Research Paper

Formulation of Knowledge Management Strategy for Manufacturing Enterprise in Industry 4.0 Era

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ABSTRACT

This research aimed to study knowledge management (KM) strategy in manufacturing enterprise. Data were collected from 4 experts to formulate many alternative KM strategy, and then analysed using Analytical Hierarchy Process (AHP) by considering some factors and knowledge management process refer to Asia Productivity Organization (APO) knowledge management framework. The enterprise business strategy was also considered as AHP's hierarchy. The results indicated that most important factor that can accelerate KM was 'Leadership', the most important knowledge management process was knowledge sharing, and the most important KM strategy was implementing reward system to encourage knowledge management. This study can be a reference to formulate knowledge management strategies and decide which one is most prioritized to execute. This research was limited to knowledge management strategy for enterprise, study case in automotive component industry in Indonesia. This research can be implemented in other enterprises or organizations, although many different characteristics make this research may be not relevant for others enterprise.

Keywords: Knowledge Management, APO, KM, Strategy, AHP

INTRODUCTION

Indonesian manufacturing industry hopefully can compete in global competition by the existence of Industry 4.0 technologies that can increase productivity, quality and efficiency of production process (Industrial Ministry of Indonesian, 2018). Industry 4.0 has brought an advancement in manufacturing technology and has replaced traditional manufacturing architecture (Telukdarie et al. 2018), but the implementation of manufacturing technology cannot enhance productivity level in a short time (Horvat et al., 2019), because this change needs employees to adapt to how they work caused by new technology implementation. There were some problems with these new technologies, such as manufacturing down time that affects lower productivity. Manufacturing downtime refers to the time or periods when machines are ready for production activities (Nwanya et al, 2017).

The research object is automotive component manufacturing enterprise which has implemented automation and digital technology. Some problems occurred during the beginning of new technology implementation which impacted lower productivity and lower economic added value. The use of robots and sophisticated machines in production processes hopefully can increase production speed, but in another way, it has the potential risk that robot or machine cannot be normally operated because the error occurred and

then need to be repaired by technician. This condition results in lower productivity, because robots or machines cannot produce products during repair and maintenance. Longer time will be needed if engineers or technicians cannot solve the problem immediately. The solution for enterprises to adapt the technology advancement is knowledge management (Ramirez *et al*., 2022).

The lifecycle of products today has become shorter due to the rapid changes in the market. Research and New Product Development (NPD) must be conducted by enterprises to produce some products that meet market demand and win business competition. Products development is a critical activity that helps enterprises to survive. Low capabilities to develop new products will affect longer development time, lower product quality, and higher product cost. Enterprise has various products which must be developed in a short period, but some problems occurred during product development such as higher product costs and product quality problems. Effective KM is needed in new product development, so that all lessons learned during product development can be used for the next product development that is resulting in good and better product. Learning capability can improve the NPD's performance (Hsu and Fang, 2009). There was a positive effect of implementation of KM method to performance of NPD (Liu *et al*, 2004).

Both problems of new technology implementation and NPD were caused by the lack of capability of human resources. Senior and high competence employees did not share their knowledge with other employees, and tacit knowledge did not convert to be explicit knowledge. Tacit knowledge is created by individuals' action and direct experience but difficult to formalize and communicate to others, Explicit knowledge is formalized knowledge that is accessible to share to others easily (Nonaka and Takeuchi, 1995). Organization competency development and

learning need to be supported by KM (Oztemel and Gursev, 2020). Effective KM strategies are needed to solve the problems.

Many previous studies have been conducted to formulate knowledge management strategy. Djajasoedarma (2019) studied the use of APO KM framework and APO assessment tools to develop KM at an agricultural enterprise in Indonesia, resulted the maturity level of KM. Some recommendations to improve KM were obtained by using focus group discussions by experts refer to the APO assessment results. The same research but focused on construction enterprise was conducted by Perez et al. (2023). Pham et al. (2021) did research about KM models by involving 10 experts to analyze the priority factors that influence KM in some universities in Vietnam by using Fuzzy AHP. Oktari et al. (2023) did research about KM strategy for managing disaster in Indonesia by using Analytical Network Process-SWOT tools to formulate KM strategy.

The APO framework has 4 basic elements, (1) Organization vision and mission, (2) accelerator, (3) knowledge process, and (4) outcomes (Young et al., 2020). Vision and mission are the foundation of knowledge management. The understanding of organization vision and mission can increase knowledge management performance (Su & Lin, 2004). Accelerators are factors that can accelerate and boost the development of KM, consisting of leadership, business process, people and technology. Knowledge process is defined as knowledge conversion process which identify, create, store, share and apply knowledge (Young et al., 2020). APO assessment tools are provided to help identify and analyze the condition or maturity level of KM in an enterprise or organization. The maturity level of KM implementation that resulted by the assessment is classified into 5 levels of maturity. Organizations can define some strategies to develop KM by referring to weakness points and opportunities to

improve that shown by low score of each question.

MATERIALS & METHODS

This research aimed to identify knowledge management maturity level, formulate some knowledge management strategy in an automotive component enterprise and decide the most priority one to be executed, conducted from November 2023 to May 2024. There were two types of data used in this research, primary dan secondary data. Primary data was obtained from questionnaire, Focus Group Discussion (FGD) and in-depth interview. Secondary data was obtained from articles, internet sources, books and institution data. Primary data involved 4 internal experts and 1 external expert. The internal experts were enterprise's top management, and external expert was CEO of OPEX Consulting Group that had long experience and knowledge related to manufacturing industry. This research method was mixed qualitative dan quantitative. Qualitative method was used to formulate knowledge management strategies, and enterprise business strategy by considering internal and external factors, and quantitative method was used to measure knowledge maturity level and decide the most priority knowledge management strategies.

This research was initiated by involving 4 experts to fill questionary by using an APO assessment tool to analyze KM maturity level. Each question then was analyzed by using FGD and derived in some opportunities to improve and develop some KM strategy alternatives. Enterprise strength, weakness, opportunity and threat were identified by FGD with internal experts. Opportunity and threat were enriched by in-dept interview with external experts to get wider view of Indonesian manufacturing industry challenge and opportunity considering political, economic, social, technology, environment and legal. Then the enterprise business strategy was formulated from SWOT analysis that was conducted by internal experts FGD. Knowledge management objectives were derived from enterprise business strategy. The questionnaire was filled by internal experts to analyze the priority of knowledge management strategy by using AHP. The research framework is shown in Figure 1.
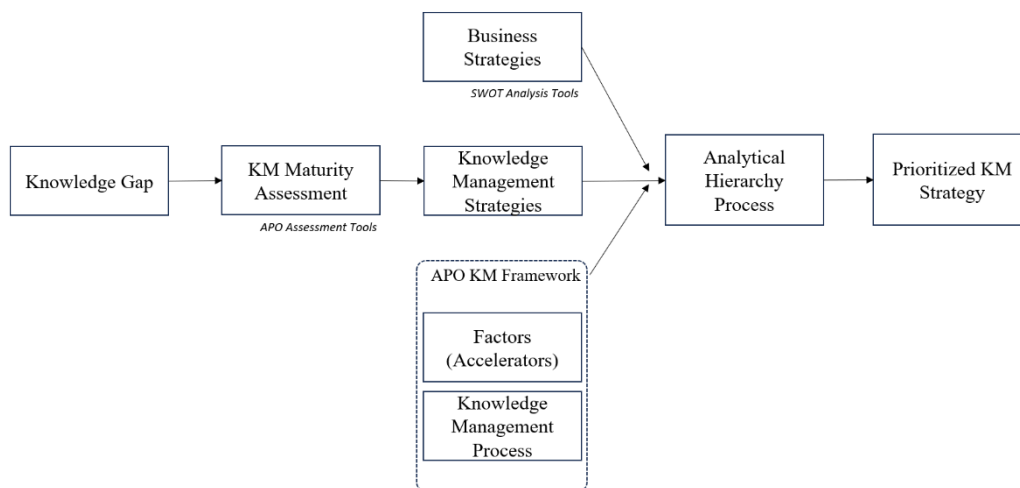

Figure 1. Research Framework

RESULT
Analysis of KM Maturity
The score result of conducted assessment that used APO assessment tools was '121', that means the enterprise currently is at the initiation level which show the enterprise just considered the importance of KM. Detail of KM maturity consists of 5 level, i.e. reaction, initiation, expansion, refinement, and mature. The assessment

showed that technology was the strength. It showed that adequate facilities and technology infrastructures which can support KM process were available in enterprise.

'KM leadership' was the weakness because the enterprise did not have an organization structure that was aimed for managing knowledge. Observations resulted that enterprise did not have an effective reward system to encourage knowledge creation and knowledge sharing. Another factor which had a low score was 'People', because there was not a systematic introduction to KM and its tools for new employees. Employees were not inducted how to use digital repository, learning management system and Wikipedia. Sharing knowledge among employees, which had not been an organization culture, had a contribution to this 'People' factor. Knowledge process was the third lower score factor, since there was not a systematic process for knowledge identification, creation, sharing and applying it. Benchmarking and sharing sessions were not facilitated by enterprise's management. Figure 2 shows the result of the assessment.
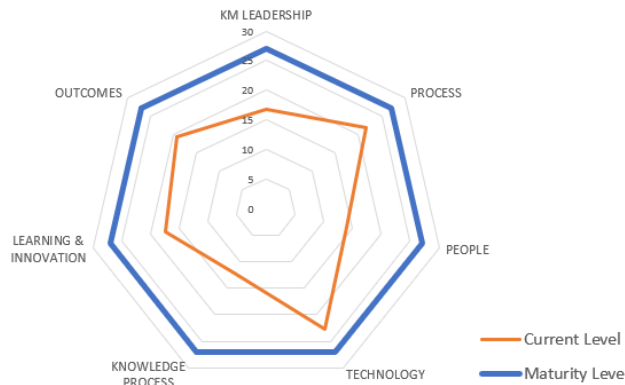

Figure 2. Assessment Result

Formulation of KM Strategies

APO assessment tools have an overall 42 questions, contains 8 questions for every 7 factors. The questions which have score under 2.5 then was analyzed by using FGD with experts to define opportunity to be improved, resulting 4 alternatives of KM strategy: (1) Implement reward system to encourage KM process, (2) Develop information technology-based KMS to support KM process, (3) Strengthen KM process trough specialist track program, and (4) Conduct periodic Project Gate Review. The weak score of APO assessment is shown by Table 1.

Table 1. The Result of APO Assessment Tools Questionnaire (Weak Score)

Factors	APO Assessment Tools Questionnaire	Score
KM Leadership	Organization structure has been established to formalize KM initiative	1.75
KM Leadership	Management promotes, recognizes, and rewards performance improvement, learning, sharing of knowledge and innovation	1.75
People	KM and how to use Knowledge Management System was introduced to new employee systematically	1.75
People	Knowledge sharing is actively encouraged and rewarded	2.00
Technology	The IT infrastructure is aligned with the organization's KM strategy	2.25
KM Process	The organization has a systematic process for knowledge identification, creation, storing, sharing and application	1.75
KM Process	Knowledge inventory and assets are well maintained by organization.	2.00
KM Process	Organization always stores the knowledge which is gathered from accomplished	2.25

	tasks or projects and share it among employees.	
KM Process	Knowledge from employees who has leaved organization are well retained.	2.00
KM Process	Knowledge from best practices and lessons learned are shared across the organization	2.25
KM Process	Benchmarking is conducted to enhance performance and to create new knowledge.	1.75
Learning & Innovation	The organization consistently strengthen the learning process and encourage innovation	2.25
	Individuals are given rewards to work collaboration and knowledge sharing	1.00
Outcomes	The product has been improved quality as the result of applying knowledge.	2.25

The result of APO KM assessment has indicated the absence of a reward system for sharing knowledge among employees. The important factor to encourage and motivate knowledge sharing behavior is reward (Jahani et al., 2011). Every employee within the organization is assigned to make an activity plan that state activity related to KM process, like knowledge documentation knowledge sharing, knowledge documentation and knowledge application. This activity plan was named 'Individual Performance Plan (IPP)' as commitment letter between employee and management. The realization will be monitored and evaluated in the middle and end of the year by employees and enterprise's management. The achievement will be scored and awarded with an annual incentive that will be given at the end of the year. A reward is not merely financial rewards, but employees also can be rewarded with some appreciation and recognition. There are two common forms of reward systems, i.e. individual-based reward and group-based reward, which individual-based reward is more effective to encourage knowledge sharing (Lee and Ahn, 2007). Rewards is not merely given as monetary as incentive, but recognition and opportunity to learn is more effective than financial monetary rewards (Šajeva, 2014)

The highest score from this assessment came from 'technology' factor, because the organization has sufficient IT infrastructure, although it was not optimally utilized to support KM process. Organization must continue to develop IT-based Knowledge Management Systems (KMS). KMS is an information technology which applied to managing knowledge process in an organization (Alavi & Leidner, 2001) such as 'digital repository', 'Learning Management System (LMS)', and 'Wikipedia'. It needs consistent and continuous support from management in developing KMS, including support for financial resource.

Develop 'Community of Practice (CoP)' would be an alternative to strengthen KM process through specialist track. Specialist track is a career path program which accommodates engineers, technicians, and designers to develop their technical competencies related to enterprise's business vision and mission. This enterprise has been implementing the specialist track program since 2022 which expertise areas included product and process engineering. The career ladle from lowest to highest level are junior engineer, engineer, senior engineer, and executive chief engineer which senior engineers is the technical level which has same level with general managers and 'executive chief engineer' has same level with enterprise's CEO. By integrating CoP with specialist track program, it hopefully can result in acceleration of knowledge creation, sharing, and application to increase enterprise competitiveness.

In accordance with assessment result, all project and assignment involved many functional departments, but some 'lesson learned' and 'best practice' were not well documented because of lack of encouragement from enterprise's management. Learning review will be a mechanism for tacit knowledge to be stored into lesson learned document so that the tacit knowledge can be changed to explicit knowledge. The document will be reserved on an information technology-based KMS,

such as digital repository.

Analysis of Objective of KM Strategy

KM strategy must be aligned with business strategy. While formulating KM strategy, a company must consider the business strategy (Greiner et al., 2007). Alignment between KM strategies and business strategies was identified as critical success of KM (Oluikpe, 2012). Business analysis in this case was formulated using SWOT analysis tools by FGD with internal experts to identify strengths and weaknesses within enterprise, challenges that must be faced, and opportunities that can be optimized. External experts were also involved by in-depth interviews to get some view of opportunities and challenges that will be faced by manufacturing industry in Indonesia.

The strengths of the enterprise are having sufficient capacity for research and development, good product quality, good delivery rate and automation and digitalization which has been implemented to business process. The weaknesses of the enterprise are the lack of supplier development and low productivity. Supply chain problems were caused by the low capacity and capability of suppliers that affected the enterprise productivity. Delayed supply caused the enterprise to catch up on the delivery schedule by adding the cost of working overtime and resulted in lower productivity. Component defects from supplier make product defect and production rework which resulted financial loss for enterprise. Another weakness is the absence of the newest technologies for the production process since automation was implemented, resulting in no opportunity to improve process efficiency.

The external factors consist of opportunity and threat. The opportunity was the stability of domestic market of automotive industry in Indonesia. New vehicles model in every year is also an opportunity to gain business income. Another opportunity to gain business income is from many new customers whose products are electric vehicles that potentially grow in Indonesian automotive market as the supportive incentive has been giving by government for electric vehicle since 2023. Otherwise, the threat must be faced by enterprise is unstable raw material price which is imported from another country as impact of fluctuated world oil and coal price. Another threat was the rise of regional minimum waxes that will directly raise production costs. Today Indonesian manufacturing production cost must compete with another country like China, India, and Vietnam. From those internal and external analyses, enterprise business strategy is formulated. Table 2 shows the SWOT analysis.

Table 2. SWOT Business Strategy Formulation

	STRENGTH S1: R&D Capability & Capacity S2: Good quality and delivery S3: Automation implementation S4: Digitalization implement.	WEAKNESS W1: No new process technology W2: Lack of supplier develop. W3: Low productivity
OPPORTUNITY O1: Stable domestic market O2: New customer (EV start up) O3: New model (current customers)	STRATEGY S-O S1O1: Modular product based S1O2: Offer modular based to new customer S3O3: Improve production system	STRATEGY W-O W3O1: Improve technical capability for product, process, and material. W3O2: Improve supplier capability W3O3: Good shop floor management.
THREAD T1: Unstable material cost T2: Higher labor cost	STRATEGY S-T S1T1: Material efficiency S3T2: Multi sourcing material supplier S4T3: Implement Automation Digitalization	STRATEGY W-T W2T2: Expand of modular product base W2T3: Outsource noncore process W1T3: Implement Automation Digitalization

The KM strategy needs to be aligned simultaneously with the organization objectives and strategy (Grainer et al., 2007). By using FGD with experts, objectives of KM strategies were derived from business strategies. The objectives are: (1) improve capability of NPD, (2) improve capability of flexible production system, (3) improve capability of automation and digitalization, and (4) improve capability of operational management. Table 3 shows the correlation between KM objectives and business strategy.

Tabel 3. Correlation between Business Strategy and KM Objectives

Business Strategy	KM Objectives
1. Enlarge business by modular product base 2. Offer modular product to new customers	Improve capability of New Product Development (NPD)
1. Improve production system 2. Material efficiency 3. Multi sourcing material supplier 4. Outsource noncore process	Improve capability of flexible production system
1. Implement Automation and Digitalization	Improve capability of automation and digitalization
1. Improve technical capability for product, process and material 2. Improve supplier capability 3. Implement good shop floor management	Improve capability of operational management

Analysis of Prioritized KM Strategy

The priority of KM strategy based was analyzed by using Analytical Hierarchy Process (AHP) with 'knowledge accelerator', 'knowledge process' and 'KM objective' were the level of each hierarchy. 'KM Leadership' and 'People' were the first and second factor which can accelerate KM development. This analysis was aligned with APO KM assessment result, that lowest score is coming from 'KM Leadership' and 'People' factors. The role of top management level is a key factor to promote that encourages all KM process. Top management must be able to transform people and organization culture, so that the effective leadership to develop KM in an organization is transformational leadership (Analoui et al., 2013). 'People' was also an important factor to accelerate the implementation of KM process and develop organization culture related to KM process. Both factors ('KM leadership' and 'People') had a strong relationship with each other. Support from top management will help to shape the organization culture and being role models will make the culture infiltrated strongly. The behavior of organization leaders will influence organization culture. Otherwise, technology is not the priority factor because it has high score of assessments since the enterprise had adequate information technology facilities. Process is also not a priority factor because the enterprise has the International Organization of standardization (ISO) standardized business process.

Next level of AHP hierarchy was KM process. The result was 'knowledge sharing' and 'knowledge storing' were the most important processes for this enterprise. Enterprise did not have sufficient employee capability, because experienced employees did not share their knowledge to other employees. Knowledge sharing is one of the most critical stages in knowledge management process (Lee and Ahn, 2007) that means formal or informal activity to transfer and exchange of knowledge, experience, and skills within employee that can conducted via written or face-to-face communications or by using information systems (Šajeva, 2014). Enterprise top level management did not support and encourage knowledge sharing sessions and knowledge storing in enterprise database. Information technology-based KMS was not effectively utilized to support knowledge management process. Knowledge creation is not a high priority because NPD, automation and digitalization and production system are integrated by technology principle or technology consultant.

Increasing NPD capability is the most important objective of KM strategy. NPD was a critical way for enterprise to grow and exist in the competition. The data from Indonesian Central Bureau of Statistic show that automotive manufacturing has been slow growing in many years. Business diversification is the most appropriate strategy for the enterprise to have another product in non-automotive components. The growth of automotive industry in Indonesia is shown by Figure 3.
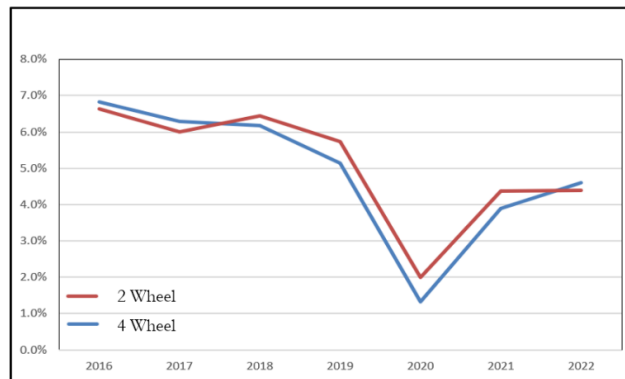

Figure 3. Negative Growth of Automotive Industry in Indonesia
(Source: Badan Pusat Statistik Indonesia 2023)

Effective NPD will have a high economic impact (either revenue or profitability) and sustainability which ensures enterprise always be exist and competitive. There were some key performance indicators of NPD. High quality products, high economic value and efficient manufacture is product development KPI of NPD (Dombrowski et al., 2013). Good performance of NPD also has side impact for more efficient of production and automation process. Effective KM will have a positive effect to NPD's KPI (Liu et al, 2005). Excellent operational management is the key factor in the development of new products, production system, automation and digitalization and plays an important role in change management while implementing development of production system and automation.

Based on AHP, the most priority KM strategy is implementing reward system to encourage KM process with performance management tools. The execution will be reviewed by employees and management and the achievement will be awarded at the end of the year. All activities which have contribution to KM process (knowledge sharing, training, learning, and benchmarking) will be evaluated and rewarded as it is committed by every employee through 'Performance Appraisal' which is the basis of evaluation of employee's knowledge management process and achievement. Design of reward should be considered to encourage knowledge sharing (Yahya and Goh, 2002), since it is very important to encourage employees to share their knowledge even though successfully exerting this encouragement is very challenging (Lee and Ahn, 2007).

The second KM strategy was the implementation of 'Project Gate Review' on every project, such NPD project, Automation integration project, information system development project, and others project. Managing knowledge is part of the project execution process which is mandatory conducted during project lifecycle and documented as lessons learned document (Project Management Institute, 2017). Learning review is one of many tools to manage knowledge during project process that can ensure all knowledges, experiences and skills of project team member can be stored, shared and applied for next project.

Developing IT-based KMS to support all process of KM was the third priority of KM strategy. Information technology facilities

and infrastructure are already provided by enterprise management. The use of 'Microsoft Office 365', 'Microsoft Teams', and 'Zoom' have many features to support knowledge sharing, but they are not optimally utilized. The existence of intranet and internet facilities is an important infrastructure to develop KMS.

'Project Gate Review' can be conducted by using information technology platforms, such as video conference meetings which results in effectiveness and efficiency. The lessons learned from project gate review can be stored into documents or videos into knowledge repository that make it is easily asynchronously. Making project lessons learned will need an effective reward system to motivate and encourage employees to store, share and apply the knowledge.

The fourth priority was strengthening the KM process through a specialist track program. Specialist track was career path which provide career opportunity based on their expertise. Performance management tools are also used to manage specialist track as guidance to do some activity to achieve organization goals. The existence of CoP through specialist track program hopefully can increase knowledge creation, knowledge sharing, knowledge storing and knowledge application. Figure 4 shows the AHP result.

Figure 4. Result of AHP
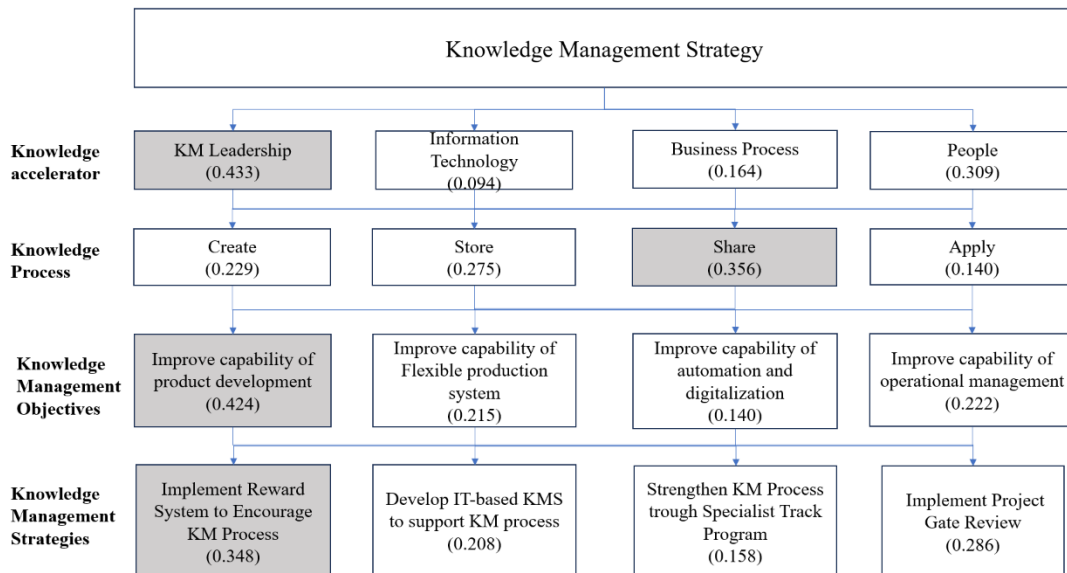
CONCLUSION

Based on APO assessment, enterprise is at initiation level which means enterprise just consider the important of KM. At this maturity level, the enterprise needs commitment and support from top management to implement KM. Some alternatives of knowledge management strategy which derived from APO assessment were implement reward system to encourage KM process, Develop IT-based KMS, Strengthen KM Process trough specialist track, and implement Project gate review. AHP resulted that leadership was the most important factor in implementing knowledge management and knowledge sharing is the most important process for developing capability of human resources. By considering all factors, knowledge process and enterprise business strategy, it is decided that implementation of reward system is the most priority of knowledge management strategy that must be executed by enterprise.

RECOMMENDATIONS

It is important to analyze the KM maturity level. The APO assessment tool is used to analyze the KM maturity level for this research. It gives guidance to find some weaknesses and opportunity to be improved by enterprise to develop knowledge management. It was also important to get commitment and support from top level management, especially for an organization which is at the initiation level. For this case, the enterprise had initiation level which means needed strong support and involvement from enterprise top management. At the initiation level, knowledge management must be a top management policy which needs top management to lead, give example and be a role model for the employee. Transformational leadership is the most effective leadership style to accelerate knowledge management development. The priority strategy to develop knowledge management must be considered and aligned with, and some relevant initiative can be effectively implemented enterprise business strategy. This research gives some recommendations for enterprise management and future research.

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