

Application of fuzzy Delphi analysis to shorten the time of new product development based knowledge management tool

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Abstract. This paper proposes a model to priority effective tools of knowledge management to reduce time of new product development process. The proposed process of the study has been implemented among some professors of knowledge management. After weighting the parameters of the model using fuzzy Delphi analysis, values of these parameters has been process. The results show that the parameters of human-based are preferred over process-based knowledge management in new product development. The process-based knowledge management is contained both part of knowledge-led and software-led knowledge management. In knowledge-led knowledge management respectively knowledge integrated production, knowledge acquisition, and knowledge diffusion and integration system are located in the priority of the first to third. And also in knowledge management respectively management information system, knowledge network, and Humans-computers interaction are located in the priority of the first to third.

Keywords: new product development, knowledge management, fuzzy Delphi.

1 Introduction

In the era based on knowledge and the present dynamic and changing world, the services and manufacturing processes have become more complicated and professional. So one of the main concerns of organizations to survive, improve and gain competitive advantage is new product development. Each organization needs to overcome the competitors, develop and shorten time new product development. One of the best tools for achieving these goals is knowledge management. As Kim and Kim (2009) state the development of new products plays the role of blood to survive of successful organizations. Most leading companies have discovered the main factors of success and competitive advantage in the market are the continuity in the development of new products (Cooper & Edgett, 2007).

The following, the article includes several sections. In the second part was paid literature review. The views of researchers are discussed in introducing new product development process and its objectives and the role of knowledge management and its tools as factors in the effectiveness of the new product development process in organizations. The third section has been formed the research model based on scholarly research. In the fourth section, model was tested with fuzzy Delphi method and finally results were analyzed.

2 Literature Review

Organizations need a good foundation of knowledge-based resources to develop and deliver products, unique services, the market success and finding profit. However, many studies have been done in this field for example Nonaka & Takeuchi 1995; Liu, 2002; Koskinen, et al, 2003 that have focused on direct effect of knowledge management on product development. Aslva (1997) noted technological innovation as the product innovation, new product development and production process, and its operational procedures. Samala (2004) believe that the new product development able organization to understand the concepts of knowledge and knowledge management.

This issue was discussed over the years. The Cochran et al (2006) noted its capability on organizational performance and Gunn (2003) and Karylz et al (2004) examined the relationship between technological innovation and knowledge management. During the other researches shown two important and influential process in development a new product consists of knowledge creation and acquisition (KMC) and Knowledge diffusion and integration (KMI) (Lai, & Lin 2012). The research was done to quantify the value of knowledge in the context of product development and pointed out that the knowledge integrated production system (KIPS) including product development and evolution of the knowledge that organization will strengthen new product development.

Also, Berlin (2001), a knowledge network (KN) of high-level knowledge management designed as a tool supports knowledge-based activities. On the other hand the reason of fast growth and the need of knowledge, share Zhen et al (2010) introduce Human-computer interaction (HCI) and John (2003) offered the Management Information System (MIS) in order to develop sharing the knowledge capabilities and accelerating the new products development.

In this paper, after reviewing the new product development process and knowledge management tools in order to model the relationship between these two areas with the introduction of knowledge management, The tools is discussed which include knowledge creation and acquisition (KMC), Knowledge diffusion and integration (KMI), knowledge integrated production system (KIPS), knowledge network (KN), Human-computer interaction (HCI) and Management Information System (MIS) in view of the knowledge management process and the role of culture in its humanist perspective.

2.1 New Product Development

New product development is collection activities and policies grow at different stages leading to partial or total change and reform to production (Cooper, 1997). Hosseini (2005) explain the process that led to the introduction of new products and also companies recognize new product development is not a long-term strategy but the fast environment changes, shorten the product life cycle, increasing competition in the market and increasing the speed of technologic. The many definitions and classification state new product development for example the Booz counseling center definite it in five categories: being new to the world, being new to the company, newly due to the expansion of the product line, newly due to product improvement (Booz, et, al, 1982). Given that the new product development process led to generate, retrieval, use and stored knowledge in the organization. Researchers use knowledge management the risk reduction of process. So knowledge management has become an important factor in product development. Many executives and business owners interested in applying knowledge management tools for new product development activities. The following, it has been paid the brief definition of knowledge management and its integration with the new product development process.

2.2 Knowledge Management

Knowledge management involves the creation, capturing, sharing, implementing and exploitation of knowledge. Knowledge management is referred to manage the corporation's knowledge through a specified process for acquiring, organizing, sustaining, applying, sharing and renewing the knowledge of employees to enhance organizational performance and create value. KM is defined as the creation, extraction, transformation and storage of the correct knowledge and information in order to design better policy, modify action and deliver results for both the employees and organizations in the life insurance business (Bruton et al., 2007).The knowledge management is to congregate, classify, store, and spread all knowledge that is required to grow and flourish the organization. Malek (2005) showed knowledge management proposed process consists of four stages; 1) the proactive acquisition and generation of new information, and the sensing of trends, opportunities and problems, 2) the conceptualization of new challenges and ideas, 3) the

development and optimization of new solutions, 4) the implementation of the new solutions. According to one definition, "Knowledge management is the processes of discovery, achievement, develop occurrence, maintenance, sharing, evaluation and using appropriate knowledge in appropriate time by appropriate person in an organization that occurs through connecting human resources, information technology and communications and producing an appropriate structure to achieve organizational goals". Hence, the number of definitions of the terms knowledge management is almost as large as the number of authors inscribing to the field. However, it is essential for any research focusing knowledge management to provide a relevant definition of knowledge management appropriate to the research purpose. The most widely employed definition of knowledge is that it is something where a belief is justifiable as truth due to systematic analysis (Grant, 1996).

2.3 Process-based View

Process-based view of knowledge management can be examined both the knowledge and the software. In knowledge processing knowledge considered as a physical element that have capability production, distribution, storage and measurement. The software processes are examined knowledge from the perspective of information technology, the globalization and breaking the boundaries of knowledge, its interaction with humans and management information systems. The following, each of these components are described as a tool for knowledge management process.

2.3.1 Knowledge- led View

In the following this view is stated in three sections.

2.3.1.1 Creation and acquisition of knowledge

The organizations effort to examine and define the knowledge and resources to create new knowledge and find new ways using employees of the organization or external sources because new knowledge can be a valuable and appropriate way to satisfy our customers and understand their future needs. The process of knowledge management is done by members inside and outside the organization that increase interaction of between people and extraction of knowledge. The knowledge is ideas, facts, concepts, data and methods which it sources is the mind and it base is information. The knowledge is obtained through experience, beliefs and personal values and is improved by decisions, actions and relationships.

In the era of knowledge economy, organizations should note about concepts like creativity, entrepreneurship and innovation to achieve sustainable competitive advantage. They should perform a structured approach to the creation and acquisition of knowledge in order to reach goals of organization (Davenport and Marchard, 1999).

2.3.1.2 Integration and dissemination of knowledge

Knowledge of the organization should be developed and extracted and to become a corporate approach. New knowledge must be filtered and organized by knowledge management team and integrate and useful knowledge provided relation of products and services. The obtained knowledge must be fully stored in detail to prevent repeat mistakes and waste costs and to help technology and information management.

2.3.1.3 Knowledge Integrated production system

The model of Knowledge management process can be shown such as the life cycle so that new knowledge is initially rather vague concept then will grow and will be tested and through various programs Published for specific audiences and becomes more mature and finally has been published widely and has been recognized as usual approach (Birkinshaw, 2002). In order to improve the probability of success of knowledge management and manufacture and integration of knowledge, models of knowledge have been emerged in recent years. Some researchers are paying more attention to aspects of construction, for example Payva et al (2008) showed the role of knowledge management as an interaction strategic resource between knowledge-building and Cross-functional activities. Karacapilidis et al (2006) designed web-

based knowledge management system in a strategic process with the extract aim of knowledge logic during the decision-making process to help users.

Most researches of knowledge management models analysis descriptively and there is lack of empirical discussion that little. However, little research has been done quantitatively such that it can be pointed knowledge integrated production system By Isu and Bernard (2011). According to this system, values of both tacit and explicit knowledge can be measured and the system includes product development and knowledge evolution that analysis the quantitative and also Knowledge measure the increases of the interaction values between knowledge and product. Obviously, this system will be very helpful to determine of reliability in new product development designed.

2.3.2 Software- led View

In the following this view is stated in three sections.

2.3.2.1 Human-computer interaction

Empirical evidences show information technology promises for improve of quality life depends on how effective use and appropriate insight and understanding of the user. Software designers need to consider user's mental model in the design process. Human-computer interaction is modern knowledge and technology study, design, implementation, and evaluation of computing systems in conversations and interactions engage between human users and computers and intelligent software agents and science of human-computer interaction.

Human-computer interaction and communication happens through interfaces of hardware and software. In this area, Chan et al (2003) presented extensive studies on Human-computer interaction and integrated in general in the following five steps:

- Diversity of users and their tasks, and their influence on the design process
- Cost and benefit sharing in user-centered design
- The life cycle of product development
- To assess the ability of the system
- Design, implementation and assessment

2.3.2.2 Management Information System

Management information system means the management based on information. The component study of the information system including data, hardware, software, people and communication systems as well as collecting of data and information and the implementation of activities such as input, processing, storage of data and information and generation of output such as management reports analysis network of communication channels of organization. To manage the nowadays situation cannot be neglected two factors of competitive strategy and cost reduction that these two strategies use information systems based on information and communication technologies and receiving, processing, preserving and retrieving the data and turn them into useful information for quick response and reach high competitive position and low costs.

2.3.2.3 Knowledge Network

The idea of knowledge network is a global movement towards a global network of knowledge. The knowledge network is creating a wide space which has received a lot of online data. Then available and useful data are extracted by fast and modern search engine and by detailed calculations and complex tools and make the knowledge development. Given the organization competition, market changes and customer needs changes, organizations can apply this idea and implement in their organizations.

2.4 Human-based View

Features and capabilities of organization people such as formal education, Experience, creativity, ability to solve problems, to understand new experiences, the interaction and communication with others and to do the team work are main focus of human-based knowledge management. In this study, all of the factors are covered by organizational culture. The culture of an organization should be spread like oxygen in the organization space and all of the human resources understand this issue. The knowledge culture is the branch of organizational culture that depends on the people communication and information generation and exchange (Oliver and Kandadi, 2006).

Culture is considered the central element of organization knowledge that can affect knowledge management for example, the role of trust and ensure is very important in exchange of personal knowledge. The accepted norms play an important role between the organizations various units for strengthening or weakening of knowledge. For example, Gould et al (2001) concluded an organization that support its members the result of having a greater potential to do behaviors that leads to the knowledge creation. Also another study is shown that shared values of the organization can affect people perceptions in the exchange of knowledge (Jarvenpaa and Staples, 2001).

Additionally culture plays a vital role in deciding on a time, place and type of knowledge that must be transmitted and use. Ernest empirical study on 431 European and American organizations showed the unfavorable organizational culture is the main obstacle of the knowledge transfer (Allameh, Zamani, Davoodi, 2011). So culture is an important and complex issue in knowledge management. The experimental study of knowledge exchange processes in the international institution showed that the organizational culture has the most important influence (Mc Cann and Buckner, 2004). Penn Askrbrch (1999) argues knowledge management systems are the more effective than the technology in knowledge creation. In general it can be said the efficient organizational culture is very effective in the knowledge management processes based on trust, cooperation and creativity in the creation and exchange of knowledge (Allameh, Zamani, Davoodi, 2011).

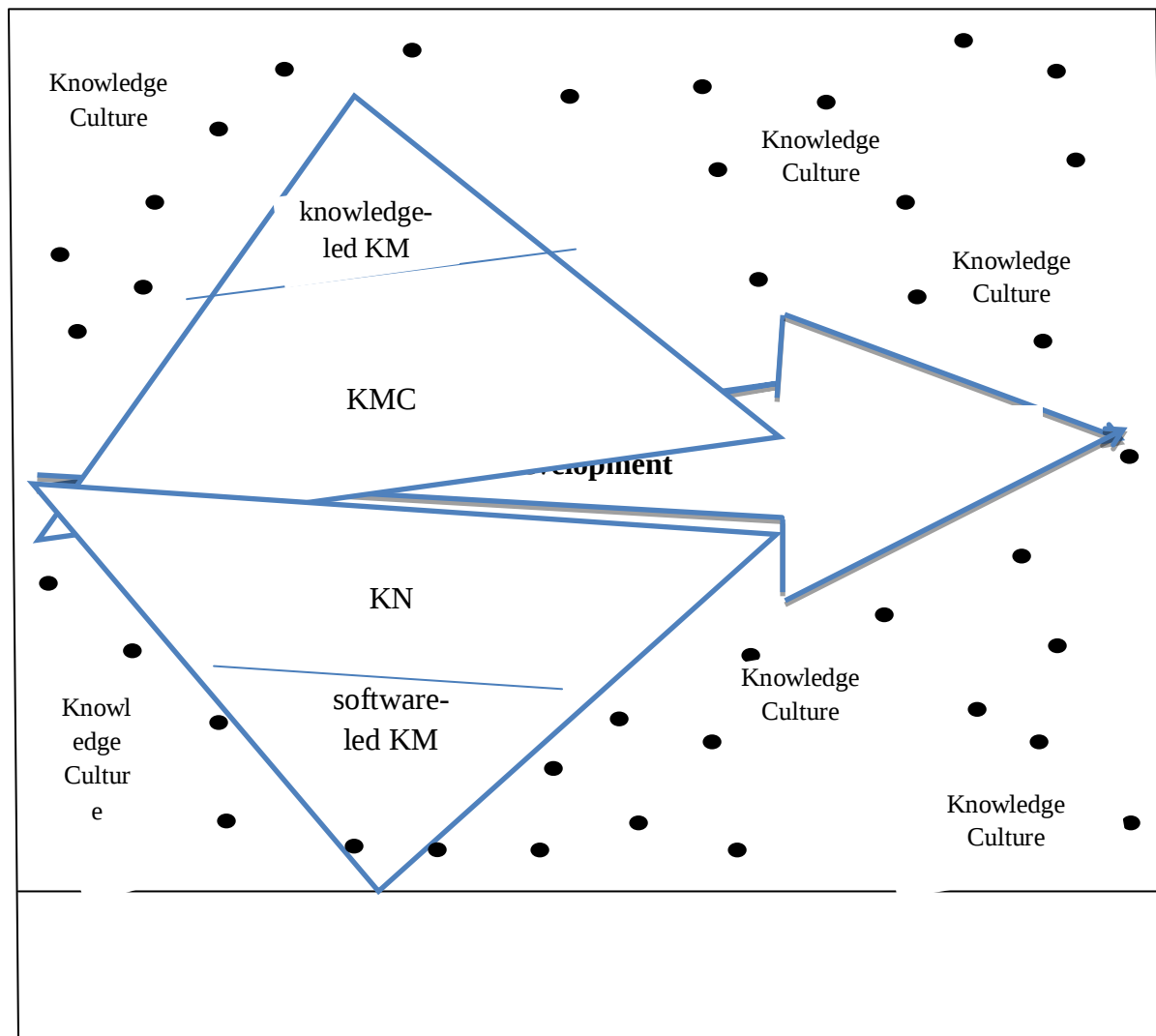
Knowledge management is a process that the organization is enabled to identify, select, organize, distribute and transmit the vital information and organizational experience as well as activities such as solving the dynamic problems, training, programming and deciding strategic. And also can be strongly argued that knowledge management skills of organizations can be used in innovation arrival. The logic of knowledge management is based on that the organization value can lead to favorable and unfavorable behavior. For example, knowledge exchange motivation and personal interaction trust leads the Knowledge management in a positive way. The negative motivation such as reluctance to share knowledge leads an unfavorable way.

DeLong and Fvahy (2000) argue organizational culture can influence Knowledge management from four different routes.

- A cultural shows the most important kind of knowledge
- A cultural acts a mediator between interpersonal and organizational
- A culture generates the social interaction and communication between members of the organization
- A cultural adjusts processes for the production and selection of modern science.

The appropriate culture can provide condition for creation and improve of the needed knowledge in new product development. In view of the impact of organizational culture on knowledge management can be noted that the role of culture in creating a social interaction. Reflections of such a role could on issues such as the number and duration of meetings, correspondence of manager, employers and supervisors and the quality of communication either the organization establishment or human relations such as culture of empathy, collaborating, collaboration, cooperation and collaboration. Thus, to implement knowledge management in any organization should concede organization knowledge as a prominent factor in the strategic planning of the organization. In flowing, It is stated the effectiveness evaluation of new product development process and prioritize each of these indicators in the organization. In figure 1 it is described Knowledge management tools.

Figure 1: The impact of knowledge management on new product development



3 Methodology

In this section, the sample, procedures of data collection, operational measures of variables and statistical analyses are studied in order to determine the affect factors in shorten the time of new product development based knowledge management tool.

3.1 Sample and procedures

As an effort to ascertain the content validity of the survey questionnaire, a draft survey was pre-tested by both academicians i.e. two Strategic Management Assistant Professor. The participants were requested to evaluate the survey questionnaire on its wording, clarity and relevancy. Ultimately, the final version of questionnaire was distributed randomly among some professors of knowledge management. From the total of 30 questionnaires circulated, 10 were returned which represent a response rate of 33.3%. The number of valid and usable questionnaires was 5.

3.2 Measure of factors

Two base dimensions of knowledge management tools including: human-based are preferred over process-based knowledge management were evaluated in this study. These dimensions were asked based on this question "Are Human-based KM tools a more important factor than the process-based tool in order to reduce the process time of a new product

development?" and in the other question the Preference rate of two process-based KM tools is asked. The Preference are asked that 4 items of knowledge-led tools ranked in Likert scale and also 3 items of software-led ranked in Likert scale. Finally, the relative weight of each indicator was determined by using Fuzzy Delphi process.

3.3 Fuzzy Delphi Method

The Delphi method has proven an appropriate tool in information systems research (Xu & Bernard, 2011; Brancheau et al. 2000; Hayne & Pollard, 2000; Holsapple & Joshi, 2002; Lai & Chung, 2002; Nambisan et al. 1999; Mulligan, 2002; Schmidt et al. 2001; Schmidt, 1997) The traditional Delphi method is one of the effective methods which enable forecasting by converging a possibility value by the feedback mechanism of the results of questionnaires, based on experts. Some revision are:

- In case of real life usage of Delphi Method, information communicated by experts is not used with complete potential.
- By pinpointing the intuition of the first response on the part of experts, feasible inference values need to be extracted so that the quality-based and semantic structure of the responses may be analyzed.
- By removing the effect caused by feedback in the Delphi method, natural and non-converged results need to be acquired; Moreover, two and more repetitive surveys are likely to cause a decline in the response rate, which may produce negative effects in the ensuing analyses.
- Only some of the information provided are actually accessed or used. And, hence we may not come to a highly accurate and realistic conclusion always.
- In general, as it is repeated, the survey becomes more costly and time-consuming. Because of a lack of statistical support for the conclusions Ishikawa et al. (1993) presented a step-wise methodology for conducting such studies (Okoli, & Pawlowski, 2004).

- Because of a lack of statistical support for the conclusions Ishikawa et al.1993 presented a step-wise methodology with name of Fuzzy Delphi Method for conducting such studies Okoli, & Pawlowski, 2004).

. In case of Intuitionistic Fuzzy Delphi Method, communication with experts is the same as Fuzzy Delphi Method yet an improved and elaborative statistical tool is used to reach in better conclusions. Subjective information is more likely to be like a quasi-objective data in case of intuitionistic fuzzy number and hence use of intuitionistic fuzzy number is more justified. Also, the experts use their individual competency and subjectivity and are somehow uncertain to air their opinions. Thus, they prefer degree of non-membership over degree of membership and this is the very reason why use of intuitionistic fuzzy concepts is more relevant than fuzzy concepts. This paper presents a Fuzzy Delphi Method by using triangular intuitionistic fuzzy number. For the implementation of fuzzy Delphi method proposed by Liu and Chen (2007) is used. The method involves the following process.

1. The survey of experts
2. Calculate the fuzzy numbers
3. The pair comparison matrix phase
4. Calculate the weight of the fuzzy parameters
5. Non fuzzy weight parameter

4 Results

According to the proposed process, in the first stage, It were evaluated with rate of 80 percent as human-based are preferred over process-based knowledge management and with rate of 60 percent knowledge-led are preferred over software-led. In the second stage, it was weighted and the results of the survey are presented in Tables 1 and 2.

Table1: Scores of the surveys indicators KM knowledge-led process-based

KM knowledge-led process-based	professors of knowledge management				
	1	2	3	4	5
KMI	3	3	5	3	3
KMC	5	7	5	7	7
KIPS	9	5	9	7	9

Table2: Scores of the surveys indicators KM software-led process-based

KM software-led process-based	professors of knowledge management				
	1	2	3	4	5
HCI	3	1	1	3	3
KN	7	5	7	5	5
MIC	7	9	9	7	5

According to the survey, it was found that knowledge-led knowledge management respectively saving knowledge, knowledge integrated production, knowledge acquisition, and knowledge diffusion and integration system are located in the priority of the first to fourth. And also in knowledge management respectively management information system, knowledge network, and computers interaction are located in the priority of the first to third.

With regard to the form of surveys, Pairwise comparison matrices corresponding to each of the indicators were formed and all of these matrices are given in Tables 3 and 4.

Table3: phase comparison matrix on based surveys indicators KM knowledge-led

	professors of knowledge management														
	1			2			3			4			5		
	KMI	KMC	KIPS	KMI	KMC	KIPS	KMI	KMC	KIPS	KMI	KMC	KIPS	KMI	KMC	KIPS
KMI	1	0.54	0.43	1	0.6	0.41	1	0.44	0.33	1	0.7	0.56	1	0.6	0.22
KMC	1.85	1	0.32	1.66	1	0.35	2.13	1	0.23	1.43	1	0.33	1.66	1	0.16
KIPS	2.32	3.12	1	2.43	2.85	1	3.03	4.76	1	1.79	3.03	1	4.54	4.76	1

Table4: phase comparison matrix on based surveys indicators KM software-led

	professors of knowledge management														
	1			2			3			4			5		
	HIC	KN	MIS	HIC	KN	MIS	HIC	KN	MIS	HIC	KN	MIS	HIC	KN	MIS
HIC	1	0.6	0.46	1	0.58	0.39	1	0.47	0.33	1	0.48	0.36	1	0.6	0.42
KN	1.66	1	0.33	1.72	1	0.22	2.13	1	0.21	2.08	1	0.27	1.66	1	0.31
MIS	2.17	3.03	1	2.56	4.54	1	3.03	4.76	1	2.77	3.73	1	2.38	3.22	1

After a survey and evaluation of its results, all results were used for pairwise comparison matrix of indicators. Therefore, Delphi fuzzy pairwise comparison matrix between new product development indexes is done and is shown in the tables 5 and 6.

Table5: The final matrix of fuzzy Delphi on based surveys indicators KM knowledge-led

	KMI	KMC	KIPS
KMI	(1,1,1)	(0.44, 0.59 , 0.7)	(0.22, 0.37, 0.56)
KMC	(2.27, 1.69, 1.43)	(1,1,1)	(0.16, 0.24, 0.33)
KIPS	(4.54, 2.72, 1.78)	(6.25, 4.16, 3.03)	(1,1,1)

Table6: The final matrix of fuzzy Delphi on based surveys indicators KM software-led

	HIC	KN	MIS
HIC	(1,1,1)	(0.47, 0.59 , 0.6)	(0.33, 0.38, 0.46)
KN	(2.13, 1.69, 1.66)	(1,1,1)	(0.21, 0.28, 0.33)
MIS	(3.03, 2.63, 2.17)	(4.76, 3.57, 3.03)	(1,1,1)

Finally, fuzzy and non-fuzzy weighted index is calculated and shown in the Tables 7 and 8.

Table7: Fuzzy and non-fuzzy weighted index on based surveys indicators KM knowledge-led

	$\tilde{Z}$	$\tilde{W}$	W
KMI	(0.233, 0.492, 0.671)	(0.078, 0.164, 0.239)	0.179
KMC	(0.948, 1.104, 1.639)	(0.173, 0.341, 0.596)	0.321
KIPS	(1.381, 1.739, 2.419)	(0.271, 0.513, 0.926)	0.498

Table8: Fuzzy and non-fuzzy weighted index on based surveys indicators KM software-led

	$\tilde{Z}$	$\tilde{Z}$	W
HIC	(0.244, 0.492, 0.624)	(0.46, 0.154, 0.217)	0.112
KN	(0.862, 1.147, 1.892)	(0.142, 0.289, 0.539)	0.306
MIS	(1.571, 1.929, 2.628)	(0.284, 0.574, 0.935)	0.582

5 Conclusions

The organizations need to survive and become known that technology and new product development develop. In the field of knowledge management and its deployment tool is very effective in achieving this goal. The knowledge management tool components are divided into two general areas: processing and humanist. The humanist dimension is more important than the other dimension was considered essential. It certainly process-based also requires high energy and cost and it is very important in the product development process for rapid response of market and surpass the competition. Other hands, two concepts of new product development are the complementary and essential. The results show that the parameters of human-based are preferred over process-based knowledge management in new product development. The process-based knowledge management is contained both part of knowledge-led and software-led knowledge management. In knowledge-led knowledge management respectively knowledge integrated production, knowledge acquisition, and knowledge diffusion and integration system are located in the priority of the first to third. And also in knowledge management respectively management information system, knowledge network, and Humans-computers interaction are located in the priority of the first to third.

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