



Developing an instrument to measure information assurance implementation for eGovernment using goal question metric approach

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Abstract

The eGovernment initiative is aimed to improve government services to the public by improving the quality and availability of services that can be accessed regardless of time and place. Consequently, the services must always be available at any time, and any threat to the information and systems should receive attention to ensure business continuity in the event of an incident. Therefore, in implementing eGovernment, information assurance (IA) must be considered. A framework of IA to support to the implementation eGovernment in Indonesia has been proposed. However, to measure its effectiveness within the Indonesian organisations, the framework needs to be implemented. One way to validate the framework is by develop it further into a measurement instrument. This paper proposes a measurement instrument which was developed using the Goal Question Metric (GQM) approach. The developed instrument was then used in a case study to test its effectiveness in measuring the IA implementation. From the results of the case study, it can be concluded that the measurement instrument for IA implementation for eGovernment was proven to be effective within Indonesian context. The results also validated the IA framework to be applicable for Indonesian context.

1. Introduction

In the modern world, technology is an integral part of everyday life and cannot be separated from progress and human development [1] and from everyday life [2]. Moreover, the use of digital technology has given rise to a new mechanism of government bureaucracy which is then known as the Electronic Government (eGovernment) [3][4]. The World Bank [5] defines eGovernment as the use of information technologies (such as wide area network, the Internet, and mobile computing) by government agencies that could transform relations with citizens, business, and other government organisations. The shift towards eGovernment was aimed at introducing changes to the traditional approach of public service delivery [6][7]. In fact, several governments have become increasingly aware of the benefits of eGovernment in improving the performance of government organisations and their interactions with their citizens [8][9][10]. One of the governments that had implemented eGovernment is Indonesia.

Despite the benefits of eGovernment, there are also problems regarding its implementation. The availability of services has become a significant concern [11]. Moreover, according to Basu [12], assurance of the security of the communications and its sources has also become an issue. Users are mainly concerned about the integrity of the communicated information. In addition, with eGovernment reliance on information systems and services, it is more vulnerable to threats and needs to be protected [13]. To overcome this problem, information assurance (IA) is needed as a mechanism to protect information systems and services.

The main purpose of IA is to protect the business by reducing risks associated with information and information systems [14][15]. The activity is driven by risk analysis and cost-effectiveness with a comprehensive and systematic management of security countermeasures [16][17]. Additionally, IA relies on multiple, related, organisational actions and controls in the form of the defence in depth model [18]. All IA processes are carried out to support corporate governance [19]. With services and business continuity assured, it is expected that the eGovernment services in Indonesia will be implemented successfully; therefore, the purpose of implementation of eGovernment will be achieved, which is to improve the effectiveness, efficiency, and quality of service to the citizens.

To implement eGovernment in Indonesia successfully, the IA of eGovernment in Indonesia requires attention. A framework of IA to support to the implementation eGovernment in Indonesia has been proposed [20]. However, to measure its effectiveness within the Indonesian organisations, the framework needs to be developed further into an instrument and then use it in a case study. The purpose of this paper is to propose an IA measurement instrument which was developed using the Goal Question Metric (GQM) approach. The developed instrument was then used in a case study to test its effectiveness in measuring the IA implementation and to validate the IA framework.

2. Research Method

2.1 Goal question metric

Goal Question Metric (GQM) is a technique to identify meaningful metrics for the measurement process [21]. It helps to determine the strengths and weaknesses of the current processes, and it provides a rationale for adopting/refining techniques, to evaluate the quality and impact of a specific process. GQM emphasizes the need to establish an explicit measurement goal, define a set of questions to achieve the goal, and identify metrics to answer the questions. The six-step GQM process includes, develop a set of goals, generate questions that define those goals, specify the measures needed to be collected, develop mechanisms for data collection, collect, validate and analyze the data, analyse the data to assess conformance to the goals and to make recommendations for future improvements [21].

2.2 Case study

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context; especially when the boundaries between phenomenon and context are not clearly evident [22]. Case studies are often used when there is a need for a detailed understanding in order to provide the researcher with rich data for a particular topic. A case study may be literally replicated, when the case is selected to predict similar results, or it is theoretically replicated, when the case is selected to predict contrasting results for predictable reasons [22].

3. Results & Discussion

3.1 Instrument Design

The confirmed framework [23] was used as a research instrument to measure IA implementation process within organisations in Indonesia. The instrument was developed based on the Goal Question Metric (GQM) approach. The GQM approach was chosen since it defines a measurement model that aids in answering a variety of questions associated with the performance of a process. It helps to determine the strengths and weaknesses of the current processes, and it provides a rationale for adopting/refining techniques, to evaluate the quality and impact of a specific process. Therefore, developing an instrument based on this approach helps to measure the IA implementation process in an organisation by answering questions associated with the performance of each practice.

Accordingly, the development of the instrument starts with the goal of achieving the factors that need to be measured. Each factor is then refined into questions and then each question is refined into metric.

The category of Organisational Management (OM) has seven Goals on the instrument that must be measured. These seven Goals are based on seven factors from the OM category [24]. Each of these Goals forms the basis for generating Questions to measure characteristics that must be met to achieve Goals. The overall Goals and Questions for OM categories can be seen in Table 1.

Table 1. IA Measurement Instrument for Organisational Management

Category	Goal	Question
Organisational Management (OM)	Leadership and Commitment	The lead of board of directors to IA implementation?
		The commitment of board of directors to IA implementation?
	Policy, Legal, and Compliance	The availability of policy to provide management direction and support for IA in accordance with business requirements?
		The availability of legal aspects to identify the organisation's legal obligation (statutory, regulatory, and contractual)?
		The availability of appropriate procedures to ensure compliance with the legal aspects that apply to the organisation?
	Management Review and Continual Improvement	The periodic review (regarding the suitability, adequacy, and effectiveness) of the information assurance policy by senior management?
		The continual improvement of the information assurance policy by senior management?
	Holistic Approach	The treatment of IA as a combination of the physical, procedural, personnel, and technical security?
	Business Alignment	The alignment between IA implementation and the organisation's business needs?
		The senior management assigned and communicated organisational roles relevant to IA?
The senior management assigned responsibilities for ensuring IA is in accordance with the policy?		
Organisational Roles, Responsibilities, and Authorities	The senior management assigned authorities to confirm information assurance is in accordance with the policy?	

Awareness, Education, and Training	The awareness of all employees in the organisation on their contribution to the IA implementation?
	The education of all employees in the organisation as relevant for their job function?
	The training of all employees in the organisation as relevant for their job function?

Secondly, for the Implementation Management (IM) category, there are five Goals on the instrument that must be measured based on five factors from the IM category [24]. Each Goal has a varied number of questions. This depends on the number of characteristics that must be met in achieving these factors.

Operations and Management factor has the most Questions, namely three questions. These three questions are needed to address the characteristics that must be met, namely on the aspects of the plan, implementation, and control. All Goals and Questions for the IM category can be seen in Table 2.

Table 2. IA Measurement Instrument for Implementation Management

Category	Goal	Questions	
Implementation Management (IM)	Risk Management	The adopted of risk management strategy of IA implementation?	
	Security Objectives	The relevance of information security objectives to the functions and levels.	
	Operations and Management		The plan of information security complied with information security policy?
			The implementation of information security complied with information security policy?
			The control of information security complied with information security policy?
	Performance Evaluation	The performance evaluation (relating to the effectiveness and maintenance) of the IA implementation?	
Recovery and Continuity Management		The adopted of disaster recovery plan of IA implementation?	
		The adopted of business continuity plan in the event major failures?	

Lastly, the Indonesian Context (IC) category has six Goals on the instrument that must be measured based on six factors from the IC category [25]. Just like the previous categories, each Goal has a variety of questions. The characteristics that must be met in achieving these factors are considered the number of questions.

Trust and Privacy factors have the most Questions, namely two questions. Both questions address characteristics that must be fulfilled, namely the aspects of trust and privacy. The overall Goals and Questions for the IM category can be seen in Table 3.

Table 3. IA Measurement Instrument for Indonesian Context

Category	Goal	Questions	
Indonesian Context (IC)	Cultural Issues	The consideration of cultural issues in the organisation during the implementation of IA?	
	Digital Divide	The consideration of digital literacy issue in the organisation during the implementation of IA?	
	Trust and Privacy		The established of trust between government and citizens?
			The protection regarding privacy of information?
	Organisational Structures	The creation of a division to be in control of handling information security issues?	
	Coordination	The coordination between institutions regarding the duties of each institution?	
Infrastructure Development	The required relevant technology and infrastructure of IA implementation?		

The approach results in a specification of a measurement system targeting a set of rules for the interpretation of the measurement data in a top-down hierarchical structure. The structure includes the conceptual level (Goals) which

is the object of measurement, then the operational level (Questions) that characterises the way the achievement of the goal is going to be performed, followed by the quantitative level (Metric) which is the data associated with every question to be answered quantitatively.

A metric of six scales for the instrument adapted from the COBIT 5 Process Assessment Model which is based on ISO/IEC 15504-2:2003 will be used to measure the IA implementation process as follows:

- Level 0: Non-existent process = 0%
- Level 1: Initial process = 20%
- Level 2: Defined process = 40%
- Level 3: Managed process = 60%
- Level 4: Established process = 80%
- Level 5: Optimised process = 100%

Moreover, the scoring process for the case study is divided into six scales. The scale is shown as following:

- Any score from 0% to 12%: **Level 0 Status** - Serious and critical improvements are needed.
- Any score from 12.50% to 37%: **Level 1 Status** - Major and urgent improvements are needed.
- Any score from 37.50% to 50%: **Level 2 Status** - Medium improvements are needed.
- Any score from 50.50% to 62%: **Level 3 Status** - Minor improvements are needed.
- Any score from 62.50% to 87%: **Level 4 Status** - Minor improvements may be needed.
- Any score from 87.50% to 100%: **Level 5 Status** - No action is needed.

3.2 Case study and Results

The case study was conducted in a government organisation. This organisation is a city government organisation. The government office is in the capital of a province in Indonesia. There were 10 participants involved. One participant was from senior management, three IT management, and six IT staff. The eGovernment has been implemented in this organization since 2008 and is one of the best organisations in its performance and adoption of the eGovernment in Indonesia. The results of the case study in this organisation for OM category are shown in the Table 4 below.

Table 4. The Results of the Case Study for OM

Category	Goal	Question	Score
Organisational Management (OM) Score: 54.29% Response: Strongly Agree	Leadership and Commitment	The lead of board of directors to IA implementation?	60%
		The commitment of board of directors to IA implementation?	60%
	Policy, Legal, and Compliance	The availability of policy to provide management direction and support for IA in accordance with business requirements?	60%
		The availability of legal aspects to identify the organisation's legal obligation (statutory, regulatory, and contractual)?	60%
		The availability of appropriate procedures to ensure compliance with the legal aspects that apply to the organisation?	60%
		The periodic review (regarding the suitability, adequacy, and effectiveness) of the information assurance policy by senior management?	40%
	Management Review and Continual Improvement	The continual improvement of the information assurance policy by senior management?	40%
	Holistic Approach	The treatment of IA as a combination of the physical, procedural, personnel, and technical security?	60%
	Business Alignment	The alignment between IA implementation and the organisation's business needs?	40%
	Organisational Roles,	The senior management assigned and communicated organisational roles relevant to IA?	60%

Responsibilities, and Authorities	The senior management assigned responsibilities for ensuring IA is in accordance with the policy?	60%
	The senior management assigned authorities to confirm information assurance is in accordance with the policy?	60%
Awareness, Education, and Training	The awareness of all employees in the organisation on their contribution to the IA implementation?	60%
	The education of all employees in the organisation as relevant for their job function?	60%
	The training of all employees in the organisation as relevant for their job function?	60%

From the calculation of the 15 Questions scores, for the OM category, the final score was 54.29%. This score represents the OM status of their organisation in implementing IA. The participants strongly agreed with this score. Furthermore, Table 5 presents the results for the Implementation Management (IM) category.

The IM category for the case study, after calculating the scores of nine Questions, got a score of 53.33%. The participants strongly agreed to this score. Which means this score represents IM status in IA implementation in their organisation. Moreover, Table 6 presents the results for the Indonesian Context (IC) category.

Table 5. The Results of the Case Study for IM

Category	Goal	Question	Score
Implementation Management (IM) Score: 53.33% Response: Agree	Risk Management	The adopted of risk management strategy of IA implementation?	60%
	Security Objectives	The relevance of information security objectives to the functions and levels.	60%
		The plan of information security complied with information security policy?	60%
	Operations and Management	The implementation of information security complied with information security policy?	40%
		The control of information security complied with information security policy?	20%
	Performance Evaluation	The performance evaluation (relating to the effectiveness and maintenance) of the IA implementation?	60%
	Recovery and Continuity Management	The adopted of disaster recovery plan of IA implementation?	40%
		The adopted of business continuity plan in the event major failures?	40%

Table 6. The Results of the Case Study for IC

Category	Goal	Question	Score
Indonesian Context (IC) Score: 42% Response: Agree	Cultural Issues	The consideration of cultural issues in the organisation during the implementation of IA?	60%
	Digital Divide	The consideration of digital literacy issue in the organisation during the implementation of IA?	40%
	Trust and Privacy	The established of trust between government and citizens?	40%
		The protection regarding privacy of information?	60%
	Organisational Structures	The creation of a division to be in control of handling information security issues?	40%

Coordination	The coordination between institutions regarding the duties of each institution?	20%
Infrastructure Development	The required relevant technology and infrastructure of IA implementation?	60%

The score for the IC category in the second case study is 42%. This score represents the calculation of the scores obtained by answering six Questions. The participants strongly agreed that this score represented the IC status for IA implementation in their organisation.

3.3 Factors Analysis

From the results of factor analysis from the case study, it shows that the factor status of each factor is varied. Most of the factors belong to the Level 3 Factor status as shown in Table 7.

Table 7. The Factors Analysis of the Case Study

Factor Category	Factor Name	Factor Status
OM	Leadership and Commitment	Level 3 Factor (60%)
	Policy, Legal, and Compliance	
	Holistic Approach	
	Organisational Roles, Responsibilities, and Authorities	
	Awareness, Education, and Training	
IM	Risk Management	Level 2 (40%)
	Security Objectives	
IC	Performance Evaluation	Level 1 (20%)
	Cultural Issues	
IC	Infrastructure Development	Between Level 2 and Level 3 (40%-60%)
	Trust and Privacy	
OM	Management Review and Continual Improvement	Level 2 (40%)
	Business Alignment	
IM	Operations and Management	Level 1 (20%)
	Recovery and Continuity Management	
IC	Digital Divide	Level 1 (20%)
	Organisational Structures	
IC	Coordination	Level 1 (20%)

3.4 The Categories Analysis of The Case Study

The radar chart of the categories analysis of the second case study in the Figure 1 and a recommendation action suggested based on the results are presented as follows.

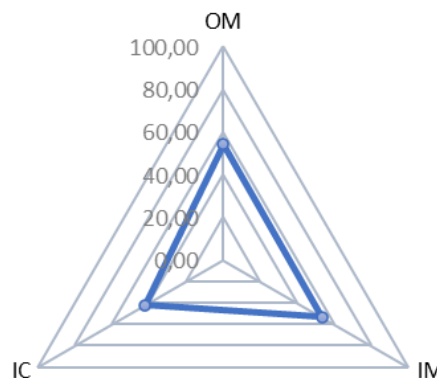


Figure 1. The Radar Chart of the Case Study

Figure 1 shows that the categories with the highest level of status, which is Level 3, are the OM and IM categories. Another one is IC with Level 2 status. Recommendations depends on the level are shown below.

Level 2 categories:

1. **42%**, Indonesian Context, Medium improvements are needed.

Level 3 categories:

2. **54.29%**, Organisational Management, Minor improvements are needed.
3. **53.33%**, Implementation Management, Minor improvements are needed.

3.5 Feedback Analysis

The feedback analysis and participants' comments on the case study from the afterthought session from the participants are presented in this section. [Table 8](#) below shows the feedback analysis.

Table 8. The Feedback Analysis of the Case Study

Questions	Responses
Q1. Organisational Management, 54.29%	Strongly Agree
Q4. Whole IA is Level 2 status, 50.55%	
Q5. Good Instrument	
Q2. Implementation Management, 53.33%	Agree
Q3. Indonesian Context, 42%	

The score of OM category in this organisation is 54.29%. The participants strongly agreed with it. Moreover, they commented that the leadership and commitment of leaders in this organisation are good enough so that the implementation of IA is not disturbed. Then, review of IA has been conducted regularly and improvement also has been carried out as needed. In addition, the aspects of physical, personnel, technical, and procedures are integrated and support each other. Further, people who are responsible for each position have been appointed by the top management according to their competency.

The score of the IM category is 53.33%. This score is agreed by all participants. They mentioned that risk management has been adopted and implemented properly. And for periodic reviews of performance evaluations, it has been carried out and improvements have also been conducted. Furthermore, this organisation has disaster recovery centres outside the city as part of continuity management to anticipate possible incidents. Additionally, the infrastructure in this organisation is sufficient to support good IA implementation.

The organisation got a score of 42% for the IC category. They agreed to this result as it represented the status of the category in their organisation. In addition, they mentioned that the organisation has policies to address cultural issues such as resistance to change or openness. Moreover, the trust from the public on this organisation is quite good, and the privacy of the users has been well managed. However, coordination with other institutions, especially the private sector, is not good enough.

Lastly, the whole IA in this organisation is categorised as Level 2 implementation with a score of 50.55%. The score is agreed strongly by the organisation during the afterthought session. They also stated that the instrument is a good instrument for measuring IA for eGovernment in the Indonesian context. Furthermore, they are satisfied with the results and would be interested to take part in the future study.

3.6 The Discussion of the Case Study

In this case, the results revealed that the final score was not affected by the Level 1 factor, as there were many moderate and average factors involved in the study, as well as all-average categories. Hence, the final IA score is Level 2 because of most factors get Level 2 score.

The case study participants in this organisation strongly agreed on the assessment of most categories. This indicates that the organisation agreed on the results and questions. Furthermore, participants agreed that the instrument was an effective instrument for measuring IA for eGovernment in Indonesia.

4. Conclusion

Using the instrument, a case study was conducted in a government institution in Indonesia. The institution had been implemented eGovernment services with a long period. Analysis of the case study showed mixed results. Two categories got Level 3 status for IA implementation in their organisations, while one category Level 2 status. Furthermore, the organisation agreed if the results reflected IA implementation status in their organisation. In addition, they were satisfied with the instrument and stated that the instrument is good and effective for measuring the process of implementing IA for eGovernment in Indonesia. Additionally, they provided suggestions for the further development of the instrument and were interested in participating again in future studies. In summary, it can be concluded that the instrument is effective to measure IA implementation for eGovernment in the Indonesian context.

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