Knowledge Management Maturity Models – A Morphological Analysis

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ABSTRACT:

A Knowledge Management Maturity Model is a structured approach for implementing Knowledge Management. Many practitioners and researchers have developed Knowledge Management Maturity Models, which have different forms, structure and characteristics. Despite the availability of many models, a comprehensive framework that can represent different perspectives and provide a holistic picture of Knowledge Management Maturity Model is not found in literature. This paper attempts to fill this gap by developing a morphological framework of Knowledge Management Maturity Model through literature survey and analysis.

Keywords: *Knowledge management, Maturity models, Morphological analysis*

1. Introduction

Knowledge Management(KM) is an interdisciplinary field covering various areas like Information and Communication Technology, Information Science, Systems Science and Engineering, Knowledge Engineering, Collaborative Engineering, Organizational Development, Change Management, Performance Management etc. It aims to create wealth and value by providing, the right knowledge, at the right place and at the right time to various organizational entities. The effective utilization of knowledge by various organizational entities results in improved skills and competencies for decision making, performance improvement and innovations. The most fundamental processes in Knowledge Management are knowledge creation, knowledge sharing and knowledge utilization.

One of the definitions of Knowledge Management is "Knowledge Management is the process of capturing a Company's collective expertise, wherever, it resides, in databases, in paper or in people's heads and distributing it wherever it can produce maximum pay off" (Hibbard,1997). Here expertise is used as synonym for knowledge. The main concept is to make available the collective or individual expert's knowledge wherever it improves the performance. Collective knowledge in the context of organization is known as organizational knowledge. The main goal of Knowledge Management is to improve the organizational performance by leveraging on the collective knowledge. Collective knowledge is created by sharing knowledge among the organizational entities.

Essentially the motivations for Knowledge Management implementation should be driven by business needs. Any Knowledge Management implementation needs a clear road map, that is derived based on goals & resources available. In order to provide a road map for Knowledge Management implementation, many practitioners and researchers have developed 'Knowledge Management Maturity Models'(KMMM). What are the different forms, structure and characteristics of these KMMMs? Despite the availability of many models in literature, a comprehensive framework that can represent different perspectives and provide a holistic picture of KMMM, is not found in literature. This paper attempts to fill this gap by developing a morphological framework of KMMM through analysis of various Knowledge Management Maturity Models available in literature.

This paper is organized as follows. The first section explains maturity models in general and KMMMs in particular. It explores fifteen KMMMs from the literature in various perspectives, as the basis of morphological analysis. The next section looks at morphological analysis, in general, followed by the morphological analysis of KMMMs. This is followed by a discussion of possible benefits, limitations and directions for future work.

2. Knowledge Management Maturity Model

Maturity models describe the development of an entity over time. The entity can be anything of interest. It can be a human being, an organization, a technology, a product, a process etc. Maturity Model gives a path to improvement. Maturity Model can also be used as a basis for comparison (Klimko, 2001). Maturity models are driven by the necessity to have a clear cut road map for any organization that is embarking on Knowledge Management implementation. It provides the clear vision with a description of the path ahead. Knowledge Management Maturity Model can be considered as an application of structured approach to Knowledge Management implementation. Maturity Model can also provide a common understanding of the terminologies involved in Knowledge Management implementation to various stakeholders. Maturity models have the following properties(Klimko,2001,Weerdmeester et al., 2003).

- The development of a single entity is simplified and described with a limited number of maturity levels (usually four to six).
- Levels are characterized by certain requirements which the entity has to achieve on that level.
- Levels are sequentially ordered, from an initial level to an ending level of perfection.
- During development, the entity progresses forward from one level to the next. No levels can be skipped.

Maturity models are basically application of life cycle approach. The entity develops through the levels , until the highest level, which is the level of perfection. A well known maturity model is Maslow's hierarchy of human needs(Maslow 1943). Maslow postulates that there are five levels in human needs. The human needs start with physiological needs and progresses to safety needs, needs of love and belonging, esteem needs and finally to self actualization needs. Another very popular maturity model is

Capability Maturity Model (CMM) and its latest version Capability Maturity Model Integration (CMMI) developed by Software Engineering Institute of Carnegie Mellon University for process improvement. CMMI supports both a staged representation and a continuous representation. In the staged representation the model has five stages. Maturity level 1 is called "Initial", which is characterized by ad hoc and chaotic processes. Maturity level 2 is called "Managed", which is characterized by processes that are planned and executed as per the policy. Maturity level 3 is called "Defined" which is characterized by standardized processes that are used to establish consistency across the organization. Maturity level 4 is called "Quantitatively Managed", which is characterized by managing the process performance through quantitative objectives. Maturity level 5 is called "Optimizing", which is characterized by continual improvement of process performance through continual and innovative process and technological improvements(Chrissis et.al, 2007).

In this paper, the entity of interest is Knowledge Management and hence only 'Knowledge Management Maturity Models' are considered. The path to success in Knowledge Management implementation involves significant changes in process, technology & other infrastructures, mindset of people and systems, process & culture of the organization. It is extremely difficult to achieve such significant changes that affects the entire organization through a 'big bang' approach in a single step. It is a worthy decision to implement KM through an evolutionary process with adequate 'absorbing time' for various organizational entities. A clear road map for such an implementation provides the necessary guidance for various stake holders.

In this paper literature survey and morphological analysis of fifteen Knowledge Management Maturity Models have been carried out. The models considered are briefly described below and listed in Table 1 without any specific order:

- Kochikar(2000), had developed a generic KMMM, in the context of Infosys Technologies Ltd. The model has five stages, viz, default, reactive, aware, convinced and sharing. The assessment methodology is objective. The model does not specify anything about validation. The Key Areas considered are people, process & technology. The model will be referred as KMMM(Infosys).
- Hubert and Lemons of APQC had developed a generic KMMM for application to APQC's road map to KM results. The model has five stages, viz, initiate, develop, standardize, optimize and innovate. The model does not specify the assessment methodology. It also does not specify anything about the validation. The model specifies the characteristics of different maturity levels in generic terms, without explicitly identifying any specific Key Areas. The model will be referred as KMMM(APQC).
- Kulkarni and Freeze (2004), had developed a Knowledge Management Capability Assessment Model(KMCA), for determining the capability levels of an organization in various knowledge areas. The model identifies six capability levels, viz, difficult, possible, encouraged, enabled, managed and continuously improved. The model specifies the subjective assessment methodology with typical questions. The model is validated by empirical methods. The model classifies the knowledge into four areas, viz, expertise, lessons learned, knowledge documents, and data. These areas are called knowledge capability areas, which are essentially the Key Areas. The model will be referred as KMCA.

- Klimko(2001), had developed a generic KMMM. The model has five stages, viz, initial, knowledge discoverer, knowledge creator, knowledge manager and knowledge renewer. The model neither specifies the assessment nor validation methodology. The model specifies the characteristics of each stage in terms of focus, key processes, challenge, tool, and pitfall. The model will be referred as KMMM(Klimko).

- KPMG Consulting(2000) had developed a generic KMMM called 'Knowledge Journey'. The model has five stages, viz, knowledge chaotic, knowledge aware, knowledge focused, knowledge managed and knowledge centric. The model neither specifies the assessment nor validation methodology. The model specifies the characteristics of different maturity levels in terms of Key Areas, viz, people, process, content & technology. The model will be referred as Knowledge Journey.

- Natarajan (2005), had developed a KMMM for software industry. The model has four stages. Each stage is called a K-stage. The model does not specify the assessment methodology. The model is validated by case study approach. The Key Areas identified are business process readiness, technology infrastructure, human behaviour and leadership. The model will be referred as KMMM(Software Industry).

- Paulzen and Perc(2002), had developed Maturity Model for Quality Improvement in Knowledge Management. The authors call it Knowledge Process Quality Model(KPQM). The model has five stages, viz, initial, aware, established, quantitatively managed and optimizing. Though the model discusses the assessment globally, it does not clearly specify the methodology. The validation of the model is discussed as the future work. The Key Areas identified are organization, people and technology. The model will be referred as KPQM.

- Mohanty and Chand (2004), had developed a KMMM, keeping the requirements of Tata Consultancy Services in mind. The model has five stages, viz, initial, intent, initiative, intelligent and innovative. The assessment methodology described is objective. The model does not discuss the validation methodology. The Key Areas considered are people, process & technology. The authors call the model as 5iKM3 and will be referred by the same name.

- Wisdom Source Technologies had developed a KMMM (Wisdom Source,2004). The model has eight levels of maturity, viz, standardized infrastructure for knowledge sharing, top-down quality assured information flow, top-down retention measurement, organizational learning, organizational knowledgebase, process-driven knowledge sharing, continual process improvement and organizational self-actualization. The model neither specifies the assessment nor validation methodology. The model specifies the characteristics of different maturity levels in generic terms, without explicitly identifying any specific Key Areas. The model is called K3M and will be referred by the same name.

- Gottschalk(2002), had developed Maturity Model for Knowledge Management Technology in Law Firms. The model has four stages of growth, viz, end user tools, who knows what, what they know and what they think. The model neither

specifies the assessment nor validation methodology. The model discusses the technology characteristics at each level. Also the model discusses the classification of knowledge into core, advanced & innovative and administrative, declarative, procedural & analytical. The model will be referred as KMMM(Technology).

- Ehmsand Langen(2002), had developed a KMMM, keeping the requirements of Siemens in mind. The model has five stages, viz, initial, repeated, defined, managed and optimizing. The assessment methodology described is objective. The model does not discuss the validation methodology. The model identifies eight Key Areas, viz, strategy&knowledge goals, environment & partnerships, people & competencies, collaboration & culture, leadership & support, knowledge structures& knowledge forms, technology & infrastructure, and processes, roles & organization. The model will be referred as KMMM(Siemens).

- Kruger and Snyman (2007), had developed a Strategic KMMM. It identifies six phases in maturity , viz, ICT as an enabler of KM, deciding on KM principles, ability to formulate organization-wide knowledge policy, building knowledge strategies, formulation of KM strategies and ubiquitous knowledge. The model neither specifies the assessment nor validation methodology. The model specifies the characteristics of different maturity levels in generic terms. The model will be referred as Strategic KMMM.

- Gallagher and Hazlett (2004), had proposed a generic KMMM. The model has four stages, viz, K-aware, K-Managed, K-enabled, and K-optimized. The assessment methodology is objective. A case study approach is proposed to validate the model. The Key Areas identified are knowledge infrastructure, knowledge culture and knowledge technology. The model is named as KM3 and will be referred by the same name.

- Pee and Kankanhalli (2009), had proposed a generic KMMM. The model has five stages, viz, initial, aware, defined, managed and optimizing. The assessment methodology is objective. A case study approach is used to validate the model. The Key Areas considered are people, process & technology. The model is named as G-KMMM and will be referred by the same name.

- Boyles et al (2009), had proposed a KM assessment tool, in the context of nuclear industry. The assessment is based on the model with five levels. It identifies seven Key Areas, viz, policy, human resource, training, documentation, technology, tacit knowledge and KM culture. In the five level model each Key Area progresses from 'not utilized' , 'to a little extent', 'to some extent', 'to a great extent' and ' to a very great extent'. Self –assessment methodology is prescribed. The model will be referred as KMMM(Nuclear Industry).

Sl. No.	Model Name	Author
1	KMMM(Infosys)	Kochikar (2000)
2	KMMM(APQC)	Hubert and Lemons
3	KMCA	Kulkarni and Freeze (2004)
4	KMMM	Klimko(2001)
5	Knowledge Journey	KPMG (2000)
6	KMMM(Software Industry)	Natarajan (2005)
7	KPQM	Paulzen and Perc(2002)
8	5iKM3	Mohanty and Chand (2004)
9	K3M	Wisdom Source (2004)
10	KMMM(Technology)	Gottschalk (2002)
11	KMMM(Siemens)	Ehmsand Langen(2002)
12	Strategic KMMM	Kruger and Snyman (2007)
13	KM3	Gallagher and Hazlett
14	G-KMMM	Pee and Kankanhalli (2009)
15	KMMM(Nuclear Industry)	Boyles et al (2009)

Table 1: Knowledge Management Maturity Models Considered

3. Morphological Analysis

The term morphology comes from classical Greek (*morphe*) and means the study of shape or form. It is concerned with the structure and parts of an entity(object) and how these fit together to form a whole. The entity can be physical, social or conceptual (Ritchey, 2006).

Morphological Analysis was developed by Fritz Zwicky – the Swiss American astrophysicist and aerospace scientist based at the California Institute of Technology, as a method of structuring and investigating the total set of relationships, contained in multidimensional, non quantifiable problem complexes (Zwicky, 1966, 1969, cited by Ritchey, 2006).

Morphological analysis commences by identifying and defining the dimensions (parameters) and probable options (values) of the entity to be analyzed. A morphological box also known as Zwicky box, is constructed by setting the dimensions and options in an n dimensional matrix. Each cell of the n dimensional box contains one particular option for each of the dimensions, which indicates a particular configuration of the entity. Each option in a dimension is a row in the matrix. The rows of same dimension are parallel to each other, and orthogonal to the rows of other dimensions. The rows of different dimensions intersect each other to form cells in the morphological box. As a simple example imagine a car with three dimensions size, color and engine type . Let the probable options for size be small, medium & large, for color be white, black, red & green and for engine type be petrol & diesel. Since there are 3 options for size, 4 options for color & 2 options for engine there are 24 (3*4*2) cells in the morphological box each

representing one particular car with one option for each dimension. The 3 dimensional matrix containing all the possible relationships is the complete and systematic morphological field.

3.1. Dimensions and Options

The morphological frame work developed for this work has identified six dimensions. Each dimension has two or more options. Fifteen reviewed KMMMs (Table 1) were used as the basis for the dimensions and options. The dimensions and options are discussed in the following subsections.

3.1.1. Context

The dimension 'Context' refers to the context in which the maturity model has been developed. The maturity model can be developed in the context of a specific organization or a specific industry sector like software, manufacturing, R&D etc. Also, it could be developed in a general context without any reference to any organization or any industry sector. Hence the three options considered for the dimension 'Context' are 'General', 'Organization' and 'Industry Sector'. Certain models clearly specify the context of development. For example the KMMM(Infosys) explicitly mention that the context is organizational, " while the model has been developed keeping the Infosys context and KM goals in mind…"(Kochikar, 2000). Some other models clearly specify that, the model has been developed keeping the context of a specific industry sector. For example the KMMM(Software industry) mention that the model is developed in the context of software export industry (Natarajan, 2005). Some models explicitly mention that the model is developed in the general context. For example the G-KMMM mention that the model is in the general context (Pee and Kankanhalli,2009). Out of the fifteen models reviewed, it was observed that eight(53.4%) models were developed in the general context, four(26.7%) were in the context of specific organization and three(20%) were in the context of specific industry sector.

3.1.2. Applicability

The dimension 'Applicability' refers to the entity to which the model can be applied. The maturity model may be applicable in general to any organization, or it may be applicable only for the specific organization, or to the specific industry sector. Hence the options of the dimension 'Applicability' are 'General', 'Organization' and 'Industry Sector'. It can be noticed that the options of the dimension 'Context' and 'Applicability' are identical. Does it indicate that the two dimensions are the same?. It can be observed from Table 2 that, the models developed in the context of 'Organization' has the 'General' applicability. For example the KMMM(Infosys) , explicitly mention that the context is organizational, while the applicability is general; " while the model has been developed keeping the Infosys context and KM goals in mind, it is sufficiently generic to be used in any organization which considers knowledge leverage as significant determinant of success" (Kochikar, 2000). Hence it can be concluded that the dimensions 'Context' and 'Applicability' are different. Out of the fifteen models referred, it was observed that twelve(80%) models were applicable in the general context, three(20%) were applicable to specific industry sector and none(0%) were applicable to any specific organization.

3.1.3. Stages

Theoretically the model can progress from a lower level of perfection to a higher level of perfection either in stages or continuously. However all the models reviewed used a staged model of progression. Hence the continuous model of progression is not considered. The dimension 'Stages' indicates the number of stages from the lowest level of perfection to the highest level of perfection. Ideally the options for 'Stages' could be any positive number. However the options considered in this analysis are, the number of stages used in the models reviewed(4,5,6&8). Out of the fifteen models reviewed, it was observed that nine(60%)models had five stages, three(20%) models had four stages, two(13.3%) models had six stages and one(6.7%) model had eight stages.

3.1.4. Assessment

The dimension 'Assessment' indicates the methodology suggested or described in the model to assess the knowledge management maturity of the organization . It could be subjective in the sense that the evaluation is purely based on the opinion expressed by various stake holders. It could be objective in the sense that the evaluation involves collection and analysis of evidences to support the opinion expressed by various stake holders. Some of the models do not explicitly mention the assessment methodology. Hence the options considered are ' Subjective', 'Objective' and ' Not known'. Out of the fifteen models reviewed, it was observed that eight(53.4%)models have not mentioned the assessment methodology, five(33.3%) models have used objective methodology, while two(13.3%) models have used subjective methodology.

3.1.5. Validation

The dimension 'Validation' indicates the methodology used to validate the model. The model could be validated by empirical methods, or by case study method, in the context of one or more organizations. It could also be possible that the model be validated by more than one method. However, that option was not considered, since none of the models, reviewed, used multiple methods. In majority of the models, the validation is not specified, indicating that the model may not be validated or the validation details cannot be revealed due to confidentiality. Hence the options considered are 'Empirical', 'Case study' and 'Not known'. Out of the fifteen models reviewed, it was observed that twelve(80%)models have not mentioned the validation methodology, two(13.3%) models have used case study methodology, while one(6.7%) model had used empirical methodology.

3.1.6. Key Areas

The dimension 'Key Areas' indicates the key areas considered by the model to characterize various maturity stages. Some of the models did not specifiy any key areas, but simply described the characteristics of various stages in general terms. Some of the models specified various key areas like people, process, technology, knowledge, content, culture, leadership, strategy, etc. These models have used a set of Key Areas like "people, process, technology", "people, process, content, technology" etc. Only the set of "people, process, technology" is used by four models (KMMM(Infosys), KPQM, 5iKM3 and G-KMMM). All other sets are used by

one model each. Also many models include the Key Area like ' people', 'technology' etc. in their respective set of Key Areas. Hence for simplicity the options considered are 'General' which indicates, that characteristics are described in general terms, without any specific Key Areas and 'Specific', which indicates that characteristics are described in terms of specific Key Areas. Out of the fifteen models reviewed, it was observed that eleven(73.3%) models described characteristics in terms specific Key Areas and four(26.7%)models have described characteristics in general terms.

Table 2 depicts the dimensions, options, models, total number of models and the percentage of models that used the options.

Sl. No.	Dimension	Options	Models	No. of Models	%
1.	Context	General	KMMM(APQC), KMMM(Klimko), Knowledge Journey, KPQM, K3M, Strategic KMMM, KM3, G-KMMM	8	53.4
		Organization	KMMM(Infosys), KMCA, 5iKM3, KMMM(Siemens),	4	26.7
		Industry Sector	KMMM(Software Industry), KMMM(Technology), KMMM(Nuclear Industry)	3	20
2.	Applicability	General	KMMM(Infosys), KMMM(APQC), KMCA, KMMM(Klimko), Knowledge Journey, 5iKM3, KMMM(Siemens), KPQM, K3M, Strategic KMMM, KM3, G-KMMM	12	80
		Organization		0	0
		Industry Sector	KMMM(Software Industry), KMMM(Technology), KMMM(Nuclear Industry),	3	20
3.	Stages	4	KMMM(Software Industry), KMMM(Technology), KM3	3	20
		5	KMMM(Infosys), KMMM(APQC), KMMM(Klimko), Knowledge Journey, KPQM, 5iKM3, KMMM(Siemens), G-KMMM, KMMM(Nuclear Industry),	9	60
		6	KMCA, Strategic KMMM	2	13.3
		8	K3M	1	6.7
4.	Assessment	Subjective	KMCA, KMMM(Nuclear Industry)	2	13.3
		Objective	KMMM(Infosys), 5iKM3, KMMM(Siemens), KM3, G-KMMM	5	33.3
		Not known	KMMM(APQC), KMMM(Klimko), Knowledge Journey, KMMM(Software Industry), KPQM, K3M, KMMM(Technology), Strategic KMMM	8	53.4
5.	Validation	Case Study	KMMM(Infosys), KMMM(APQC), KMMM(Klimko), Knowledge Journey, KPQM, 5iKM3, K3M KMMM(Technology), KMMM(Siemens), Strategic KMMM, KM3, KMMM(Nuclear Industry)	12	80
		Empirical	KMMM(Software Industry), G-KMMM	2	13.3
		Not known	KMCA	1	6.7
6.	Key Areas	General	KMMM(APQC), KMMM(Klimko), K3M, Strategic KMMM	4	26.7
		Specific	KMMM(Infosys), KPQM, 5iKM3, G-KMMM, KMCA, Knowledge Journey, KMMM(Software Industry), KMMM(Technology), KMMM(Siemens), KM3, KMMM(Nuclear Industry)	11	73.3

Table 2: Morphological Analysis

3.2. Discussions And Contributions

The dimensions and options considered were derived from the fifteen models reviewed. For certain dimensions, it is possible to have more number of options.(For example, the options for the dimension 'stages' could be any other number also). Also for some dimension the options considered may not have been used by any of the models analyzed. For example, the option 'organization' for the dimension, 'applicability' does not apply to any of the models. However that option indicates that, it is possible to develop a model with that option.

The morphological analysis described, provides a holistic view of the Knowledge Management maturity models based on the published literature. Analyzing different KMMMs based on different options provide multiple perspectives. It also provides an indication of the options of various dimensions, which different models have dealt with. The analysis also provides a quantitative picture of the usage of various options by the models in literature.

Each model can be described in terms combination of the options. For example KMMM(Infosys) can be described by the following combination of dimensions. Context: Organization, Applicability: Organization, Stages: 5, Assessment: Objective, Validation: Not known, Key Areas: Specific. Any other KMMM can also be mapped into the morphological frame work and analyzed in terms of the dimensions and options.

The morphological analysis considered six dimensions and constitutes a six dimensional matrix. The total number of cells in the morphological box (Table 3) is 648(3*3*4*3*3*2), which indicates 648 maturity models are possible based on the dimensions and options considered.

Sl No	Dimension	No. of options
1.	Context	3
2.	Applicability	3
3.	Stages	4
4.	Assessment	3
5.	Validation	3
6.	Key Areas	2

Table 3: Morphological Box

This paper may probably be the first attempt to use a morphological analysis of KMMMs. The analysis has implications both for practitioners and researchers. A practitioner can classify certain options as strengths and certain others as weaknesses depending on the application and then evaluate various models based on the morphological framework and select the appropriate one, which has maximum strengths and minimum weaknesses. A researcher interested in developing a new model can evaluate the available models in the literature based on the morphological framework and identify the gaps in the literature. A researcher can also develop a model that combines the strengths and eliminates the weaknesses of the existing models.

4. Conclusions And Future Work

This paper develops a morphological framework for KMMMs. It reviews fifteen KMMMs and maps them on the morphological framework. It provides a quantitative analysis of the extent of usage of different options by various models. The developed morphological frame work provides guidelines for researchers and practitioners in developing new models or adopting an existing model. The morphological framework is limited to the perspectives detailed in the fifteen models reviewed. It is possible to identify additional dimensions and options and the morphological framework can be further extended. It may also be possible to combine some of the dimensions and make the morphology more compact. Literature survey can be extended to include more number of models and the morphological analysis can be repeated to observe the variations in the quantitative results, if any. For example the current study with fifteen models indicates that the maximum number (53.4%) of models were developed in the general context. An analysis with more number of models can be carried out to observe whether there is any change in the trend.

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