Development of information systems in integrated management systems in order to increase organisational performance in a construction company

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Abstract. There are various information systems to improve organisational performance that are well-established in construction companies. However, information systems, especially in integrated management system, are not yet well-established to describe productivity of the worker in order to improve organisational performance. There is still needed development in the procedure and manual in this information system. These are developed by an integrated management system clause (high level structure). These procedure and manuals will reduce rework, accident, sickness and waste as part of an integrated management system in a construction company. Information systems are needed as a component of communication, sharing and exchanging information in an integrated management system in construction companies. This information system is used for the efficient implementation of integrated management system resources. An integrated management system is required to make the system more effective and efficient in supporting the company’s business processes. The efficiency can be done by looking for any variables in an integrated management system that can increase organisational performance in a construction company through integrated information systems. This research’s variables are based on previous research. Methodology used in this paper is literature review to describe database and model base in information systems. The result of this paper is a database and model base algorithm.

1. Introduction

Globalisation has led many companies to implement various management systems to ensure profitability and reliability of the organisation [1]. Approximately 80% of the activities of the quality management system, health and safety management are common to every management system [2]. There are various processes (through PDCA cycle)[2][3][4][5][6], risk [7][8][9][10], and audit [5][11][12][13]. The culture and track record of integrated management systems prove that organisational commitment to improve performance can result in cost-effectiveness, increased productivity of employees, customer satisfaction, and sustained progress[5].

Implementation of an integrated management system at operational level needs considerable extra work [14]. It may lead to employees’ resistance, especially site workers on the front-line. So, it needs simplifying in terms of procedure and manual based on a high-level structure. It is common that people do not like to change their familiar ways of doing things,
and are reluctant to adapt to procedures that may involve substantial changes. Executing a system involves knowledge management that successfully implements ISO 9001, ISO 14001 and OHSAS 45000 [15].

In order to fulfil customer satisfaction, fewer accidents and healthier workers and sustainable environment, management scholars have employed scientific management techniques to increase the productivity of manual workers in terms of task efficiency [16][1].

Companies are often motivated to improve their organisational performance to benefit the health and morale of their workers [17]. Therefore, the 21st century strategy is to increase the “productivity of knowledge-workers”, mainly in terms of unstructured intellectual tasks [16][17].

Information systems, as a combination of information technology and community action, can support operations, management and decision-making to engage and support all business activities [18]. Information systems needed for business decisions need to be sound and relevant and timely throughout the organisation [14]. A successful company is one that has good communication, both internally and externally, with other companies and clients

2. Literature Review

*Integrated Management System*

Integrated Management System (IMS) is known as a system that combines ISO 9000 Quality Management System, Environmental Management System ISO 14000 and Occupational Safety and Health Management OHSAS 18000, but is not limited to this standard. IMS is a management system that combines all business components into a comprehensive system that enables the achievement of its goals and mission [10] in high-level structure (HLS).

| Table 1. The ISO Annex SL high level structure for management system standards |
|---|---|
| 1. Scope | 7. Support |
| 2. Normative references | 7.1 Resources |
| 3. Terms and definition | 7.2 Competence |
| 4. Context of the organisation | 7.3 Awareness |
| 4.1 Understanding the organisation and its context | 7.4 Communication |
| 4.2 Understanding the needs and expectation of interested parties | 7.5 Documented information |
| 4.3 Determining the scope of the XXX management system | 7.5.1 General |
| 4.4 XXX management system | 7.5.2 Creating and updating |
| 5. Leadership | 7.5.3 Control of documented information |
| 5.1 Leadership and commitment | 8. Operation |
| 5.2 Policy | 8.1 Operational planning and control |
| 5.3 Organisational roles, responsibilities and authorities | 9. Performance evaluation |
| 6. Planning | 9.1 Monitoring, measurement, analysis and evaluation |
| 6.1 Action to address risks and opportunities | 9.2 Internal audit |
| 6.2 XXX objectives and planning to achieve them | 9.3 Management review |
| | 10. Improvement |
| | 10.1 Nonconformit and corrective action |
| | 10.2 Continual improvement |

Source: Reproduced ISO 2015
Table 1 explains about indicators in a high-level structure in integrated management systems. High-level structure is defined as the scope of an organisation, normative references, terms and definitions, context of organisation, leadership, planning, support, operation, performance evaluation, and improvement [19][5]. An integrated management system can be understood as a series of interrelated processes that share human resources, information, materials and infrastructure, financial resources. IMS is organised to meet the objectives associated with satisfying different stakeholders [20]. In previous research, we found that integrated management systems consist of an integration process [2][3][4][5][6][21], integration risk [7][8][9][10][21], and integration audit [5][11][12][13][21].

**Information System in Integrated Management System on Construction Company**

There are various information systems to improve organisational performance that are well-established in construction companies. However, information systems, especially in integrated management systems, do not yet describe the productivity of the worker in order to improve organisational performance. There is still needed development in procedures and manuals in these information systems. Procedures and manuals are developed by an integrated management system clause (high-level structure). These procedures and manuals will reduce rework, accidents, sickness and waste as part of an integrated management system in a construction company. Information systems are needed as a component of communication, sharing and exchanging information in an integrated management system in construction companies. The novelty of this paper is shown in Table 2.

| Reference | Variable | Methodology |
|-----------|----------|-------------|
|           | CO  | LS | PL  | SP | OP  | PE  | IM | e-Proc | BIM | Work flow | DSS |
| Mourogouan, 2015[19] | √  | √  | √  | √  | √  | √  | -  | -      | -   | -         | -   |
| Rebele et.al., 2016[22] | √  | √  | √  | √  | √  | √  | -  | -      | -   | -         | -   |
| Calcedo et.al., 2015[1] | √  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Parachivescu, 2016[23] | √  | -  | √  | -  | √  | √  | -  | -      | -   | -         | -   |
| Mustapha et.al., 2017[24] | √  | √  | -  | √  | √  | √  | -  | -      | -   | -         | -   |
| Harrison et.al., 2011[25] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Rajkumar, T. M. 2001[26] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Prescutti Jr, W.D. 2003[27] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Johnson et.al., 2002[28] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Bendoly et.al., 2006[29] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Weisheng Lu (2017)[30] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| S.Yu. Eroshkina (2016)[31] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Zhen-Zhong Hu (2016)[32] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Hosseini (2017)[33] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Inge van de Weerd, 2016[34] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Yang Sui (2018)[35] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Dalmarco (2017)[36] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Karam Kim (2018)[37] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Yusuf Latief (2003)[38] | -  | -  | -  | -  | -  | -  | -  | -      | -   | √         | -   |
| Jing Du (2014)[39] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Villarraga (2017)[40] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Anita et.al. (2013)[41] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
| Kang et.al. (2017)[42] | -  | -  | -  | -  | -  | -  | √  | -      | -   | -         | -   |
Table 2 describes the novelty of information system integrated management systems that have seven clauses, context of organisation (CO), leadership (LS), planning (PL), support (SP), operational (OP), performance evaluation (PE), and improvement (IM). It also describes what information systems in construction companies have already been done, but information system integrated management systems with seven clauses and work flow have not been discussed simultaneously.

Organisational Performance

Organisational performance in this paper is to determine performance goals for quality, health and safety as well as the environment, which consist of:

a. Scope. The scope in the management system takes into account external and internal concerns, interested parties and organisational products and services while meeting or avoiding environmental pollution customer demands, and injury to labour.

b. Normative reference. The norms or standards for which the management system should be integrated are 10 (ten) HSL ISO 9001: 2015 clauses with 10 clauses in the HLS and the innovative component is an important step towards an integrated management system.

c. Terms and definition. Organisations can define the most important and general terminology in the process approach as design, implementation and operation of an integrated management system.

d. Context of organisation has to understand the organisation being built and the context, and understand the needs and expectations, the scope of management, management systems that require integrated goals, vision and values (knowledge sharing) for the organisation.

e. Leadership that has the minimum characteristic of leaders at all levels is committed to establishing unity of purpose and direction, achieving organisational goals, involvement of people active in an organization, aligning strategies, policies, processes and resources to achieve its objectives.

f. Planning has to be measured to recognise risks and their handling, setting goals and requirements of system changes and system development, and increased system integrity, availability of resources, and the regulation of responsibility and authority.

g. Operational has to explain about determining and providing resources (human, infrastructure, technology, finance, environment as a place of operation), to determine to improve and monitor and measure resources, concern for the use of resources, communication systems and information used and which can increase the productivity of workers by making workers more familiar with the goals of the organisation.

h. Process Support has various points to consider, such as determining and providing resources (human, infrastructure, technology, finance, environment as a place of operation) to build, implement, maintain and continually improve and monitor and measure resources, concern
for the use of resources, and communication systems and information used and which can increase the productivity of workers by making workers more familiar with the goals of the organisation.

i. Evaluation performance has the minimum content of organisations needed to determine and evaluate the level of control and influence on the lifecycle to purchase or obtain products, services, or outcomes required from outside the company for the performance of the work, and ensure efficient organisational structure and organisational work based on the organisational context and consideration of customer satisfaction, health and safety aspects, and significant environmental, compliance and risk-related risks and threats.

j. Improvement of organisation shall ensure that all components of the clauses above must have an improvement programme; organisations must find and filter out improvement opportunities and take critical action to respond.

3. Framework of research
This paper used literature review to build the database and model base system. Through information system integrated management system in this research, we found that it can improve organisational performance [48][49][50]. First, we developed framework that will be the knowledge base of the information system. From this framework, we will develop a structured situation diagram that is representative of a dependency diagram with order as shown in Figure 1.

Figure 1. Framework of Research

Figure 1 explains the information system that was built in the framework of the integrated management system and consists of:

a. Organisational performance in a construction company will increase if their workers’ productivity is improved. This is shown based on standard, procedure and manual of the integrated management system and includes quality management system, health and safety management system, and environment management system. Actual performance of worker is compared with the standard procedure manual of IMS.

b. If there is variance that can cause decrease in organisational performance, it will need preventative action through the integrated management system. Options for preventative action is chosen by certain research. The preventative action chosen will hopefully increase organisational performance.
c. To produce this information system in integrated management system, seven studies have been used. At each stage of the study it has produced findings that are entirely outlined in this information system so as to obtain useful programme applications.

4. Development of Information System Integrated Management System

This information system is first developed as knowledge-based, which consists of a database integrated management system and a model base integrated management system. Knowledge base is chosen from seven previous studies, as shown in Figure 2.

Figure 2 Data Management Component

![Data Management Component](source: Own Research)

Figure 2 shows the components of data management. Data components stored in a query data directory have the features of retrieval/retrieval and retrieval processes, update process, and delete/deletion process, as shown in Figure 2:

a. Database management. Researchers prepare the data components to be managed in a database management system from the first to the fifth studies.

b. Model base management. Model data are produced from model equations obtained from the results of regression analysis for use in the process of improving the performance of the organisation and its business and its probability in integration risk research.

c. Dialogue management is used to communicate between the system and the user in the utilisation of a knowledge-based model, requiring a dialogue management or so-called user interface dialogue management in knowledge management research.

d. Internal and external factors. These data are obtained from the input of internal factors and external factors in the form of scope, normative references, terminology and definitions, organisational context, leadership, planning, process support, operational, performance evaluation, and improvement.

5. Programming Information System Integrated Management System

This information system integrated management system programme used by employees in construction management is embedded in database management, as shown in Figure 3.
Figure 3 explains the consequences which consist of:

a. The process integration clause from the literature review conducts content and construct validation to experts who are experts in QMS, OHSMS and EMS, consisting of four BUMN experts working on the paper, four experts from independent auditors and one expert acting on foreign companies credible in Indonesia and who has worked in state-owned companies.

b. Validating clauses carries out a preliminary survey to assess the reliability of the survey instrument. The survey instrument was paired with a comparison matrix with Saaty Scales (1990).

c. The tested instrument became the final instrument for survey respondents. Respondents in this study were 19 employees from several state-owned companies working with details of five respondents from top management, six middle-level respondents and eight lowest level respondents.

d. The survey results of respondents were analysed by the RII method. After that, a discussion of research findings and conclusions was conducted to answer the research question.

e. Validation of the extract and draft content of the instrument was by using the Delphi method by asking the opinions of experts in the field of SMM and SMK3L in the management of construction projects.

f. The results of the study were to answer the first problem formulation as input into the case study research process through RII analysis.

g. The variables chosen then became input to the integration of database management processes. The variables are then analyzed for their highest risk and then becomes a database management model.
h. These variables are shared with all types of work responsible for knowledge that is carried out through the RACI RAM method. The entire process is then translated into a physical design database that can be communicated to users.

i. Organisational performance in construction companies will increase if their labour productivity increases. This is indicated by standards, procedures and integrated management system manuals, including quality management systems, health and safety management systems, and environmental management systems. The actual performance of workers is compared to standard STI manual procedures.

j. If there is a variance that can cause a decrease in organisational performance, preventative measures will be carried out through an integrated management system. Options for precautionary measures are chosen by certain studies. Preventative actions chosen will hopefully improve organisational performance.

k. To produce this information system for an integrated management system, research needs to be carried out on process integration, risk integration, audit integration, knowledge management and organisational performance. Each stage of the study has produced findings that are fully described in this information system so as to obtain useful application programmes.

6. Conclusion

Information system integrated management system programmes used in a construction company will improve worker productivity, which will increase organisational performance. Worker productivity is translated into achievement of organisational performance in the high-level structure of integrated process, integrated risk and integrated audit. For implementation of an information system it also requires RAM RACI for knowledge management arrangement. For future research, we will develop a web-based information system integrated management system.

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