Implications of Open Innovation Approaches on Future PLM

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Abstract. Doing business globally causes the increase of very complex and dynamic processes. It demands a high level of flexibility and adaptability from the companies involved. The aim of companies is to find efficient ways in order to produce new products and to better meet customer demands. Open Innovation (OI) approaches contribute to this aim and therefore drive the evolution of future Product Lifecycle Management (PLM). Based on four scenarios, developed using scenario planning method, the implications are shown on different levels of PLM. A catalogue of requirements for PLM 2020 was drawn up on the basis of the results of interdisciplinary panels, qualitative and quantitative interviews, and of a sector-specific use case for the automotive industry. The paper discovers ways in which PLM can be made more successful in future and pinpoint challenges that PLM will have to meet with regard to OI concepts.

Keywords: PLM, Open Innovation, Scenario Planning Method, Data Management, Data Security, Human Factor

1 Introduction

For manufacturers today, innovation is the engine of growth [1]. In order to produce new products and better meet customer demands, companies i.e. innovate in production, processes and business models. To access a broader creative potential within innovation processes, external knowledge and ideas have to be taken into account. In this sense, the term OI determines new approaches to involve people from outside the borders of the organization in the product innovation process. The key driver here is the Internet which offers access to a vast supply of resources and workforce. It is concretized in a variety of possible forms of organization of the innovation process between companies and the market. However, these relationships do need an overall organizing principle and this is one aspect that PLM intends to be. Directions of potential PLM evolutions and requirements have been in focus of the research project "Future PLM", conducted at VIRTUAL VEHICLE research center in Graz, Aus-

adfa, p. 1, 2011.

tria. At present the term PLM is used in several different ways, and often it is wrongly understood as meaning merely an IT system. Its full definition is as an approach for managing a product, including the relevant intellectual property, over its entire life cycle. PLM consists of processes, organizational structures, methods and related IT systems. Used as an overall approach, PLM has the potential to give companies the structure and orientation they need to be profitable under competitive conditions. One particular aspect, which has been considered in the Future PLM project, is the implication of OI on future PLM. Considering OI in PLM, challenges occur in different topics, e.g. acquisition and management of customer feedback data, data security and intellectual property protection, or human factors.

2 Overview of Open Innovation and research project FuturePLM

2.1 Open Innovation

Reichwald and Piller [2] distinguish "requirement information" from "solution information" in OI processes. Requirement information is information about the customer and market needs, i.e. information about the preferences, desires, satisfaction factors and buying motives of current and potential customers or users of services. Solution information comprises the information needed to solve specific problems and critical issues in product development and innovation processes. Management of solution information is closely related to crowdsourcing which – as stated before - is not gathering support of corporate functions and structures from the supply chain, but from the intelligence and workforce of a mass of free-time workers on the Internet. Reichwald and Piller state that this is necessary to keep the innovation-process as efficient and effective as needed. Depending on the branch often more than 50% of new developed products are not able to satisfy user-needs [3]. The development-, production-, distribution- and advertisement costs are not justified in this case and are simply gone. Therefore the "how to innovate" is focused to reduce insecurity to market and technology in an early phase of the innovation process. Innovation has to be an iterative process between company and market to use the creativity potentials of external sources. User innovations are often considered to be not radical enough because they are based on other concepts the user already is used to and therefore incremental, but this is disproved by surveys. [2]

A different definition from Henry Chesbrough is to open the company-boarders permanently to gain the necessary potential that is needed to be innovation-leader in a particular market and to gain the chance to emerge in new markets. "OI is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external pathways to market, as the firms look to advance their technology. OI combines internal and external ideas into architectures and systems whose requirements are defined by a business model." [4] **Fig. 1** shows H. Chesbrough's approach. The illustrations depict the difference between closed- and open innovation:

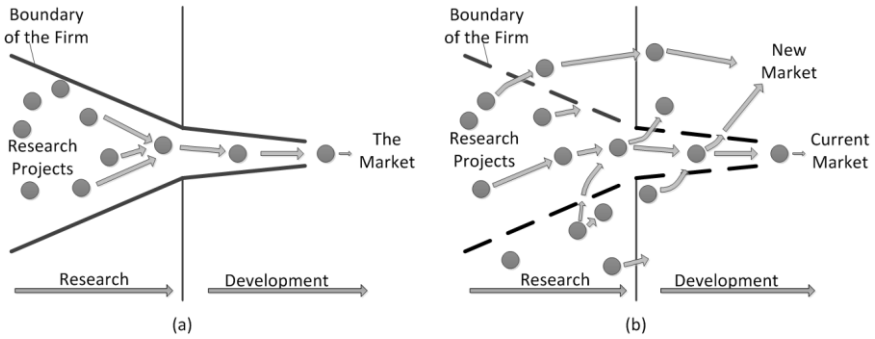

Fig. 1. Closed innovation (a) vs. open innovation (b) [4]

Chesbrough's approach was criticized later by [5] that it does not put enough emphasis on the condition of availability of knowledge. Pénin states that access to an open resource needs not automatically to be free of charge and claims that any positive price for access to intellectual property potentially restricts access. The suggested definition of OI by Pénin must encompass three constitutive elements:

1. Voluntary knowledge disclosure from participants,
2. knowledge being open (which is equivalent to say that "spillovers are not controllable" [6]), and
3. continuous and dynamic interactions among participants.

2.2 Future PLM

Within the research project Future PLM, the Virtual Vehicle Research Center in Graz investigated future demands for product life cycle management in terms of the way it manages roles and participation of people. The project intended to discover ways in which PLM can be made more successful in future and to pinpoint challenges that PLM will have to meet. The results presented here have been worked out on the basis of contributions from all project partners.

First, a common PLM definition had been set up that will be used in the scope of this paper as well: Product Lifecycle Management is seen as a strategic concept used for managing intellectual properties of a product over the entire lifecycle [7]. However, in order to foster a holistic PLM within a company, the improvement of processes and methods is a necessity. Challenges in future product development include:

- Managing the entire lifecycle of a product.
- Collaboration between different disciplines and cultures.
- Globally distributed development locations.
- Integration of customers and suppliers.

Further a catalogue of requirements for PLM 2020 was drawn up on the basis of the results of interdisciplinary panels, four derived future scenarios on product development in 2020, qualitative and quantitative interviews in automotive industry [8].

For a better understanding, the catalogue of requirements is inset in a matrix with specific levels versus topics [9]. In the catalogue of requirements the previously collected ideas and suggested solutions are clarified and documented along with their chain of effects. In this paper the focus is set on matrix intersections with the topic OI.

3 Analyzed challenges in the field of Open Innovation and PLM

The next subsections pinpoint some challenges in the field of OI that PLM will have to meet.

3.1 Data Management and Data Security

From the point of view of data which is generated within the innovation process and has to be managed, two major aspects have to be distinguished: marketing and engineering. Marketing data results from customer feedback and customer requirements. Customer feedback can be collected in the usage or Mid of Life (MoL) phase of a product based on the real existing product and customer experiences (usage, maintenance, service). Customer requirements can also be collected based on concepts and virtual products in early phases of the product development process.

Both can be considered as base to define and fix the requirements set for the development of new or refurbishment of existing products. Especially, social media or web 2.0 tools like forums offer a vast supply of different information sources, are developing fast, and can be utilized to collect marketing data but this data has to be analyzed and structured in order to be valuable for the definition of requirements. Another option is to develop special, questionnaire like web tools to collect data at least in a semi structured form or even enhance products with capabilities to return feedback data from usage. Another point of distinction is whether feedback data is collected on a product class in general or a single instance basis (identified product instance) which would require respective PLM enhancements.

On the other hand the crowd sourcing aspect of OI requires handling and exchange of various types of typical engineering data though here are conceptual contradictions between the required structuredness of enterprise information management and the creativity of the OI processes. The main question is how transparency in decision making and evaluation of alternatives in the OI process can be ensured and what enhancement of PLM functionalities have to be provided to suit the demands outside the inner circle of the own organization and even outside the outer circle of business partners such as suppliers or contractors. This is predominantly not a challenge with respect to IT issues since all available IT systems in this area support ubiquitous web technology but essentially with respect to legal aspects (accountability, liability, export restrictions etc.) and organizational aspects (transparency in processes, definition of the granularity of tasks and information to be transferred into the crowd sourcing community, management of the crowd etc.). Resulting data of crowd sourcing processes does not only contribute to requirements but to various tasks of engineering design and product development.

The major issue in the context of data management in crowd sourcing processes is certainly the security issue. The term Intellectual Property Protection (IPP) represents the business objective to protect the know-how of a company as part of a supply chain or engineering network against risk of industrial espionage, patent violation, and plagiarism. IPP also comprises Data Leakage Prevention (DLP), i.e. means to prevent data leakage incidents where sensitive data is disclosed to unauthorized personnel either by malicious intent or inadvertent mistake [10]. To Implement IPP, different so called Enterprise Rights Management (ERM) approaches using encryption technology are available. These control access to corporate documents by selectively granting access to certain portions of the digital content or certain operations [11] and thereby enable companies to extend security to third-party partners, suppliers and customers [12].

ERM is based on identity management (user authentication) and requires a policy server in which rights are defined, an encryption mechanism that controls access to the data, and a software or device that enforces the policy. ERM solutions focus on document exchange security which represents static content, but in typical IT solutions for PLM, content is tied to a business process and dynamically changing, i.e. rights on a document are not only defined by the identity and role of a user but especially by its status or maturity. In multiple party crowd sourcing processes, user identification maintenance of roles with respect to PLM environments will be an intricate task and prone to failure. Main requirements are that protections stay together with document wherever the document travels and the owner remains in full control, i.e. access rights can be modified or revoked at any time. This means that each access to protected documents requires access to a server as independent authority which stores access rights and decryption information and raises questions of organizational aspects for managing identities, defining roles, or classifying data.

3.2 Process

During the last few years, there has been rapid technological development and new possibilities have emerged for collaboration, communication and the management of product lifecycle information and knowledge. Some of the major changes are related to the novel possibilities offered by the emergence and, in the business sense, the maturing of web 2.0 and social media–based approaches (e.g. [13]). Social media integration in PLM has been an important trend of major PLM vendors, allowing e.g. the use and sharing of non-structured and tacit knowledge, which are problematic in traditional PDM and PLM systems. According to Stocker and Tochtermann [14] web 2.0 focusses technologies that enable users to communicate, create content and share it with each other via communities, social networks and virtual worlds - faster and easier than ever before. They emphasize the power of users to select, filter, publish and edit information, as well as to participate in the creation of content in social media [15]. To sum up, web 2.0 and social media provides quite novel and useful ways of interacting and collaborating in the innovation process, as well as for creating new information and knowledge for innovations.

Based on Chesbrough the authors Gassmann and Enkel [16] define three processes to integrate OI into the development process as shown in **Fig. 2**. The processes are:

- The outside-in process where ideas generated outside the company are used inside,
- the inside-out process where knowledge or products are exploited outside the current market, and
- the coupled-process where outside-in and the inside-out processes are combined.

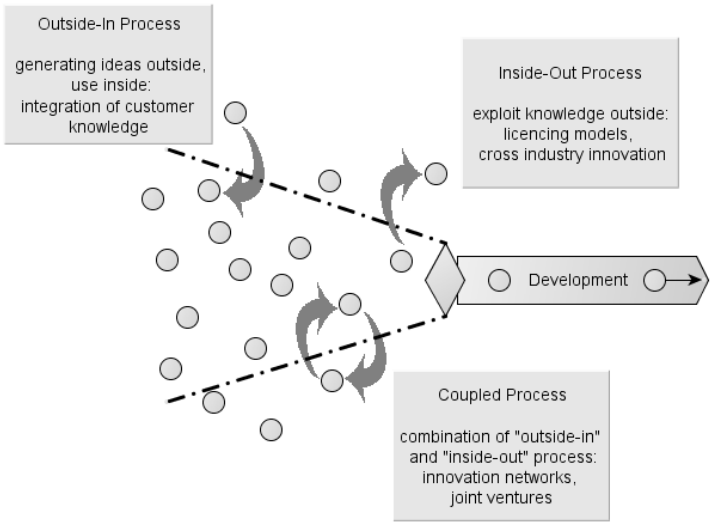

Fig. 2. Core-processes to integrate OI into the development process [16]

Sherhan, Albers and Miller [17] show outside-in and inside-out methods in the automotive industry where German Original Equipment Manufacturers (OEM) and supplier in the automotive industry are surveyed and analyzed. The study also recommended two further steps in the innovation process: An innovation impulse step for managing internal and external innovation inputs and an innovation transfer step to maximize the benefit in R&D productivity [17].

3.3 Human Factor

According to Golas [18] a company in its environment represents an open and targeted social system. Humans in the field of automotive industry are working in complex socio-technical systems. No matter how much technically dominated this operational environment is – the creative, social and individual facets of people remain very important. Working in complex systems is on the one hand characterized by routines and on the other hand by exceptional situations or crises. These situations require e.g. that people make decisions under time pressure and high risk or find new innovative solutions within very limited time. Therefore people are the highest potential in a company and have to get major support in communication and collaboration to achieve the corporate goals. They need the best possible support by a suitable envi-

ronment - a well-balanced system between human factors, organization and technology [19]. In the workplace of the future access to information and technology-related knowledge will be much more open and flexible. This simultaneously increases the available range of information. In response, employees are increasingly moving into information flows and create independent and self-organized individual information as well as their own system environment. The transparency of knowledge and knowledge holders will continually rise in companies. For practitioners, it is often more important to identify the relevant knowledge holders in the companies than the explicit knowledge itself. [19]

A typical pitfall which has been observed in projects is the NIH syndrome (not invented here) coming from the co-workers within a company. A solution which was not developed inside of internal R&D is often not considered trustful and is different from solutions of the company. This often results in resistance from the people who are working for this company [20].

4 Identified requirements for Open Innovation in PLM 2020

The perspectives of the scenarios, the statements of the experts and the analyzed challenges in the field of PLM are combined to perform a requirements catalogue for future PLM. The requirements catalogue is divided into five classes which are product, human, organization, process, and IT, taking into account that single requirements can be in one, some or all classes.

- Product: relationship between overall product and product parts (customer wish - product requirements, complexity).
- Humans/team: individuals and their relationships (team), common understanding of mission, associations and threads.
- Organization: cross-domain and global communication and collaboration
- Process: interaction of total product development process and sub-processes, transdisciplinarity.
- IT: new technology and methods for new information and communication tools (e.g. Web 2.0).

As a research result the relations of all 317 requirements and classes are shown. This paper deals with the catalogue entries that include the topic of OI. Some of them are described in detail below. At each headline, the assignment of classes is listed in parentheses.

4.1 Strong cooperation across domains (human, organization, process, IT).

OI processes are benefited in the case that employees are independent because it forces them to contact companies and communities to share knowledge with people from different areas of interests. OI can be seen as integration of customer-knowledge into the existing one. Customers all over the world are able to take part in creation or improvement of the products. Requirements to PLM 2020 are particularly: Support

interaction with the customers in the product development process; integration of analytical tools; integration of alternative procurement strategies.

4.2 Virtual work of the company (human, organization, IT).

Virtual work is one of the key trends of the future. Due to "cloud" technology, fast internet-based information exchange as well as communication channels for interaction between customers, employees and all participants of the supply chain in a product development process will become an essential part. Problems can be published to a community which provides recommendations for the problems and additionally makes changes and edits solutions. Information synchronization as a key concept of cloud technology forces interactivity and interdisciplinary working what leads to radical innovations. Creating social networks inside a company will help to share information between different departments, discuss tasks and solutions online with the required personal of the company. Trust between employees will increase.

4.3 Communication in product development (product, human, organization, process, IT).

Customers can take direct participation in the development of the products. All comments of the customers have to be implemented or at least labeled to be considered. Language and cultural barriers have to be solved. Power and quickness of the product development depends on the interaction between employees and customers. Quick review of the development process allows a faster development in general. The communication between two or more participants has to be structured.

4.4 Workstation of the future (human, organization, IT).

Due to increasing mobility each employee needs external access to working data. Specialists in small areas of interest will be available on demand and work for one or more companies, assisted by virtual assistants. The product service system is intersected with OI as well when the customers give their feedback using different possibilities. One of them is to classify the product in a simple way, e.g. mechanisms as the "like" button on "Facebook".

5 Discussion

OI in the automotive industry is no longer an empty phrase. Sheran, Albers and Miller [17] state that in the next 10 years the way of creating and profiting from innovation will change completely in the automotive industry. They also delineate that OI is a phenomenon that has become increasingly important over the last few years in the automotive industry [17]. Gassmann [16] argues that some trends like globalization, new technologies, or new business models will foster OI concepts in industry. Gassmann´s arguments recover most of the aspects in the scenarios which were de-

veloped in the FuturePLM project, especially the mega trend globalization described in the scenario “Globalization Extreme!” [7].

The scenario “People take center stages” is formed upon the following assumptions: (1) Recognition of importance of employees (2) Mutual trust within companies increases acceptance and understanding of PLM due to deployment of new technologies, processes and organization forms (3) High cultural diversity in companies (4) Deep PLM integration, and (5) Flexible infrastructure and working conditions in complex business environments [7]. In this regard, people working from diverse locations can use social software such as wikis and blogs [13] as a modern way of disseminating information and knowledge within the company and out of company, which creates a simple form of community. Contained in the general assumption that the way companies are organized will change dramatically in future is the implication that the definition of workplaces and working time models will change as well [19]. All shifts recommended above will require equivalent changes in PLM implementation models, which will affect how goals are defined, how the system is introduced and how it is used [8].

6 Conclusion & Outlook

Being able to innovate is the key factor of success for companies in high tech branches. OI on the one hand side means customer integration rather than customer orientation. On the other hand side, OI approaches leverage the work force and creativity of the mass of smart and talented people from all around to enable new ways of idea generation to solve product development problems. Since our society heavily depends on innovative products, the new approaches of innovation processes have to be implemented in companies and have to be supported adequately by means such as PLM.

PLM is a concept of how to manage a product in terms of people, workplace and organization. The main driver will be the evolution of the concepts of employees as part of the value creation process and the growing importance of individual human potentials. To manage this successfully, a wide-ranging dialogue with the people affected will be necessary. A new culture of how information is shared needs to be developed. The technological systems development must follow the developing needs of the people and create solutions which meet the needs of both users and tasks in such a way that people can use them with enthusiasm.

The combination of concepts in the field of OI and PLM needs to change the adjustment of the company with regards of openness. New methods in research and development phases should afford an opportunity to look outside of company boundaries.

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