THE DEVELOPMENT OF A KNOWLEDGE MANAGEMENT MODEL TO SUPPORT PRODUCT DESIGN PROCESS WITHIN BRAZILIAN SME COMPANIES

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Abstract

The knowledge management has received attention from designers responsible for the product development process (PDP) because many of the design activities require a creative thought and are highly dependent on individual's knowledge. Furthermore, the product development process deals with a large amount of knowledge which makes the process more critical. Therefore, this work analyses the state of the art of the knowledge management and it proposes a theoretical model, based on the occurrence of four types of conversions of the knowledge (i.e. socialization, internalization, externalization and combination) to be used during the product development process. If efficiently managed and along with the participation of all members of the company, the intellectual capital within SME may turn up to be a promoting mechanism of creation processes to support knowledge transfer as well as improving and supporting the product development process. A theoretical model for knowledge management within the product development process was developed based on a extensive theoretical review on knowledge management, organizational learning and product development process management issues. It is expected that application of this model will result in a more effective way of developing products.

Keywords: knowledge management model, product development, innovative products, small and medium enterprises (SMEs)

1 Introduction

The competitive advantage of the companies is directly related to their capacity of introducing new products in the market at periods and costs comparatively smaller. As a consequence, the product development process has become an important aspect for marketing strategy and company´s differentiation. Based on that, it has been observed that understanding how product design knowledge is managed within an organization has become one of the main resources for improving company competitiveness.

The product design process (PDP) involves many different aspects such as: marketing, manufacturing, assembling, packing, environment etc [7]. Therefore, to be more effective, it requires a good knowledge management (KM) [2, 6].

The present fierce competition results in the search of even more creative solutions, continuous improvements in company products and processes and continuous investments in technological innovation. As a consequence, companies have to respond quickly to any new market opportunity as well as to (new) the customer's needs.

Companies´ efficiency for knowledge creation is given by their capacity in converting the tacit knowledge in explicit knowledge. Then, this work presents a knowledge management model which indicates that company's creation is dependent on how knowledge is shared among the members of the organization.

Therefore, this work presents how company´s knowledge is important for competitiveness and shows a theoretical model of knowledge management to help organizations to improve their PDP through sharing knowledge acquired from all company members.

2 Research Methodology

The research methodology was based on a literature review that included a collection of references related to knowledge management and it aims to understand the knowledge is operated within companies. Based on that, a theoretical knowledge management model for improving the PDP was developed. Finally, some considerations have been made related to the importance of the model applicability in the improvement of the PDP in the small and medium enterprises (SMEs). This model will be validated later on in "real case" situation.

3 Literature Review on Knowledge Management

Knowledge has become the more important economical factor for competitiveness. This knowledge is mainly based on market demands, technical processes, customer requirements, technology improvements, competitors etc [13].

Drucker [3] has pointed out that in this new era, traditional production factors such as labor work, capital and natural resources have become less important when comparing to company´s knowledge. Stewart [12] reinforces that idea suggesting that in this new "era of information" the fundamental sources of wealth are knowledge and communication, and not natural resources or labor work.

During the first decades of the computer science, the emphasis was data management. In order to transform data into information it is required tools. However, in order to transform information into knowledge it is needed time. Knowledge is to use information (and as a consequence data) to generate new ideas or solutions.

DEVENPORT & PRUSAK [2] differentiate these three classes of elements as: i) Data - a discreet and objective group of facts of a certain event (i.e. temperature of the atmosphere, 32 degree Celsius); ii) Information - a message containing an originator and a receiver and whose meaning involves a new interpretation based on a group of data (i.e. due to temperature and the atmospheric pressure, it should rain within 1 hour), and; iii) Knowledge - a mixture of experiences, values, contextual information and intuition, forming a framework in a person's mind that enables him/her to evaluate and to obtain new experiences and information.

The larger is individual's knowledge the best will his/hers appreciation and analysis of the data and information available. As a consequence, the better is the quality of the decisions taken within the product development process.

NONAKA & TAKEUCHI [6] identified two important distinction of types of knowledge that has been used: i) The tacit knowledge - it is the knowledge that the people possess but it is not described in any place. It is just residing in your heads; ii) The explicit knowledge - it is the knowledge that is registered in some ways and therefore it is available for the other people. Many studies on knowledge management is based on the successive passages from tacit knowledge to explicit knowledge and vice-versa [13].

NONAKA & TAKEUCHI [6] have also suggested four basic conversion patterns for the knowledge creation in an organization:

- **From tacit knowledge to tacit knowledge or socialization**: it is a process of sharing experiences and, therefore, the creation of tacit knowledge. The secret for the acquisition of this knowledge type is experience. Without sharing experience it is difficult for anyone to know the process of other individual's reasoning. This shared knowledge usually happens through frequent dialogue and communication "face-to-face" and sharing work experience such as "master-apprentice", observation, imitation and learning by doing process.

- **From tacit knowledge to explicit knowledge or externalization**: it is a process of articulation of the individual's tacit knowledge in explicit concepts. This conceptual knowledge usually happens through: i) symbolic representation of the tacit knowledge through metaphors, analogies, model, concepts, hypotheses by using the figurative language; oral reports and films (i.e. recording of the oral reports and images of occurrences/actions); description of part of the tacit knowledge through spreadsheets, texts, images, illustrations, rules, scripts, design history, lessons learned etc.

- **From explicit knowledge to explicit knowledge or combination**: it is a conversion process of some type of explicit knowledge generated by an individual to add up to the explicit knowledge of an organization. Individuals exchange and combine knowledge through documents, meetings, chats etc. Usually this systemic knowledge happens by grouping and processing different explicit knowledge that could generate into a new knowledge for the organization.

- **From explicit knowledge to tacit knowledge or internalization**: it is the process of incorporating explicit knowledge from the organization into individual's tacit knowledge. This operational knowledge usually happens through: i) reading/visualization and individual studying of documents from different formats (i.e. texts, images, etc); ii) individual interpretation and experimentation (i.e. practices and lessons learned).

The figure 1 presents these four basic standards in such a way that the creation of the organizational knowledge is based on a continuous and dynamic interaction between the tacit knowledge and the explicit knowledge.

	Tacit Knowledge	Explicit Knowledge
Tacit Knowledge	Socialization (Sharing Knowledge) e.g.: see, perceive.	Externalization (Conceptual Knowledge) e.g.: write, talk, design.
Explicit Knowledge	Internalization (Operational Knowledge) e.g.: read, hear, listen.	Combination (Systemic Knowledge) e.g.: group, combine.

Figure 1. Ways of converting knowledge [6].

The organizational knowledge is not only found in documents, databases and information systems. They can also be found in the business processes, group practices and in the accumulated experience of individuals. The knowledge is transmitted from people to people through means such as videos, books, documents and Internet. Furthermore, individuals can gather knowledge from those who already have it by interpersonal learning and sharing experiences and ideas. New technologies such as Internet, Intranet and Extranet have been used to propose interesting ways of communication among communities of common

practices. A better quality knowledge can make organizations to improve their decisions in marketing, sales, production, distribution, and so on.

It is important to observe that the people have been using knowledge within organizations for a long time. However, the recognition that this knowledge is a resource that needs to be managed is relatively recent. "Knowledge management is a certain form of looking into the organization in the search of points of the business process where knowledge can be used as competitive edge" [13]. Knowledge management is not technology but it can be benefited from new technologies of the information and of communication. Knowledge management is not creativity and innovation but it is related to how to use the innovations generated in the company in a systematic way for a better market positioning. Knowledge management is not quality but it uses techniques and tools that have already been applied in the quality management and in the approaches of continuous improvement. Knowledge management is not marketing but it can help companies in the competitive intelligence. Knowledge management is not documentation but it is related to organizational collective memory. Knowledge management is not also administration of human resources but it only takes place with the people of the organization. Knowledge management is a new area within information technology and management, a new field among the strategy, culture and information system an organization. Knowledge management is not new. However, a large number of companies is concerned on how to transform information in knowledge.

WENDI R. BUKOWITZ and RUTH L. WILLIAMS [14] define knowledge management as being the process by which the organization generates wealth, from their knowledge or intellectual capital. In this context, wealth happens when an organization uses its own knowledge to generate more efficient and effective processes.

Companies tend to differentiate themselves from what they know (intellectual capital) and from how they use this knowledge. The interest for knowledge within companies began with identification that the value of market of several companies such as: Microsoft, Apple, and Yahoo is much larger than the value of their own physical patrimony (facilities, equipments etc.). The total value of the shares of those companies incorporates an intangible "data" such as: the value of their brands, their patents, their capacity of innovation, the talent of their employees and the relationships with their own customers. Companies turned into knowledge management with the intention of understanding, organizing, controlling and profiting with this intangible value (i.e. knowledge).

4 Objectives

The PDP can be improved by good KM because its activities are essentially characterized by creative thoughts and, therefore, it is dependent on the individual knowledge and abilities that accomplish them. However, individual knowledge does not assure an organizational learning. Therefore, it is important to share the individual learning so that organizations can move towards a changing process that it will lead them to a continuous innovative and improve process. In order words, a concept of continuous learning improvement where all members can share their own knowledge. This process is called organizational learning or "organization that learns ".

The organizational learning can be defined as being a process of detection and correction of wrong decisions [4] as well as its capacity of self-development and self-transformation [11] or its capacity to acquire knowledge through experience [10].

Shaw and Perkins [10] presents a model of organizational learning (figure 2) that starts with a system of faiths (a combination of values, knowledge and experience). This system has

influence on how people behave, working as "lenses" through which the world is noticed and molding their form of acting.
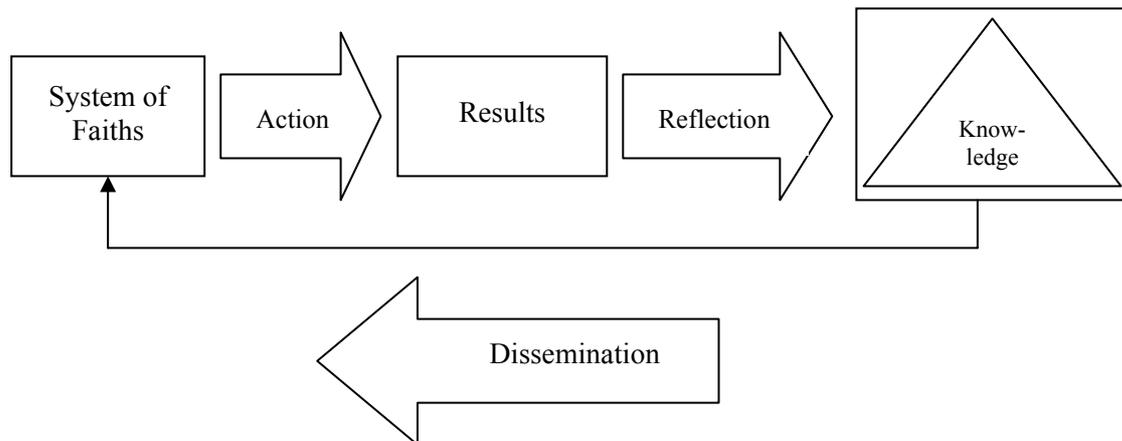

Figure 2. Organization learning model [10].

Besides that, an effective KM should allow that the solutions and experiences adopted in each project they can be spread throughout the organization, allowing continuous improvement on business performance. However, how knowledge will be managed within the company it will depend on some aspects such as: culture organization, motivation, training, teamworking, large amount of explicit knowledge, among others. In that way, it is very important to improve them, specially regarding the PDP.

Therefore, basic aspects of how organizations can learn and the reduction of product life cycle are some of the important factors for organizations that want to continue improve their competitiveness. As a consequence, a constant search for new KM practices can lead companies to have better results in terms of in technological innovation.

The purpose of this work is to verify the contribution of KM, through a theoretical model, to the increasing of learning process within the organization that will result in benefits to the technological innovation and, as a consequence, to the PDP.

5 The Product Development Process

The product development process has become an intensive process of knowledge application. Product quality is associated to the systematically application of the knowledge in the many phases of its development.

Juran [5] defines product development as "an experimental process of choice the product characteristics that corresponds to the customers' needs". Therefore, the product development consists of a process of transformation of information. Each activity of the product development process should be seen as a theoretical-empiric framework, limited by the time, where a group of information is treated, transformed and passed ahead to another activity at the appropriate time. The information do not enter at the beginning of each activity and nor leave in the end of each activity, the flow of information happens at every moment of the product development process.

Knowledge is created through the interaction and sharing that happens among people during the execution of those activities and the flow of information happens in a chaotic way during that process. The tacit knowledge that emerges from this process is interactive and it is the base of the process of knowledge creation within the organization.

The decisions taken based on the information and the knowledge created within the process are responsible to determine, for instance, the product concept that will be developed and the level of its corresponding quality. When considering product quality, the initial phases of the product development are decisive because they define which information will be taken ahead.

The potential contribution of the tacit knowledge is still underestimated. This is due to old fashion culture that still remains in the current organizations. Currently manners of transmitting knowledge privilege the explicit, formal and logical side of the knowledge transmission process. This provokes a gap in the creation process for adding value of a product. This gap remains up to the end of the product design process, resulting directly in the quality of the product developed.

6 Theoretical Model of Knowledge Management applied to the Product Development Process

The theoretical model of knowledge management applied to the product development process is presented in figure 3.
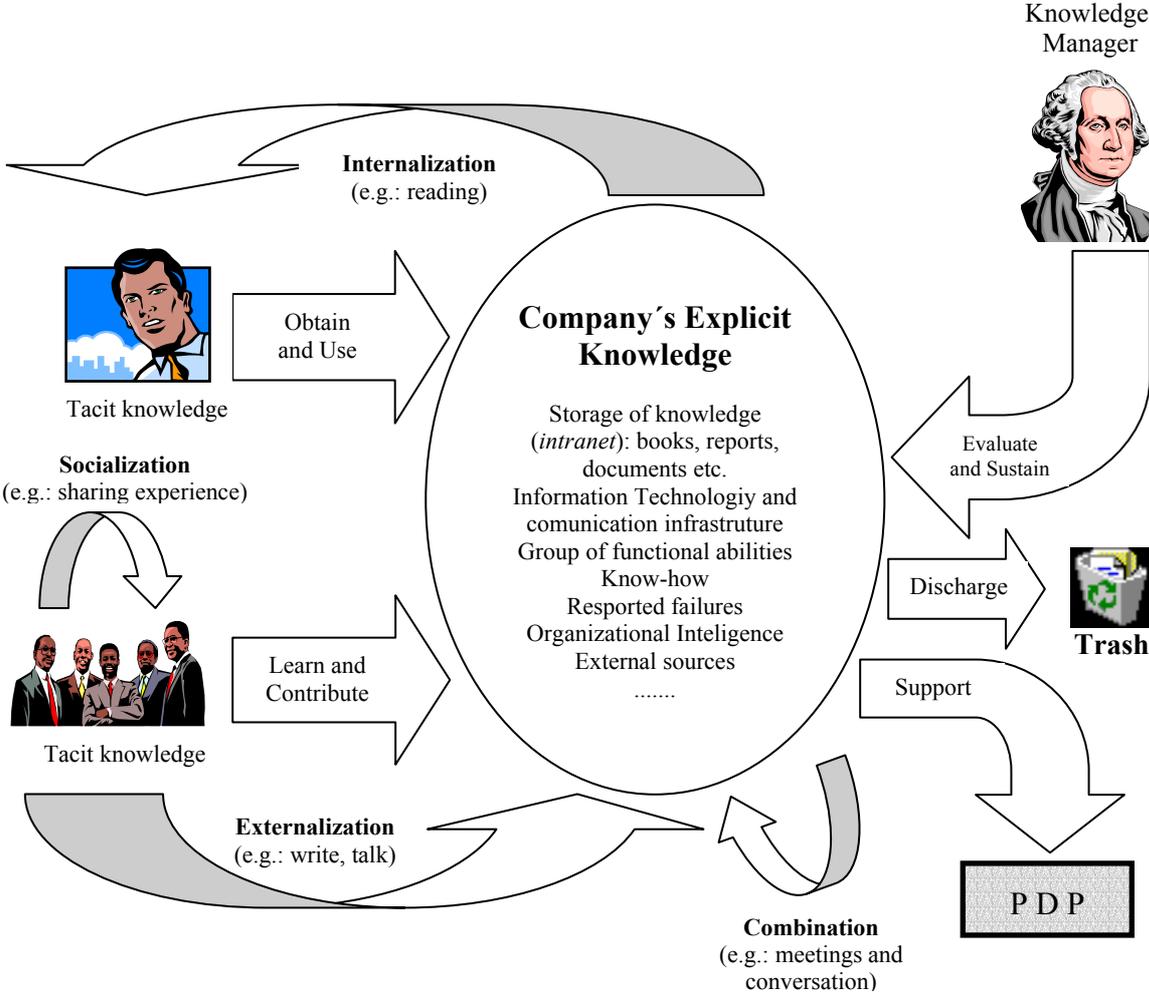

Figure 3. Theoretical Knowledge management model (adapt from [14]).

This model is a simplified manner to present how organizations can generate, retrieve and dispose its knowledge to strategically create adding value for their products. Besides the four conversions of the knowledge described in section 3 (i.e. socialization, externalization,

combination and internationalization), many other steps (i.e. obtain and use; learn and contribute; evaluate and sustain; discharge and support) were added to this model in order to increase the knowledge of the company and, consequently, to improve the product development process.

The model presents the company´s knowledge. This knowledge is composed by the sharing knowledge of each individual. Based on the steps described in the model (i.e. obtain and use; learn and contribute; evaluate and sustain; discharge and support) an efficient and effective management of the intellectual capital of the company is obtained. The processes "obtain" and "use" are well known within organizations [14]. People always seek information and use them later to solve their problems, to take decisions or to create new products. Therefore, new technologies (e.g. intranet) allow that the large amount of information that flows within organizations can be correctly managed.

The steps "learn" and "contribute" are relatively new for organizations [14]. However, the formal recognition that these steps can be used as competitive advantage is new. The challenge for the organizations is to find out how to integrate the learning process to the way that people work. For example, it has been difficult to convince employees to contribute to the company´s knowledge base. New technologies have helped companies easily organize, send and transfer certain types of information. However, this facility has been seen by the employee as a threat for his/hers own job security. Therefore, the most difficult task is to convince individuals that their contribution will give return to their organization as well as to themselves.

The step "evaluate" indicates that the organization should define its own necessary knowledge for its mission and classify its own currently intellectual capital. The knowledge manager should be responsible to measure if the organization is increasing its own knowledge level and profiting from investment in intellectual capital as well as answer questions on-line, facilitate the discussions on-line, explore useful materials and establish a community net [14]. In other words, the knowledge manager does more than organize the content in system on-line, he/she should understand and foresee the community's needs.

The step "sustain" or "maintain" should assure that the future intellectual capital will maintain the organization viable and competitive. Organizations tend to build their own intellectual capital through their relationships with customers, employees, suppliers etc. Therefore, the knowledge manager should also be responsible for the maintenance of the company´s knowledge base.

The step "discharge" excludes any useless knowledge from the company´s knowledge base. However, some knowledge can be more valuable if it can be transferred to outside of the organization.

Finally, the step "support" can be used for the continuous improvement of the product development process. The validation of this model will be carried out based on a practical application in a SME company within the furniture industrial sector. It is believed that this sector is a good example of application of design and production practices.

Therefore, in order to evaluate the applicability of the model, it is intended to compare company´s performance (e.g. product quality improvement, cost reduction and increasing market sale) before and after the application of the theoretical model. After its validation, the theoretical model can be tailored to be applied to specific company needs.

7 Results

It is expected that the knowledge management model can be useful to improve product development process within SME companies. The model should be tailored to specific company´s needs and also help the company to "learn" more about their product development process. The model is intended to make companies move from a "take decisions" approach to a "thinking decisions" approach. It is believed that this new managerial approach will help companies to "learn" more about themselves as well as better understanding how their products have been developed and, as consequence, becoming a "learning organization". This will help them to search for alternative solutions and, as a consequence, develop innovative products.

It is also expected that this knowledge management model will help companies to improve their product development process in such a way that competitive gains can be achieved (e.g. improving companies´ image, product cost reductions, quality improvements and shorten time to market).

8 Conclusion

At the moment, research on knowledge management applied to product development is still in its infancy in Brazil. Most of the research work done so far is found highly fragmented and disperse. For example, it has been very difficulty to evaluate and to systematize the explicit knowledge stored in a company.

In this context, new technologies can play a fundamental part in any model of knowledge management. However, that is not enough. In order to be successful, it is also necessary that organizations change their culture regarding knowledge management. Therefore, one of the great challenges of this new era is changing company perspective regarding the introduction of managerial procedures. This process is more evident when SME companies are involved.

The main contribution of this paper was to link these findings in a broader view and to develop a model tailored to specific company´s needs. Besides, the proposed model intends to be implemented in parallel with the currently formal structure of the organization and it should coexist formally or informally with this structure.

References

[1]   AMARAL, D.; ROZENFELD, H. "Gerenciamento de conhecimentos explícitos sobre o processo de desenvolvimento de produto". Florianópolis – SC: III Congresso Brasileiro de Gestão do Desenvolvimento de Produto, set, 2001.

[2]   DAVENPORT, Thomas H., PRUSAK, Laurence. "Conhecimento Empresarial: como as organizações gerenciam o seu capital intelectual". Rio de Janeiro: Campus, 1998.

[3]   DRUCKER, Peter Ferdinand. "Administrando em tempos de grandes mudanças". São Paulo: Pioneira, 1995.

[4]   GARVIN, David A. Construindo a organização que aprende. "Gestão do conhecimento". Harvard Business Review. Rio de Janeiro: Campus, 2001.

[5]   JURAN, Joseph M. "A qualidade desde o projeto: os novos passos para o planejamento da qualidade em produtos e serviços". São Paulo: Pioneira, 1992.

[6]   NONAKA, I.; TAKEUCHI, H. "Criação de conhecimento na empresa". Rio de Janeiro, Campus, 1997.

[7] PUGH, Stuart. "Total design". Addison-Wesley, Reading, Massachusetts, 1991.

[8] RODGERS, P.A.; CALDWELL, N.H.M.; HOXOR, A.P.; CLARKSON, P.J. "WEBCADET: a knowledge management support system for new product development". Cambrdge/UK: 6th IPDMC, 1999. Proceedings.

[9] SILVA, S.; ROZENFELD, H. "Proposta de uma ferramenta de diagnóstico da gestão do conhecimento no processo de desenvolvimento do produto". Florianópolis − SC: III Congresso Brasileiro de Gestão do Desenvolvimento de Produto, set, 2001.

[10] SHAW, Robert B.; PERKINS, Dennis N.T. Ensinar as organizações a aprender: o poder dos fracassos produtivos. In: NADLER, David A.; GERSTEIN, Marc S.; SHAW, Robert B. et al. "Arquitetura organizacional: a chave para a mudança empresarial". Rio de Janeiro: Campus, 1994.

[11] STARKEY, Ken. "Como as organizações aprendem: relato do sucesso das grandes empresas". São Paulo: Futura, 1992.

[12] STEWART, Thomas. "Capital intelectual: a nova vantagem competitiva das empresas". Rio de Janeiro: Campus, 1998.

[13] TEIXEIRA FILHO, J. "Gerenciando conhecimento: como a empresa pode usar a memória organizacional e a inteligência competitiva no desenvolvimento de negócios". Rio de Janeiro: Ed. SENAC, 2000.

[14] WILLIAMS, RUTH L.; BUKOWITZ, WENDI R. "Manual de Gestão do Conhecimento". Porto Alegre: Bookman, 2002.

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