

SUSTAINABLE INNOVATION

In Search for the Value Added Configuration

Rink Weijs¹ and Niels Faber^{2,3}

¹Delft University of Technology, Delft, The Netherlands

²Fryske Akademy (KNAW), Leeuwarden, The Netherlands, Doelestraat 8, P.O. Box 54,
8900 AB Leeuwarden, nfaber@fryske-akademy.nl, +31 58 2336911

³ University of Groningen, Groningen, The Netherlands

Abstract

The concept of sustainable innovation goes beyond realizing technical solutions. For innovation to be effective, knowledge that is developed during the innovating activity requires to be dispersed to assure benefit of the innovation in production, use, maintenance and disposal. Actually doing so might jeopardize an organization's competitive advantage. Knowledge that has carefully been developed during costly innovation processes becomes available to third parties.

The question is however, to what extent should knowledge sharing be realized to ensure that sustainable innovation functions properly on the one hand, and on the other hand not to lose its ownership. Losing ownership might imply that a firm also loses its competitive advantage depending on the nature of the collaboration. Therefore mechanisms for protection of intellectual property are of strategic importance. This creates an innovation paradox, since Intellectual Property Rights do provide incentives to create knowledge, but do not stimulate knowledge diffusion. The seemingly contradiction between carefully building up a knowledge base that secures the market position of an organization striving for sustainability and providing free access to this knowledge is the topic of this article.

We discuss knowledge sharing from the dual perspective of realizing sustainability and preserving ownership. It provides a framework for knowledge collaboration with multiple stakeholders and explore various configurations for sustainable knowledge sharing.

Keywords

Sustainable innovation, knowledge sharing, intellectual property, business model configurations, stakeholder collaboration

1. Introduction

In the last five decades, the insight has developed that mindless economic activity has devastating effects to our planet (e.g. WCED, 1987 and Meadows, Meadows & Randers, 1972). Organizations have been identified as the key players in problems relating to sustainability (McElroy, 2003). And, it is these organizations that are taking responsibility and actively changing their activities into more sustainable directions. One action that fits within this new direction of activities is to implement sustainable innovation processes. Though laudable, this new direction also confronts organizations with new challenges from a business perspective, where on the one hand they attempt to change to the Good or the Better (Faber, 2005), and on the other hand are uncertain about the consequences for the competitive position of their business.

Jorna (2006) and Faber (2006) have explored the concepts of sustainability and sustainable innovation, and provide insights in their underlying mechanisms from a knowledge perspective. They start from the premise that sustainability is not a problem of a technical nature - technology can however be part of a chosen solution. Instead, they identify human behaviour and knowledge that drives this behaviour as the determining factor in sustainability. Here, we build on their reasoning and extend the discussion on knowledge and sustainability towards the ways organizations arrange accessibility of their knowledge.

In this paper, we provide a view on the apparent paradox between innovation practice and the requirements sustainability brings forth, from a knowledge perspective. We provide a view on the way organizations might deal with sustainable innovation in relation to knowledge. In the innovation process, new knowledge is created relating to a certain product. This newly created knowledge directly and indirectly affects the ways people behave in relation to the product focusing on the flow of knowledge that is needed to realize sustainability. We address the ways organizations arrange their product innovation process, and the effects of their choices on their competitive position in.

Connecting sustainability to its products implies that an organization 'takes on responsibility for the environmental impacts of the products they market' (Richards and Kabjian in Information systems and the Environment, 2001; p. 66). This means that an organization takes responsibility for everything relating to its products in each stage of the product's lifecycle (e.g. Stark, 2005). The term product lifecycle is ambiguously used in organizational

contexts. In marketing and economics, the product life cycle describes the stages of a product's life from introduction to saturation focusing on the market size. From a technical and environmental perspective, the product lifecycle describes the stages of a product's life from its creation until it is finally abandoned. Five general stages are recognized, being i) imagine, ii) define, iii) realize, iv) useful life, and v) end of life (Stark, 2005, p.18). In this article, we imply the technical-environmental perspective when using the term product lifecycle. Because we start from the perspective of knowledge and behaviour, identification of actors in the distinguished stages is needed (see also Andrews, 2001). The relevant actors in a product's lifecycle are i) inventor, ii) innovator, iii) manufacturer, iv) user, v) maintainer, and vi) recycler and disposer. The extension of an organization's responsibility relating to its products connects the various stages of the product lifecycle and involves the various actors that play a role. This extension concerns both downstream, to actors towards the end of the product lifecycle, as well as upstream, to preceding stages.

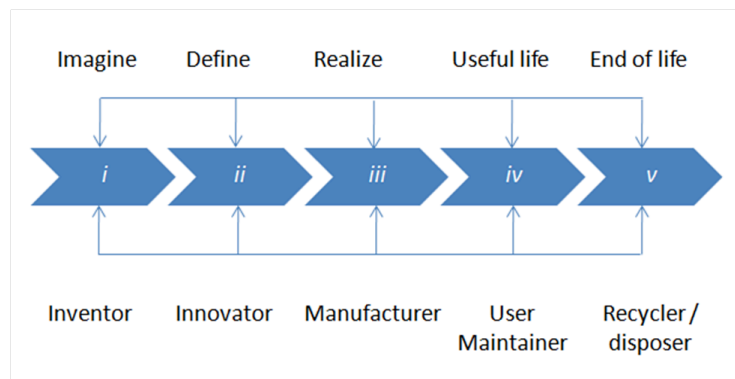


Figure 1: Phases and actors of the product life cycle

Taking the perspective of the innovator, the following downstream extension is envisioned. During realization, the innovator ensures that the manufacturer is able to produce the product in a way it does not harm our planet or its employees. During the useful life of the product, the innovator sees to it that users and maintainers can handle the product without being harmed, and that the product does not inflict damage to the environment. During disposal, the innovator makes sure that the product can be taken apart for recycling and remaining waste is degradable by nature. Upstream, manufacturers, users, maintainers, and recyclers inform the innovator about their experiences with the product, enabling the innovator to make necessary improvements.

To ensure that each of the described stages and processes within take place in a correct fashion (i.e. meet sustainability criteria), the actors involved in each stage need to be informed about the characteristics of the product in relation to their interaction with it. For

instance, a user needs to know what s/he can and cannot do with the product to ensure safe operation, and a maintainer needs to know how the product can be safely taken apart to repair broken parts (see also the C2C principle of McDonough & Braungart, 2002). Informing all actors in the various stages of a product's life cycle, demands knowledge about the product to be made available. This affects the exclusivity of an organization's knowledge.

The main question that is addressed in this paper is if current innovation practice aligns with the necessity of knowledge sharing that results from pursuing sustainability as a new organizational objective. A conceptual exploration is provided. We focus on the ways organizations handle knowledge to achieve various objectives. These objectives concern both traditional organizational objectives, which lie in the economic realm, as well as the more contemporary objective of sustainability. Relating to this knowledge, organizations are provided with mechanisms of protection encompassed in intellectual property rights of various sorts. These mechanisms are in place to prevent knowledge from being accessible from others except the knowledge owner. In this paper, we will address such protection mechanisms as far as they are relevant within innovation practices and sustainability efforts; we will not discuss the complete legal body of them. Furthermore, we focus on product innovation, leaving service and organizational innovations outside of the discussion. The outcomes of our discussion might however not be limited to product innovation exclusively.

This paper is structured as follows. In the next section, we explain the role of knowledge in and current practices of organizations in relation to this knowledge. Section three provides the implications of these current practices for sustainability. Particularly, the function of knowledge sharing, on which sustainability is dependent, is discussed. We discuss where current practice and sustainability are compatible, and at what points they conflict. In section four, we explore various configurations for arranging knowledge sharing. We conclude with a general discussion and questions for further research in the final section.

2 Role of knowledge in organizations

Knowledge is the very source of competitive advantage (Slater, 1996; Barney and Wright, 1998; Lubit, 2001; McEvily and Chakravarthy, 2002; Dehning and Stratopoulos, 2003). It has become the fundamental building material for corporations. Firms establish a competitive advantage by their optimal deployment of existing resources and capabilities, while developing the firm's resource base for the future. Knowledge as such is a principal economic asset and its management and protection have become the cornerstones of corporate strategy (Hanel, 2006). Knowledge assets are valuable while it can help a firm to develop effective strategies, make profits or weaken the threats from the market. Dispersion

of strategic vulnerable knowledge can lead to declining competitive advantage and fewer profits. If a firm and its competitors all own the same knowledge assets, then it does not create competitive advantage for a firm.

A firm's knowledge assets can only provide a competitive advantage when they are valuable. Knowledge assets are valuable when they can enable a firm to improve its market position relative to competitors (Peteraf, 1993), or to conceive of or implement its strategies to improve its performance (Barney, 1991). Barney (1991) argues that knowledge assets must have four attributes to obtain competitive advantage for a firm. First, a knowledge asset needs to be valuable. Two values are distinguished relating to knowledge, namely 'usage value' relating to its usefulness and 'exchange value' denoting the purchasing power (Rodgers, 2003). The second attribute is the rareness of knowledge. If a firm can leverage rare knowledge assets to create value, then the firm has potential to obtain a competitive advantage. Barney (2002) indicates that a firm with valuable and rare knowledge assets is likely to be a strategic innovator as it can come up with and perform a strategy, which others do not have. Imperfect imitability is the third attribute of knowledge that is needed to obtain a competitive advantage. A firm can have unique changes to create knowledge assets, such as historical conditions, causal ambiguity, and social complexity. Social complexity exists in interpersonal relationships among employees or in the relationships between a firm and its suppliers, customers, or other collaborative partners. When competitive advantage is based on such social complex phenomena, the abilities of competitors to imitate these knowledge assets are significantly limited (Barney, 1991). The fourth and final attribute is non-substitutability of knowledge assets. If knowledge assets are substitutable they do not have a cost disadvantage in obtaining them. A firm's competitive advantage that is based on such knowledge assets is temporal. However, if the cost of the competitors of gaining these assets is greater than that of the incumbent firm, the competitive advantage created by these knowledge assets can be sustained (Barney, 2002).

2.1 Appropriability and Intellectual Property Rights

Another important aspect of knowledge assets is their appropriability. This refers to 'the ability of the owner of a resource to receive a return equal to the value created by that resource' (Grant, 1996). Appropriability is considered a main motivational factor of whether firms are willing or not to invest in product or process innovations (Arrow, 1962; Levin et al., 1987). Especially in a competitive environment it is difficult for a firm to acquire full benefits from the investment of innovation or to maximize returns, since the cost of innovation is high while the cost of imitation is low. Appropriability of knowledge assets will decline as they become mature, more codified, and easier to transfer. In order to retard this impact, a firm

can strive to advance its knowledge frontier fast enough to keep the rivals behind (Saviotti, 1998). Another option is protecting the firm's intellectual property.

In the shift to a knowledge-based economy, whereby ideas gain economic value, it is believed that the existence of Intellectual Property Rights are absolutely vital in order to prevent others from producing and selling copies of your own ideas (Kenny, 1996, p. 701). But, although patents and copyright protect knowledge owners legally by established property rights, knowledge itself is not appropriate for market transactions because of its characteristics (Grant, 1996).

Knowledge is different from commodities, in that many can make use of knowledge without degrading it; in contrast, commodities are only consumed once. Both explicit and tacit knowledge have certain characteristics that have effects on transferability and mechanisms for transfer. Tacit knowledge assets are more difficult to imitate than explicit knowledge assets. Explicit knowledge can be communicated, for example by using information technology, and can be acquired and resold without losing it. The mere act of marketing knowledge makes it available to potential buyers (Arrow, 1972). Tacit knowledge is revealed through its application and can be codified. It is not directly appropriable because it cannot be directly transferred; only applied in activity (Grant, 1996). Currently, trends such as a more mobile labor market, outsourcing and the increased connectivity of Internet pose new threats to the control of intellectual property rights. Thus limitations on the dissemination of knowledge have attractions.

It is apparent that assigning intellectual property rights is aimed at restricting the accessibility of knowledge in order to preserve or enhance its value as a commodity. With the assignment of intellectual property right, knowledge is 'captured' and then delivered as a service (Fuller, 2001). Intellectual property rights are directly concerned with the privatization of knowledge for monetary gain. Organizations establish an appropriability regime that represents a combination of available and effective means of protecting innovations, their profitability and increased rents due to research and development (Hurmelinna-Laukkanen and Puumalainen, 2007), thereby securing return on investments. In this article we will focus on explicit knowledge protected by IPR's because tacit knowledge is implicit and on the organizational level it is embedded in the routines and capabilities (Teece, 1995).

There are five major instruments to protect intellectual property. The first instrument is patenting. Mazzoleni & Nelson (1998) identify several objectives of using patents, such as preventing other firms to copy or patent a related invention, strengthening the organization's position in negotiations with other organizations (as in cross-licensing), earning of license revenue or securing a royalty income, and preventing infringement suits. Patents more

effectively protect product innovations than process innovations because firms often need to reveal information about products to the customers.

Copyright is the second instrument for protection of intellectual property. Copyright concerns the set of exclusive rights, granted to the author or creator of an original work, including the right to copy, distribute and adapt the work (Wikipedia, 2010a). These rights can be licensed, transferred and/or assigned. Copyright lasts for a certain time period after which the work is said to enter the public domain.

A more recent protective instrument is the database right, which under European Union is 'the right to prevent extraction and/or reutilization of the whole or of a substantial part, evaluated qualitatively and/or quantitatively, of the contents 'of a database' (EC, 1996). To gain this protection, the database creator must establish only that there has been 'a substantial investment in either obtaining, verification, or presentation of the contents'. The term of protection is 15 years, but is renewable whenever the database holder makes 'any substantial change' to the contents of the database. The US doesn't assign intellectual property rights to databases because uncreative collections of facts are outside of Congressional authority (Wikipedia, 2010b).

Trademarks form the fourth instrument that is distinguished for protection of property rights. Trademarks are distinctive signs or indicators used by an individual, business organization, or other legal entity to identify that the products or services to consumers, with which the trademark appears, originate from a unique source, and to distinguish its products or services from those of other entities (Wikipedia, 2010c).

The fifth and last protective instrument is the trade secret. Trade secrets can be any information that provides an economic advantage to a business relative to its competitors. The information cannot be generally known or easily ascertainable, and reasonable precautions must be taken to maintain its secret.

Intellectual property rights are considered effective for the appropriation of benefits from product and process innovations. Patents for instance provide a motivation for inventions because they safeguard the investments and commercialization of technologies. They create a temporary monopoly that offers some protection for imitation, which enables the inventor to earn back investment costs and make an extra profit. Reducing the availability of knowledge keeps prices high.

As we identified, protection provides incentives to organizations to undertake innovative research. Well-defined property rights may help to facilitate the creation of new technologies (Carlaw et.al. 2006). Without them, there would be little incentive for firms to spend time on research and development to create new innovations (Drahos, 2005). They would be unsure

as to whether or not they would have an economic return. Imitations of innovative products and processes are less costly and can result in free-rider behavior. Without protection of some kind it is suggested that there would be no incentive for a continued investment in the time, energy and capital that is necessary for the creation of yet more ideas (Carlaw et. al, 2006).

Intellectual property rights have a downside too: patents do provide incentives to create knowledge, but do not stimulate knowledge diffusion (CBS, 2009). In contrary, they can slow dispersion of useful technologies (for sustainability) and restrict the opportunity for innovation. Sustainable innovation requires dissemination of knowledge to assure maximum benefit of the innovation and a proper functioning of all stages of a product's life cycle. And for innovation itself it's important being able to build on existing knowledge. The economic growth process exploits complementarities through combinations and re-combinations of technological knowledge, an idea already described in the early work of Schumpeter (1934). The increase of sources for knowledge leads to higher innovative performance (Leiponen and Helfat, 2009).

The mechanism of intellectual property rights is reducing availability of knowledge. Patents and copyright restrictions control the flow of knowledge (Ramello, 2006; Towse, 2006). Intellectual property rights limit the exploitation of the protected knowledge by subsequent innovative entrepreneurs who will themselves create innovations by applying the knowledge in novel ways (Carlaw, 2006). Thus, protection slows the diffusion of proprietary knowledge to public knowledge and limits the value extractable from it in the quest for (sustainable) development. Like Ashton (1955) suggests: 'If Watt's Fire Engine Act had not extended the life of his steam engine patent we would have had a railway system earlier'. 'The patent system is at best ineffective for innovative purposes, or at worst, a brake on invention and its dissemination' (MacLeod, 1988, as refenced by Carlaw et. al, 2006, p. 634). Intellectual property rights restrict availability between proprietary and public knowledge, thereby reducing knowledge flows through the cultural space (see figure 2:knowledge cycle as proposed by Max Boisot, 1995).

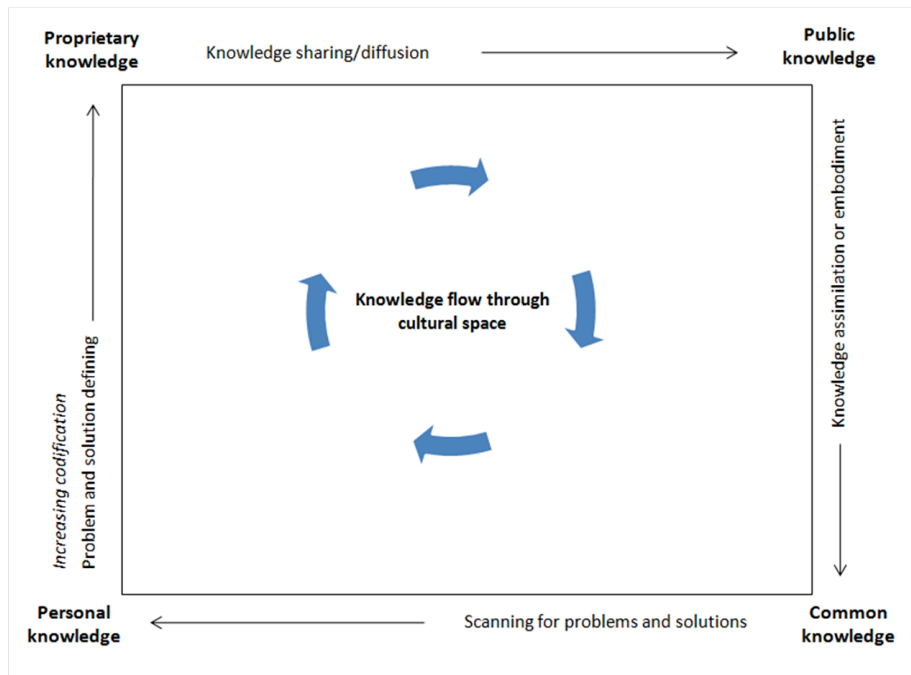


Figure 2: Knowledge flow through cultural space (Boisot, 1995)

Mazzoleni and Nelson (1998) conclude that there is reason for concern that the present movement towards stronger patent protection may hinder rather than progress. It is questionable what effects the observed trend - more protection of intellectual property and patenting - has on innovation and the diffusion of changes in knowledge. This distinct relation between intellectual property and the intellectual commons affects the process of sustainable innovation, growth and economic development. Granstrand (2000) argues that we are entering an era of intellectual capitalism. Private ownership of intellectual capital has consequences on the innovative capacity of our society. Mechanisms like Digital Rights Management systems and intellectual property will restrict the possibilities for knowledge diffusion (Dijkstra and Kneppers-Heijnert, 2006). In effect, knowledge can become limited to those who are willing (and can afford) to pay for it. As the economic interest of knowledge increases and the techniques offer better protection of intellectual property, it becomes questionable to which extend information will be accessible within the public domain.

3. Impacts on sustainable innovation

What are the implications of this seemingly contradiction for sustainable innovation of products? First, public access to relevant knowledge can increase the transition speed of businesses a more sustainable way of producing goods and services substantially. But, as we discussed before, knowledge dissemination can undermine the organization's competitive position in a market. Allowing other parties, i.e. competing organizations, to

utilize the organization's knowledge freely, enables them to enter into same market. The effect is a diminishing of the sales potential and thus of the potential earnings of the organization. In the following, we elaborate on the implications of the installation of protective mechanisms as described in the previous section on sustainable innovation. In order to describe these implications, we start with the identification of the knowledge processes to explain why access to relevant knowledge is needed for sustainable innovation.

Two knowledge processes are identified that play central roles in sustainable innovation (Jorna, 2006; Faber, 2006). These processes are knowledge production and knowledge integration. Knowledge production concerns the creation and acquisition of new knowledge by an individual or group of individuals. Knowledge integration equals the distribution of knowledge within a group of individuals, to those individuals who need that particular piece of knowledge to execute their tasks. A third knowledge process relates to the use of knowledge; McElroy (2003) equals this third knowledge process to normal business processes. It concerns the utilization of established knowledge towards the achievement of the goals of the organization. In this article, we adopt McElroy's (2003) distinction between pure knowledge processes (i.e. production and integration) and those processes in which knowledge is used.

Sustainable innovation requires that individuals i) execute behaviours that are considered to be sustainable, and if this is not the case, ii) they are able to correct these behaviours. The former requirement implies that an individual possesses knowledge that enables him/her to execute a task in a sustainable way. The latter requirement relates to those situations in which the individual is unable to perform the task in a sustainable manner. In this case, the individual needs to be able to seek the knowledge s/he lacks, either by receiving it from some resource (i.e. another individual, or other sources of knowledge) or develop it. The latter requirement principally implies that the processes of knowledge production and knowledge integration should be in place in order to realize a sustainable innovation (see also Jorna, 2006). Having both processes in place is not confined to a singular organization. As indicated, adopting sustainable innovation implies extending an organization's responsibility in relation to the products it brings forth. From a conceptual perspective, knowledge production and integration therefore apply to all organizations along a product's lifecycle.

Section two identifies various mechanisms that are applied by organizations to protect their knowledge base. Barriers to knowledge processes are generally recognized in the field of knowledge management (e.g. Dalkir, 2005). In essence, the installment of such protections impedes free flow and availability of knowledge and thus sustainable innovation. Anyone

outside is kept from using knowledge from the originating organization. On the one hand, competing organizations are unable to use particular knowledge that provides the organization its competitive position. On the other hand for instance a recycler, whose task it is to take apart and recycle a product is unable to perform this task because s/he is withheld from using knowledge about for example the materials used in the product. Hence, sustainable innovation does not benefit from any of the described protective measures in place. However, a nuance is needed here. Disallowing competitors from utilizing an organization's knowledge is regarded different, from the utilization of this knowledge by actors along a product's life cycle. The latter concerns actors that require particular pieces knowledge related to a product in order to execute their tasks; they are not driven by competition. Instead their need for knowledge is purely task-related and hence of a functional nature.

Current protection mechanisms do not distinguish between users of knowledge with task-related (functional) or competition-related motives. It seems as if an organization aiming to switch to sustainable innovation finds itself in a position where it needs to choose between free availability and access to or maintaining strict confinement of its knowledge base. While this choice is highly dependent on the location in the network of actors in the product life cycle. Looking at the concept of supply networks, which resembles some relevant aspects of the product life cycle, the literature identifies three key dimensions of such networks: vertical structure (number of stages), horizontal structure (number of channels) and location in the network (Harland, 1996; Lambert et al., 1998; Randall and Ulrich, 2001; Spens and Bask, 2002). By studying these dimensions we can get a better understanding of the types of interactions that can occur between network partners. Relating these dimensions to the two motives for knowledge usage as discussed in the previous section we distinguish the following connection. Competition-related knowledge use is deemed analogous to horizontal integration within a supply network, as identified in the field of strategic management (Porter, 1980). Vertical integration is analogous to collaboration in the product life cycle and relates to the task-related motive for knowledge use. In section 4, we explore various alternative configurations of knowledge sharing that enable organizations to handle the paradox relating to knowledge.

4. Configurations for knowledge sharing

By identifying the previously mentioned dimensions involved in knowledge sharing for sustainable innovation, we have a better understanding of the types of interactions that can occur between network partners along the product life cycle. In summary, we concluded that organizations that wish to improve their sustainable performance, have to realize two

seemingly paradox organizational objectives which are preserving their competitive advantage and sharing knowledge for sustainable innovation. We identified four important dimensions: (1) value of knowledge assets; (2) the appropriability regime; (3) accessibility of information; and (4) network relationships. These aspects combined provide a framework on the basis of which configurations can be derived for knowledge sharing.

In order to define the impact of knowledge sharing on these organizational goals, the value of the knowledge assets shared must be identified first, using the four attributes proposed by Barney (1991) and Rogers (2003). This is complemented by the level of the relationship, depending on the location in the network. This can range from competition-based (horizontal structure) to collaboration, which is the case along the product life cycle (vertical structure). Depending on the nature of the information shared and the level of relationship, an organization can choose the degree of accessibility and a matching appropriability regime. Table 1 shows the framework including the identified dimensions, studies, description and defined types. Organizations can compose their optimal configuration for sustainable innovation using these variables that shape the dynamics of the knowledge exchange.

As example, we describe three basic configurations that can be defined based on a continuum from closed to open business models and their corresponding dimensions. These are the (1) Closed Innovation Model; (2) Open Innovation Model; and (3) Open Access Model.

Closed Innovation Model: Making innovation proprietary and exclusive is an essential feature of the Closed Innovation Model (Chesborough, 2003b). This means that an organization estimates the potential value of their knowledge assets and approaches a relationship with partners in the supply chain as undesirable from a competitive point of view. The degree of information sharing will be minimized, to prolong temporary monopoly rents. The knowledge remains proprietary and the innovators protect the intellectual assets by using an appropriability regime designed to protect (explicit and tacit) knowledge flows from the internal organization.

Open Innovation Model: The Open Innovation Model is characterized by the ability to extract new ideas from the market of ideas (Chesborough, 2003a). In contrary to making the innovation proprietary and exclusive like the Closed Innovation Model, this model is characterized by the exploitation of intellectual property in order to create value (Shapiro and Varian, 1999a). This requires adopting new business models and firms need to adopt a 'totally new approach to protecting their innovations and profiting from them' (Hurmelinna et. al., 2007, p. 134). Depending on the intensity of relationships with external partners, organizations select the degree of information sharing and protection mechanisms. Options

to derive more financial value can be licensing of new technologies, strategic partnerships (e.g. with non-disclosure contracts) and commercializing ideas through external channels such as start-ups.

Table 1: Framework for knowledge sharing in sustainable innovation

Dimensions	Study	Description	Types & attributes
Value of knowledge assets	Barney (1991, 2002) Rodgers (2003)	Four attributes that determine value of information	- usage and exchange value - rareness of knowledge - imperfect imitability - non-substitutability
Level of relationship	Spekman et.al. (1998) Porter (1980)	Intensity level of relationship	- competition - cooperation - collaboration
Degree of information sharing	Gavirneni et al. (1999)	Types of inter-organizational information sharing (IIS)	- none - partial - full
Appropriability regime	Hurmelinna-Laukkanen and Puumalainen (2007)	Mechanisms to protect innovations and their profitability	- patents - copyright - trademarks - database right - secrecy

Open Access Model: This model is aimed at increasing the availability of knowledge which otherwise would be restricted for reuse. Access to this kind of information is regardless of the value, relationship with partners and without any appropriability regime. The degree of information sharing is fully open. Current examples are Open Source initiatives for Web 2.0 applications, Open Access for online access to scholarly journals and Creative Commons. Formerly mentioned provides an alternative to the traditional copyright. Creative Commons copyrights give legal owners of information options to license rights to the public common, such as the right to copy, distribute and create derivative works based on the original content.

Obtaining certain legal rights and using particular appropriability mechanisms are critical to both innovation models when companies want to survive competitive pressure created by the actions of rival firms, according to Hurmelinna et. al.(2007). It's clear that protection mechanisms secure financial returns on investments. This is the main distinction between

the two innovation models and the Open Access Model. As we have shown in this article, the last model however is prerequisite to innovation itself. The application of intellectual property rights mechanisms, create a lock-in for knowledge dissemination. This is certain for a specified period of time, like 20 years for patents and 15 years for databases. Lessig invented Creative Commons, when after an effective lobby of Disney in 1998; the American Congress prolonged the traditional copyright from 70 years to 95 years.

From a sustainability perspective, the pursuit of profit maximization through reducing availability of valuable knowledge to keep prices high changes within the current transformation towards more sustainable business models that relate to the '*triple-P*' bottom line (Elkington, 1997). The shift within a knowledge economy striving for sustainability pushes towards a balanced valuation of social, financial and environmental performance of organizations. Therefore enhanced public access to information related to sustainable innovation can be regarded as a value on itself. In the current attempt to create a circular flow of resources to promote sustainability, it's just as critical to improve the knowledge flow related to the sustainable innovation of products during their life cycle.

5. Discussion

In this article we have presented a conceptual discussion on the paradox that confronts organizations after having decided to pursue sustainability as a business goal. The paradox centers on the question how the organization should deal with their knowledge. Their carefully build up knowledge base provides a competitive position within certain markets. The objective of sustainability however, demands that organizations start sharing their knowledge with third parties along the product life cycle of its products, i.e. task related knowledge sharing (following from Jorna, 2006). These third parties need to obtain particular pieces of knowledge in order to perform various tasks in the product life cycle. Traditionally, an organization's knowledge base is placed behind lock and key. Various instruments are in place, protecting the organization's intellectual property and block accessibility to the knowledge base. Adopting sustainability as a business objective implies that organizations rethink their protective regimes and setup ways to enable knowledge sharing with specific third parties.

The aspects of value, and appropriability of knowledge and the extend of the relationship and degree of knowledge sharing of an organization with third parties are the dimensions of the framework we sketch for knowledge sharing in innovation. The dimensions of the framework enable an organization to reflect upon the ways it copes with its knowledge base. Although not explicitly discussed as such, the four dimensions provide an order in which this reflection takes place. First, an organization needs to determine what the value is of the

knowledge it possesses. For this, the attributes identified by Barney (1991, 2002) and Rodgers (2003) are used. The value of knowledge has two sides. On one side, this valuable knowledge enables an organization to gain a certain competitive position amidst a group of competitors. This position is gained, because competitors are unable to duplicate or imitate an essential piece of knowledge. On the other side it indicates to what extent third parties in general are able to develop a certain piece of knowledge (here we refer to those third parties that perform various tasks along the product life cycle of products brought forth by the organization). Within a competitive field, in which uniqueness is awarded, valuable knowledge is desired. However, from a more technical perspective, in the case of for instance a repairman who aims to repair a product but is unable to access knowledge about the product that is needed to fulfill this aim, this uniqueness is a hindrance. Hence, whenever an organization is about to determine the value of its knowledge, the issue of what organizational objective is pursued becomes apparent.

The second dimension, which forms the second stage in the process of reflection, concerns the kind of relationship the organization has with third parties. Three levels have been distinguished, derived from Porter (1980), namely competition, and Spekman et al. (1998), namely cooperation and collaboration. These three levels indicate the time horizon on which a relation is established. A competitive relation between organizations indicates a short-term horizon: essentially, no relation is built up between two organizations. In cooperation, two organizations decide to work together on a specific issue, e.g., a project or one particular product. The most extensive relationship is denoted by the collaboration relationship. In this relationship two organizations decide to work together on many fields for an extensive period of time. In relation to knowledge transfer, a competitive relationship will work counterproductive. Knowledge transfer, and thus sustainable innovation, builds on long-term relations between organizations. Hence, if an organization decides to adhere to sustainability as a business objective, long-term relationships with third parties along the product life cycle need to be built. Only such relationships provide the proper environment to realize the knowledge transfers that are needed to contribute to sustainability. The third stage in the reflection process concerns the degree of knowledge sharing that takes place from the organization to third parties. Gavirneni et al. (1999) provide a classification of three levels: none, partial, and full. Similar to the competition relationship of an organization, the level none indicates that no knowledge is shared with third parties. Likewise, the decision to partially share knowledge with third parties resembles the cooperation relationship. Also here, only a limited set of an organization's knowledge is shared with a third party. The full variety of knowledge sharing provides full access to the

organization's knowledge base for a third party. Again, limiting access to its knowledge base hinders the efforts of an organization to become sustainable. Determining beforehand what knowledge a third party can access and what knowledge not proves to be a complex task. Providing a third party limited access to the organizational knowledge base might be a good solution on the short term. Clearly, the organization can trace what knowledge the third party uses and what clearances are given. However, needs of third parties that perform certain tasks along the product life cycle relating to knowledge change. For instance, new insights in what materials are hazardous will make a recycler request more knowledge about used materials in a specific product. With limited access to the organization's knowledge, the recycler is unable to perform his task. In case the organization is still aiming to become sustainable, it needs to reconsider the access the recycler has to its knowledge base. In case full knowledge sharing had been used, such a situation is avoided. The fourth and last stage of the reflection process for organizations is to consider the appropriability regime that is installed on its knowledge base. That is the organization needs to decide if and how its knowledge is used to receive some returns. Traditionally, organizations strive for maximization of revenues from their knowledge base. The underlying rational for this position is that prior investments in innovation need to be earned back. In order to enforce a chosen appropriability regime and to protect their knowledge base, various instruments are at the organization's disposal. These instruments focus on different aspects of the knowledge base, but are generally used to safeguard an organization's financial returns. E.g., patenting limits the use of a technological principle to one organization: the patent holder. This instrument ensures its owner the exclusivity and opportunity to develop the patented technology into a product that has the propensity to yield a financial return on a market. Similarly, a copyright limits the use of original work of some author or creator, without this person's approval. In effect each of the presented instruments will, when applied by a person or organization, limit access to a certain piece of knowledge, and therefore forms a barrier on a path towards sustainability.

In summary, when an organization makes the choice to adopt sustainability as a new objective for their business, one of the implications is the necessity to reconsider the ways it perceives and handles its knowledge. As illustrated an organization will encounter various stages of reflection. We identified four above. A result of this reflection is that an organization, if committed to the new objective of sustainability, needs to make various principle decisions regarding the question how they perceive their own knowledge, and how they choose to deal with third party organizations. Carefully considering the order of stages presented above

makes us conclude that decisions on these issues precede decisions in the financial realm, namely the installment of protective measures.

This article is conceptual, and presents a perspective we derived from various theories and insights on sustainable innovation, strategic management, and intellectual property protection. In this perspective, we identified three models, or archetypes, to which organizations can relate in shaping their knowledge transfer processes as part of their efforts towards sustainable innovation. In two directions, the presented perspective needs to be improved. As indicated, we only provided an innovators view on intellectual property rights and limited ourselves to the techno-environmental perspective on the product life cycle. Therefore, the presented framework only is a first attempt. Further theoretical exploration is required to obtain a complete picture. Furthermore, for this is a conceptual paper, any empirical support for our claims lacks. Hence, the second direction of improvement would be to perform various empirical studies to i) further assess the relationship between knowledge sharing and sustainable innovation, and ii) determine the application of the three presented models on knowledge sharing and sustainable innovation.

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