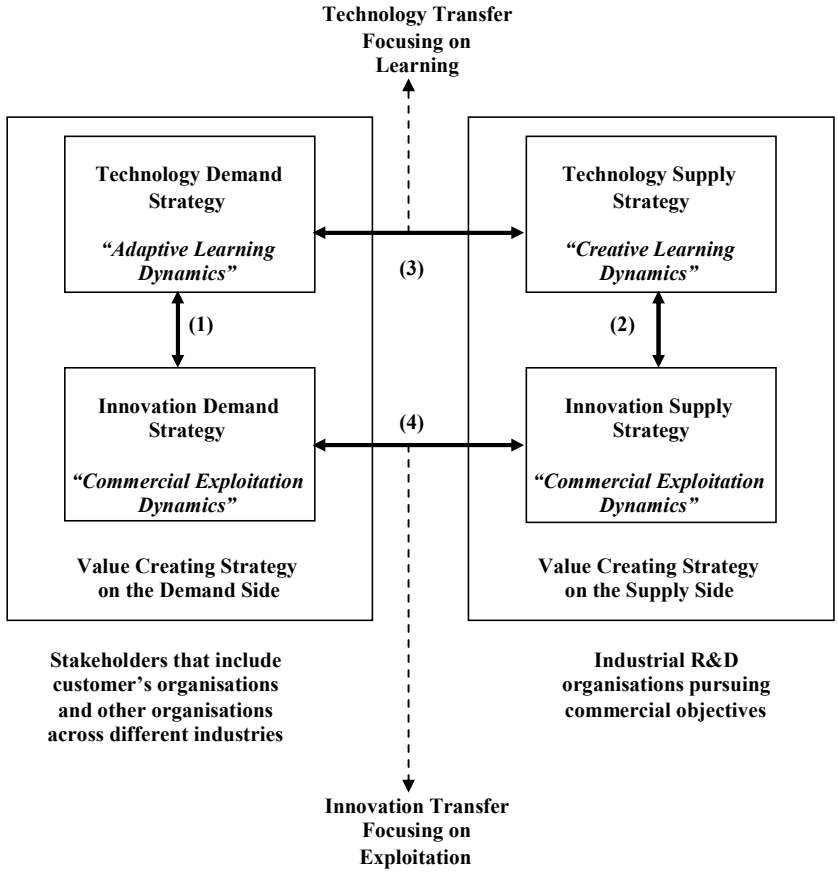
idea of supplying open technologies that be easily integrated with other pieces of technologies from other suppliers. Furthermore, a strategic technology roadmap takes into account the need for rapid deployment of technologies as they come out of the lab. The technology supply strategy is an alternative to the traditional R&D strategy focuses on R&D project selection and the allocation of research funding to those projects. By articulating value propositions in particular when research is moving from an embryonic phase to deliver emerging, pacing and key technologies (Roussel et al, 1991; Gomery, 1992; Flyod, 1997), industrial R&D organisation will be able to invest in research in an informed way. This means that industrial R&D organisations would then be capable to say if we invest this way in research, we can apply the developed technologies that way to fulfil the demand in the marketplace. As industrial R&D becomes fully responsible for the development and the execution of the technology supply strategy, it is also its concern to decide on investment on technology development projects. The value propositions of the technology demand strategy provide the link between the technology being developed and the potential innovations that represent the commercial exploitation opportunity.

However, our findings suggest that in order to address the "endemic" problem to almost every industrial R&D organisations that consists of the accumulation of a reservoir of technology competence with little commercial exploitation achievements, an *innovation supply strategy* should be introduced as an augmented component of a technology supply strategy. The case studies at BTexact in the UK and TNO ICT in the Netherlands reveal that a view of the strategy of industrial R&D that focuses solely on technology competence development does no longer hold. For example the innovativeness of an industrial R&D organisations are generally measured by the number of patents produced. This approach is merely determined by the technology competence objective and the need to use patents by corporations as defensive weapon against potential competitors. In this context industrial R&D organisations usually lack an innovation supply strategy addressing how to exploit the patents produced. The lack of such an innovation supply strategy have led to unexploited portfolio of patents and other on-the-shelf technologies such testing technologies for telecommunications networks at BTexact and at TNO ICT for decades. Subsequently opportunities to generate revenues in a cross-industry innovation approach were missed as BTexact and TNO ICT used to focus on developing technology solely for use within the British Telecom Group and within KPN respectively.

The shift towards commercial objectives at BTexact and at TNO ICT led to new strategic thinking within the R&D organisation where patents are perceived as products that can generate value in term of new revenue streams. Our findings suggest that the value propositions regarding the production of patents are associated with the notion of quality that goes beyond the technology achievement to include the accompanying non-technical skills and knowledge of the business applications needed to successfully commercialised the patents. It becomes evident that the quality of the patents is associated with the cost of the commercial exploitation that in turn affects the profitability of the patent. Trying mainly to produce a huge number of patent may turn out to be an expensive and unsuccessful approach with respect to the innovation supply strategy. This means that the value propositions of an innovation supply strategy that are articulated on the basis of the number of patents may be misleading with respect to the innovativeness of the industrial R&D organisation. In the sense, there should be a balance between the value perception based on the number of patent and the quality. Further, the value propositions embodied in the innovation supply strategy of industrial R&D organisations should be supportive of short-term and long-term strategic objectives of their stakeholders. The strategic forces that simultaneously need to be considered from the stakeholder viewpoint include cost, quality, speed, new revenues, profit for example. This suggests that the innovation supply strategy should be congruent with the technology supply strategy of an industrial R&D organisation, as when research progresses and technologies come out of the lab, there should be an understanding at R&D level of how these technologies will strategically transferred to the marketplace (Tidd et al, 1997) through innovations based on the value as perceived by customers and other stakeholders on the demand side.

Synergistic perspectives for value creation: Our proposed theoretical framework suggests an appreciation of technology strategies and innovation strategies in the context of dynamic demand and supply relationships between an industrial R&D organisation pursuing commercial objectives and its stakeholder's organisations that include customer's organisations among others. It highlights the importance of achieving synergy in two perspectives, namely: synergy in an internal organisation perspective between learning and exploitation; and synergy in a cross-organisation perspective between the demand and the supply of technologies and innovations. With respect to the internal organisation perspective, the synergy between learning and exploitation is based on (1) the degree of congruency between the technology demand strategy and the innovation demand strategy of the value creation strategy on the demand side; and on (2) the degree of congruency between the technology supply strategy and the innovation supply strategy of the value creation strategy on the supply side. With respect to the cross-organisation perspective, the synergy is based on (3) the degree of congruency between the technology demand strategy and the technology supply strategy that is supportive of the technology transfer on the one hand; and on (4) the degree of congruency between the innovation demand strategy and the innovation supply strategy that is supportive of the innovation transfer on the other hand.

Figure 1. Proposed Theoretical Framework for a Dynamic Management of Demand and Supply of Technologies and Innovations at strategic level



The interdependencies encompassed between the components of the proposed framework in Figure 1 are representative of the congruence approach in the synergistic perspectives elaborated in this study. The congruency is the result of a fit between the dynamics associated with learning and exploitation activities.

To illustrate the necessity of the congruency between the components of a value creation strategy on the demand side and the components of the value creation strategy on the supply side we consider the example of a mobile payment innovation service called "Rabomobiel" that was launched in 2006 by the Rabobank, one of the main financial companies in The Netherlands that suddenly became a competitor of KPN in the mobile telecommunications service market. The Rabobank understood that the mobile phone was no longer useful only as a device for a making phone calls or sending "sms" messages. The company envisaged the use of the mobile phone device as a wallet. The value proposition is based on mobility features in combination with online payment service and discount on mobile voice charges. 3 to 4 years ago, KPN didn't seriously considered the opportunity to deliver such a service in partnership with a financial organisation while the technology and skills to develop and launch a mobile payment innovation service was available in its R&D organisation. The lack of an innovation demand strategy on the business side that is congruent with an innovation supply strategy on the R&D side within KPN ultimately led to missed opportunities. Compared to the Rabobank, KPN had a leading position on technologies that could have enabled the development and the deployment of such an innovation service as "RaboMobiel". But KPN didn't manage to successfully create a synergy between the learning dynamics and the exploitation dynamics in a cross industry vision of innovation. We suggest that innovation transfer in addition to technology transfer is a prerequisite to successfully leverage knowledge assets and create value in increasing global and liberalised competitive world where competitors are not only companies operating in the same industry. The following addresses the organisational implications of a dynamic management of the demand and the supply of technologies and innovations.

Organisational Implications of a Dynamic Management of the Demand and the Supply of Technologies and Innovations

The organisational implications of our proposed framework in relation to technology transfer and innovation transfer, involve the transformation of the organisation design of the industrial R&D organisations and of customer's organisations as well as other stakeholder's organisations in order to overcome organisation inertia that obstruct the fulfilment of value.

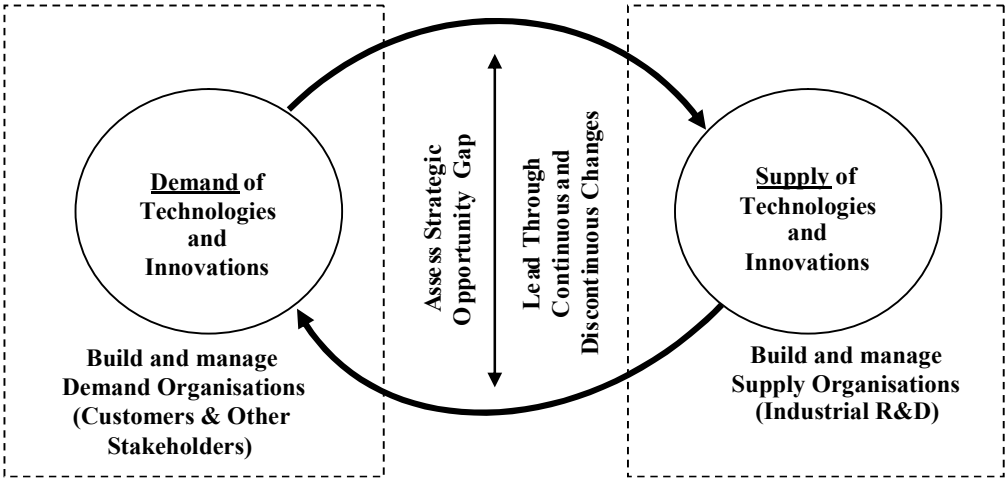
Such a transformation consist of 1) building and managing demand organisations and supply organisations; and 2) building and managing cross-organisations processes as well as cross-industry processes, as illustrated in Figure 2. The implications emerged from our findings of the study of BTexact and TNO ICT, but also from the idea that absorptive capacity (Lane and Lubatkin, 1998) that underpin technology transfer and innovation transfer is an inter-organisational phenomenon.

Building and Managing Demand Organisations and Supply Organisations

The value creation strategies on the demand side and on the supply side require organisation design solutions capable to cope with continuous and discontinuous changes associated with today's rapid cycles of technology and innovation advances. As we associate technology transfer and innovation transfer with continuous and discontinuous changes, we suggest that managers need to build and manage demand organisations and supply organisations based on ambidextrous design instead of pursuing a functional or cross functional design that merely focuses on reducing the span of control.

An ambidextrous design enables the integration of operational cost and efficiency oriented incremental innovations with adaptability and growth oriented radical innovations at managerial level within a single organisation (Tushman et al, 1997; O'Reilly III and Tushman, 2004). The ambidextrous design can be operationalised by designing managerial principles of demand organisations and supply organisations alongside structure, people, internal processes, culture and reward in order to deal with the different dynamics (McDonough III and Richard, 1983, 1986) of the demand and the supply of technology and innovation solutions. After the outsourcing of its R&D organisation to TNO, KPN didn't pay attention to the need to build and manage a demand organisation for R&D services delivered by TNO ICT. As a consequence there was not a structure in place within the corporation capable to provide guidance in strategic deployment of result of the research projects for business benefits. The absence of a demand organisation that strategically balance short-term and long-term objectives led to a shift towards incremental innovation and missing opportunities for discontinuous innovations. Conversely, the absence of a supply organisation at R&D level led to missing opportunities to generate more revenue from on-the-shelf technologies in supporting existing and emerging businesses. Industrial R&D tended to operate more reactively than proactively towards the business. However, it needs to proactively lead through changes while remaining responsive.

Figure 2. Managing Inter-Organisational Demand and Supply of Technologies and Innovations



Building and Managing Cross-Organisations and Cross-Industries Processes

The area of tension between demand organisation and the supply organisation tends to be the strategic opportunity gap in relation to continuous and discontinuous changes. The perceived strategic opportunity gap by a supply organisation is not necessarily recognized by a demand organisation and reciprocally. For example, 5 years ago TNO ICT have developed a service platform using Internet technologies for value-added telephony services on top of circuit based ISDN fixed networks platform. KPN had collaborated with TNO ICT to develop the service platform that was meant to be a prototype. However KPN didn't agree on further collaboration with TNO ICT for commercial exploitation because in the end KPN didn't share the

vision of the opportunity gap in the market for the deployment of the service platform. Studies have focused on the need of collaborative technology development, less attention been paid to the collaborative nature of commercial exploitation activities at R&D level. Our findings suggest that that in order to effectively manage collaboration both at technology transfer level (learning) and at innovation transfer level (exploitation), executives and senior managers need to build and manager cross-organisation processes in the context of an inter-organisational absorptive capacity of technologies and innovations. Differences in the demand and supply dynamics as well as industry's characteristics suggest to pay attention to how to design and implement cross-organisations and cross-industries processes in order to support an effective innovation transfer and technology transfer. The concept of lateral processes (Galbraith, 1995) can be applied in building such cross-organisation processes and cross-industry processes.

Conclusion

This empirical study presents the case of industrial R&D organisations that moved away from the cost-centre model of managing industrial R&D in a close and vertically integrated corporate structure to embrace a revenue driven model of industrial R&D in a so-called innovation ecosystem (Godell et al, 2001) or open innovation paradigm (Chesbrough, 2003). The outsourcing of corporate R&D as well as the shift of corporate R&D towards commercial objectives that is driven by increased liberalisation and competition on a global scale pose new challenges but also opportunities for the management of technology transfer and innovation transfer. Regarding the opportunities, the findings suggest that the strategic reorientation of industrial towards commercial objectives have had a catalyst effect on the transfer of on-the-shelf technologies and innovations from the research labs to the marketplace. This study therefore proposes a new focus on the enquiry of creating value from R&D investment by enlarging the scope of the traditional technology competence driven R&D strategy to include commercial exploitation objectives. Based on our proposed framework for a dynamic management of the demand and supply of technologies and innovations at strategic level, we suggest that technology transfer augmented with innovation transfer in the today's increasing global and liberalised competitive world is a prerequisite for value creation from R&D investment. Accordingly, a dynamic management of the demand and the supply of technologies and innovations, should take into account a synergistic approach between learning and exploitation dynamics. In this context, there is a need to reassess current concepts of R&D management and the technology strategy frameworks that are based on a cost-centre model of R&D when a corporate R&D organisation engages into a strategic reorientation towards commercial objectives.

While previous studies have focused essentially on collaboration for technology development and knowledge sharing, this study suggests that with respect to their commercial objectives some industrial R&D organisations faces the challenge of developing collaborative activities with customers and business partners for the commercial exploitation of their on-the-shelf technology and innovation expertises across different industries. The concept of value creation strategy embodied in our proposed framework provides a vehicle which can help to reconcile knowledge generation and knowledge exploitation in an attempt the reduce the degree of tension between learning and exploitation objectives (March, 1991; Schoohoven and Jelinek, 1997). Organisational implications involve the imperative for executives and senior managers to recognize the necessity to build and manage ambidextrous organisations (Tushman et al, 1997; O'Reilly III and Tushman, 2004) on the demand side and on the supply side. The relationship between demand organisations and supply organisations of technologies and innovations needs to be supported by cross-organisation processes and cross-industry processes. Future research will involve: 1) the investigation of strategic decisions associated with the congruency between the a strategic technology roadmap and a strategic innovation roadmap in relation to the value creation; 2) the investigation of the use of management control systems such as the balanced scorecard to assess commercial exploitation collaborations between demand and supply organisations of technology and innovations based on cross-organisation as well as cross-industry processes; 3) the replication of the proposed theoretical framework for a dynamic management of the demand and the supply of technologies and innovations in other industries.

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