IoT-based Knowledge Repository Design for Supporting Knowledge Integration within the Marine Information System Study Program

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Abstract. Knowledge repository is commonly used to store and manage explicit knowledge from knowledge worker. The development of internet of things (IoT) in Industry 4.0 enables the improvement of quality and quantity of knowledge repository. This study focuses on developing IoT-based knowledge repository as a means to support knowledge integration within the Marine Information System Study Program. The study provides architectural designs of a knowledge repository that consists of 5 knowledge domains of marine information system and the design of IoT-based knowledge repository, both of which are based on reviews on relevant literatures and focus group discussion. The solution offered by the current study allows knowledge integration through Community of Practice as the provider and the user of the knowledge.

1. Introduction

Knowledge repository is a system that is used to store and manage intellectual assets of an organization in order to be re-accessed and retrieved with ease and quickly [1]. Intellectual assets are owned by knowledge workers, people with the competence or the ability to learn and understand new issues to create knowledge that can be used to help the organization in solving problems in their unit or to create an innovation. Knowledge repository is essential as it affects knowledgeable action, as suggested in K. L. Sumathy’s research[2]. Research on knowledge repository has been done by several researchers (See Table 1).

| Knowledge repository use                                      | References |
|---------------------------------------------------------------|------------|
| Repository knowledge in service-oriented architecture         | [3]        |
| Promoting student competence on software engineering          | [4]        |
| Retrieving and sharing knowledge in companies                 | [5]        |
| Providing knowledge in terms of regulations stipulated by the Ministry of Marine Affairs and Fishery | [1]        |

IoT can be immersed in knowledge repository to facilitate collaborative business-to-business knowledge sharing among companies [6], or collaborative software maintenance design [7]. The
current research focuses on designing IoT-based knowledge repository that can facilitate collaboration among Community of Practice in the field of marine information. The immersion of IoT-based repository could facilitate knowledge integration and sharing of among its users and stakeholders. Integration of knowledge is best defined as the process of merging two or more knowledge structures that initially were not connected to a particular structure[8].

Knowledge structure is an important part of knowledge repository. As a new study program and the first one in Indonesia focusing on marine information system, Study Program of Marine Information System is required to innovate to accelerate processes of planning, constructing and developing marine and fishery sectors, as stipulated by the government as its top priorities. Within the framework, the study focuses on the knowledge structure of marine information system and its IoT-based knowledge repository design to support knowledge integration.

2. Methodology
As elaborated above, the study attempts to produce knowledge structure of marine information system and to design IoT-based repository knowledge. Four steps are involved in the study (shown in Figure 1). The first stage was conducting literature study on knowledge structure on knowledge structure and marine information system. The second stage was organizing a group discussion forum to determine knowledge domain of Study Program of Marine Information System. The third stage was designing the knowledge structure, and the last one was designing IoT-based knowledge repository system with reference to studies on relevant literature study and reviews on website-based knowledge management system applications.

3. Result and Discus

3.1. Knowledge Structure of Knowledge Repository
Knowledge structure codes a collection of basic information relevant as their domains [9]. The knowledge structure in this study demonstrates some possible knowledge in the domain that can integrate one another. The knowledge domain of the study program was determined through a group discussion forum which was held on November 19, 2019 and was attended by the lecturers of Study

![Figure 1. Research Stages.](image-url)
Program of Marine Information System. The forum resulted in a research roadmap, dividing the knowledge domain into five domains: information system, fishery, geographic information system, marine remote sensing, and marine science, as shown in the figure below:

![Figure 2. Knowledge Domains of Study Program of Marine Information System](image)

The integration of the five domains are expected to create innovations of the study program. In developing knowledge structure, each domain is labelled with codes as follows

| Domains              | Codes |
|----------------------|-------|
| Information System   | SI    |
| Geographic Information System | SIG |
| Fishery              | P     |
| Marine Science       | IK    |
| Marine Remote Sensing| PJK   |

One of the scenarios of the knowledge structure is illustrated in the figure below:

![Figure 3. Knowledge Structure Scenario of Marine Information System](image)

Based on Figure 3 above, there are eight knowledge integrations, namely those of:

1. Information System, Geographic Information System, and Fishery,
2. System information, Marine Science, and Marine Remote Sensing,
3. Information System and Geographic Information System,
4. Information System and Fishery,
5. Information System and Marine Science,
6. Information System and Marine Remote Sensing,
7. Geographic Information System and Fishery
8. Marine Science and Remote Sensing

Several possible innovations as results of knowledge integration in Figure 3 are as follows:

1. Knowledge integration of geographic information system and marine remote sensing can be used for mapping seas and shores. The data can be used for explorations of sea natural resources and determining sea borders to prevent illegal fishing[10].

2. Knowledge integration of information system and marine science could help detect tsunami in advance. Tsunami Warning System (TWS) is an innovation of information system and marine science which can alarm people about the tsunami real-time. TWS is built on Ensemble Clustering (ECG) and classifications on anomaly of aquatic animals’ (turtles, worms, and fish) behaviors in responding to seismic disruptions[11].

3. Knowledge integration of information system, marine science, and remote sensing is beneficial in geologically identifying the conditions of particular sites or mapping future sea conservations. Remote sensing can give information about, for example, the conditions of mangroves through sensors measuring the amount of carbon deposit at the seashores. Hence, such information may serve as a variable in making a policy[12].

4. Knowledge integration of information system, geographic information system, and fishery may produce a system from which fishery agencies can get information on when or where to catch fish, as well as what decision to make at its managerial level[13].

5. Knowledge integration of fishery and information system may lead to advanced fishery business, in which big data and food processing can be controlled by a device or a smartphone from anywhere and anytime via internet connection[14].

6. Knowledge integration of marine remote sensing, marine science, and information system may give information on Fishing Potential Zone (ZPPI). It can also be used for gathering information about water appropriateness for fish cultivation, seashore potentials, and future sea conservation zones[15].

3.2 IoT-based Knowledge Repository

The architecture of IoT-based knowledge repository is a further development of knowledge repository developed by Knowledge Management System Application (ASMAPE). ASMAPE is a knowledge management applied in Study Program of Marine Information System. The diagram components of the application is illustrated in the figure below:

![Figure 4. Asmape’s Application Component Diagram.](image)

As depicted in Figure 4, the knowledge repository is rooted from publication, collaboration, and e-learning services provided by Asmape application (http:asmape.com). Figure 5 shows an example of its interface.
Figure 5. Services provided by Asmape (accessed on September 28, 2020)

The application consists of Publication, Collaboration, E-Learning, and Discovery services. Publication service gives an opportunity for users to write papers collaboratively, utilizing document collaboration tools, such as google drive. Collaboration service provides online discussion forums. E-learning can be used by users to share documents, videos, or quizzes. Discovery helps users to search and retrieve knowledge in the forms of documents or videos.

From the perspective of IoT, Asmape has so far incorporated internet for facilitating knowledge management by knowledge workers within the study program, namely lecturers and students. Further architectural development of the knowledge repository will demonstrate the interaction of knowledge and the thing through internet. As suggested by Chen, IoT leads to harmonic collaboration between “smart thing” and humans[7].

Based on the previous knowledge repository and literature reviews on IoT, the design of the IoT-based repository knowledge produced in this study is shown in the figure below. The figure illustrates that Community of Practice (CoP) and other organizations which can utilize marine information knowledge repository system. CoP is divided into five domains: Marine Information System, Marine Science, Fishery, Geographic Information System, and Remote Sensing. CoP consists of students, lecturers, or researchers interested in the fields. Meanwhile, the organizations which might benefit from the repository are Ministry of Marine Affairs and Fishery and Indonesian Institute of Sciences (LIPI).

Asmape application’s role is to integrate knowledge by using latent semantic indexing algorithm or vector space method on knowledge retrieval to search and show relevant knowledge[16,17]. Marien Information System Repository Knowledge does not only consists of knowledge but it can also be data or information gathered using IoT, for instance the utilizations of smart float, equipped with sensors in fishery sector as a means to collect data of temperatures, pH value, salinity, and dissolved oxygen concentration [18].
The reuse of knowledge in the repository is influenced by perceived knowledge repository capability and intrinsic motivation. Perceived knowledge repository capability can be defined as knowledge repository’s ability in capturing, packaging, and distributing knowledge. Meanwhile, intrinsic motivation can be measured through better self-image and knowledge growth[19].

4. Conclusion
There are three major conclusions of the study. First, the knowledge structure of marine science information may serve as a foundation to develop CoP. Second, the artefacts stored in the repository are not only knowledge (papers, journals, or articles) but also data and information, in the forms of video, texts, audios, maps, and images. Third, it is possible to integrate the knowledge repository of Study Program of Marine Science Information with those of Ministry of Marine Affairs and Fishery and Indonesian Institute of Sciences.

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