Development of Maturity Grids to Assess Organizational Innovation Capability in Knowledge Perspective

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***Abstract*—The present paper aims to develop a new assessment method on evaluating the enterprises' knowledge management performance to improve their innovation capability. The development of the capability assessment tool is based on the innovation and knowledge management literature, and the tool has been statistically tested in a number of case companies in different sectors. This paper provides evidence of the relationship between knowledge management and innovation capability, with an emphasis on embedded assumptions about organizational change in the formulation of the maturity ratings. It is proposed as a new construct focusing on integrating both innovation and knowledge literatures. The assessment method will extend the literature and add knowledge to the two areas of research. Further study is needed in order to refine and develop its features.**

***Index Terms*—Innovation capabilities, innovation, knowledge management, capability assessment.**

I. Introduction

Innovation is the method which can be applied to generate new wealth-producing assets or enhance current resources to have more potential for creating profitability. Innovation is "doing things differently or better across products, processes or procedures for added value and/or performance" [1]. Innovation "leads to a dominant competitive position" and is a key driver of organizations' performance [2]. An organization which is able to constantly generate innovations is considered to have sustained competitive advantage [3]. Innovation is a sort of execution of ideas, which is closely linked to knowledge [4]. Innovation is a "process of knowledge creation". Knowledge as a complex concept is implanted within a wide range of entities in an association, such as culture, policies, official records, and staff [5]. It has been reported that "knowledge has become the key economic resource and the dominant and perhaps even the only source of comparative advantage" [6]. The ability to create and to apply knowledge has become a competitive advantage for organizations. This capacity clearly appears as "a core capability to create, develop, and enhance a competitive advantage" [7]. The ability to facilitate knowledge process is significant to advance innovations. Knowledge Management (KM) is "critical for successful innovation" [8].

In the literature review, wide-ranging research has "dealt with the knowledge-based capabilities on the one hand, and the innovation-based capabilities on the other hand" [7]. Some literatures state that KM is the critical performance to improve innovation in organizations. However, few references focus on evaluating knowledge performance and its relationship to innovation [9]. There is a gap in previous research that taking into consideration of the integration of KM and innovation, and also the approaches for its measurement [7]. Hence, the innovation capability assessment tool in knowledge perspective is proposed on the basis of an extended literature review and case study research. It may enhance researchers' understanding on how to leverage the innovation performance and KM in organizations.

In this paper, the authors will first review the relationships between knowledge, KM and innovation in the following section. Next, the research methodology and steps will be illustrated. Then, the paper will present the details of the assessment tool. Finally, case study and analysis will be shown.

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II. Literature Review

A. Innovation and Knowledge

Knowledge as "a dynamic human process of justifying personal belief toward the truth" [10], [11] is a vital resource for organizational innovativeness and competitiveness. Knowledge is recognized as a key strategic resources for organizational performance.

Knowledge is often embedded in an innovation processes [12]. The innovation process is part of the problem solving cycle. Innovations are activated when selecting and aiming to solve a problem from a series of known problems, and a problem is solved by a successful solution or evolution of an innovation outcome. Innovation is the execution of a process which can be represented as a life cycle. The whole process is comprised of several distinct but related phases, including problem recognition, ideation, development, performance, valuation and exploitation. However, knowledge creation is not an isolated activity which is embedded in the innovation process. Knowledge capture occurs throughout the innovation life-cycle. At each step of the process, relevant knowledge needs to be selected from the appropriate knowledge resources. Then, these knowledge objects are used to address the problem [13]. Additionally, original experience is obtained and shared with others during application of knowledge. Conversely, new knowledge is gathered at each moment of the innovation process [14]. Therefore, innovation and knowledge influence each other and act reciprocally (see Fig. 1).

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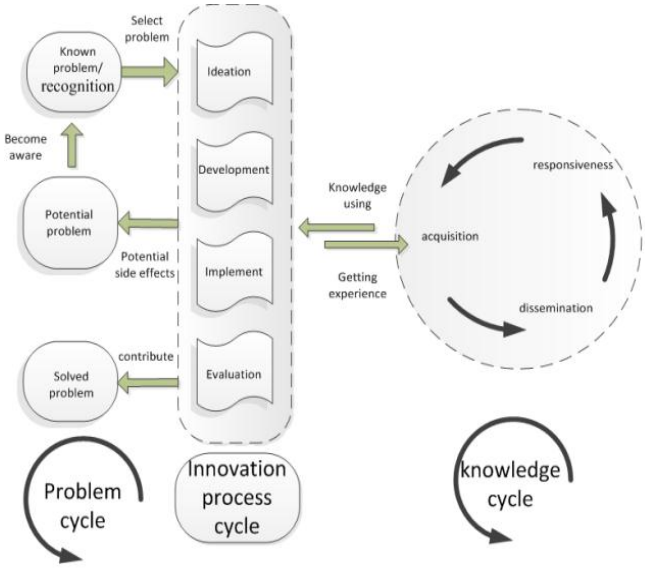

Fig. 1. Relationship between innovation and knowledge [14].

B. Innovation and Knowledge Management

Knowledge management has been defined in diverse ways. Ref. [15] defined that KM ''encompasses the managerial efforts in facilitating activities of acquiring, creating, storing, sharing, diffusing, developing, and deploying knowledge by individuals and groups''. KM is "the explicit and systematic management of vital knowledge and its associated processes of creation, organization, diffusion, use and exploitation" [4]. KM is "the process of critically managing knowledge to meet existing needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities" [16]. KM involves a conscious strategy for people absorbing, sharing and utilizing knowledge that improve organizational performance [17]. Ref. [18] argued that KM "as the set of business policies and actions undertaken for the purpose of favoring the creation of knowledge, its transfer to all firm members and its subsequent application, all of it with a view to achieving distinctive competencies which can give the company a long-term competitive advantage". Ref. [19] stated that KM is about "creating an environment that encourages people to learn and share knowledge by aligning goals, integrating bits and pieces of information within and across organizational boundaries, and producing new knowledge that is usable and useful to the organization". KM is an approach to successfully achieving value within enterprises. The effective KM to leverage knowledge resources is a tactical initiative for organizations [20]. It also affirms that "leveraging knowledge is crucial, and in today's highly competitive environment and rapidly changing markets it might be the most important job management has" [21].

There is a close bond between organizations' knowledge, KM and innovation capacity. Many research conducted by scholars demonstrate the positive relationship between KM and innovation and how KM supports innovation capabilities. For instance, KM is an activity to enhance enterprises' innovation and add value to enterprises [4]. The essentiality of KM has been emphasized as enhancing organization's innovation and performance [6]. Knowledge and KM are one of the factors influencing innovation capabilities and innovation is considered to be the greatest reward from KM [4]. Ref. [22] highlights that innovation heavily depends on knowledge. Innovation ability is a performance of a firm to manage and create knowledge [23], [24]. Innovation as "a process of interrelated activities from ideas to invention and to its commercialization, where new knowledge is created and used through these activities" [25]. Organizations are interested in KM "to boost the efficiency of their processes, increase their productivity and quality of their services, and to achieve innovative solutions and products" [26]. KM is considered as the critical performance for organizational competitiveness [27], [28]. Therefore, it is logical to conclude that KM processes and practices will support innovativeness of an organization.

III. Research Methord and Steps

After understanding the relationship between knowledge, KM and innovation, the method and research steps of this research is discussed in this section.

This study is divided into two stages to achieve the research results. The first stage seeks to develop the theoretical framework of the KM capability assessment. The second stage intends to test and verify the assessment framework. The first phase of this study is to build the theoretical frame of the assessment. It requires the development of a theoretical understanding of knowledge key factors, KM process targets and assessment approach. The second stage is to test and verify its feasibility by applying the strategy in several firms. The researchers have designed the questionnaire and used it in the whole case studies to ensure all the case studies processes are following the same questions. Besides that, the selection of companies to apply the process is to cover a wide range of sectors and types of companies. In the end, the specific feedback from users regarding the assessment tool and the effectiveness of the process evaluation are discussed.

After discussed the method and the research stages of this study, the details of each research phases showed in the next sections.

IV. Step One: Assessment Tool Delveopment

Ref. [29] suggests that measuring ''builds on a model to identify gaps between current and desired performance, and to provide information that can be used in developing action plans to improve performance''. Assessment of capabilities can sustain, repeat and accelerate organizations' abilities [6]. Ref. [20] states that "only through adequate measurement of these knowledge assets can firms begin to tie their capabilities to value generating metrics and move towards a sustained competitive advantage". Thus, the assessment framework is created to meet the requirements for assessment and constant improvement of knowledge management and innovation capabilities.

In this framework, it is asserted that there are three crucial factors in knowledge management effect innovation: knowledge acquisition, dissemination and responsiveness [14], [30] as mentioned in the literature review section.

Additionally, a wide range of literature suggests that organizational infrastructure containing technology and culture along with process construction are critical domains for effective process implementation [31]. Ref. [32] identified that the critical factors for process implementation are technology and systems, culture and performance. Process management requires top leaders' understanding and involvement, information systems and culture based on process [33]. Ref. [5] also states that "the KM process emphasizes and expects collaboration among a wide spectrum of contributors that ranges from people and processes to supportive technologies in an organization".

Furthermore, Ref. [34] explains that a "Capability Maturity Model (CMM) is a technique to assess organizational process by providing descriptive text along with a number of intermediate or transitional stages. These transitional stages are behaviorally anchored scales." This assessment technique predicts an organization's performance to help enterprises to target higher level goals and provides guidance on targeting improvement through following the description of performance progression at each different stages [35]. The CMM has been extended in a wide range of areas. More than 150 maturity models have been developed to measure the maturity of Innovation Management, Knowledge Management, Strategic Alignment, Service Capability, Program Management, and Enterprise Architecture [36].

Therefore, the integration of key factors of knowledge related to innovation, CMM, and targets of KM is considered to be the foundation and structure of this assessment to assess enterprises' KM and innovation performance. The framework of this assessment and the characters are described as follows.

The structure of the capability assessment tool is constructed of a three dimensional framework, which consists of the following axes: a KM maturity levels construct, a target of KM construct and knowledge key factors in innovation construct (see Fig. 2).

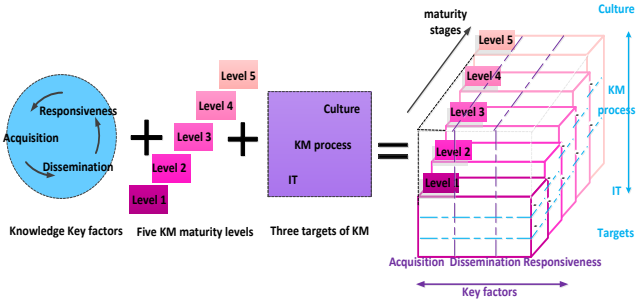

Fig. 2. The structure of knowledge management and innovation capability assessment.

A. Description of Knowledge Management Key Factors

Knowledge acquisition: seeking and detecting fresh knowledge are involved in knowledge acquisition [1]. Three vital determinants of innovation associated with knowledge acquisition have been defined as follows: The knowledge source is the first determinant. High degrees of novelty and fewer market sources involved are positive for innovation [37]. Internally, employees can attain useful knowledge from company's repositories. Externally, new information, knowledge and solutions can be acquired into a company [38]. Another determinant is the type of knowledge, both explicit and tacit knowledge used to develop innovation [39]. Explicit knowledge can be easily codified, transferred and shared, whereas tacit knowledge is the skill and experience that are difficult to be transferred and shared [40]. Also, it depends on the "absorptive capability", or the previous knowledge of a group. An organizations' absorptive capacity is defined as the basis of existing organizational knowledge, but it may act like a filter and decrease a firm's ability to pursue new knowledge. It is an organization's ability to "recognize the value of new, external information, assimilate the information, and then apply the learned knowledge to its own internal product and service outputs" [23].

Knowledge dissemination: Tacit and explicit knowledge are being disseminated by transferring and sharing of knowledge [40]. It is considered that information flows and is absorbed through the interchange and interaction of knowledge between tacit and explicit knowledge [41]. Integration is a two-dimensional conception, which involves structural and cultural parts [42]. The structural dimension is described as "interaction, representing the formally coordinated activities between functional departments and includes meetings, memoranda and flow of standard documentation" [1], [43]. The cultural dimension is referred to as "collaboration, representing the more unstructured affective nature of interdepartmental relationships and emphasizes continuity of relationship between departments rather than just transactions" [1]. Additionally, KM technology helps innovation by "assisting in creating tools, providing the platform, aiding collaboration across inter and intra-organizational boundaries, ensuring availability and accessibility, ensuring integration of the organization's knowledge base" [44]. Technologies such as Internet, collaborative tools, content management systems, media and others can make an important contribution on knowledge dissemination [38], [40], [20].

Knowledge responsiveness: knowledge responsiveness can be considered as "a kind of response to the diverse knowledge an organization gains or has access to" [30]. Ref. [45] provides that "knowledge cannot be absorbed or achieved completely if it is only captured and disseminated but not responded to". Additionally, Ref. [1] states that "new knowledge can present obvious worth when it brings a change to the organization. It is called innovation when it derives from the usage of new knowledge generally". The main characteristic of knowledge responsiveness is agility which can be considered the mobility of an organization's activities [46].

B. Description of the Five Maturity Stages

Level 1: it is described by [47] that "This is the most basic level of maturity at which most organizations begin their KM journeys. At this level, the organization lacks consistent processes or practices for successfully identifying, capturing, sharing, transferring, and applying its core knowledge." Typically, these processes are administrated unconsciously, knowledge-related practices do not resulted from goal-setting and preparation but by a stroke of luck instead. Changes in companies do not occur as an accident rather than an intentional result of response to new knowledge. There is little

awareness about the importance of KM for the efficiency and effectiveness of innovation. There is "an eventual adoption of KM practices in a non-structured manner" [48].

Level 2: The organization recognizes the association between obtaining potential business benefits and harnessing its organizational knowledge at this level. A practical characterization of KM is defined and its applicability is considered within an organization. KM strategy has been established, which should bond closely with the organization's business strategies and categorize business opportunities to harness knowledge sharing and dissemination [47]. Change occurs based on "conceptual knowledge and past experiences of change initiatives" [49]. Companies are aware of the importance of KM for innovation and the existing technology systems provide basic support to KM. There are low participation and engagement of employees in general [48].

Level 3: At the third level, management of KM strategies, processes and methods is the primary focus. Lectures assert that the KM team has responsibilities for the supervision of KM approaches and processes such as identifying and selecting KM approaches, securing funding and resources, communicating, implementing strategy and standardizing KM methodologies [47]. The standard procedures have been employed to use the newly-acquired knowledge [49]. KM approaches and processes are fostered and supported by practical rules, mechanisms and relevant technical systems throughout the organization [5]. Companies appear to be oriented the culture of innovation which rooted in the organizational processes to the creation and use of knowledge [48].

Level 4: The main focus of level four is the establishment, standardization of the foundations for KM and expansion strategies by the application of the organization's standardized KM approaches and processes. These KM approaches and processes should be combined to enhance an organizational capability strongly. Indirectly, the evolution resulting from that development should be managed by the organization [47]. Thus, qualitative and quantitative indicators are measured regularly, which is related to the effectiveness, efficiency and success of KM evolution [5]. Organizational structures, responsibilities and processes have been set up to the response to the new knowledge [49]. Companies have high awareness of KM and corporate KM is guided by the participation of most employees. These companies use external resources and support for better KM [48].

Level 5: At this level, organizations have developed a capability that can be nurtured and sustained in the knowledge sharing and innovative atmospheres, which is provided by intensely encouraging culture. In order to attain desirable business effects and breakthrough innovation, organizations optimize standardized KM tactics and routes to improve core business processes and embeds them in to the business processes [47]. There are no barriers as they can be surmounted with created KM competency in enterprise. Firms have developed a culture of knowledge and learning, backed by capabilities that enable them to incorporate acquisition and use of new knowledge as a way of managing their businesses [49]. KM can emerge in any stakeholder of the environment. it is expected that "KM transcends its practices beyond the boundaries of the organization"[48].

C. Description of the Three Targets in KM Process

KM process: It is widely acknowledged that KM is rooted in the conception of the learning establishment [50]. KM is considered to be a set of processes to advance the ability of organizations to generate, obtain, store, conserve and transfer the organization's knowledge. Researchers propose that "knowledge processes can be thought of as a structured coordination for managing knowledge effectively"[5]. KM requires assessment to measure its effects and it is improbable that it will develop without assessable success, enthusiasm and maintenance [50].

Technology: Technologies are another essential factor in the propulsion of processes implementation and advancement. It is a necessary condition that the effectiveness and efficiency of technology maintains process management execution through the stages of maturity [51]. The use of technology can help process management implementation and conduction [32]. Ref. [51] asserts that "the component of KM relates primarily to the technology that is implemented in order to collect, store, and disseminate knowledge within an organization".

Culture: Ref. [32] provides a definition of culture as "about creating a facilitating environment that complements the various process management initiatives". Culture integrates individuals' shared values, rules, principles and beliefs in an enterprise [52]. It is individuals' acceptance, practices and advancement of process management which is related to the processes. Some academics hold the opinion that a company's culture is influenced by values, convictions and work systems that could encourage or discourage process management [53].

D. Assessment Tool

The assessment tool based on the framework is introduced above. The assessment tool is a practical tool which to scale an organizations' innovation performance in knowledge view. In order to provide a clear and simplified way to measure the organization's innovation capability, the maturity grids according to the KM key factors, KM targets and maturity levels discussed above have created. The maturity grids show five distinct maturity stages in a horizontal direction and each key factor and KM targets in a vertical direction. There are three maturity grids totally, including:

- Knowledge acquisition maturity grid (See Appendix A)
- Knowledge dissemination maturity grid (See Appendix B)
- Knowledge responsiveness maturity grid (See Appendix C)

The set of maturity grids are very convenient to use when conducting measurements. The investigator considers the descriptions in every row of each grid and ticks off one description in each row which matches the organization's situation.

V. Stage Two: Testing and Validation

After conducted the case studies and data analysis by using questionnaire and interview, a number of the case companies have been evaluated their innovation capabilities on

knowledge perspective. The result of maturity levels of case companies are between level 1 to level 3 with average scores of 2.4.

Fig. 3 showed the distribution of the innovation capabilities levels results from data analysis results. When looking at the figure, every company's maturity level distribute at a different range. It means this tool can evaluate the different capabilities levels of the case companies.

Additionally, it can be seen clearly that the scores of each KM factors are quiet even. Thus, it illustrates that the standard of each level of this assessment tool is moderate.

Looking at the average of the results for each of factors which are 2.35- 2.45 sitting at the middle level. This means that the standard of the measurement tool is correct. Conversely, if the average score is at a low level, the standard of the measurement tool is too high. Vice versa, if the average score is at a high level, it indicates the standard setting is too low.

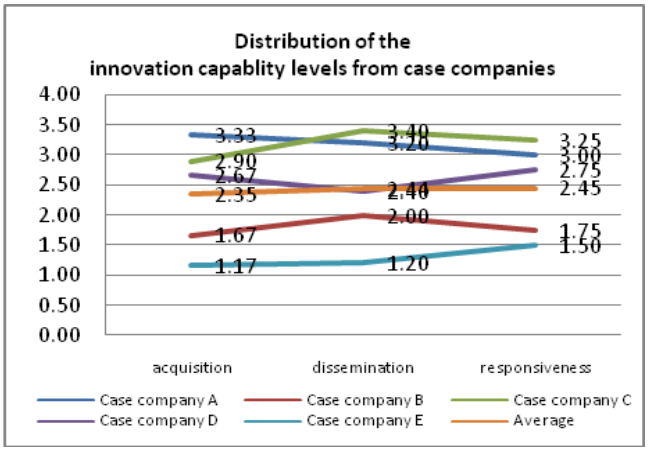

Fig. 3. Distribution of the innovation capability levels from case companies.

When look at the Fig. 4, it illustrates the frequencies of each innovation capability maturity level. The outcome shows that the frequencies of low levels are higher than the high levels. It means that the higher levels are more difficult to achieve compare to low levels, which matches the characteristics of maturity capability.

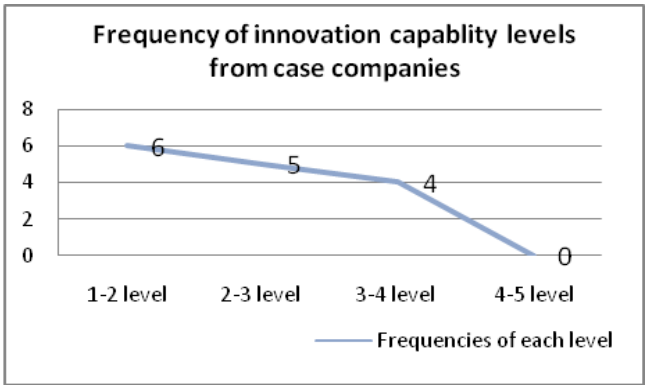

Fig. 4. Frequency of innovation capability levels from case companies.

Beside the data analysis, the investigation of users' feedback has been done by questionnaire. In this questionnaire, there are several characteristics that have been highlighted:

- This tool was easy to use
- Maturity tables were easy to understand
- This tool helped to identify strengths and weaknesses of the organization
- This tool gave some ideas about what capabilities are needed to developed next
- This was overall an effective tool to assess knowledge and innovation capabilities

After implementing the assessment tool, the case companies replied about the use of the tool and its measurement of effects. According to the results, the companies agreed that the assessment method satisfies the demand of assessing an organization's capability. This was an overall effective tool, it was easy to understand, to use and it identified strengths and weaknesses in the organization strategies on how to develop their capabilities. It also provided a guideline to develop organizational capability further. The tool was considered by case companies as well-structured to capture the current level of maturity, and thus a good understanding of the gap to close.

VI. Conclusion

Knowledge plays an essential role in innovation development. It supports innovation as the foundation and enables it to convert important sources to sustain an enterprises' competitive advantages [6]. However, how to conduct KM to improve innovation capabilities is still a challenge for a wide range of enterprises as they have no appropriate and systemic approaches or any cognition of their own capabilities.

Very few maturity assessment models make or address the relationship between knowledge and innovation. The aim of this article was to create a method to evaluate organizations' KM and innovation performance. This research establishes a bond between KM capability maturity and innovation. It has proposed a capability assessment tool for assessing organizations' KM and innovation capabilities which has shown to be able to solve this difficulty effectively and conveniently. It not only offers an assessment scale but also provides a road map for development. It can help companies recognize the opportunities for moving ahead and can guide them to reach a higher maturity level.

This study has the following limitations that need to be overcome in future research. This research only conducts into a few case companies so far, more validation and development of the tool need to conduct in the further research.

Appendix A: Knowledge Acquisition Maturity Grid

Targets	Key factors	Level 1	Level 2	Level 3	Level 4	Level 5
process	Process of acquiring knowledge	Employees use their own way	Seek knowledge when needed	Structured process to scan for and acquire knowledge	Process is monitored for effectiveness	Optimised & combined processes
	Sources of knowledge	Limited external e.g. customers or suppliers inquiry	Limited mix of both Internal & external sources	Wide range of internal and external sources	Novel & wide range of sources	Novel sources & access to experts in the field
	Internal knowledge base	Not clear	Roughly defined	Well defined	Flexible and open to change	Continuously developed and expanded
technology	Technology	Basic e.g. Google search ,emails	Supported e.g. electronic database	Systematic e.g. organisational website, intranet	Interactive and dynamic data analysis	Optimised and wide information scanning processes
culture	Training	No formal training	Mostly Informal & some formal training	Most people have access to Formal training if they require	Formal training linked with personal development goals	Formal trainings is integrated with company wide organisational learning objectives
	Awareness of knowledge types (tacit and explicit)	Lack of awareness of different types and their impact on learning	General awareness of different types of knowledge	Awareness of various knowledge flows for different types	Seeking appropriate knowledge type for the type of innovation activity	Encourage the integration of different knowledge types

APPENDIX B: KNOWLEDGE DISSEMINATION MATURITY GRID

Targets	Key factors	Level 1	Level 2	Level 3	Level 4	Level 5
process	Process	Employees use their own way	Share knowledge when needed through agreed processes	Standard processes for collaboration and sharing knowledge	Knowledge sharing process is monitored for effectiveness	Optimised & combined use of processes to disseminate
	Integration	Limited interaction & collaboration	Partial Interaction e.g. department meetings	Enterprise-wide Interaction	Formal Inter-departmental relationships	Interdepartmental relationships continually developed
technology	Technology	Technology used only for storage	Creating Tools and platforms to access information	Tools and platforms for sharing knowledge	Tools and platform for internal collaboration	Tools and platform for external collaboration
culture	Attitude towards knowledge sharing	Limited awareness of importance of sharing knowledge	General awareness	Organisationally Encouraged	Organisationally Incentivised	Natural way of sharing knowledge
	Type of knowledge conversion	Not recognised	Recognised	Basic Understanding e.g. tacit to tacit Explicit to explicit	Advanced Understanding e.g. tacit to explicit Explicit to tacit	Understanding the integration of types

APPENDIX C: KNOWLEDGE RESPONSIVENESS MATURITY GRID

Targets	Key factors	Level 1	Level 2	Level 3	Level 4	Level 5
process	Process of responding to new information	Unplanned and ad-hoc processes	Loosely defined processes	Standard procedures in place	Measures exist for effective and prompt response	Continuously improving the ability to respond to new information
	Level of Agility	Mainly indifferent to new information, changes occur accidently	Personal response based on conceptual knowledge and experience	Organisational response to new information	Focus on organisational flexibility and speed	Proactive and forecasting new changes
technology	Technologies to support change	Basic communication technologies E.g. email, telephone	Intranet based information systems	Systematic use of technology to implement change	Specific tools and platforms for change management	Accepted widely & optimised use of change management technology
culture	Attitude towards change	Not welcomed	Recognised the need for change	Encouraged to look for change	Embracing change	Sustained improvement

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