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Research paper



The Intelligent System in IT Governance: A review pointing the Institute of Higher Learning in Malaysia

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Abstract

The established governance of IT in higher learning institution is necessary for institution to address the key issues successfully. This study initiates to investigate existing research of Information Technology Governance (ITG) focusing Institute of Higher Learning (IHL) in Malaysia. The research aims to discover the up-to-date tabulation of Intelligent System (IS) research covered by ITG domain, to identify the structure of research being performed in this area, to identify the outcome produced by conducted study as well as recommendation of study to be performed in future. The investigation performed through a systematic review from literature to answer the research questions. The outcome indicates the opportunity of area to be researched involving intelligent system in ITG domain and intelligent system for decision-making to support ITG in IHL. The qualitative approach found to be the method use for information collection. The approach of multiple case studies and scientific result to support future method is recommended. The contributions of this study are to produce the review and mapping of studies to identify research areas that has been covered besides identifying potential investigation to be explored in future. The significance of our findings is essential for the start-up research of intelligent system in ITG focusing the IHL in Malaysia.

Keywords: *Agent Based System; Artificial Intelligent; Intelligent Decision Making Support System (IDMSS); Information Technology Governance (ITG); Institute of Higher Learning (IHL).*

1. Introduction

The emergence of computer advancement plays an essential role to support human beings to ease and simplify daily tasks. Undeniably, it is time-consuming when running computationally intensive tasks. Hence, it is important to simplify and make these activities autonomic. However, the computer technology has its limitation to provide appropriate decision. The same condition applies with user when giving instruction. Since both parties are interrelated in a decision-making process, the consequences of wrong decision could lead to wrong outcome or delivery.

One of the key researchers in the field of management and decision making mentioned that intelligence is the first phase in decision making process [1]. When Artificial Intelligence (AI) is on the rise, humans have fixated themselves to improve life across every spectrum with involvement of technology.

The contemporary business organisation is critically facing issues of overload information. With huge amount of information resources, there is strong need to derive a framework to ensure every decision made is effective and efficient. In this paper, business organisation refers to Institute of Higher Learning (IHL), in which a critical role for governance is required to monitor and control the behaviour of management. In this context, the term 'management' means those are being hired to preside over the day-to-day activities of running the organisation.

Various definition of IT governance has been considered by prominent researchers. IT governance is defined as specifying the decision rights and accountability framework to encourage desirable behaviour in using IT [2]. The IT Governance Institute defined IT Governance as a structure of relationships and processes to control the enterprise in order to achieve the enterprise's goals by adding value while balancing risk versus return over IT and its processes [3]. In broader scope, governance includes responsibility for holding specific duty or decision; authority to impact behaviour; communication; and empowering in commanding authority to act. The term 'governance' also encompasses inaugurating measurement and control mechanisms to enable people to execute roles and responsibilities. In addition to that, the goal of governance is to ensure the results of an organisation's business processes meet the strategic requirements of the organisation [4]. In the auxiliary of implementing good governance, the need to implement good decision in discipline yet adaptable is important. It is not about making correct decisions, but about the best possible process for making those decisions [5]. The decisions aim to target the right problems [6].

The advent of information system, involving real- time computers assist human in making decision. The application has been given responsibilities to computers to make decisions that impact governance [6]. Supported by [7] the attention to use software to assist decision making in complex environments is increasing. Based on [8], the main activities for establishing ITG involves assumptions, set vision, align IT to the business, identifying regulations and standards and create policy. Each of these activities involves sub activities that rely in decision-making process to ensure successful outcome of the activities. Subsequently, the need for intelligent system to support decision-making is essential to provision these activities. From the duty and decision making identified in ITG, a number of studies has been identified to research on machines and

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computers in performing its thinking and decision making purposely to reduce mistakes made by human and support the organisation. Undoubtedly, individuals require support to structure their decision. This is performed by application of intelligent system to support the structure of decision, evaluation and understanding to provide users assistance in overcoming the barriers to good decision making related to governance [9]. This is emphasised by [10] on the recent concern of the aptitude to utilise IT facilities to place organisations in their right perspectives. Thus, the goals for decision-making is to make the efficient yet best possible decision for organisation. The decision is trusted by the people in the organisation [11].

2. Related Works: Intelligent System in IHL

The definition of Intelligent System (IS) is widely interpreted. As described by [6], it is the overarching software that controls the particular application. The word 'intelligent' describes the software due to its need to be highly interactive. In some cases, it requires to 'learn' about the user's cognitive competencies, personal values, and decision-making styles. Intelligent system is a system that reveals intelligence, which created through working out the system with data to solve specific problems.

Artificial Intelligent (AI) however is still having some open loops in the area of study on how to make intelligent system works. The connection between artificial intelligent and intelligent system is; an intelligent system is a system with artificial intelligence with more realistic expectation on what to be achieved.

The complication in making decision occurs when there are several potential decision solutions to identify and evaluate. As described by [6], there are times when individuals would require support to conclude and articulate the values they wish to apply to the current decision problem. Such scenario happens in every organisation including educational institution. As mentioned by [12] the educational institutions which ruled on the same ground as other organisations also disturbed over the needs to govern its IT facilities and resources in the business.

IT Governance has been recognised as a new concept since 2004 by [13]. The growth of this study has constantly progress due to its potential to convey strategic value at all levels [10]. The growing numbers of ITG research has been conducted and encompassed in other areas. In Malaysia, ITG research has covered in private sector [14], public sector [14, 15], manufacturing [16], security [17], IT practitioners [18], competency assessment of boards of directors [19] and framework for government [20]. These has proven that ITG is likely to be explored to support organisation to achieve its strategic objective.

Due to its potential, the area has expanded in institute of higher learning to investigate ITG in the specific area. Specific studies was conducted to measure ITG effectiveness [21], intelligent ITG framework [10] and Intelligent Decision Making Support System (IDMSS) [12]. In addition, a study of ITG from provider perspective was conducted by [22] and an empirical research of ITG implementation in public university Malaysia was performed by [10]. Furthermore, a study by [23] was conducted to support university in ITG framework concerning development of academic program. The findings revealed an absence of strategic IT alignment among universities despite aiming to be the world-class universities. The investigation continues to expand in using agents for risk mitigation [24] and exploration for research opportunities for ITG in institute of higher learning [25].

The conducted study has unleashed the important role of ITG to support the performance of academic institutions. The suitability of ITG in IHL reveals its purposes that relate to structures, processes and relational mechanisms for IT decision making in organisation [10]. Nevertheless, ITG is still in its infancy stage. Thus there are great opportunity to research ITG in IHL [12].

The purpose of this article is to present the findings of how the research of intelligent system in ITG has been covered in the area of institute of higher learning in Malaysia. The findings directed by research questions in Section 2. Section 3 describes the method and search strategy adopted for getting the result while the findings, discussion and recommendation discussed in Section 4. The last section is concluded with remarks and future direction in this area.

2.1. Research Question

The outlined research questions as shown in Table 1.

Table 1: Research Questions

	Question	Motivation
1	What are the potential areas for intelligent system in ITG domain?	To identify potential area to be researched for intelligent system in ITG domain.
2	What is/are the elements of intelligent system being rsearch?	To identify the elements of intelligent system being researched.
3	Which method being used to analyse the data?	To identify the analysis method being used for the data.
4	What method being proposed for future research?	To identify the method proposed for future research.
5	What is/are the outcomes of research?	To identify the outcome of research.
6	What is/are the recommendations proposed for future study?	To identify future recommendations and possible research area to be performed in future.

3. Data extraction and Systematic Review Process

3.1. Search Strategy

For this study, it is important to determine the search keywords as key references. This is because the keywords help to define a search strategy for detection of primary studies. The primary sources for this study was obtained from Scopus index to find relevant articles. The years ranging from 2010 to 2016 due to the necessity for having the latest research conducted in the area of study. The search string was created using AND and OR operators to limit the search outcomes. The search string used in the mapping study as follows:

- Intelligent system AND IT Governance AND Malaysia
- Intelligent system AND Information Technology Governance AND Malaysia
- Intelligent system AND IT governance AND Institute of Higher Learning
- Intelligent system Information Technology Governance AND Higher Learning Institute AND Malaysia
- Decision Support System AND IT Governance AND Malaysia
- Decision Support System AND Information Technology Governance AND Malaysia
- Decision Support System AND Information Technology Governance AND Institute Higher Learning AND Malaysia

Table 2: Academic Publication Retrieved

No	Regular	Title	ID
1	Arshad [10]	Intelligent IT Governance Decision-Making Support Framework for a Developing Country's Public University	#1
2	Ahlan, et al. [12]	IT Governance in a Malaysian Public Institute of Higher Learning and Intel-	#2

		ligent Decision Making Support System Solution	
3	Anthony Jnr, et al. [24]	Autonomic Computing Systems Utilizing Agents for Risk Mitigation of IT	#3

Table 3: Objectives of Publication Retrieved

No	Paper ID	Objectives
1	#1	To explore issues of ITG and provide suggestions for ITG Intelligent Decision Making Support System (IDMSS) in public university in Malaysia
2	#2	To explores issues of IT governance and the use of IDMSS in a public university in Malaysia.
3	#3	To propose an autonomic computing model developed to mitigate risk; mainly operational and technical in IT Governance by measuring the risk and providing risk report to the management and staffs in organisations

Table 4: Inclusion and Exclusion Criteria

Criteria	
Inclusion	• Publications that comprise of intelligent system in IT governance with details and specific domain area where the area of research covered in IHL of Malaysia;
Exclusion	• Publication that do not cover intelligent system in IT governance research area in IHL of Malaysia. • Studies that do not cover empirical findings or literatures that are not discussed thoroughly. • Publication that produced earlier than 2010

The search strings display the results of three papers as shown in Table 2. Next, a qualitative assessment was conducted to outline the content for quality of work purposes. The layers of filtration conducted to extract the content to answer the research question. Consequently, the outcomes were categorised to answer the research questions for this study. The answer of this study is presented followed by discussions and recommendations. The papers were assigned with identical number (ID) for easy referencing. Table 3 outlines the objectives of publication retrieved. We define the inclusion and exclusion criteria for this study to help in defining relevant study for answering the research questions. The inclusion and exclusion criteria is outlined in Table 4.

4. Findings and Analysis

Once the criterion completed, the data is critically analysed. This section discusses on the results obtained from the systematic review study. The discussions on findings and analysis are based on the following research questions.

4.1. Answer for Research Question

The findings from Table 5 shows the IT Resource Management has majority studies performed in intelligent system perspective. This is followed by Risk Management area. The findings depict that there is lack of study in domain areas like IT Strategic Alignment, Performance Management and IT Value Delivery embedding intelligent system.

Table 5: Mapping of Publication Retrieved in ITG Domains

No	Paper ID	Objectives
1	-	IT Strategic Alignment
2	#1, #2	IT Resource Management
3	#3	Risk Management
4	-	Performance Management
5	-	IT Value Delivery

The IT Strategic Alignment is focus to align the business and collaborative solutions. The Performance Management is define as monitoring results for corrective action while IT Value Delivery is define as executing the value proposition throughout delivery cycle [3]. These important areas are vital to be supported with intelligent system elements. The requirement for ITG must be reasonably caused by facilities and establishment in universities that depend on IT-enabled systems to facilitate better management [12]. The investigation in these areas are possible to be implemented by recognising the process and requirements implemented in the university.

There are opportunities of study to be performed in IT Strategic Alignment domain. The intelligent system has potential contribution by assist in recognising effective strategy to be executed by the board and IT strategy committees. This approach is important to assist them in complicated decision-making. The outcome from the process, results and effect can be stored in the systems to be utilised for future decision-making which immensely useful for academic institution. The study set out by [26] mentioned the application of various automated systems eloquently improve the management of educational process.

There is similar opportunity for Performance Management domain. In this domain, the boards involved to assess management's performance of IT strategies in operation. However, there are many boards that carry out the governance duties through committees that oversee critical areas such as audit, compensation and acquisitions [3]. Through these accountabilities, the intelligent system involvement could assist the boards to decide for critical decisions in their duties by storing the requirements in knowledge base or repository based from previous experience to be used in future decision- making. The advantages will support the boards to retain the knowledge. This is useful for any movement of people in organisation and future evaluation of decision made for future enhancement.

There are similar opportunities for IT Value Delivery domain to be investigated. Theoretically, IT value delivery is more on concentrating to elevate expenses and ascertaining the value of IT [27]. Consequently, this demands fast and within-budget delivery of appropriate quality which target to achieve the benefits promised although it is challenging to measure. In university, these include competitive advantage, employee productivity, profitability and learners' satisfaction. The situation that happened when the top management and boards fear to invest in IT due to the uncertainty of the outcome. Therefore, the role of intelligent system is vital to support the board and top management of higher learning institution to make fast yet precise decision to guarantee the return of investment in IT facilities for institution. The potential research to be investigated within this area could be explored in the value of technology, procedure, framework or model and the process of innovation that support cost effectiveness in IHL [25].

4.2. Answer for Research Question 2 (RQ2):

Table 6: Elements of Intelligent System

No.	Paper ID	Elements of intelligent system identified
1	#1	Agent based system
2	#2	Intelligent Decision Making Support system (IDMSS) • Information extraction • Predictive Capability
3	#3	Autonomic Computing System • Multi agent-based with reasoning

The study by #1 highlighted the future and potential of agent-based systems. This idea aims to support intelligence phase of decision making to contribute for a better understanding of user need and anticipation. In addition, the study by #2 emphasised in

Intelligent Decision Making Support System with components of information extraction and predictive capability. Both components extract useful information into IDMSS to be presented and predicted into trend. The components have predicted capability or predicted intelligent behaviour to support decision making from the top management. The research in #3 emphasised in reasoning element through Autonomic Computing Systems (ACSs). The ACS is a system that capable to manage themselves through agents that has capabilities for reasoning. The reasoning is used to measure the risk probability and risk impact based on available data in the knowledge base or previous experiences. The ACS provides risk advice that aimed at providing decision support to management hence assist mitigating risk in IT Governance. The multi agent concept introduced collaboratively work in risk identification, risk decision, risk treatment and risk monitoring to mitigate risk effectively. The multi agents utilise the data from previous risk cases to build a qualitative measuring scale to define and calculate the risk probability and risk impact.

The similarity found from the studies emphasised the element of intelligent system to support ITG in IHL in related process, procedures and tasks. Each paper used specific elements of intelligent system. The elements of intelligent system that can be found in #1 is agent based to support decision making whereas #2 utilised the elements of information extraction and predictive capability to support decision making whereas #3 utilised element of reasoning to support risk mitigation. The findings from the study has resulted the potential of intelligent system to support ITG in university areas. Hence conclude that there are impending areas of ITG in university to be explored and supported by intelligent system.

4.3. Answer for Research Question 3 (RQ3):

Table 7: Method Used to Collect and Analyse Data

No.	Paper ID	Qualitative Approach
1	#1	• Interview • Document analysis
2	#2	• Document analysis • COBIT framework (benchmark)
3	#3	• Interview sampling

Based on findings shown in Table 7, all studies used qualitative approach as the method of investigation. Interview and document analysis have been chosen for the methods of the study. However, the study performed by #2 has used additional ITG framework as benchmark to guide the input. The data was analysed using Nvivo for understanding the depth of risk mitigation processed and practices. The qualitative method in data collections helps to have a thorough understanding by investigate the viewpoints and behaviours of people in the situation that they involved with. As highlighted by [28], qualitative research is useful to understand about new technology, people's insight, the causal process developed as well as to improve certain development. The strength is useful to understand the ground and beginning of studies. Figure 1 represents tabulation of data collections method used based on three sources of data in qualitative approach which are observation, document, interviews and surveys [28].

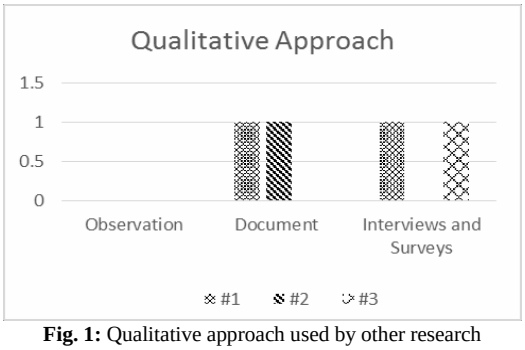


Fig. 1: Qualitative approach used by other research

4.4 Answer for Research Question 4 (RQ4):

Table 8: Recommendations of Future Methods

No.	Paper ID	Method proposed for future research
1	#1	Qualitative approach in multi- case study with scientific results portrayed to support evidence.
2	#2	Qualitative approach in multi- case study research
3	#3	No proposed method for future

Table 8 tabulates the recommendations of future methods made from collected study. Both #1 and #2 emphasised to conduct the study in qualitative approach using multi-case study with scientific results to support the evidences. Multi-case study allows comparative evidence for in-depth understanding of phenomenon [29] and suitable to recognise the variances and the likenesses between cases [30]. The method is advocated for its advantages and capability to compare the experiences, comprehend successful implementation of ITG in university and to determine how university process has become stagnant. The comparison helps to support researcher with literature that enclosed with significant influence from the contrasts and similarities [31]. Conversely, there is no recommendation for future method by #3. Nevertheless, there is encouragement to conduct the study in risk mitigation for its complications and necessities to assists ITG.

4.5. Answer for Research Question 5 (RQ5)

In responding for future recommendations of the study, paper #1 highlighted the need for effective ITG in university and the framework to adopt ITG in public university. In addition, the study recommended agent- based system to support intelligent phase for decision- making. The recommendation is essential to improve the understanding of user expectation. Due to this, paper #1 emphasised to explore the requirements for design development of intelligent software agents. The outcome of #2 emphasised the need for effective governance in university to ensure accurate implementation in dealing with IT resources. Moreover, the study highlighted for the management to have interest in practicing systematic control of IT resource. This permits IT department to govern resources effectively. Furthermore, the study by #2 highlighted Bayesian Network to support decision- making and logic semiotic approach as the methods for IDMSS. Additionally, the outcome by #3 highlighted the autonomic computing model to mitigate risk in ITG. The model covered operational and technical elements of ITG by given risk report to potential people in organisation.

The research conducted has produced different elements to elevate ITG. Based from the study, the intelligent system of ITG in university has proven for future investigation and exploration to support any decision-making involvement. This has been acknowledged to ensure ITG is successfully governed and adapted effectively.

4.6. Answer for Research Question 6 (RQ6):

The study conducted by #1 emphasised the needs of ITG in public university and to conduct it in comparative study to know how the process has become stable. In addition, the study highlighted the importance for each IDMSS to be tested in larger sample site to ensure its adequacy and robustness in every environment. Moreover, the study emphasised on having hypotheses study for the main cause of ITG failures. The identified cause is poor in IT socio-politics power in finance, management and manufacturing. The study by #2 highlights on testing the IDMSS to approve its dynamic performance in environment. The research conducted by #3 highlighted the problems and solutions to overcome the issues in risk mitigation

process. The study emphasised the important of obtaining data in risk mitigation process. However, there are lack of data found to support this. Hence, the study proposed to develop innovative tools to obtain data to support IT practitioners to solve risk in ITG. Based on the results retained from RQ6, the similarities of recommendations can be found from multi case study and testing the IDMSS system for performance in different environment. Due to essentiality of obtaining data, the recommendation to cultivate tools for IT practitioners' sustenance in resolving risk were highlighted. The deficiency of data has resulted difficulties to mitigate the risk

5. Conclusion and Future Work

This paper deliberated the encouragement for more research to perform in intelligent system focusing ITG in institute of higher learning in Malaysia. This is accentuated by [12] that more study and improvement on IDMSS needs to be done in public and private institutes of higher learning in Malaysia. In respond to the research questions, there are opportunities of study in ITG domains specifically in IT Strategic Alignment, Performance Management and IT Value Delivery. Similarly, for IT Resource Management and Risk Management. There is potential for the area to be explored based on up-to-date changes and requirement of organisation. The future direction on each literature reviewed in this study is highly recommended to be accomplished in future to gain in-depth understanding of study in this area.

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