Ontology Based Knowledge Integration Framework for Managing Flood in Malaysia

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***Abstract*—Flood management has become a national agenda in Malaysia with heavy rainfall throughout the year lead to the frequent occurrences of flood disaster. The current practice of flood management in Malaysia is unable to effectively harness the fragmented knowledge residing within flood related agencies due to lack of coordination and inefficient knowledge sharing. This paper explores the potential of ontology based knowledge integration framework to establish a governing layer in managing flood knowledge thus improve overall performance and preserve semantic consistence through ontological backbone.**

***Index Terms*—knowledge management framework, knowledge integration framework, ontology, flood management**

I. Introduction

In recent years, there is significant increase of natural disaster occurrences happened throughout the world. For countries that are located within the region that receive heavy rainfall throughout the year, flood disaster is a major issue to solve. Since decades ago, large number of structural and non-structural solutions have been implemented to solve flood problems but many are not able to deliver as per expectations. The existing practice of flood management in Malaysia is generally weak in terms information sharing and lack of coordination between agencies [1], [2]. Thus, there is need to establish a Knowledge Management Framework (KMF) in order to improve interoperability between agencies. Within KMF exist Knowledge Integration (KI) which functions as the core process of KMF where new knowledge are created and existing knowledge are improvised. With the advancement of ICT infrastructure, knowledge and information sharing are heavily distributed through online medium contributed by flood related agencies as well as the public communities. To ensure consistency of knowledge transfer within virtual domain, ontology is essentially required as a tool to deliver controlled vocabularies and concepts. Realizing the importance of KI within the context of Knowledge Management (KM), this research propose a Knowledge Integration Framework (KIF) for managing flood in Malaysia with ontology as the backbone. This paper is organized as follows; Section II elaborates the position of KI within KMF. Section III provide an overview of KI from existing literature and identify the essential processes. Section IV explores the context of ontology within the framework for smooth flow of implementation. KIF for flood management is proposed in Section V and this paper concluded in Section VI.

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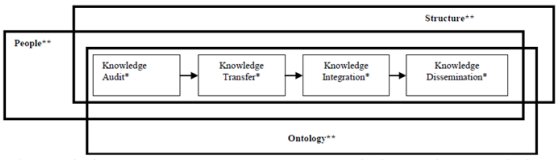
II. KMF in Flood Management

Within the context of KMF, many authors have discussed various frameworks that specifically focus on the domain of which the framework is being implemented. In the field of disaster management which is the focus of this paper, Zhang et al. [3] proposed a KM framework for humanitarian assistance and disaster relief (HA/DR). The characteristic of the framework architecture is based on difficulty of prediction, tremendous damage to society, and short decision time. The framework basically determines the efficient and effective use of available resources so that relief agencies can make timely and accurate decisions for disaster mitigation and recovery. The presented KM processes are indexing, categorisation, sharing, linking, creation, maintenance, acquisition and filtering.

In addition to the existence of a framework, KM initiative is also significantly influenced by critical success factors. This paper adopt the framework proposed by M. Rodzi et al. [4] that comprise of knowledge processes and critical success factors as depicted in Fig. 1. KI stands as the core process of KMF since the process of KI will deliver the creation of new knowledge and improvise existing knowledge for the purpose of decision making and forecasting.



*Knowledge Management Processes: Knowledge Audit, Knowledge Transfer, Knowledge Integration, Knowledge Dissemination
**Critical Success Factors: People, Structure, Ontology

Figure 1. KMF for flood management adopted from [4].

III. KI Overview and Essential Processes

The KI domain has been extensively discussed by many authors over the last few decades. Grant [5] viewed KI within an organisation as a process of integrating the

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knowledge of the experts among the employees. Grant's approach places greater emphasis on knowledge application than on knowledge creation. This emphasis can be seen through the methods proposed by Grant, namely: rules and directives, sequencing, routines, group problem-solving and group decision-making. Sousa [6] regarded KI as a problem-solving process involving the analysis of perceptions of organisational actors' activities and practices. From a different angle, Enberg *et al.* [7] explored the dynamism of KI from the perspective of acting and interacting in project teams. Their approach emphasised the importance of the project management function in assuring KI by appreciating the learning dynamic with reference to the project context. In recent work, Tsai [8] found that automated-based knowledge management and integration operations, supported by an advanced automated IT system, can overcome the barriers of employee unwillingness to share knowledge and of complicated documentation.

Nonaka, Toyama and Konno [9] elaborated upon the concept of knowledge from the root level as something personal and internally developed through an understanding of the environment, work routines and the ability to deliver a particular job requirement within an organisation. They proposed that the tacit nature of knowledge is made explicit in a codified form that later becomes a medium for knowledge transfer. Their "socialisation, externalisation, combination, and internalisation" (SECI) framework basically deploys techniques for preserving employee skill and talent. This is carried out through a continuous process of socialisation between employees, the externalisation of knowledge, the combination of new knowledge and existing knowledge, and the internalisation of knowledge so that knowledge becomes a tool for better job performance. The SECI framework complements Grant's concept of the knowledge-based firm and KI, as knowledge cannot be integrated without first being created.

Generally, the approaches to KI vary from one author to another and are argued based on the discipline in which the integration method is applied. Although the approach of Grant [5] towards KI leads to the development of competitive advantage for firms through knowledge application, the core processes involved to create the integrated knowledge are still relatively unclear. As discussed above, Nonaka, Toyama and Konno [9] introduced the SECI framework to clearly identify the process of knowledge creation. However, the SECI approach lacks emphasis on the creation of integrated knowledge, which was later introduced by Sousa [6] through the problem-solving process of KI. By evaluating the differences and combining the similarities, iCAE is proposed, incorporating the essential processes of identification (i), creation (C), assimilation (A) and evaluation (E). It is anticipated that the iCAE approach will preserve the essence of KI, while at the same time broadening the variation of end applications.

Identification (i). Identifying the compatibility of the knowledge to be integrated with other knowledge in the knowledge field. Accordingly, this will then enable the process of creation.

Creation (C). Once identified, the knowledge creation process will occur when comparing existing knowledge with past knowledge (codified experiences). The outcomes of this process are the creation of new knowledge or the improvement of existing knowledge.

Assimilation (A). From the creation process, knowledge is then disseminated amongst knowledge users. Knowledge users will assimilate the new knowledge and utilize in real world applications.

Evaluation (E). Knowledge user will evaluate the outcome of the implemented knowledge based on its performance and objective of creation thus determine whether the knowledge can be stored or revised.

With the advancement of computing systems that enable large-scale network accessibility through the internet, the essential processes of KI can be further developed as an ontology. As a result, iCAE can function in the virtual realm as a standardised form for online repository development. The essential processes of knowledge integration are crucial to ensure that the integrated knowledge delivers the expected objective and purpose.

IV. Ontology

An ontology is a tool to effectively translate theory into practice in the information systems (IS) field. It is generally defined as the shared, formal conceptualization of a domain [10]. Ontology also focuses on the definitions of concepts, which is important for effective knowledge sharing and useful for computational implementation. The further evolution of technology required the need to separate the 'essence' from the 'technology' [11] and made it necessary to understand the common processes in executing the data rather than just manipulating the data.

Colomb and Ahmad [12] discussed the ontological approach from the perdurant or process perspective. It was expected that a perdurant ontology which resides at the upper layer ontology would be stable and invariant in interoperating activities, which is crucial in the disaster management scenario. Applying an ontology in the KM domain is likely to be an advantage as its benefit has been proven in other domains, especially in the realm of virtual communication and collaboration systems.

A. Perdurant Ontology

In the ontological concept, a perdurant is something that is composed of temporal parts which can be referred to events and processes, such as a rescue mission, race, conversation or business process. The perdurant ontology of KI basically comprise of the essential processes that is supposedly common for all knowledge initiatives

B. Endurant Ontology

An endurant is something that is wholly present and does not have temporal parts, such as a person, a house etc. In this research, the endurant ontology is the tool and

algorithm that are customizable and perform the perdurant ontology that is generic and standardised.

V. KIF for Flood Management

The construction of KIF involves the fusion of essential processes in KI and ontology within the KMF. For implementation level, perdurant (process) ontology is perform and supported by endurant (data/object) ontology. Each process in KMF is a pre-requisite to one another similar to a factory production line. The output for each process starting from knowledge audit is the input to the next process.

As highlighted by M. Rodzi *et al.* [4], critical factors that govern KMF which determine the success and failure of the implementation stand before knowledge audit. For people factor, it involves the collaboration between agencies and public to provide collective and sufficient information into the KM repository in explicit form. The structure such as digital terminal to transfer the information should be accessible in large scale to assist the smooth flow of knowledge transfer. This include smart phones and laptop which owned by most people. With variety of information transferred, ontology is required to ensure the consistencies and provide common specifications/format for smooth integration.

From the vast information provided by agencies and public contributors, KI that reside within the KMF perform extraction and creation of knowledge. With the advancement of technology, flood related information are also provided by sensors and live feed camera that continuously monitor the physical environment to provide indication and alert on the potential occurrence of flood.

Knowledge created for FM through KI processes will be disseminated and evaluated by knowledge users to justify the functionality and performance of knowledge to be stored as newly integrated knowledge. Improvements of existing knowledge will go through the iterative KI processes for each FM process identified.

This paper proposed KIF as presented in Fig. 2.

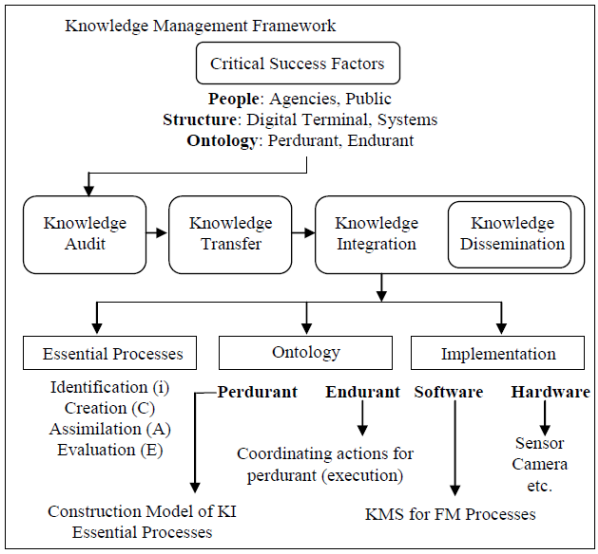

Figure 2. KIF for flood management.

VI. Conclusion

In the proposed framework, KI that reside within KMF comprise of essential processes, ontology and implementation. The essential processes serve as the core processes that represent the foundation of KI initiative. Departing from the KI processes are the perdurant and endurant ontology that become the backbone of implementation by harnessing the advancement in software and hardware of ICT infrastructure. KIF is expected to evaluate the performance of knowledge transferred into the online repository thus improve overall efficiency and accuracy in flood management and flood relief operation in Malaysia.

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