Knowledge Management and New Product Development: An Integrative Framework for Resource-limited Organisations

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Abstract. Knowledge management (KM) is one element that determines New Product Development (NPD) success. This study explores how KM can be integrated with NPD practically, for resource-limited organisations to analyse their extant KM tools and focus on ones that are most critical to their NPD. With insights gained from extant literature, it is concluded that the practicality of extant frameworks is not yet satisfactory, particularly in the balance between the depth of analysis and the resources required for analysis. This study proposes an alternative approach of analysing KM needs based on a short- and a long-term perspective of NPD. Based on this approach, a NPD KM analysis roadmap is developed. It contains four intermediate options from simple to sophisticated complexity, for resource-limited organisations to effectively analyse their extant KM tools according to the resources available, but also able to improve the depth of their analysis when it becomes appropriate overtime.

Keywords: Knowledge Management, New Product Development, Resource-Limited Organisations

1. Introduction

The ability to execute New Product Development (NPD) efficiently and effectively is critical for organisations to remain competitive in a global environment [1]. In the context of research and development (R&D) and manufacturing, the execution of NPD includes phases such as preliminary assessments, detailed investigations, development, testing and validations, and full production and market launches [2]. Most companies have their own NPD phase modified according to their needs. Söderquist argues, "the complex knowledge flows in NPD are crucial for advancing the (NPD) process but difficult to manage" [3], suggesting NPD is a knowledge-intensive process [4]. Knowledge is hence one of the elements that determine NPD success. Knowledge management (KM) processes include identifying, creating, acquiring, using, sharing and storing individual and collective knowledge [5]. In an NPD context, KM can potentially shorten product launch time [6], and allow organisations to suffer less work delays caused by staff turnover [7].

Despite the benefits of KM, there is a scarcity in practical models to analyse KM in an NPD environment [8], especially for evaluating whether particular activities and IT software for KM processes — defined as KM tools in this study — are beneficial to an organisation's NPD. One gap in this context is the absence of clear distinctions between different KM needs within NPD, which leads to an ambiguous integration of NPD and KM. The KM solutions for NPD hence generate a common notion that NPD success requires involvement from all staff for all KM processes. This ideal is difficult to achieve for companies limited by resources such as Small and Medium-sized Enterprises (SMEs). Kraaijenbrink et al. suggest that some SMEs do not adopt specific KM tools because the cost of the tools are beyond their ability [9]. With no clear NPD and KM integration, companies adopt KM processes and tools without knowing what their critical NPD needs are, making value measurement and justification of KM process effectiveness difficult. Hence, the question this study explores is how KM can be integrated with NPD practically, for resource-limited organisations to analyse their extant KM tools and focus on ones that are most critical to NPD.

2. Extant Options and Their Practicality for Resource-Limited Organisation

Through a focus on integrating KM processes and tools required during NPD, one option appeared amongst extant studies is considering NPD as one phase. This option emphasizes the NPD and KM integration on the notion that "NPD is an activity that requires intensive knowledge". This leads to the exploration of "what type of knowledge is required by NPD?" and hence the distinctions of tacit/explicit and

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internal/external knowledge. Based on the knowledge distinctions, corresponding KM processes and tools are generally discussed in detail in these studies. Kraaijenbrink et al.'s KM watermill model [10] is one study that represents this option. Kraaijenbrink et al. suggest that obtaining knowledge is represented by three KM stages where 'identification' and 'acquisition' are specific to external knowledge, and 'utilisation' is applicable to both internal and external knowledge in NPD. The three KM stages are generated by KM activities such as codification, detection, assessment, transferring, nurturing, elicitation and motivation. Although Kraaijenbrink et al.'s framework has highlights different types and depths of knowledge required in the generation, selection, and design stages within NPD, the study does not further distinguish the three NPD stages in the context of KM process and companion tools. Other representative examples can be found in [6, 11]. Most frameworks in this option emphasize the differences between tacit and explicit knowledge; some will further distinguish between internal and external knowledge sources. These distinctions are significant because business nature and NPD strategy determine organisations' preference of knowledge type and source [9, 12], they are hence critical features for NPD KM frameworks.

This option provides users an in-depth understanding of the relationship between the types of knowledge required by NPD, and the different KM processes and tools available. However, the exploration tend to stop with different types of knowledge require by NPD – lacking further investigation of different aspects of NPD, perceiving NPD more or less as a black box. This perhaps simplifies NPD and allows more focus on the analyses between different types of knowledge, KM processes, and KM tools. But without distinguishing the contribution of individual KM processes or tools to specific needs of NPD, it then creates an underlying assumption that all KM processes and companion tools have similar effects on NPD, which is not necessarily appropriate. Furthermore, without further acknowledging the nature of NPD in the context of KM, NPD becomes no different to other organisational functions or processes that "require intensive knowledge". And if organisations analyse their KM based on this approach, their findings, as well as solutions, are likely to be generic. Whether a NPD specific framework is required is then questionable, using a generic KM framework for analysis may just be as effective. This however, is not suggesting that this approach is ineffective for improving NPD. But because this study aims to break down the analysis further for resource-limited organisations to focus on aspects that are most critical to their NPD, a more in-depth focus on NPD is perhaps more practical.

Another option appeared amongst extant studies is breaking the NPD black box and analysing each NPD phase individually. This forces the users to closely investigate the needs of each phase, beyond the tendency of perceiving NPD as a knowledge-intensive activity. For instant, what type of KM processes and tools does 'testing and validation' phase needs? Are there specific KM tools used by the engineers in this phase that other phases do not require? Are these tools actually improving the 'testing and validation' phase? This option has the potential to provide an in-depth understanding of the relationship between the types of knowledge required by NPD, and the different KM processes and tools available like the studies in the first option, which appears to be closer to what this study seeks. However, such detailed analyses are likely to result in each NPD phase containing KM processes and companion tools that are also applicable to other NPD phases. This overlap is expected because each NPD phase is essentially a knowledge exercise, and some processes and tools are simply fundamental to each exercise. The overlapping processes and tools will generate a complex framework, which requires many resources to generate. One study that represents this option is McGrath and Walsh's matrix framework [13]. It analyses multiple KM processes juxtaposed to NPD phases; the outcome is a matrix with various KM tools used in different KM processes of varying NPD phases. An example of those tools is 'management-integrated CAD simulation' as a knowledge-creation KM tool during the project development phase. However, the case study presented in this study focuses on how the case company's IT can assist KM, the KM tools listed in the matrix framework hence focus on accessing explicit knowledge. Another representative example can be found in [14]. There is also a group of studies (such as [15, 16]) that design software architecture framework development for KM systems, categorising NPD knowledge items and linking knowledge items and their repositories systematically. Although these frameworks state clear relationships between knowledge items and NPD phases, which fit into the second group of studies, they generally focus on explicit knowledge items such as CAD components or engineering drawings. Hence, the KM processes tend to be related only to explicit knowledge. Despite the in-depth

understanding this approach can potentially offer, whether resource-limited organisations can devote the resources for regular evaluations is questionable.

From the review above, it is concluded that the practicality of extant framework for resource-limited organisations is not yet satisfactory, particularly in the balance between the depth of analysis and the resources required for analysis. It is therefore useful to propose a roadmap, with several intermediate options from simple to sophisticated complexity, for these organisations to effectively analyse their extant KM tools according to the resources available, but also able to improve the depth of their analysis when it becomes appropriate overtime.

3. A NPD KM Analysis Roadmap with 'Short- and Long-Term NPD Perspectives'

The two NPD KM integration options discussed above analyse the KM needs of NPD by either perceiving NPD as a single phase or dividing into various execution phases. This study, based on Kraaijenbrink et al.'s argument that, "on the one hand, NPD requires long-term capabilities, such as design and research competences, while on the other hand, it also requires knowledge that might just be collected instantaneously, like new product ideas or properties of a specific material" [10], proposes an alternative approach, which analyses KM needs based on a short- and a long-term perspective of NPD. Below is the proposal of four intermediate options of the NPD KM analysis roadmap.

3.1. Option 1

Based on the notion that not all KM processes and tools serve NPD needs immediately; some have long-term impacts on organisational learning that reflect on NPD performance in the long run, Option 1 deploys the short-term knowledge need of NPD ("how can we meet the NPD requirements?") and long-term knowledge need of NPD ("how can we maintain the new NPD knowledge for future reuse?") to distinguish between different KM tools (Figure 1). A common scenario for most organisations is a better performance in short-term NPD perspective than long-term [8].

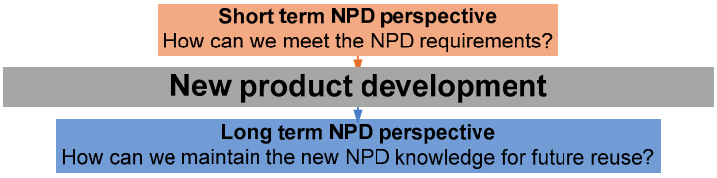

Fig. 1: Option 1 (short- and long-term NPD perspectives)

3.2. Option 2

To better describe a complete knowledge flow during NPD, it is possible to divide each perspective into sub processes. Figure 2 illustrates six main processes for the short- and long-term NPD perspectives. It should be noted that, when knowledge is identified and extracted to be applied to NPD, the knowledge can either be from internal or external sources; when new NPD knowledge is recognised and extracted, it is eventually stored in the internal knowledge source. Furthermore, knowledge flow should be a constant process throughout the entire NPD, especially for the long-term perspective. Valuable knowledge is lost if companies execute long-term sub processes only near the end of NPD.

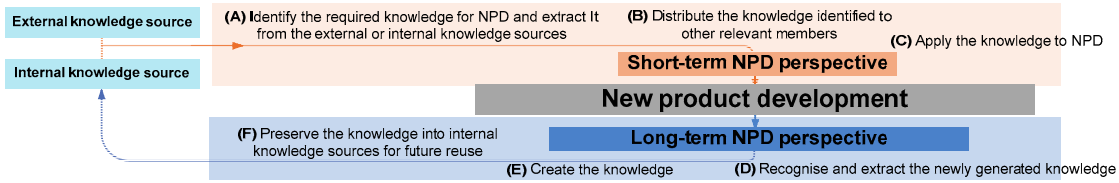

Fig. 2: Option 2 (additional sub processes)

3.3. Option 3

As mentioned above, clear distinctions between different types of knowledge is critical because organisations tend to have their preferences on the type of knowledge they utilise, and this will reflect on the KM tools they adopt. To acknowledge this, Option 3 further distinguishes the tacit and explicit knowledge in

each sub process. Figure 3 has several tool examples for each type of knowledge in each sub process The advantage of this option is to enable organisations to gain a further understanding on what sub processes are involved in their NPD. And more importantly, this complexity allows them to 1) identify any missing KM tools for different sub processes; 2) match the function of their KM tools against different sub processes and evaluate their contributions in the context of NPD; 3) determine whether sufficient resources are deploy to the type of knowledge they wish to focus on.

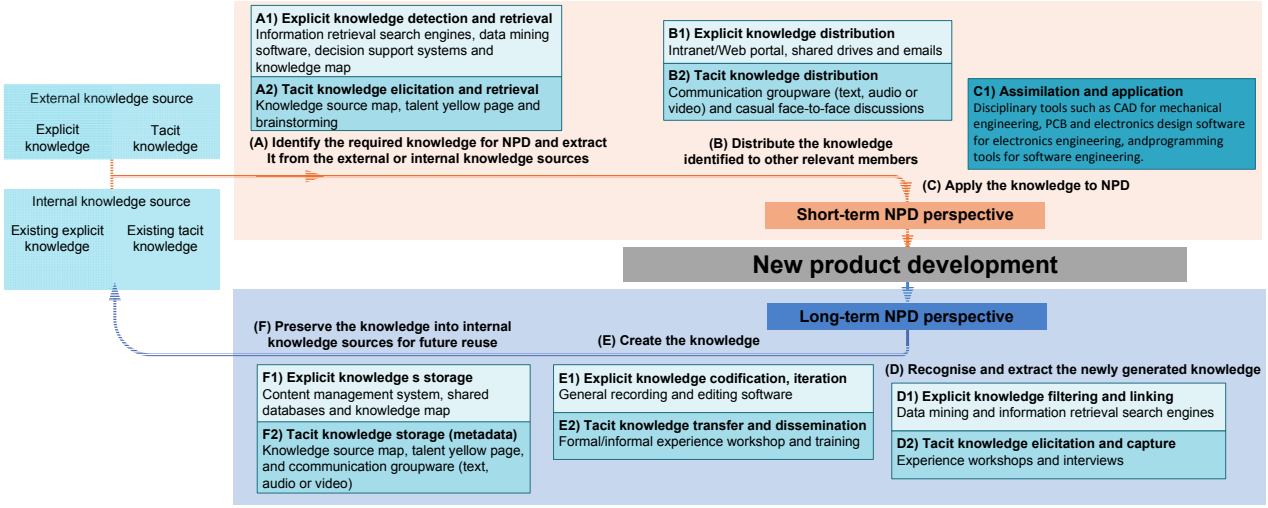

Fig. 3: Option 3 (additional distinctions on types of NPD knowledge)

3.4. Option 4

The last option is to conduct individual analysis proposed above to all NPD phases (Figure 4), which is the closet to the second type of studies discussed in the literature review. This option requires the most effort to conduct – but it certainly provides the most insights of organisational KM. Nevertheless, it is optional to conduct the analysis on certain NPD phases only. This depends on the focus of the organisations and their resources available.

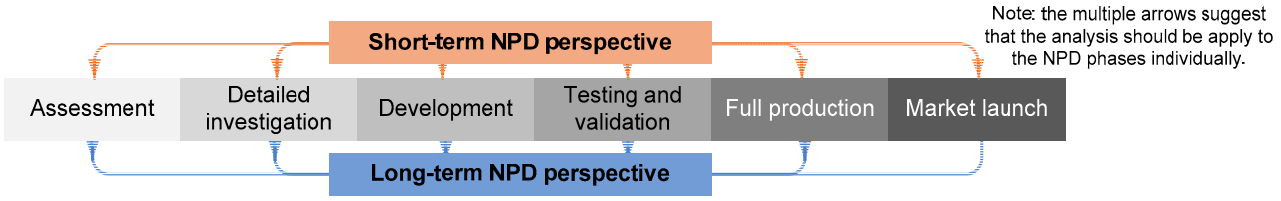

Fig. 4: Option 4 (individual analysis for each NPD phase)

3.5. Practical Implications

The four options above comprise the NPD KM analysis roadmap, which enables organisations to identify critical gaps between their current KM performances and the ideal outcome in different depths, depending on the resources available. A brief guideline on conducting the analysis, organisations should 1) identify their extant KM tools; 2) select a framework they would like to deploy (Figure 5 is an example of Option 3) and adjust their sub processes or NPD phases accordingly; 3) match the function of their KM tools against different sub processes and evaluate their contribution in the context of NPD (contribution evaluation is not included in Figure 5 due to space limitation); 4) identify missing KM tools (in this case, there are missing tools in sub process D1).

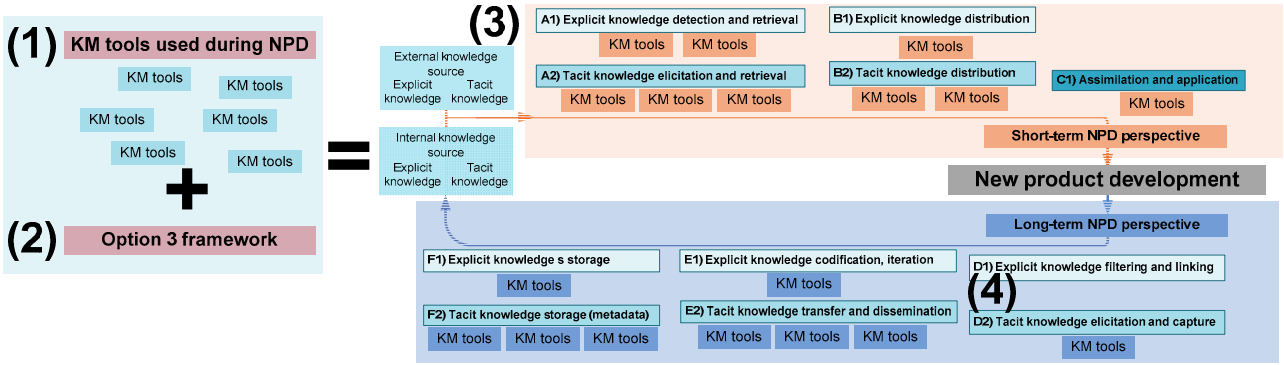

Fig. 5: Option 3 application

4. Conclusion

For resources-limited organisations to gain a better understanding of how their present KM processes and tools add value to NPD, this study explores how KM can better integrate with NPD. The outcome is a NPD KM analysis roadmap with four options focusing on short- and long-term perspectives of NPD needs from KM. Since this study is a theoretical proposal, future empirical validation is essential.

5. References

[1] Teece, D. and G. Pisanp, *The Dynamic Capabilities of Firms: an Introduction.* Industrial and Corporate Change, 1994. **3** (3): 537-556.

[2] Cooper, R.G., *Stage-gate systems: A new tool for managing new products.* Business Horizons, 1990. **33** (3): 44-54.

[3] Söderquist, K.E., *Organising Knowledge Management and Dissemination in New Product Development: Lessons from 12 Global Corporations.* Long Range Planning, 2006. **39** (5): 497-523.

[4] [4] Macher, J.T., *Technological Development and the Boundaries of the Firm: A Knowledge-Based Examination in Semiconductor Manufacturing.* Management Science, 2006. **52** (6): 826-843.

[5] Heisig, P., *Harmonisation of knowledge management – comparing 160 KM frameworks around the globe.* Journal of Knowledge Management, 2009. **13** (4): 4-31.

[6] Shankar, R., S. Acharia, and A. Baveja, *Soft-system knowledge management framework for new product development.* Journal of Knowledge Management, 2009. **13** (1): 135-153.

[7] APQC. *KM Overview*. 2010 [cited 2010 24/06]; Available from: http://kmedge.org/features/kmoverview.html. "http://kmedge.org/features/kmoverview.html" http://kmedge.org/features/kmoverview.html.

[8] Wochele, V., *Managing product innovation: actual practices of New Zealand industry regarding use of knowledge management in engineering new product development*, in *Mechanical Engineering*. 2010, University of Canterbury: Canterbury.

[9] Kraaijenbrink, J., A. Groen, and F. Wijnhoven, *Knowledge Integration by SMEs - Practice*, in *Knowledge Integration: The Practice of Knowledge Management in Small and Medium Enterprises*, A. Jetter, et al., Editors. 2006, Physica-Verlag: Heidelberg, Germany. p. 29-45.

[10] Kraaijenbrink, J., D. Faran, and A. Hauptman, *Knowledge Integration by SMEs — Framework*, in *Knowledge Integration: The Practice of Knowledge Management in Small and Medium Enterprises*, A. Jetter, et al., Editors. 2006, Physica-Verlag: Heidelberg, Germany. p. 17-28.

[11] Herder, P.M., et al., *Follow the rainbow: a knowledge management framework for new product introduction.* Journal of Knowledge Management, 2003. **7** (3): 105-115.

[12] Hansen, M.T., N. Nohria, and T. Tierney, *What's your strategy for managing knowledge?* Harvard Business Review, 1999. **77** (2): 106-118.

[13] McGrath, F. and J. Walsh, *Framework for knowledge management in the new product development process*, in *Second European Conference on Knowledge Management*, D. Remenyi, Editor. 2001, Academic Conferences Limited: Slovenia.

[14] Deng, Q., *A Contribution to the Integration of Knowledge Management into Product Development*. 2007,

University Magdeburg: Magdeburg, Germany.

[15] Baxter, D., et al., *A knowledge management framework to support product-service systems design.* International Journal of Computer Integrated Manufacturing, 2009. **22** (12): 1073-1088.

[16] Heng, X. *A process model of collaborative product design based on design chain and knowledge management*. in *Logistics Systems and Intelligent Management, 2010 International Conference on*. 2010.