Designing a Business Process Based on Knowledge Management and Product Development Process in IT Industry

Amalia Suzianti and Adhwa Rana Sausan
Department of Industrial Engineering
Universitas Indonesia
Depok, West Java, Indonesia
suzianti@eng.ui.ac.id, adhwa.rana@ui.ac.id

Abstract

Recent studies have shown that knowledge management holds a very important role in determining a company innovation, especially when it comes to their product development process. This study aims to design a business process that will combine both product development process and knowledge management for IT Industry as it is one of the industries with the highest innovation growth in Indonesia. This study will use risk management framework to identify, eliminate and minimize risk in designing the product development process. Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) will be used in to assess which knowledge management method is the suitable activity that can support knowledge conversion process for each step of product development process. At last, both product development process and knowledge management activities will be combined and mapped as one whole business process as an innovation process guideline for IT Industry in Indonesia.

Keywords
Business process, knowledge management, product development process, AHP, TOPSIS

1. Introduction

Knowledge management can be defined as a process of capturing, disseminating and using knowledge effectively in a company or business entity. Knowledge management is a very important process within the company, because the process has a very large influence on the quality of innovation that can be produced by a company, although it does not have a direct impact.

The importance of the knowledge management process in a company produces a separate function or unit that is tasked with carrying out the knowledge management process in the company as a whole which ultimately produces important information for the innovation process called Knowledge Intensive Business Services or can be abbreviated as KIBS (Muller & Zekker 2001). Some companies decide to outsource to other companies to carry out the functions of KIBS, but there are also companies that use their internal human resources to carry out the functions of KIBS in an implicit and divided manner. The process carried out by KIBS is an important key in the company's innovation process in other words, it has a very large influence on the New Product Development process (Lee et al. 2003; Martinez-Fernandez & Martinez-Fernandez 2015).

Like KIBS which has a focus on renewable technology, reported by thejakartapost.com in 2021, the information and communication technology sector is predicted to be the sector that has the biggest influence on Indonesia's economic growth in 2022 which is driven by the COVID-19 pandemic phenomenon, which is predicted IT sector will grow 9.8% - 10.3% based on the projection made by the Fiscal Policy Agency.

This study seeks to create an overall business process design to describe the product development process along with the knowledge management activities in it.

1.1 Objectives

Previous research that combines knowledge management and new product development processes for IT industry in Indonesia is very limited. Where this will be a research gap that will be carried out at this time, namely describing integrated business processes in the creation of knowledge-based innovation in the IT industry. This study aims to provide insight for companies engaged in the IT sector in Indonesia that can be used to evaluate and standardize business processes in the creation of knowledge-based innovations.

2. Literature Review

According to Leidner (2001) knowledge management is mostly considered as a process that involves various activities. In practice, Leidner argues that there are at least 4 stages in the balancing process, namely creating, storing or retrieving, transferring and applying knowledge.

Based on research conducted by Galbreath (2000) knowledge management comes from the business world. Knowledge management combines the process and application of technological tools to digitize, store and make universally available, via electronic networks, the ongoing creation and transfer of knowledge and wisdom throughout the life cycle of the educational experience. Through the research it produces by linking knowledge management and technology, as is the case with a group of software technologies. To fully take advantage of the benefits of a knowledge management program, perhaps the best place to start is to define the overall approach and process.

Ode and Ayavoo (2020) conducted a study to prove the effect of knowledge management and find out which knowledge management activities have the most influence on the innovation process in a company and it was found that knowledge management has a positive impact and directly impacts the innovation process, then the knowledge generation process positively affect the company's innovation process, knowledge storage positively affects the company's innovation process and knowledge diffusion indirectly affects the company's innovation process through knowledge application. This study further strengthens the evidence that knowledge management does play an important role in the process and quality of innovation produced by a company.

Based on research conducted by Lonescu and Alin (2005) new product development is perhaps the most important process for many companies, but it is also one of the least understood. The researcher explained that NPD is important because it is responsible for the income and margins that can be achieved by the company and its final value. Lonescu & Alin defines new product development as starting with the identification of opportunities in and ending with a successful product launch. Among these are the many activities of defining requirements, developing and testing product concepts, fully defining and developing products, sourcing for suppliers involved, planning manufacturing and supply chains, and preparing marketing programs. Moreover, it is about defining the product strategy, managing the overall product program, and monitoring all the necessary projects and activities to drive the new product development process.

3. Methods

This study uses the Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods to select appropriate knowledge management activities for product development processes in IT companies in Indonesia. The following are the steps of the research method with AHP and TOPSIS:

Step 1: Problem Hierarchy Design. The problem hierarchy is structured to assist the decision-making process by taking into account all decision elements involved in the system. Most problems become difficult to solve because the solving process is carried out without viewing the problem as a system with a certain structure. At the highest level of the hierarchy, stated goals, objectives of the system to which the solution to the problem is sought. The next level is the elaboration of these goals. A hierarchy in the AHP method is a description of elements arranged in several levels, with each level including several homogeneous elements. An element becomes the criteria and benchmark for the elements under it.

Step 2: Relative Measurement. The first thing to do in determining the priority of elements in a decision making is to make pairwise comparisons, which is to compare in pairs all criteria for each hierarchical subsystem. Comparisons between alternatives for the hierarchical subsystem can be made in the form of an n x n matrix.

Step 3: Eigenvector Calculation. An eigenvector is a vector which, when multiplied by a matrix, the result is the vector itself multiplied by a scalar number or parameter which is none other than the eigenvalue.

Step 4: Consistency Ratio Calculation. With the Analytical Hierarchy Process (AHP) method that uses human perception as its input, inconsistency may occur because humans have limitations in expressing their perceptions consistently, especially if they have to compare many criteria. Measurement of the consistency of a matrix itself is based on the maximum eigenvalue.

Step 5: Decision Matrix. Create a normalized decision matrix with the following equation:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

Step 6: Weighted Normalized Decision Matrix. Create a weighted normalized decision matrix with the following equation:

$$v_{ij} = w_j r_{ij}$$

Step 7: Matrix of Ideal and Negative Solutions. Determine the positive and negative ideal solution matrices with the equation:

$$A^+ = \{(j \in J), (j \in J'), i = 1,2,3, \dots m\} = \{v_1^+, v_2^+, v_3^+, \dots v_m^+\}$$

$$A^- = \{(j \in J), (j \in J'), i = 1,2,3, \dots m\} = \{v_1^+, v_2^+, v_3^+, \dots v_m^+\}$$

Step 8: Positive and Negative Ideal Solutions. Calculate positive and negative ideal solutions with the equation:

$$S_1^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)}$$

$$S_1^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)}$$

Step 9: Relative Proximity to the Ideal Solution. Calculating the value of relative proximity to the ideal solution with the equation:

$$c_i^+ = \frac{s_i^-}{\sqrt{s_i^- + s_i^+}}, 0 \le c_i^+ \le 1$$

Step 10: Ranking Alternatives.

4. Data Collection

In designing the flow of knowledge management, we must know the obstacles and challenges that may occur in each process. According to Choi, et.al (2021), the knowledge management activities carried out can be diffused into each stage of the product development process. Where the product development process itself will be divided into 3 main phases, namely phase 1 which consists of ideation, validation and scoping, then phase 2 which consists of design, integration and testing, and finally phase 3 which consists of commercialization, feedback and improvement.

In the AHP process, the first thing to do is to determine the criteria and sub-criteria that will be used as the main comparison for each alternative. The criteria and sub-criteria used in this study are obstacles or challenges that can be encountered when implementing knowledge management based on literature studies. The criteria in this study are divided into 4 (four) which are sources of challenges that can occur, namely strategic challenges, organizational challenges, technological challenges, and cultural challenges (table 1).

Table 1. List of Criteria for AHP

Criteria	Code	Sub-Criteria	Reference
Strategic Challenges	SB1	Lack of KM adoption planning	Blumenberg, S., Wagner, H., & Beimborn, D. (2009).
	SB2	KM activities are not integrated with business processes	Zhao et al. (2012), Natti and Ojasalo (2008)
	SB3	Lack of funding for KM system development	Zhao et al. (2012)
	SB4	Lack of understanding for KM adoption	Aziz and Sparrow (2011)
Organizational Challenges	OB1	Lack of communication between team members	Spanellis et al., (2021)
	OB2	There is resistance to change	Spanellis et al., (2021)
	OB3	Limited space, both formal and informal, to share, reflect and generate knowledge	Hutzschenreuter and Horstkotte (2010)
	OB4	Differences in the meaning of "Information" and "Knowledge"	Aurum et al., (2007)
Technological Challenges	TB1	Difficulty in codifying tacit knowledge	Wagner and Buko (2005), Simonin (2004)
	TB2	Lack of technology infrastructure to adopt KM	Wong and Wong (2011), Aurum et al., (2007)
	TB3	Lack of qualified staff in the use of technology	Al-ghamdi & Al-ghamdi, (2015)
	TB4	Lack of security of data and information	Kumar and Thondikulam (2006)
Cultural Challenges	CB1	Lack of availability and sharing spirit among members	Hutzschenreuter and Horstkotte (2010)
	CB2	Lack of trust and commitment among members	Samuel et al. (2011), Maqsood dan Finegan (2007), Aurum et al., (2007)
	CB3	Differences in values, culture and ways of communicating between teams	Wong and Wong (2011)
	CB4	Lack of creative learning culture that can generate knowledge	Al-ghamdi & Al-ghamdi, (2015)

Furthermore, the determination of alternatives that will be used as a choice of knowledge management activities that can be carried out. There are thirteen choices of activities that can be alternatives resulting from the literature study (Table 2).

Table 2. List of Alternatives

Activities	Code	Reference
Formal training	S1	Gray (2001)
Knowledge repositories	S2	Gray (2001)
Communities of practice	S3	Gray (2001)
Talk rooms	S4	Gray (2001)
Digital Lifecycle Record	S5	Kiklhorn et al., (2020), Aurum et al., (2007)
Personal Network	S6	Aurum et al., (2007)

Utilizing Social Media	S7	Muninger et al., (2022)
Sematic Web	S8	Douligeris and Tilipakis (2006)
Group-based knowledge flows (GKF)	S9	Liu and Li (2011)
Knowledge based customization	S10	Cheung et al. (2012)
Strategic alliances	S11	Wong and Wong (2011)
Transparent work flow or open-door policy	S12	Kasper, Muhlbacher, and Muller (2008)
Virtual communities	S13	Al-ghamdi & Al-ghamdi, (2015)

Based on the results of determining the criteria, sub-criteria and alternatives that will be used for the calculation of AHP and TOPSIS, an alternative selection framework is designed.

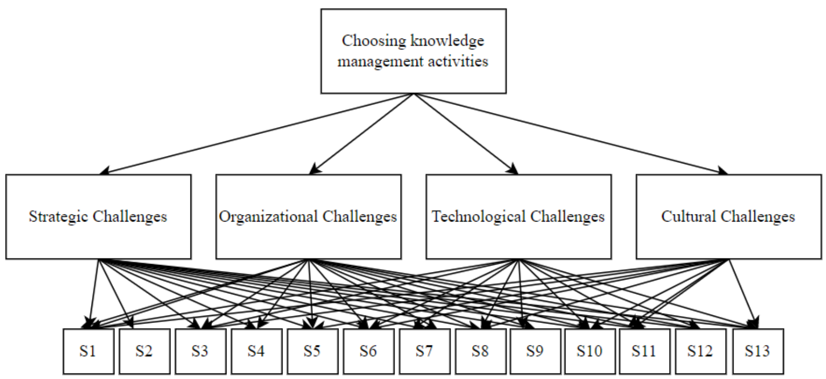

Figure 1. AHP & TOPSIS Decision Tree

The first step for AHP is to perform pairwise comparisons between criteria and sub-criteria. This pairwise comparison will be repeated and 3 (times) in accordance with the mapping of the 3 phases of the product development process due to different conditions for each phase (Figure 1).

The weighting is carried out together with each representative from each business division as well as the Business Director at an artificial intelligence company in the IT industry.

Pairwise comparisons were carried out using a Likert scale of 1 (one) to 9 (nine) which described the level of importance between the criteria and their sub-criteria.

After all the assessments are said to be consistent, then a weight is generated for each criterion and sub-criteria for each phase of the product development process and a ranking is found for each sub-criteria weight. This weight will be used in the selection of alternatives using TOPSIS.

5. Results and Discussion

5.1 Numerical Results

According to AHP and TOPSIS, each phase of product development process has different main challenges in which affected the most suitable knowledge management activities (Table 3-5).

Table 3. AHP Result for Phase 1

Criteria	Criteria Weight	Sub-Criteria Code	CR	Weight	Rank
Strategic Challenges	63.40%	SB1	0.10	0.1986348123	8
		SB2		0.1400682594	11
		SB3		0.5870307167	2
		SB4		0.0742662116	15
Organizational Challenges	21.55%	OB1	0.08	0.6028712104	1
		OB2		0.2183281699	7
		OB3		0.1049734455	12
		OB4		0.07382717415	16
Technological Challenges	5.47%	TB1	0.06	0.174521046	10
		TB2		0.08460355195	14
		TB3		0.2953433086	6
		TB4		0.4455320934	3
Cultural Challenges	9.58%	CB1	0.04	0.1801801802	9
		CB2		0.3009009009	5
		CB3		0.1027027027	13
		CB4		0.4162162162	4

Table 4. AHP Result for Phase 2

Criteria	Criteria Weight	Sub-Criteria Code	CR	Weight	Rank
Strategic Challenges	4.77%	SB1	0.10	0.03604409279	16
		SB2		0.6035327058	1
		SB3		0.2053166965	8
		SB4		0.155106505	10
Organizational Challenges	10.60%	OB1	0.08	0.4780850186	3
		OB2		0.04696657037	14
		OB3		0.3574081717	5
		OB4		0.1175402394	11
Technological Challenges	58.09%	TB1	0.10	0.06778206212	13
		TB2		0.03924572153	15
		TB3		0.5879331291	2
		TB4		0.3050390873	7
Cultural Challenges	26.54%	CB1	0.02	0.1660489706	9
		CB2		0.337622676	6
		CB3		0.07383961388	12
		CB4		0.4224887395	4

Table 5. AHP Result for Phase 3

Criteria	Criteria Weight	Sub-Criteria Code	CR	Weight	Rank
Strategic Challenges	13.02%	SB1	0.07	0.1174899866	11
		SB2		0.5507343124	1
		SB3		0.2723631509	8
		SB4		0.05941255007	14
Organizational Challenges	50.97%	OB1	0.10	0.3263083863	5
		OB2		0.08839792404	12
		OB3		0.5449386429	3
		OB4		0.04035504681	16
Technological Challenges	5.40%	TB1	0.10	0.05403087479	15
		TB2		0.5467409949	2
		TB3		0.1266178076	10
		TB4		0.2726103228	7
Cultural Challenges	30.61%	CB1	0.03	0.1339869281	9
		CB2		0.07189542484	13
		CB3		0.2745098039	6
		CB4		0.5196078431	4

As seen on the table, each phase has different main challenges. For phase 1 of PDP (ideation, validation and scoping), strategic challenges hold the biggest weight with unintegrated KM activities as the number one challenge. For phase 2 of PDP (design, integration and testing), technological challenges hold the biggest weight, however the number one challenge is also unintegrated KM activities, the same with phase 1 of PDP. Lastly, for phase 3 of PDP (commercialization, feedback, improvement) organizational challenges hold the biggest weight, with unintegrated KM activities still the number one challenge.

The result of AHP will be the input for criteria weight that will be calculated to choose the most suitable knowledge management activities for each phase of PDP. For TOPSIS calculation, the alternative that will be chosen aims to minimize all of the challenges that listed as the criteria. Hence, the criteria will be considered as cost for the calculation (table 6-8).

Table 6. TOPSIS Result for Phase 1

Alternative	D+	D-	Preference	Rank
S1	0.282	0.870	0.755	14
S2	0.156	0.724	0.823	1
S3	0.187	0.778	0.806	3
S4	0.200	0.793	0.798	4
S5	0.157	0.727	0.822	2
S6	0.244	0.809	0.768	10
S7	0.244	0.787	0.763	11
S8	0.272	0.867	0.761	12
S9	0.207	0.796	0.794	5

S10	0.252	0.836	0.769	9
S11	0.325	0.912	0.737	13
S12	0.196	0.750	0.793	6
S13	0.189	0.717	0.792	7

Table 7. TOPSIS Result for Phase 2

Alternative	D+	D-	Preference	Rank
S1	0.256	0.880	0.775	10
S2	0.223	0.823	0.786	8
S3	0.246	0.865	0.779	9
S4	0.142	0.747	0.840	1
S5	0.165	0.774	0.824	2
S6	0.189	0.780	0.805	4
S7	0.194	0.777	0.800	5
S8	0.329	0.954	0.744	13
S9	0.220	0.835	0.792	7
S10	0.270	0.900	0.769	10
S11	0.293	0.898	0.754	12
S12	0.186	0.790	0.809	3
S13	0.252	0.848	0.771	11

Table 8. TOPSIS Result for Phase 3

Alternative	D+	D-	Preference	Rank
S1	0.156	0.733	0.824	1
S2	0.229	0.780	0.773	8
S3	0.219	0.798	0.785	5
S4	0.211	0.776	0.786	4
S5	0.212	0.761	0.782	6
S6	0.187	0.738	0.798	3
S7	0.187	0.741	0.798	2
S8	0.257	0.848	0.767	10
S9	0.246	0.825	0.770	9
S10	0.260	0.853	0.766	11
S11	0.271	0.838	0.756	12
S12	0.241	0.823	0.773	7
S13	0.328	0.904	0.734	13

Based on the results of data processing using AHP and TOPSIS, it was found that for phase 1 the most appropriate knowledge management activity was knowledge repository, for phase 2 the most appropriate knowledge management activity was talk rooms and for phase 3 the most appropriate activity was formal training.

6. Conclusion

This study aims to describe the overall business process to describe the innovation process based on the product development process and knowledge management activities. Data processing was carried out using the Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods.

It can be seen from the calculation above, each phase of product development process has different main challenges. However, unintegrated knowledge management activities remain the biggest challenge for all of the phase. Thus, an integrated system for knowledge management activities should be developed in order to facilitate the knowledge storage and conversion process from the knowledge management activities.

Other than that, this study also calculated the most suitable knowledge management activities for each phase of product development process with AHP and TOPSIS. The results of AHP and TOPSIS for the most suitable knowledge management activities for each phase of the product development process are:

1. Knowledge repository for phase 1 (ideation and validation)
2. Talk rooms for phase 2 (design, integration and testing)
3. Formal training for phase 3 (commercialization, feedback and improvement)

Suggestions that can be given for further research with similar topics are that research can be done by developing a knowledge management system and conducting a conformity analysis of the implementation in the company.

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Biographies

Amalia Suzianti is an Associate Professor in the Department of Industrial Engineering, Faculty of Engineering, Universitas Indonesia. She holds a PhD in Innovation System Design from Technische Universitaet Berlin, Germany, and the University of Luxembourg, a Master of Science in Technology and Innovation Management from Brandenburgische Technische Universitaet Cottbus, Germany, and a Bachelor of Engineering in Industrial Engineering from Universitas Indonesia. Her research interests lie in the fields of new product and service development, technology and innovation management, and technology policy and sustainable innovation. She is also a member of the Product Development and Management Association (PDMA) and the Design Society (DS). She is currently active as the Head of the Product Development and Innovation Laboratory in Industrial Engineering Department, Universitas Indonesia.

Adhwa Rana Sausan holds a Bachelor's degree from the Department of Industrial Engineering, Faculty of Engineering Universitas Indonesia. She is currently a Master's degree student majoring in Industrial Engineering Innovation and Design, Faculty of Engineering Universitas Indonesia. She was a laboratory assistant at the Product Development and Innovation Laboratory, Department of Industrial Engineering, Universitas Indonesia.