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Selecting a knowledge management methodology in Society 5.0

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Abstract

Society 5.0 is a knowledge-driven society that is impacted by rapid changes in the digital world. Due to the influence of the tools and technologies introduced by Industry 4.0 or the Fourth Industrial Revolution (4IR), Society 5.0 is challenged by the amount of knowledge created through the integration of cyber and physical spaces. The exploitation of the 4IR's technological advancements increases the potential of knowledge creation, presenting with it a knowledge management (KM) challenge. Therefore, the purpose of this research was to identify the KM methodologies available for adoption in Society 5.0. In this research, systematic literature review was used to identify and evaluate existing KM methodologies from academic reviewed papers published between 2006 and 2020. It was found that some of the KM methodologies are industry specific and derived from best practice, while others focused on the development and implementation of KM systems. Based on the findings, elements of a potential KM methodology for knowledge management in Society 5.0 are presented.

1. Introduction

The world is currently in the era of the Fourth Industrial Revolution (4IR), which is a megatrend of connectivity, intelligence and flexible automation, and the evolution of digital technologies (De Boer, 2019). It brings with it technological advancements with promises to increase organisational knowledge potential (Di Maria et al., 2018). The integration and exploitation of technological advancements have become increasingly important for societies, governments (Tolbert & Mossberger, 2006) and businesses (Hess et al., 2016). Governments are adopting digital technologies to fast-track the efficient and effective delivery of services to citizens (Mergel et al., 2019; Tolbert & Mossberger, 2006). In contrast, organisations are going through changes in their business models, and are developing new capabilities to remain competitive (Hess et al., 2016). Digital technologies have shown great value in the generation of knowledge (Antonelli, 2017). This has resulted in a high flow of knowledge that requires effective capabilities to manage it (Manesh et al., 2020; Schumann & Tittmann, 2015).

The benefits of the introduction of 4IR technologies encourage even more adoption, resulting in more and more knowledge being created, changing the KM landscape (Smuts & Van der Merwe, 2022). The complexity of the intelligence that can be gathered using artificial intelligence (AI) technologies and automation necessitates an emphasis on KM (Di Maria et al., 2018).

Society 5.0, as defined in the Japanese Government's Fifth Basic Plan for Science and Technology (2016–2020), aims to create a human-centered society, where people can enjoy a high quality of life with a balance of both economic development and the resolution of societal problems through a system that integrates cyber space and physical space. The assumption of cyber-physical space is that a myriad of data is generated in cyber space through the introduction of digital technologies in the physical space. Based on this knowledge exchange between the cyber and the physical space, organisations, governments and societies require efficient ways to achieve sustainability and detect meaningful information so as to develop sophisticated uses of knowledge, while adapting to the emergent changes in the environment (Manesh et al., 2020; Smuts & Smith, 2021).

For the purposes of this study, the authors investigated a knowledge-based view of the elements that make up a KM methodology by considering the research question: *"What are the elements of a KM methodology that can be adopted in Society 5.0?"*. By understanding the KM methodology elements, organisations will be able to effectively apply KM capabilities to manage knowledge.

The remainder of this paper is structured as follows: Section 2 presents a review of the key concepts. Section 3 follows with the research approach, and Section 4 presents a discussion of the analysis and findings of the study. The details of the contribution of the study are outlined in Section 5. Section 6 concludes the paper.

2. Background

This section provides a short introduction to knowledge management. This is followed by a perspective of knowledge in Society 5.0. This section ends with an overview of KM methodologies.

2.1 Knowledge management

Knowledge is the understanding and practical experiences of people (Omotayo, 2015). It is acquired through multiple processes of reasoning, perception, communication and learning (Siregar et al., 2019). Knowledge can either be explicit or implicit (tacit). Explicit knowledge is documented, recorded and codified for future use, whereas implicit or tacit knowledge is based on peoples' experiences and is undocumented. Knowledge is a key resource for organisations, societies and individuals (Shahzad et al., 2016). It ensures that organisations remain competitive through its incorporation into business strategy, processes and culture (Bollinger & Smith, 2001; De Boer, 2019; Kaplan et al., 2004). It also has a critical role to play as the foundation to economic development (Davenport & Prusak, 2000; Omotayo, 2015). Successful organisations acknowledge their need to manage knowledge, and that meaningful knowledge management efforts need to be put in place (Naik & Chandran, 2016).

Knowledge management is multidisciplinary and many organisations are engaging in it to leverage its benefits. Knowledge management provides a structured approach to leveraging organisational knowledge assets through KM processes (Girard & Girard, 2015). Heisig (2009) found that the most commonly used KM processes are to identify (extract explicit or tacit knowledge), to create (create new knowledge), to store (engage in the structured storage of knowledge assets), to share (to retrieve stored knowledge and share it within or outside organisation) and to use it (the utilisation of stored and shared knowledge). The incorporation of technology in facilitating KM processes has made inter- and intra-organisational collaboration easier, leading to value creation, innovation and organisational learning (Shahzad et al., 2016).

Heisig (2009) identified critical success factors for the implementation of KM. These include management processes (strategy, goals and measurements), human-oriented factors (culture, people and leadership), organisation (processes and structure) and technology (infrastructure and applications). Although the contribution of these factors has been acknowledged in the management of knowledge, their integration yields effective knowledge management (Heisig, 2009; Omotayo, 2015; Zbuchea & Vidu, 2018).

2.2 Knowledge in Society 5.0

Society 5.0 is envisioned as the merging of cyber space and physical space for economic advancement, while also resolving social challenges (Deguchi et al., 2020). Society 5.0 is a response to Industry 4.0 and a progression in human development from the information age where the focus was on the internet and communication technology (Mavrodieva & Shaw, 2020). The priority of this phenomenon is on the digitisation of the economy and society through the exploitation of 4IR technologies. Society 5.0 is about the development of knowledge-driven and super-smart societies.

The adoption of 4IR technologies such as Big Data, AI, the Internet of Things (IoT) and robotic technologies presents an opportunity for data from the physical space to be analysed more efficiently for the advancement of society (Potočan et al., 2020). However, these technologies produce an increasing amount of unstructured data and information. Until now, substantial human resources and a great amount of time were required to analyse data and information to produce knowledge. The tight integration of the cyber space and the physical space with the availability of knowledge, along with structure, will see a transformation of both organisations and society (Deguchi et al., 2020; Mavrodieva & Shaw, 2020; Potočan et al., 2020). Furthermore, the creation and use of knowledge in Society 5.0 is expected to achieve true sustainability and differentiation through the provision of high-quality products and services as and when needed within society (Mavrodieva & Shaw, 2020).

As the enablement of the vision of Society 5.0 continues, complexities on how to manage this knowledge will arise, emphasising the need for KM requirements to be considered (Yıkılmaz, 2020; Zbuchea & Vidu, 2018).

2.3 Knowledge management methodologies

The KM discipline does not have a widely accepted methodology due to the diversity of KM requirements based on the diverse domains in which KM has been adopted. Rubenstein-Montano et al. (2001) stated that there has been more emphasis on KM frameworks that have also been used to describe the KM phenomena (Heisig, 2009). Both frameworks and methodologies are important in the implementation of KM initiatives (Rubenstein-Montano et al., 2001). A KM framework provides the structure, which comprises KM elements, their relationships and the principles of interaction (Heisig, 2009), while a KM methodology provides more detail than the framework that underpins it (Heisig, 2009; Smuts et al., 2009).

Rubenstein-Montano et al. (2001) recommend three guiding principles for the development of a KM methodology. Firstly, it must be underpinned by a framework to provide a structure for the methodology. Secondly, it should be comprehensive, providing sufficient detail to ensure that the methodology can be implemented. Thirdly, the entire KM process must be considered. This includes organisational learning, culture, strategy, tacit vs explicit knowledge, and the KM tasks. Moreover, the organisational benefits of conducting KM must be defined in alignment with the resulting KM methodology.

3. Research methodology

The purpose of this research was to determine what elements of a KM methodology are relevant in Society 5.0. A systematic literature review (SLR) was used to review existing KM methodologies and establish the elements that would make up a comprehensive KM methodology for adoption in Society 5.0. The approach followed comprised three main stages made up of eight steps, as discussed by Xiao and Watson (2019). The first stage is the planning of the review, which involves the formulation of the problem, and the development and validation of the review protocol. In the second stage, the review is conducted by searching the literature, screening for inclusion, assessing the quality of the research articles, extracting data, and analysing and synthesising the data. The third stage entails the reporting of the review findings.

The search was executed via a Scopus database search. The query used the string *TITLE-ABS-KEY ("knowledge management methodology")* with a time period from 2006 to 2020 to limit the study to the 10 years prior to the Japanese Government's Fifth Basic Plan for Science and Technology. A total of 48 studies were reviewed. Table 1 shows the number of identified publications within this time period. The subject areas from which the papers emanate are computer science, business, management and accounting, engineering, social sciences, decision sciences, mathematics, physics and astronomy, energy, arts and humanities, and economics, econometrics and finance.

Time period	Number of papers
2006–2015	30
2016–2020	18
Total	**48**

Table 1: Period of papers

In selecting the papers, the researchers only focused on those papers they found to directly propose KM methodologies, and those that applied KM methodologies to solve a specified KM problem. Table 2 provides a summary of the number of papers analysed. By applying backward and forward snowballing, the authors only selected the results they considered relevant for the purpose of the study, with five additional papers added and 38 excluded. Some of the papers were excluded due to language limitations. The full text papers of some articles were not available, while some were irrelevant for the purpose of the study. The result was a total of 15 papers.

SLR execution	Excluded and included papers	Number of papers
Initial search	Included 48	48
Backward and forward snowballing	Included 5	53
	Excluded 38	15

Table 2: Summary of paper analysis

4. Data analysis and findings

The objective of this study was to identify elements of a KM methodology for adoption in Society 5.0. Based on the analysis of the publications identified in Table 3, methodologies were evaluated based on focus (whether they proposed or applied a KM methodology), whether the methodology underpinned a framework, and whether the KM processes and technology were seen as a critical success factor. Where an element was identified, it was indicated with a tick (✓), and where the element was absent, the cell was left blank. Below is a high-level summary of each of the KM methodologies per author:

Dani et al. (2006) proposed a methodology to identify, capture, share and reuse best-practice knowledge. This methodology was divided into two parts: the identification of the best-practice knowledge for product development, and the structuring of the identified best-practice knowledge for sharing and reuse.

Neumann (2007) proposed a framework for the identification, creation, acquisition and sharing of knowledge in project settings since a lot of knowledge does not seem to be documented. Though described as a framework, a methodological approach was proposed.

Sureephong et al. (2007) used a three-part KM methodology and a KM system to collect, share and reuse knowledge. This methodology was based on knowledge engineering theory.

Chalmeta and Grangel (2008) proposed a methodology to direct the process of developing and implementing a KM system for the collection, management and application of knowledge. This methodology comprised five stages, outlined the activities to be performed for each of the stages, the techniques and tools to be utilised, and the expected outcome for each phase. The use of this methodology promised better definition of the vision and strategy of the project, better planning and management of the project, and a greater chance of implementing the project with success.

Smuts et al. (2009) proposed a comprehensive framework and methodology for the implementation of KM systems. The KM framework and methodology comprised five phases with sub-phases and detailed steps to enable implementation. It was implemented in a telecommunications organisation that was highly driven by product innovation.

Davis et al. (2011) proposed a strategic transfer of engineering and architectural knowledge (STEAK) model using KM methodologies and techniques. This model was intended to aid the management of engineering knowledge through the identification, transfer and integration of knowledge.

Li et al. (2011) proposed a KM methodology called intelligent knowledge management based on extension theory and web intelligence. This KM methodology helped construct a systematic knowledge map for product innovation through the integration of human knowledge and technology-based knowledge. This KM methodology was implemented in an electric company with great benefit for the company and its customers.

Garrido-Baserba et al. (2012) presented an innovative knowledge-based methodology that facilitated the creation of process flow diagrams for decision making in a wastewater treatment plant.

Leung et al. (2012) proposed a KM methodology for the creation, storage and dissemination of knowledge in higher education. This KM methodology was intended to be supported by integrated KM systems.

Paolino et al. (2014) presented a model to capture tacit business knowledge through an expert multi-agent system to promote innovation learning.

Maleki et al. (2017) proposed an ontology that structured domain knowledge by applying a KM methodology. This ontology development was based on three phases that provided the details of the development process. It was validated through its implementation on a shared repository linked to a legacy computer-aided design (CAD) system.

Feng et al. (2017) proposed a KM methodology for the management of knowledge in manufacturing, specifically for the creation, capture, sharing and updating of domain-specific knowledge. This methodology intended to integrate the disconnected data sources of knowledge generation in manufacturing.

Estrada et al. (2018) discussed a systematic continuous improvement model that applied a KM tool and KM methodologies to capture, structure and store solutions for future reuse.

Kalogeraki et al. (2018) proposed a KM methodology based of the knowledge conversion modes of socialisation, externalisation, combination and internalisation (the SECI modes) to enable knowledge sharing. This methodology is enabled by an associated tool.

Orenga-Roglá and Chalmeta (2019) developed a methodology called the Web 2.0 Knowledge Management (W2KM) methodology for the benefit of organisations using Web 2.0 and Big Data tools. This methodology makes the implementation of KM systems to discover, gather, manage and apply knowledge more efficient. The W2KM methodology is made up of seven phases, each outlining activities to be carried out, and defining tasks for each of the activities.

Author(s)	Focus	Technology	Technology examples	KM processes								
				Framework	Identify	Create	Capture	Store	Organise	Use	Share	Evaluate
Dani et al. (2006)	Propose	✓	Content management system	✓	✓		✓		✓	✓	✓	
Neumann (2007)	Propose	✓	Knowledge repository, content management system	✓		✓	✓	✓	✓	✓		
Sureephong et al. (2007)	Application	✓	Content management system	✓		✓		✓		✓	✓	✓
Chalmeta and Grangel (2008)	Propose	✓	Knowledge portal	✓	✓		✓	✓	✓	✓		
Smuts et al. (2009)	Propose	✓	Knowledge portal	✓	✓	✓	✓	✓	✓	✓	✓	✓
Davis et al. (2011)	Application	✓	Knowledge encoders and decoders	✓	✓	✓	✓		✓	✓	✓	
Li et al. (2011)	Propose	✓	Data mining tools, product innovation system	✓	✓	✓	✓	✓	✓	✓		✓
Garrido-Baserba et al. (2012)	Propose	✓	Data processing modules	✓	✓				✓	✓		✓
Leung et al. (2012)	Propose	✓	Knowledge repository			✓		✓		✓	✓	
Paolino et al. (2014)	Propose Application	✓	Knowledge repository	✓			✓	✓		✓		✓
Maleki et al. (2017)	Application	✓	Computer-aided design system, sensor ontology	✓	✓	✓	✓	✓	✓	✓		
Feng et al. (2017)	Propose	✓	Smart manufacturing systems	✓				✓	✓	✓	✓	
Estrada et al. (2018)	Propose Application	✓	Knowledge-based engineering applications	✓		✓		✓	✓	✓		
Kalogeraki et al. (2018)	Propose	✓	Collaborative KM systems	✓	✓	✓		✓	✓	✓	✓	
Orenga-Roglá and Chalmeta (2019)	Propose	✓	Web 2.0 and Big Data tools	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3: Overview of KM methodologies

The analysis of the 15 KM methodologies shows that 80% of the researchers (n = 12) propose a KM methodology. Only one of the methodologies does not have an underpinning framework in accordance with the guidelines proposed by Rubenstein-Montano et al. (2001). In the publication, the lack of structure is associated with the implementation of KM being immature in the domain for which it is proposed (Leung et al., 2012). Only two of the publications focus on applying a KM methodology and follow the guidelines of an underpinning framework and defining KM processes. Two of the KM methodologies are proposed from applying knowledge-based methodologies and three of the publications are based on the application of a KM methodology. These applied KM methodologies were noted to be based on frameworks and described KM processes.

It was also noted that all the KM methodologies emphasised the use of knowledge. The other KM processes can be ranked as follows:

1. Organise (*n = 12*)
2. Store (*n = 12*)
3. Create (*n = 10*)
4. Identify (*n = 9*)
5. Capture (*n = 9)*
6. Share *(n = 8)*
7. Evaluate *(n = 6)*

The KM methodologies of Chalmeta and Grangel (2008), Orenga-Roglá and Chalmeta (2019) and Smuts et al. (2009) were proposed for the development and/or implementation of KM systems, with the latter two publications being more comprehensive in their detail of the methodologies. In terms of technology, although all the analysed publications showed elements of information systems implementation to enable KM processes, some focused on utilising content management systems and knowledge repositories to implement KM. A combination of the knowledge repositories, and collaborative and innovation system technologies emerges in the latter years of the analysis. Only one of the publications specified the adoption and use of 4IR technologies (Big Data).

5. Discussion and contribution

The literature review showed that there are opportunities for Society 5.0 to benefit from the smart technologies introduced by Industry 4.0. The importance of Society 5.0-specific KM initiatives is acknowledged, which require KM methodologies to be identified for implementation. In addressing the research question, the researchers found, through their analysis of the 15 papers, that most of the available KM methodologies are knowledge based. With regard to KM processes, the analysis showed that there are more common KM processes among KM methodologies, i.e. identify, organise, store and create. The process of evaluation does not feature in more than half (57%) of the publications. In the analysis of technology as a factor for KM implementation, it was found that all the publications incorporated technology to enable KM processes. However, 4IR technologies were not common in the dataset. The most comprehensive papers clarified the need for technology and a framework, and covered all the KM processes. Although only one of these specifically applied a 4IR technology (Big Data), the elements of a KM methodology remained the same. By considering the elements of a KM methodology, i.e. an underpinning framework to guide KM, KM processes and the technology to enable the KM processes, Society 5.0 organisations will be able to manage their knowledge by effectively applying KM capabilities.

6. Conclusion

The purpose of this study was to investigate the elements of a KM methodology for Society 5.0. The influence of 4IR tools and technologies has introduced a challenge relating to the vast amount of knowledge being created. Society 5.0, as a knowledge-driven society, requires this knowledge to be managed efficiently to realise its benefits of product innovation, sustainability and differentiation.

Following the guidelines provided by Rubenstein-Montano et al. (2001) for the development of a KM methodology, the researchers analysed published peer-reviewed articles using the SLR process. The study's findings showed that KM methodologies can either be proposed based on existing best-

practice methods and techniques or they can be adopted and applied to specific KM situations on a needs basis. Some benefit organisations by guiding the development and implementation of KM systems or the implementation of KM initiatives. In Society 5.0, organisations still require their KM initiatives to be driven by KM methodologies that are based on frameworks, with KM processes enabled by 4IR technologies for efficiency.

Since the study only established a knowledge-based view of the KM methodologies, further research could use Society 5.0 principles in the review. In addition, KM methodologies published after 2020, when digital transformation was accelerated due to the COVID-19 pandemic, can be analysed to identify potential unique traits that are likely to be informed by Society 5.0 requirements.

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