AN ARTIFICIAL INTELLIGENCE-BASED KNOWLEDGE MANAGEMENT SYSTEM FOR OUTCOME-BASED EDUCATION IMPLEMENTING IN HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

The main challenges faced by Higher Education Institutions (HEIs) in Indonesia in the context of Industrial Revolution (IR) 4.0 lie in the development of knowledge-intensive skills and the development of outcome-oriented curricula. This study investigates the role of Knowledge Management Systems (KMS) and artificial intelligence (AI) in facilitating the implementation of Outcome-Based Education (OBE) as a strategic approach to improve the quality of HEIs in responding to the demands of IR 4.0. Specifically, this study investigated the knowledge creation process in KMS to support the implementation of OBE in HEIs. The objectives of this study include developing relevant knowledge pool in the area informatics for KMS, to develop a learning analytics technique for KMS in order to support the implementation of OBE in HEIs, to validate the KMS developed for OBE implementation in HEIs and to evaluate its acceptance among the users. AI in KMS is used in the knowledge creation process. The Bert2Bert model is used in the multi-document summarisation of Indonesian-language knowledge in the knowledge combination process. Recommendation system on learning analysis was implemented in a hybrid algorithm combines Rule-based and Content-based filtering algorithms. KMS validation was carried out through expert assessment, and the user acceptance of the KMS was evaluated using a survey method, which adopted a questionnaire from the Technology Acceptance Model (TAM) framework. Based on the results of the knowledge creation in KMS, it succeeded in meeting learners' learning needs. The upload function represents the externalisation of knowledge. This function enables the expert to add knowledge, and followed by scraping and summarising knowledge, represented by a combination of knowledge. The scraping process extracted knowledge from online media, and knowledge from various documents or sources was then summarized. Based on the results of the evaluation of Bert2Bert model the readability for summarising 2 and 3 knowledge documents using the Flesch-Kincaid Grade Level (FKGL) showed that the average values were 20.35 and 18.1, the Gunning Fog Index (GFI) method 7.52 and 8.165, and the Dwiyanto Djoko Pranowo method 20.33 and 32.2. The evaluation explained that adults and learners at higher education levels can understand the summarized knowledge. Readability evaluation was carried out manually by Indonesian language experts. A total of 20 document knowledge was evaluated manually, and the results from document summary were understood. Internalisation of knowledge in KMS was represented through the learning analytics function, followed by an automatic recommendation system to improve knowledge. Based on the evaluation results using the confusion matrix, the Recall value was 59.1%, Precision was 100%, F1-Score was 74%, and Mean Absolute Error (MAE) of 0.97 (testing 31 data with 5 categories and target range 0-4), indicating that the recommendation system in the KMS has good classification capabilities and high accuracy in prediction. KMS also received positive validation from learning media experts, learning content, and information and communication technology (ICT) experts, with the percentage of assessment results of 79.54% and 86.1%, respectively. These results indicate the developed of KMS achieved level good and suitable for use category and does not need revision. A survey from 95 learners HEIs adopted from TAM revealed that KMS was significantly accepted for implementation of OBE via personalized learning and hence, be able to improve learners' learning. This study has significantly contributed to the development of KMS, especially in the context of personalized learning to support OBE

implementation in HEIs and the integration of AI technology in the knowledge creation process in KMS.

Keywords: KMS, personalized learning, OBE, HEI, knowledge creation, summarisation, recommendation system, validation, evaluation, and TAM Model

APPROVAL

This is to certify that this thesis conforms to acceptable standards of scholarly presentation and is fully adequate, in quality and scope, for the fulfilment of the requirements for the Degree of Doctor of Philosophy.

The student has been supervised by: **Professor Ts Dr Titik Khawa Abdul Rahman & Professor Dr Muhammad Ali Ramdhani**

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17 June 2025

DECLARATION

I hereby declare that the thesis submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy is my own work and that all contributions from any other persons or sources are properly and duly cited. I further declare that the material has not been submitted either in whole or in part, for a degree at this or any other university. In making this declaration, I understand and acknowledge any breaches in this declaration constitute academic misconduct, which may result in my expulsion from the programme and/or exclusion from the award of the degree.

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Signature of Student: **Date**: 17 June 2025

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LIST OF ABBREVIATION

AeU	Asia e University
AI	Artificial Intelligence
BERT	Bidirectional Encoder Representations from Transformers
CLO	Course Learning Outcomes
FKGL	Flesch-Kincaid Grade Level
GFI	Gunning Fog Index
HEI	Higher Education Institutions
IR	Industrial Revolution
KM	Knowledge Management
KMS	Knowledge Management System
OBE	Outcome-Based Education
PL	Personalized Learning
PLO	Program Learning Outcomes
PS	Problem Statement
RO	Research Objective
RQ	Research Question
SECI	Socialisation, Externalisation, Combination, Internalisation
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action

CHAPTER 1

INTRODUCTION

1.0 Introduction

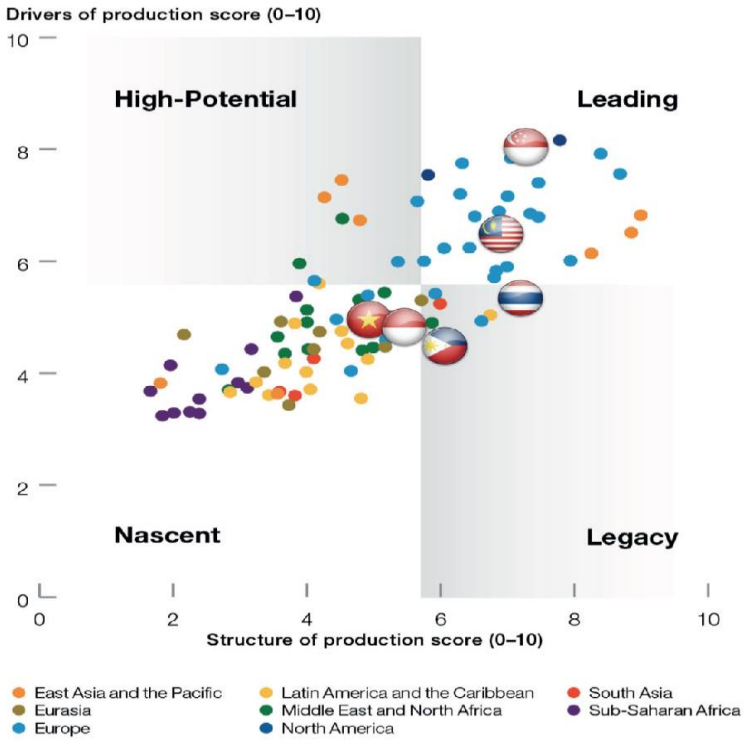
Adapting to every change is the key to success for higher education institutions (HEIs) in facing the challenges of Industry 4.0. Adaptation to continuous scientific and technological advances is the key to success for HEIs in improving the quality of education. One of the adaptation processes involves developing a knowledge management system (KMS) to support the adaptive learning process of organisational members. Artificial intelligence (AI) technology in KMS is widely utilised in the knowledge creation process, one of which is natural language processing (NLP). Implementing NLP using the BERT2BERT model can assist in multi-document summarisation of knowledge. AI technology is also utilised to create personalised learning environments through learning analytics. Recommendation systems in learning analytics use hybrid algorithms (collaborative filtering and content-based filtering). The next adaptation is the ability of HEIs to adopt a learning outcomes-based curriculum (OBE). This study discusses the development, implementation, and evaluation of KMS in HEIs. The structure of Chapter One discusses the background of the study, including the problem statement, research objectives, research questions, justification of the research significance, and a summary of Chapter 1.

1.1 Background of Study

Based on the 2018 World Economic Forum Readiness for Future Production Report regarding the readiness of countries in the world to face Industry 4.0. According to this report, Indonesia is one of the countries considered unready to face the challenges of Industry 4.0. This unpreparedness is marked by Indonesia's production structure and

drivers, which are needed to catch up to other countries in the ASEAN region. One of the production drivers is the human capital factor (Kearney, 2018).

Figure 1.1: Global Map of Readiness Assessment Results 2018



Source: Kearney, 2018

Increasing human capital is the biggest challenge for Indonesia in facing the Industrial Revolution (IR) 4.0 and developing various knowledge-intensive skills (Iswanto, 2019; Kearney, 2018, Mehralian et al., 2018). The Indonesian government has made various efforts to develop various skills that suit the needs of RI 4.0, one of which is involving higher education institutions (HEI). The government and HEIs must support the development of Education 4.0 because Industry 4.0 requires Education 4.0 (Sima et al., 2020). One of these developments is adapting the curriculum based on learning outcomes (OBE) at HEI (Jadhav et al., 2020; Kementerian Perindustrian Republik Indonesia, n.d.; Rathy et al., 2020; Sima et al., 2020).

HEI's active participation in improving various knowledge-intensive skills can be realized through efforts to become an effective learning organization. An effective learning organization can increase capacity and intellectual capital, motivate employees to learn adaptively, generatively, and continuously, learn together, and share knowledge so that each employee has high competence (Senge, 1990). In order to become an effective learning organization, HEI needs to transform continuously. One of the transformations is adopting processes in knowledge management (KM) to gain a competitive advantage in the future (Damartini & Lorenzo, 2017; Jamalzadeh, 2012; Kalsom, 2014). The processes in KM are related to how to generate value from wealth—intellectual property owned by HEI. Through the process of creating, storing, disseminating, and using knowledge, HEIs can improve innovation and organizational performance (Jones & Leonard, 2009; Nonaka & Takeuchi, 1995; Shujahat et al., 2018; Song & Sun, 2018).

Knowledge in organizations consists of tacit and explicit knowledge. Tacit knowledge is rooted in action, experience, and involvement in a specific context. The tacit knowledge dimension consists of cognitive and technical elements. Cognitive elements refer to an individual's mental model consisting of mental maps, beliefs, paradigms, and points of view. The technical component consists of knowledge, craft, and concrete skills that apply in a specific context. Meanwhile, explicit knowledge is a dimension of knowledge that can be articulated, codified, communicated, and disseminated in symbolic form and natural language (Alavi & Leidner, 2001; Jones & Leonard, 2009; Nonaka, 1994).

Knowledge in organizations is created through continuous dialogue between tacit and explicit knowledge. The socialisation process in KM converts tacit knowledge into tacit knowledge through shared experiences and daily social

interactions. The externalisation process is the articulation of tacit knowledge into explicit knowledge, and it can be shared with others to become the basis of new knowledge. The combination process is creating explicit knowledge from other explicit knowledge. Explicit knowledge is collected from inside or outside the organization and then combined, edited, or processed to form more complex and systematic explicit knowledge. Meanwhile, the internalisation process in KM is explicit knowledge created and shared throughout the organization and then converted into tacit knowledge by individuals (Nonaka & Takeuchi, 1995; Nonaka & Toyama, 2003; Shujahat et al., 2018)

The process of creating knowledge in KM is a cognitive process. The knowledge environment strongly influences the creation process, both sources and technology used to obtain or process knowledge (Avdeenko et al., 2016; Cha et al., 2015; Córdova & Gutiérrez, 2018; Supic, 2018). Cognitive processes in KM must be able to provide adaptive learning spaces. Personalized learning (PL) adjusts learning needs to learners' interests, talents, and abilities. PL provides a flexible learning environment for individuals to learn under different conditions (Basham et al., 2016; Davis & Jiang, 2014). PL can utilize learning resources from online media or big data, utilizing Artificial Intelligence (AI) technology to support learning (Damartini & Lorenzo, 2017).

Paradigm changes in HEIs require the ability to adapt, collaborate, innovate, master technology, and manage intellectual assets as capital in improving the quality of education. This change is marked through the implementation of KM, the use of AI and OT technology to improve the quality of education at HEIs (Ahmed et al., 2018; Bhusry et al., 2011; Mansur et al., 2019; Kong et al., 2021; Lemay et al., 2021; Munir & Rohendi, 2012; Ouyang & Jiao, 2021; Quadir et al., 2021; Zhang & Aslan, 2021).

KMS in Indonesian HEIs has not been widely implemented. HEIs that have implemented a Knowledge Management System (KMS) include the Bandung Institute of Technology (ITB) in 2016 (Sopandi & Saud, 2016) and Bina Nusantara University (BINUS) in 2018 (Prabowo, 2010; Qisty, 2021).

The most fundamental change to HEI is HEI's ability to adapt the OBE curriculum. Through the OBE curriculum, educational success is measured by the learning success achieved by learners. Significant learning experiences reflect learners competence (Spady, 1994). OBE is a student-centered curriculum. Emphasizes assessing learners performance results, knowledge, skills, and behavior (Jadhav et al., 2020; Rathy et al., 2020). The implementation of the OBE curriculum in HEIs in Indonesia still faces various challenges. These challenges relate to the readiness of teachers who are accustomed to traditional learning methods, strategies, materials, and assessment tools (Mufanti et al., 2023; Piyasena et al., 2023; Susanti et al., 2024).

This research studies and develops a knowledge management system (KMS) at a university. The primary goal is to implement AI to provide knowledge that supports an adaptive, personalised, and results-driven learning process. The KMS implements the Bert2Bert model in the automatic summarisation of multi-document knowledge in the Indonesian language. Hybrid algorithm (Rule-based and content-based filtering algorithms) are implemented in the automatic recommendation system for learning analytics in the KMS. The rules for developing KMS at HEI refer to the SECI model. The model focuses on knowledge creation, storage, dissemination, and use (Nonaka & Takeuchi, 1995). Transformation of knowledge in the hybrid model combines the SECI model with the case-based reasoning (CBR) knowledge representation model in case solving (Avdeenko et al., 2016). The Network of Damage Adjusters (RAS) model adopts the SECI model. The RAS model facilitates employee learning to acquire

higher expertise at work (Córdova & Gutiérrez, 2018). Specifically, Galeon and Palaoag (2019) developed a KMS framework to support the sustainable implementation of OBE in HEIs in the Philippines (Galeon & Palaoag, 2019). PL in KMS provides a framework for how learning processes in KMS are carried out adaptively, according to the interests and needs of learners (Basham et al., 2016; Johns & Wolking, 2016; Nitchot et al., 2019).

1.2 Problem Statement

Knowledge at HEI comes from internal and external organizations. Knowledge in KM is collecting and combining knowledge from various sources, both internal and external to the organization (Dalkir, 2005). Utilizing knowledge from various sources is one of the keys to creating an effective learning organization (Damartini & Lorenzo, 2017; Jamalzadeh, 2012; Janus, 2016). Exploring knowledge sources comprehensively and utilizing technology in presenting knowledge is a challenge for HEIs. More than efforts to explore knowledge from various sources are needed in terms of storage media (Munadi et al., 2019), HEIs need to identify knowledge sources that suit the learning needs of organizational members.

Tacit knowledge is personal, specific, and sourced from experience or work (Nonaka & Takeuchi, 1995). They are building implicit knowledge into a social context to expand knowledge. A medium is needed to articulate tacit knowledge and resolve conflicts towards a higher conceptual level (Nonaka, 1994). HEIs widely use online media and has become quite an effective medium for sharing knowledge, exchanging ideas, conveying ideas, or sharing experiences (Carvalho & Gomes, 2017; Cerchione & Esposito, 2017; Cetto et al., 2018; Córdova & Gutiérrez, 2018; He et al., 2017d; Un Jan & Contreras, 2016). Disseminating knowledge in online media (Cha et al., 2015; He et al., 2017) produces knowledge documents with many pages.