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TABLE OF CONTENTS

JSI

JURNAL SISTEM INFORMASI
JOURNAL OF INFORMATION SYSTEMS

TAM Analysis on the Factors Affecting Admission of Students for Ruangguru Application

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Abstract

A new paradigm emerged in the field of education along with the development of increasingly advanced technology, namely the emergence of an electronic learning system known as e-learning. One of the e-learning media that is currently popular in Indonesia is Ruangguru online learning application that can be accessed through a smartphone. The purpose of this study is to analyze the factors that influence student's acceptance of Ruangguru application using the Technology Acceptance Model (TAM) method. The 5 (five) constructs of the TAM research model were used, namely Perceived Usefulness, Perceived Ease of Use, Attitude Toward Using, Behavioral Intention of Use and Actual System Use. The data collection used is an online questionnaire from Google Form with a purposive sampling technique. Valid questionnaire data is processed using the SmartPLS 3 program with 3 (three) structural analysis models, namely outer model analysis, inner model analysis, and hypothesis testing. The results show that Attitude Towards Using did not have a significant effect on Behavioral Intention of Use, meaning that the students' attitude towards using did not affect students' intentions in using Ruangguru application. At the same time, the relationship of Perceived Ease of Use to Perceived Usefulness is the most significant influence where the ease in using Ruangguru application makes users feel that Ruangguru application is useful.

Keywords: Technology Acceptance Model, Ruangguru Application, E-learning, Perceived Usefulness, Perceived Ease of Use, Attitude Toward Using, Behavioral Intention of Use, Actual System Use

Introduction

The advanced technology developments cause electronic media to be used in the dissemination of various information. In the field of education, the development of information technology raises a new paradigm in the learning process where the process is not only limited to face-to-face learning activities in the classroom but can also be done online. This learning system is known as electronic learning (e-learning) [1]. E-learning holds a number of important benefits for students, including

access to learning tools and resources such as text, audio, video, online discussions, and evaluation results. This is a very useful tool for improving the quality of learning [2].

The presence of e-learning not only increases the speed of knowledge transfer, but in this method, teaching, and learning activities shift from the form of teacher-centered delivery to the form of student-centered delivery. E-learning appears as an important strategy to provide broad and easy access on high-quality education [3].

Since 2000, the role of information technology in learning activities to support e-learning began to be created by universities. In Indonesia, the concept of e-learning is usually applied in universities to support learning activities and student administration [4], but now the concept of e-learning has been used in the broader scope of education, which is not only limited to the scope of higher education.

One of the e-learning media that is currently popular in Indonesia is Ruangguru application. Ruangguru application is an online learning application that provides various learning contents such as tutorial videos, exercises, private lessons, and tryouts for elementary to high school students that can be accessed through smartphone.

This study aims to analyze the factors that influence student acceptance on Ruangguru application. The method used is the Technology Acceptance Model (TAM) where this method is one of the models built to analyze and understand the factors that influence the acceptance of the use of technology.

Literature Review

Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) is a well-established model that is based on the psychological interaction of a user with technology and it addresses the issue of how users accept and use information technology [5].

TAM is adopted from another popular theory called Theory of Reasoned Action (TRA) from the field of social psychology that explains human behavior in general. TAM specifically explains the determinants of acceptance on computer technology, and it can explain user acceptance in various computing technologies [6].

TAM was first introduced by Davis in 1986, and it is one of the most widely used models in information technology studies because it is simple and easy to use. TAM is a model used to explain how users receive and use certain technologies. According to TAM, Actual System Use is directly or indirectly influenced by Behavioral Intention of Use, Attitude Towards Using, Perceived Usefulness, and Perceived Ease of Use perceived from the system [7].

TAM method is chosen to use in this study because prior research has found TAM as the most widely used framework in the field of information systems to measure the acceptance of technology, its validity has been empirically proven and highly predictive model of IT adoption [8][9].

Although the use of the TAM method has been used in various sectors, research on TAM's application in education was limited in the past [9]. Besides, the use of TAM method to predict and explain the use of a learning management system has so far received little attention [8]. This study delved more deeply into the TAM research by applying it in the education sector, namely the Ruangguru e-learning application.

This study uses 5 (five) constructs of the TAM research model by Davis (1989) [10], namely Perceived Usefulness, Perceived Ease of Use, Attitude Toward Using, Behavioral Intention of Use and Actual System Use.

Perceived Usefulness (PU)

Perceived Usefulness is defined as the subjective probability of prospective users in which using a specific application system will improve their performance in the organizational context [8]. This variable is measured based on easier learning indicators, learning performance, increasing productivity, effectiveness, and usefulness.

Perceived Ease of Use (PEU)

Perceived Ease of Use is defined as the extent to which prospective users expect the system to be effortless [8]. This variable is measured based on the indicators that are easy to use, to access, to learn, to apply, and to understand.

Attitude Toward Using (ATU)

Perceived Usefulness and Perceived Ease of Use will influence individual Attitude Towards Using of technology [6]. These variables are measured based on pleasant indicators, good ideas, and other things considered necessary and supporting the learning process.

Behavioral Intention of Use (BI)

Behavioral Intention of Use defines the actual use of information systems which therefore determines the acceptance of a technology [8]. The Behavioral Intention of Use will determine whether or not someone will use technology [6].

Actual System Use (AUSE)

Actual System Use is influenced by two main elements, namely the Perceived Ease of Use and Perceived Usefulness. Therefore, this construct is a reflection fragment of Behavioral Intention of Use [11]. This variable is measured based on indicators that are continuously used, used for the learning process, and used for certain processes.

E-Learning

E-learning is a learning process created by the interaction between digital content, network-based services, and tutoring. E-learning is often referred to as the use of information and communication technology networks in the teaching and learning process [12].

The benefits of using e-learning include the ability to share material in all types of formats such as videos, slideshows, documents, and PDFs and to provide opportunities for students to adapt their learning styles [13].

Ruangguru

Ruangguru is an online learning application that provides various learning content such as tutorial videos, exercises, private lessons, and tryouts for elementary to high school students that can be accessed through smartphone. Ruangguru application adopts tutoring services but is packaged in the form of online so that the teaching and learning process can be accessed through smartphones connected to the internet.

Figure 1 shows the home page of Ruangguru application.

Source: Ruangguru Application (2019)

Figure 1. The Display of Ruangguru Application

Ruangguru company was established in 2014 by Belva Devara and Iman Usman. In 2017 Ruangguru became a government partner to provide quality education through Learning Management System through collaboration with 32 provincial governments and more than 326 city and district governments in Indonesia.

Previous Studies

Understanding the user's preferences and characteristics are critical issues in improving e-learning usage and affectiveness [14]. Previous research states that three factors influence student Attitudes Towards Using e-learning. These factors are Perceived Usefulness, Perceived Ease of Use and content design. These findings indicate that with great benefits, ease of use, and preferred e-learning system design, students will have a better attitude towards the system [15].

Other studies have found that Behavioral Intention of Use of an e-learning system is the result of two factors, namely Perceived Usefulness and Attitude Towards Using, where the Attitude Towards Using factor is the most significant factor [16]. The attitude of students to educational technology can shape behavior towards it and eventually lead them to accept it or not [17].

In this study, the relationship between factors such as the above research will be analyzed, with additional links to the Actual System Use factor.

Conceptual Model

This study uses 5 (five) constructs of TAM research models, namely Perceived Usefulness, Perceived Ease Of Use, Attitude Toward Using, Behavioral Intention of Use and Actual System Use. The framework of this research can be illustrated in Figure 2.

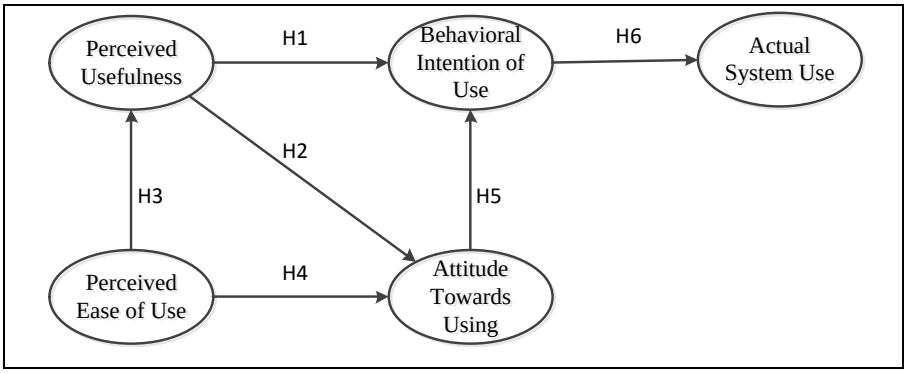


Figure 2. Framework

Based on the framework in Figure 2, the hypotheses can be developed as follows:

H1. Perceived Usefulness has a positive and significant effect on Behavioral Intention of Use.
H2. Perceived Usefulness has a positive and significant effect on Attitude Towards Using.
H3. Perceived Ease of Use has a positive and significant effect on Perceived Usefulness.
H4. Perceived Ease of Use has a positive and significant effect on Attitude Towards Using.
H5. Attitude Towards Using has a positive and significant effect on Behavioral Intention of Use.
H6. Behavioral Intention of Use has a positive and significant effect on Actual System Use.

Methodology

Sampling and Data Collection

Data collection in this study was conducted by survey method, which is in the form of an online questionnaire by using Google Forms. The research sample was taken based on purposive sampling technique. In this method, the selection of samples is carried out on certain qualities on the sample by deciding what to know and to determine to find out the samples [18]. The required samples in this study are Indonesian students, the Ruangguru application users and have subscribed to certain learning packages for at least one month.

Prospective respondents are Instagram social media users who actively comment on Ruangguru's official account, @ruangguru. Then manually, the message is sent to prospective responders via Instagram direct messages. This message contains a brief introduction, research objectives, requests for filling out the questionnaire and a link to Google Form to be able to access the questionnaire.

The number of respondents who filled out the questionnaire on Google Forms was 116 students, but only 99 questionnaires were further processed. A total of 17 questionnaires were rejected because they were invalid and did not meet the requirements. For example, students had not subscribed to certain learning packages in the Ruangguru application.

Measurement Development

The questionnaire was designed to collect the information needed from respondents for research purposes. The questionnaire is divided into three main aspects which are modifications of the questionnaire used in previous studies, namely information about the background of respondents, information about the experiences of respondents in using Ruangguru application, and information based on the conceptual model. For the questionnaire measurement scale, questions were made by adopting Likert scale of 5 points, namely 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

Analysis

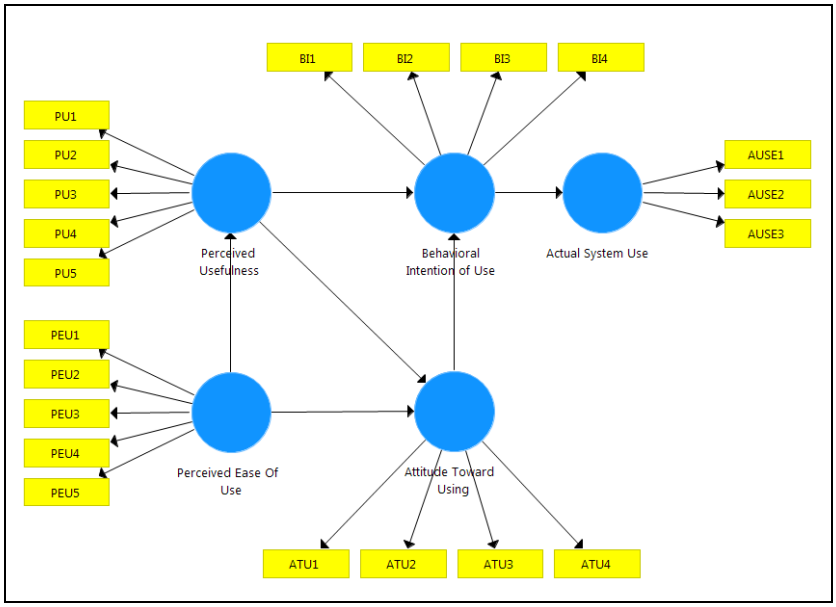
Of the 116 questionnaires obtained through Google Forms, 99 were considered valid and further processed. Profile of respondents shown in Table 1.

Table 1. Respondents Profile

Characteristics	Category	Number of Respondents	
		Respondents	%
Level of Education	Elementary students (SD)	2	2,02
	Middle school students (SMP)	21	21,21
	High school students (SMA)	76	76,77
	Total	99	100
Gender	Male	24	24,24
	Female	75	75,76
	Total	99	100
Duration of Application Usage Time	< 6 months	50	50,51
	6-12 months	48	48,48
	> 12 months	1	1,01
	Total	99	100

Source: Data processed (2019)

After selecting the data obtained, the valid data was then processed by using SmartPLS 3 for further analysis. The structural model constructed is illustrated in Figure 3.



Source: SmartPLS 3 (2019)

Figure 3. Structural Model

The structural model analysis was carried out with 3 (three) stages, namely the outer model analysis, inner model analysis, and hypothesis testing.

Outer Model Analysis

The outer model analysis is conducted to ensure that the measurements taken are feasible, valid, and reliable by specifying the relationships between latent variables and their indicators.

Convergent Validity

The value of convergent validity is the value of loading factors on latent variables with their indicators. The indicator is declared to be convergently valid if the value of the loading factor (λ) >= 0,5 [19]. Table 2 below shows that the research model has the value of loading factor for each indicator >= 0,5. Therefore, the measures displayed adequate convergent validity.

Table 2. Loading Factor Value

Indicator	Loading Factor	Conclusion
Actual Sysem Use 1 (AUSE1)	0,669	Valid
Actual Sysem Use 2 (AUSE2)	0,868	Valid
Actual Sysem Use 3 (AUSE3)	0,867	Valid
Attitude Toward Using 1 (ATU1)	0,794	Valid
Attitude Toward Using 2 (ATU2)	0,821	Valid
Attitude Toward Using 3 (ATU3)	0,797	Valid
Attitude Toward Using 4 (ATU4)	0,856	Valid
Behavioral Intention of Use 1 (BI1)	0,800	Valid
Behavioral Intention of Use 2 (BI2)	0,782	Valid
Behavioral Intention of Use 3 (BI3)	0,780	Valid
Behavioral Intention of Use 4 (BI4)	0,730	Valid
Perceived Ease of Use 1 (PEU1)	0,785	Valid
Perceived Ease of Use 2 (PEU2)	0,743	Valid
Perceived Ease of Use 3 (PEU3)	0,856	Valid
Perceived Ease of Use 4 (PEU4)	0,784	Valid
Perceived Ease of Use 5 (PEU5)	0,725	Valid
Perceived Usefulness 1 (PU1)	0,833	Valid
Perceived Usefulness 2 (PU2)	0,824	Valid
Perceived Usefulness 3 (PU3)	0,801	Valid
Perceived Usefulness 4 (PU4)	0,646	Valid
Perceived Usefulness 5 (PU5)	0,778	Valid

Source: Data processed (2019)

Besides the value of loading factors, convergent validity can also be seen from the value of Average Variance Extracted (AVE). A good model has an AVE value for each construct of more than 0,5 as shown in Table 3 [19]. In this study, AVE value for each construct is above 0,5, so there are no convergent validity problems in the tested model.

Table 3. Average Variance Extracted Value

Construct	AVE	Conclusion
Actual System Use	0,651	Valid
Attitude Toward Using	0,668	Valid
Behavioral Intention of Use	0,598	Valid
Perceived Ease of Use	0,608	Valid
Perceived Usefulness	0,607	Valid

Source: Data processed (2019)

Discriminant Validity

Discriminant Validity can be tested by comparing the value of CR square root AVE with the correlation value among constructs.

Table 4. Comparison of CR Square Root AVE with the Correlation Among Constructs

Construct	1	2	3	4	5
1. AUSE	0,807				
2. ATU	0,576	0,817			
3. BI	0,643	0,616	0,773		
4. PEU	0,576	0,691	0,652	0,780	
5. PU	0,651	0,720	0,715	0,719	0,779

Source: Data processed (2019)

From Table 4, it can be seen that the square root value of AVE is greater than the correlation of each construct, so it is concluded that there are no problems with discriminant validity.

Reliability or Unidimensionality Test

Reliability test is done to test the consistency of answers from respondents. The reliability or unidimensionality test was conducted by using the composite reliability indicator and Cronbach Alpha.

Table 5. Composite Reliability and Cronbach Alpha Value

Construct	Composite Reliability	Cronbach Alpha
Actual System Use	0,847	0,724
Attitude Toward Using	0,889	0,834
Behavioral Intention of Use	0,856	0,780
Perceived Ease of Use	0,886	0,838
Perceived Usefulness	0,885	0,837

Source: Data processed (2019)

Table 5 shows that all constructs have composite reliability and Cronbach Alpha ranges between 0,724 and 0,838. It can be concluded that all five scales have an acceptable internal consistency based on the 0.70 threshold value of Nunnally (1978) [20]. Table 5 also indicates that all factors have composite reliability of at least 0.80, which is higher than the threshold value of 0.70 [20]. It can be concluded that there are no problems with reliability or unidimensionality in the model.

Inner Model Analysis

Inner model analysis or structural analysis model is carried out to ensure that the structural models are robust and accurate. This analysis is done by testing the significance of the influence between variables by looking at t-statistics or t-values. The relationship is significant if the t-statistic value is > 1.96 at the 5% level [21].

Table 6. T-Statistic Value

	T-statistic	**Information**
Attitude Toward Using -> Behavioral Intention of Use	1,818	Insignificant
Behavioral Intention of Use -> Actual System Use	11,589	Significant
Perceived Ease of Use -> Attitude Toward Using	2,690	Significant
Perceived Ease of Use -> Perceived Usefulness	14,502	Significant
Perceived Usefulness -> Attitude Toward Using	3,900	Significant
Perceived Usefulness -> Behavioral Intention of Use	4,694	Significant

Source: Data processed (2019)

From Table 6 it can be concluded that of the 6 relationships described in the structural model, there are 5 significant variable relationships while 1 relationship was not significant, namely the relationship between Attitude Toward Using and Behavioral Intention of Use.

Hypothesis Test

The coefficient of determination (R^2) is used to measure how far the ability of the model in explaining variations of the independent variable. The coefficient of determination (R^2) is between zero and one ($0 < R^2 < 1$). The greater the coefficient of determination, the greater the variation of the independent variable affects the dependent variable. The influence criteria R^2can be seen in Table 7.

Table 7. Determination Coefficient Interval and Level of Influence

Coefficient Interval	**Influence Level**
0,00 – 0,20	Very weak
0,21 – 0,40	Weak
0,41 – 0,70	Strong
0,71 – 0,90	Very Strog
0,91 – 0,99	Extremely Strong

Source: Siri *et al.* (2017) [22]

Hypothesis test can be seen from the value of t-statistics as a Critical Ratio (CR) value and probability value. For the hypothesis test using statistical values for the alpha value of 5%, the t-statistical value used is 1.96. Therefore, the acceptance criteria for the hypothesis are if the t-statistic is > 1.96 and the p value is < 0.05. The results of hypothesis test can be seen in Table 8 below:

Table 8. Hypothesis Test Results

Dependent Variables	R^2	Adj. R^2	β	T	P	Results
DV PU	.517	.512				
PEU			.728	14,502	.000	H3 accepted
DV BI	.532	.523				
PU			.580	4,694	.000	H1 accepted
ATU			.199	1,818	.070	H5 rejected
DV ATU	.581	.572				
PU			.469	3,900	.000	H2 accepted
PEU			.351	2,690	.007	H4 accepted
DV AUSE	.413	.407				
BI			.655	11,589	.000	H6 accepted

Source: Data processed (2019)

Hypothesis 3 examines the relationship between Perceived Ease of Use and Perceived Usefulness. The results show that the Perceived Ease of Use (β = 0.728, t-statistic > 1.96, p < 0.05) had a positive and significant effect on Perceived Usefulness in the use of Ruangguru application. This means that if the Perceived Ease of Use increases, the Perceived Usefulness will linearly increase as well. Therefore, H3 was accepted. Furthermore, the value of R^2 shows a value of 0.517, meaning that the influence of Perceived Ease of Use on Perceived Usefulness is at 51.7% with the level of influence "Strong".

Hypothesis 1 and 5 examine the relationship between Perceived Usefulness and Attitude Towards Using on Behavioral Intention of Use. The results show that Perceived Usefulness (β = 0.580, t-statistic > 1.96, p < 0.05) had a positive and significant effect while Attitude Towards Using (β = 0.199, t-statistic < 1.96, p > 0, 05) did not have a significant effect on Behavioral Intention of Use. Therefore, the conclusion is that H1 was accepted, and H5 was rejected. Furthermore, the value of R^2 shows the value of 0.532, meaning that the influence of Perceived Usefulness and Attitude Towards Using on Behavioral Intention of Use is at 53.2% with the level of influence "Strong".

Hypothesis 2 and 4 examine the relationship between Perceived Usefulness and Perceived Ease of Use on Attitude Towards. The results show that Perceived Usefulness (β = 0.469, t-statistics > 1.96, p < 0.05) and Perceived Ease of Use (β = 0.351, t-statistics > 1.96, p < 0.05) have a positive and significant effect on Attitude Towards Using, so H2 and H4 are accepted. Furthermore, the R^2 value is 0.581, meaning that the influence of Perceived Usefulness and Perceived Ease of Use on Attitude Towards Using at 58.1% with the influence level of "Strong".

Hypothesis 6 examine the relationship between Behavioral Intention of Use on Actual System Use. The results show that Behavioral Intention of Use (β = 0.655, t-statistics > 1.96, p < 0.05) had a positive and significant effect to Actual System Use, so H6 were accepted. Furthermore, the value of R^2 is 0.413, meaning that the influence of Behavioral Intention of Use and Attitude Towards Using on Actual System Use is at 41.3% with the influence level of "Strong".

Discussion

In this study, student's acceptance in using Ruangguru application was identified based on 5 constructs of TAM model. The results of the statistical test give the conclusion that of the 6 hypotheses studied, 1 hypothesis was rejected and 5 other hypotheses were accepted.

The relationship of Attitude Towards Using with Behavioral Intention of Use was insignificant and the hypothesis was rejected. This means that the attitude of students' use does not affect students' intentions in using Ruangguru application. This rejects the results of previous studies which state that the attitude of students to educational technology can shape behavior towards it and eventually lead them to accept it or not [17].

The relationship of Perceived Ease of Use to Attitude Towards Using was significant. Therefore, the much easier the Ruangguru application is, the higher the attitude towards using of students' will be. This supports the results of previous studies which state that Perceived Ease of Use is one of the factors that influence Attitude Towards Using [15].

The relationship of Perceived Ease of Use to Perceived Usefulness has the most significant influence. This means that the use factor of Ruangguru application which is easy makes students feel that Ruangguru application is useful. This rejects the results of previous studies which state that Perceived Ease of Use does not significantly impact Perceived Usefulness [23].

In addition, Perceived Usefulness is significant to Behavioral Intention of Use. Therefore, it can be concluded that if students feel Ruangguru application is useful, so the students' attitudes towards the use of Ruangguru application will significantly increase as well. This supports the results of previous studies which state that Perceived Usefulness is one of the factors that influence Behavioral Intention of Use [16].

Perceived Usefulness is simultaneously significant to Attitude Towards Using. Therefore, it can be concluded that if students feel Ruangguru application is useful, so the students' attitudes towards the use of Ruangguru application will significantly increase as well. This supports the results of previous studies which state that Perceived Usefulness is one of the factors that influence Attitude Towards Using [15].

Furthermore, Behavioral Intention of Use is significant on Actual System Use. This means that if the intention towards using of student's increase, it will actually increase the use of Ruangguru applications by students as well. This supports the results of previous studies which state that Actual System Use of e-systems especially the e-learning ones is directly affected by the Behavioral Intention [24].

Conclusions and Recommendations

In this study, the TAM model is used to assess student acceptance of the Ruangguru e-learning application. This application is one of the e-learning applications that are quite popular among elementary to high school students in Indonesia because it offers the convenience of private tutoring without having to meet with the teacher.

In the research results discussed above, the ease of use factor is stated as the most determining factor for students in using e-learning applications, in this case, Ruangguru application. When e-learning applications are considered easy to use, the implication is that students will use these applications to support learning activities.

From the conclusions above, it is highly recommended that Ruangguru keeps improving the features of Ruangguru application to make it easier to use and to meet the students' needs in the learning process. These convenience factors include the ease of application to be used, operated, accessed, studied, and applied. Moreover, the material delivery factor that is easy to understand is also very important, considering the main purpose of this application is to support the learning process of students in understanding lessons at school.

Future research is expected to be able to analyze further about external factors that might influence, such as Self-Efficacy (SE), Subjective Norm (SN), Enjoyment (ENJOY), Computer Anxiety (CA) and Experience (EXP).

Questionnaire Items

Perceived Usefulness

PU1. Ruangguru application makes it easy for me to understand the subject matter.
PU2. The Ruangguru application helps me prepare for the exam.
PU3. The Ruangguru application helps improve grades in school.
PU4. Ruangguru application is alternative learning besides taking private lessons.
PU5. The Ruangguru application helps students who have difficulty understanding lessons at school.

Perceived Ease Of Use

PEU1. The Ruangguru application is easy to use.
PEU2. The Ruangguru application is easy to access.
PEU3. The Ruangguru application is easy to learn.
PEU4. The Ruangguru application is easy to implement.
PEU5. The method of delivering the material used in the Ruangguru application is easy to understand.

Attitude Toward Using

ATU1. I like the Ruangguru application.
ATU2. Using the Ruangguru application is a good idea.
ATU3. I need to use the Ruangguru application.
ATU4. Ruangguru application is the best solution to support my learning process.

Behavioral Intention of Use

BI1. Ruangguru application is useful to support my learning online.
BI2. The Ruangguru application helps students who are less able in terms of costs if they take regular private lessons.
BI3. Ruangguru application is cheaper than ordinary private lessons.
BI4. The Ruangguru application is more effective and efficient to follow than regular private lessons.

Actual System Use

AUSE1. I intend to use and subscribe to Ruangguru for the long term.
AUSE2. I will use the Ruangguru application to support the daily learning process.
AUSE3. I use the Ruangguru application as an alternative aid in overcoming obstacles while studying.

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E-Supply Chain Management Value Concept for The Palm Oil Industry

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Abstract

The harmony of information technology (IT) and business is an asset and the foundation of the organizations to improve and build business competitive strategies. There is a need to integrate and coordinate all business partners of the organization, particularly those associated with information technology and suppliers, raw materials or resources needed in the supply chain management. The effectiveness of an electronic supply chain management (E-SCM) in the palm oil industry will be the crucial factor to provide the organization with business opportunities and improve competitive position in the marketplace. This study aims to investigate critical factors E - Supply Chain Management in oil palm industry through Theory Resource-Based View (RBV). With RBV theory, this study develops a concept that can be utilized for identifying the critical success factors of E-SCM value in palm oil industry. The quantitative research method is used for collecting data in four Palm Oil organizations in South Sumatera. This research reveals that IT human resources and IT infrastructure are the critical factors and capability to operate E-SCM effectively and efficiently.

Keywords: e-supply chain management, resource-based view, IT infrastructure, IT human resources

Introduction

Organizations are increasingly concerned about the use of Information Technology (IT) in their operations. This is because IT implementation can help them to meet and compliance standards with a competitive business strategy. In addition, with IT the organizations might develop a foundation for its business process and achieving business and IT harmony. *Supply Chain Management (SCM)* is an approach that is efficiently implemented to integrate suppliers, business partners, and warehouses in order to distribute products are produced with the right quantity, appropriate location, and the right time to minimize costs and satisfy customer needs (Simchi-Levi et al. 2008). The development of *SCM* has changed in line with the development of technology which can be known as the *E-SCM. Electronic Supply Chain Management (E-SCM)* is a system developed to meet the stakeholder needs and improve the competitive position in the marketplace that has been supported by an electronic information exchange system, in principle the E-SCM functions the same as SCM in general (Blanchard 2010). E- SCM is a platform used to operate SCM manually being a digital system, the use

of the E-SCM method will greatly help the behavior business to monitor the turnover of goods that occur under the SCM systems (Lancioni et al. 2000; Soo Wook 2006).

The role of the E-SCM of an organization will be the crucial factor to whether an organization will be competitive in the market (Kasemsap 2015). The oil palm industry / plantation is one of the strategic industries of the agricultural sector (agriculture-based industry) and one of the sectors in Indonesia, has a significant contribution to non-oil and gas exports (Asmani and Si 2014). Recognizing that oil palm industry has shown a significant contribution in the global and national economies and even locally, therefore it is necessary to develop a concept or framework from the analysis of E-SCM capabilities and strategies to address issues faced in an effort to increase added value and competitiveness industry to national palm oil industry by implementing Electronic Supply Chain Management (E-SCM).

The concept of the value of E-SCM is a popular approach to evaluate the performance of E-SCM services (Hu and Hsu 2010; Ninlawan et al. 2010). It provides an inclusive framework for identifying organizational performance. Mukharromah et al. (2017) for example, *Green Supply Chain Management* (GSCM) is one method used to improve the performance measurement method of business units in an organization. GSCM is a performance measurement model that integrates all processes along the supply chain, both ones involve the forward chain or backward chain with considering environmental aspects. Wahyuniardi et al. (2017) discuss performance measurement supply chain with the Supply approach Chain Operation References (SCOR). Supply chain mapping classification is obtained by observation and interview with the supply chain manager classified by five main processes namely plan, source, make, deliver and return at SCOR. Azmiyati and Hidayat (2017) examine the measurement of performance against supply chain management carried out in the process of the residential stage finished product and release finished product to deliver. The method used in measuring performance is a method SCOR which is assisted by the FAHP method (Fuzzy Analytical Hierarchy Process) inside the process of determining the weight in each metric. The results of these calculations will be known organizational performance indicators that are relatively low so that it can be given proposed improvements and known what metrics only that greatly affects the performance of workers. Tanaka and Nurcaya (2012) explain how to assess whether supply chain management is a performance the organization has done well seen from the four balanced scorecard perspectives namely customer perspective, financial perspective, internal business process perspective, and learning perspective and growth. The balanced scorecard is a system where integrated performance management connects various objectives, performance measures and strategies of an organization, with interpreting the strategy into a process that not only became the top management mil but also every individual at every level of the organization.

The purpose of this study is to identify critical factors to evaluate the value of E - SCM in the Palm oil industry. A concept developed by the competitive position of an organization is determined by the main resources of organizations. Most resources require to be analyzed and the most important of its existence before the organization determines the strategy or build internal governance of organization resources compared to external factors (Antoni et al. 2018; Sharma and Vredenburg 1998). Resource-Based View (RBV) is the main theoretical framework for understanding relationship between IT and business value (Wernerfelt 1984). With this theory, this research can identify the capabilities of organization as a set of potential resources and capabilities to improve its performance (Antoni et al. 2016; Antoni and Jie 2013). The aim of this research is to identify IT capacity of E-SCM in organization especially in Palm oil industry for optimizing E-SCM by analyzing internal resources, namely IT human Resources and IT Infrastructure.

IT infrastructure including systems and technology is a significant factor that coloring business trends today. Technology is designed to complement the human resource capacity and help someone to apply their knowledge (Antoni et al. 2016). In addition, the adoption of technology is employed to support capacity of staff or human resources and replace it (Benitez-Amado and Walczuch 2012; DeLone and McLean 1992). Therefore, the IT infrastructure is the human capacity that used to build on competence of IT.

This research consists of parts, namely: the first part is Introduction. This section describes a comprehensive of the content, issues of this study. The second section contains a literature review,

which includes previous studies that serve as a basis for foundation and strengthening the points of strategic planning ideas. The third section is the research methodology, describing the research method. This includes research design, population and samples, research instruments, data collection techniques and data analysis techniques. The fourth section is a discussion of the results of the study consisting of analyzing and reviewing the readiness of the company. The fifth part is the final or concluding part of this research which contains conclusions from the results of the study as an affirmation of the answers to the research problem.

Developing E-Supply Chain Management Concept

Electronic Supply Chain Management

According to Indrajit and Djokopranoto (2002), Electronic Supply Chain Management (E-SCM) is a management concept in which organizations effort to utilize information and internet technology to integrate all of their business partners, especially those related to the system of supplying raw materials or resources needed in the production process. According to Chaffey (2009) E - SCM is defined as an approach and strategy that is applied in internet technology as a channel system connecting all organizational natural supply chains to improve service or provide benefits to the customer.

Several previous studies have suggested compulsory components or resources be managed by the company. The research conducted by Ravichandran et al. (2005) states the influence of the information system (IS) resources and capabilities on organizational performance . It contains four elements that connected each other's, namely the organizational performance, IT Support to core competencies of the organizations, IS competence, and IS Resources. Arslan and Ozturan (2011) argue that there are two factors in the process of creating business value, firstly: Complementary resources will provide a sustainable competitive advantage for the company, and secondly, IT investment is in the breed with the company's strategy. Bharadwaj (2000) identify the factors of IT human resources and IT Infrastructure, by using the concept RBV theory. The organization's resources are part of the initial analysis step before the organization determines the strategy or conducts IT governance. Gómez-Cedeño et al. (2015) identify the supply chain management factors namely firstly, the ability of human resources who have the technical skills of IT. It is designed for equipping IT human resources and helps them to apply their knowledge. Hence, the adoption of technology to support capacity's someone and not replace it. Secondly, technology is an adopted to provide facility for the achievement of business objectives of an organization by providing a framework for cooperation between business partners through both electronic media and communication. It can provide benefits in enhancing competitive advantages, reducing operational costs, and achieving better cooperation and coordination between business partners in the supply chain. Table 1. shows the summary of prior research related to the use of IT in E-SCM implementation.

Table 1. Previous Studies

Resources / Factors	Ravichandran & Lertwongsatien (2005)	Arslan & Ozturan (2011	Gómez-Cedeño et al. (2015), Bharadwaj (2000)	Tanaka (2018)	This research
IT Human Resources	✓	✓	✓		✓
IT Infrastructure	✓	✓	✓		✓
IT Partnership Quality	✓				
Complementary Resources		✓			
Information Sharing				✓	
Long Term Relationship				✓	
Cooperation				✓	
Process Integration				✓	

This study uses a model developed by Benitez-Amado et al. (2010), Bharadwaj (2000) Arslan and Ozturan (2011) The model has two factors, namely the IT human resources is the ability of human resources to work on IT competencies; and IT Infrastructure is a technology resource that provides a platform for application systems and technology to organizations. To identify the ability of the IT human resources and IT Infrastructure in E-SCM, this study will use the Theory of Resource-Based View.

Resource-Based View Theory

Wernerfelt (1984) argues that organizations can obtain and maintain a competitive advantage by developing and using a valuable resource and capability. Barney (1991) states that sustainable design advantages exist in organization only if the efforts of other organizations are unsuccessful to replicate these advantages. Meanwhile, the RBV theory states that organizations are not able to expect to purchase or take the sustainable competitive advantage from another organization. This is because that advantage is rare, difficult to replicate, and irreplaceable resources. Hafeez et al. (2002) define ability as a combination of an organization obtained from a resource that allows to carry out several business processes or activities to achieve competitive advantage.

The *RBV* highlights the importance of resources and capabilities that are valuable, rare, difficult to replicate and are difficult to provide services or produce more economical products (Barney 1991; Ray et al. 2004). Adopting the RBV theory, much research has identified the resources and capabilities in an organization. For example, Kettinger et al. (1994) argue that the ability of an organization to achieve profits is determined by Information Technology (IT) infrastructure. Bharadwaj (2000) argues that IT capability is the ability of an organization that is created precisely by the interaction between the IT Infrastructure, IT human resources and IT intangible assets in an organization to improve the performance of organizations. Tippins and Sohi (2003) argue that IT capabilities are the ability of organizations to use IT resources to improve performance. The following sections are description about factors of *E - SCM* based on Resource Based View Theory approach namely IT human resources and IT Infrastructure.

Human Resources and Information Technology

The IT of human resources is the ability of human resources to carry out duties and responsibilities given to them with education, sufficient training, and experience (Antoni et al. 2016; Antoni and Jie 2012). Duncan (1995) defines that human resource power is the main supporting pillar, as well as the drive for organizational activities in business, realize the vision and mission and goals of the organization. This is because the organizations should be ensured that management of human resources done as well as possible to be able contribute optimally within efforts to achieve organizational goals.

The process of planning and managing Human Resources Information Technology, is identify staffing needs, determine the recruitment process, determines the programs and training allocating human resources IT, determine reward, and so on (Gabčanová 2012). It can be concluded IT human resources is human resources with technical capability. IT technical skills are the appropriate technical skills to be updated, which are related to systems both *hardware* and *software* held by employees.

According to (Benitez-Amado et al. 2010), IT human resources consists of two indicators of managerial and interpersonal abilities and technical and analytical skills. Managerial ability and interpersonal skills are required by IT employees in conducting their organizational business processes through knowledge. In conducting business activities and a job in a particular field, requiring the understanding how the resources and capabilities work and interact together. There are two factors of IT human resources within the context of the organizations namely a). Knowledge of business is referred to as knowledge capital or intellectual capital in business. knowledge in this business is an important element that enables organization to operate in the targeted sector as an organization purpose, b). Knowledge of

technology and business processes is utilization of technology Information aligned with organizational structured business plans. The aim of this knowledge is every application of Information Technology can provide value to organization, c). Knowledge of the procedures and regulations for the organization is a work principle professional that should be obeyed by each element in the organization. This is aimed to set each element in the organization to be able to perform its duties professionally, d). Understanding of the main organizational values organization should be able to create conditions where each element can work together effectively and optimally. The main value is also outlined that the purpose of the organization has to be in accordance with the ability of the IT human resource then that organizational goals can be achieved, e). An understanding of the division of duties within the organization is the elaboration of tasks that should be adjusted between the ability and type of work to be handled, besides that it is accompanied by procedures and work discipline to be easily understood by the workers concerned, f). The ability to operate the routines and the system implemented in the IT department is the ability in the field of IT should be owned by IT human resources to conduct the system that applied in organizations.

Technical IT and analytical ability to solve several issues related to IT in an organization. However, a systematic framework is needed to accelerate finding solutions to these issues. Technical ability is the capability of IT human resources in organization that will be able to exploit the existing working methods. This means that organizations that have the technical capability that includes working procedures, working methods, and tools that exist as it has in the value can increase the work maximally and greatly. The ability to learn and apply new technology is an effort to strengthen the carrying capacity of science and technology in increasing the competitiveness of organizations. The skills and knowledge of IT projects are ability of IT human resource particularly for IT projects, project attributes, and describes the various obstacles in the project. The ability to manage and integrate IT into the business is the knowledge, skills in leveraging IT technologies in the organization as a competitive strategy in business.

Information Technology Infrastructure

Information technology infrastructure (IT infrastructure) is the fundamental IT planning capability in organization. It includes technical and human capabilities that are realized in the form of services and reliable applications. In general, IT infrastructure consists of four main elements, namely hardware, software, databases, and networking. Each element has the complexity of the issue itself that requires good IT governance that is able to generate value for the organization through a reliable package of services (Jogiyanto 2003).

Information technology infrastructure is a shared technology resource that provides a platform for detailed application of company information systems (Antoni et al. 2016; Antoni and Jie 2013). Information technology infrastructure includes investments in hardware, anti-software, and services such as consulting, education and training that are spread throughout the organization or scattered throughout the business units in the organization. According to Powell and Dent-Micallef (1997 IT Infrastructure consists of two indicators, namely Network and Platform, and Data and Application.

In term of network and platform, IT infrastructure consists of the existence of infrastructure to connect business units is the most important objective of Information Technology infrastructure within the organization is to increase the dissemination of information to entire business units; availability of an infrastructure to connect with business partners with the use of the system can reduce costs, unique products and relationships with customers and business partners can be perceived by the organizations; The existence of infrastructure to support business operations is one of the factors that contributed to the operational progress of the organization's business with the support of IT infrastructure; Infrastructure network capacity, IT networks can improve coordination in efforts to develop new products or services for the organizations.

In term of data and application, IT infrastructure indicators in the corporate context consists of; Infrastructure network speed, software development, and development can expand the network throughout the business unit and stakeholders; Data distribution in the organization, information technology is used to process data, including processing, obtaining, compiling, storing, manipulating

data to produce quality information and then distributed; Modularity of application systems, utilization of IT as a strategy for how organization place IT for review, monitoring and evaluation ;Standardization of infrastructure components, information technology help analyze business processes and the development of enterprise information architecture wider.

Based on the description above, this research develops a conceptual framework to clarify how theories relate to various factors that have been identified as important issues. Frameworks in this study can be illustrated in Figure1. below.

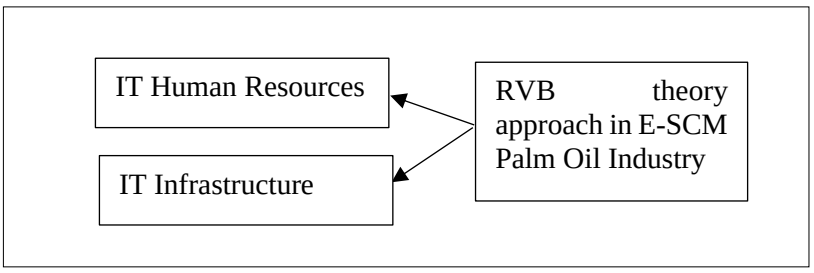

Figure1. Conceptual Framework

In this study, this research is identified two factors *E-SCM* utilized in the palm oil industry, namely, IT human resources and IT Infrastructure. Table 2 shows a summary of the critical factors of IT human resources and IT infrastructure within the organization in accordance with the RBV theory approach that the organization's competitive advantage for conducting several business processes or activities is derived from unique resources and capabilities.

Table 2. Research Variables

Variable	Dimension	Indicator	Item	
IT human Resources is one of the most important and influential things in the success of an organization in utilizing information technology. human resources, especially those in charge of IT competencies, have a significant role in developing in the organization, and therefore they must have strong technical, analytical, managerial and interpersonal skills.	Managerial	Managerial and Interpersonal Ability (A)	A1	Knowledge of business process
			A2	Knowledge of the organization's technology and business processes
			A3	Knowledge of procedures and regulations in the organization
			A4	Understanding of the organization's main values
			A5	Understanding of the division of tasks within the organization
			A6	Ability to run routines and systems that are implemented in the IT department
	Analysis	Technical Ability and Analysis (B)	B1	Technical Ability
			B2	Ability to learn and apply new technology
			B3	IT project skills and knowledge
			B4	The ability to manage and integrate IT into business
IT infrastructure is a resource that plays a significant role in organizations in the utilization of information technology, IT infrastructure such as computers, additional equipment, software, procedures, and services. All of these resources are used to collect, store, analyze and distribute data within the organization.	Network	Network and Platform (C)	C1	The existence of infrastructure to connect business units
			C2	The existence of infrastructure to connect with business partners
			C3	The existence of infrastructure to support business operations
			C4	Infrastructure network capacity
	Data	Data and Application (D)	D1	Infrastructure network speed
			D2	Data distribution within the organization
			D3	The modularity of application systems
			D4	Standardization of infrastructure components

Research Method

This research is designed to find out a situation regarding the application of a research model to real conditions in an organization that is used as a case study by researchers. The study used a survey method, where data were collected from a sample of the oil palm industry population using questionnaires as a tool for primary data collection by distributing questionnaires to 200 respondents to organization and its stakeholders. Secondary data is a collection of data previously collected from documents and literature studies, both published and unpublished relating to the palm oil industry. The population in this study is organization in the palm oil industry that fulfills the characteristics of the Palm Oil organizations and uses the benefits of information technology / *E-SCM* in the palm oil industry. The selection of respondents is done by means of *purposive sampling (Non-Probability Sampling)*, namely selection with consideration of respondents based on industry in the Musi Banyu Asin (Muba) district of South Sumatra province. Based on data from the South Sumatra Plantation Service in 2011, the Province of South Sumatra is one of the largest palm oil producers in Indonesia with an area of 866,763 hectares (Asmani and Si 2014).

To adequately address the research question, the proposed framework has to be validated first. A survey is conducted for collecting the data. The questionnaire includes three types of questions for capturing (a) the demographic profile of the participants, (b) the IT Infrastructure, and (c) the overall perceptions about the IT Human Resources. The questionnaire uses a five-point Likert-type scale where the value "1" represents "not important at all" and the value "5" represents "highly important." Prior to the distribution of the questionnaire, a pilot study was conducted to test the appropriateness of the questionnaire items.

The paper-based survey was conducted in South Sumatera between January 2017 and March 2017. The target population from the Palm Oil industry has used IT in their daily business operations. Approximately 300 questionnaires are distributed. To enhance response rate, 350 questionnaires with a hardcover letter. 36 questionnaires are undeliverable and 44 are identified as incorrect addresses from follow up mobile phone calls. Most of the undeliverable questionnaires are caused by organization out of business. A large number (70) of respondents refuse to participate in the survey. The reasons for non-response could be respondents' lack of interest in the research topic, their level of education (low education level), or some other social and economic factors. A total of 200 responses are received with a 50.7 % response rate. Six responses are unusable; therefore, they were removed from data analysis. The remaining 200 responses were retained. Table 3 shows the demographic profile of the respondents. Data are stored and screened using SPSS Statistics for addressing the missing values, validity, reliability, outliers, normality.

Table 3 Profile of Respondents

No.	Respondents	Num.	%	No.	Respondents	Num.	%
1	Sex			4	Experience		
	Male	130	65		<5 years	50	25
	Female	70	35		6-10 years	80	40
2	Education				11-15 years	35	17.5
	High school	110	55		16-20 years	27	13.5
	Diploma	20	10		> 20 years	8	4
	Bachelor	50	25	5	Position		
	Postgraduate	20	10		director	4	2
3	Age				The manager	8	4
	<30 years old	30	15		Marketing	40	20
	31 - 35 years old	87	43.5		Production employees	88	44
	36 - 40 years old	50	25		Administrative Staff (Finance, R & D staff, and those who understand the condition of the company)	40	20
	41 - 45 years old	25	12.5		Supplier	20	10
	46-50 years old	8	4				

Statistical analysis as showed in Table 3 indicates that the demographic characteristics of questionnaire respondents. Our survey is targeted at several industries and managers above the middle management level. There are two main reasons for this. Firstly, the capability of IT infrastructure and IT human Resources contribute to greater effectiveness in a wide range of industries and organizations. Secondly, for increasing the generalizability of these research findings, we utilize a diverse sample of person who generally understands their organizational capabilities and has the capability utilizing IT resources to perform business operations in their organization. Therefore, the respondents could effectively provide correct responses for our questionnaire survey.

The collected data are analyzed using SEM techniques for identifying the critical factors for evaluating value of e-supply chain management in the Palm Oil Industry. Such a technique is required in this research for testing the relationships between measured variables and unobserved constructs, and for estimating the relationships between unobserved constructs. SEM uses various types of models to depict the relationships among observed variables(Hair 2010). To assess the initial conceptual constructs, confirmatory factor analysis (CFA) and analysis of Moments structures (AMOS) version 21 are used. CFA tests a measurement theory by providing evidence on the validity of individual measures based on the model's overall fit and other evidence of the construct validity (Hair 2010). To assess the model's overall fit, various goodness-of-fit (GOF) measures were used including chi-square (x2), the ratio of x2 to degree of freedom (x2/df), the GOF index (GFI), root mean square error of approximation (RMSEA), Tucker–Lewis index (TLI), and comparative fit index (CFI). The maximum likelihood estimation technique is used for estimating the parameters in the model.

Data Analysis

Figure. 1 shows the initial measurement model developed for evaluating value of e-supply chain management in Palm Oil Industry. The measurement model for IT human resources and IT infrastructure. IT human resources determined by managerial and analysis capability and IT infrastructure consists of network and data capability.

Managerial capability consists of Knowledge of business process (A1), Knowledge of the organization's technology and business processes (A2), Knowledge of procedures and regulations in the organization (A3), Understanding of the organization's main values (A4), Understanding of the division of tasks within the organization (A5), Ability to run routines and systems that are implemented in the IT department (A6). Analysis ability is determined by Technical Ability (B1), Ability to learn and apply new technology (B2), IT project skills and knowledge (B3), The ability to manage and integrate IT into business (B4).

In terms of IT infrastructure, network is determined by the existence of infrastructure to connect business units (C1), The existence of infrastructure to connect with business partners (C2), The existence of infrastructure to support business operations (C3), Infrastructure network capacity (C4). Data capability consists of Infrastructure network speed (D1), Data distribution within the organization (D2), Modularity of application systems (D3), Standardization of infrastructure components (D4). None of the indicator variables in either model is cross-loaded on multiple constructs.

To analyze and evaluate the framework, construct and related indicators, convergent, discriminant and factorial validity are conducted in this research. Convergent validity is conducted by considering; (a) loading factor (SFL) in each indicator, (b) construct reliability (CR) and (c) average variance extracted (Hair et al. 2010). Loading (SFL) in each indicator should be more or equal to 0.5 for use in further analysis. Construct reliability for each is calculated as the squared of the loading factors sum divided by the squares sum of summing factor loading and the sum of error (Hair et al. 2010). Acceptable CR values must be between 0.6 and 0.7 (Hair et al. 2010). The average variance extracted (AVE) is calculated by dividing the total of all SFL squares by the number of indicators or items (Hair et al. 2010). AVE value received must be more than 0.5. All indicators in each construct that met the above requirements are re-examined with discriminant validity. It measured the extent of the differences in each construct in the e-government model. To obtain the satisfactory value of discriminant validity, the

AVE quadratic roots for each construct must be greater than the correlation between them (Hair et al. 2010). Furthermore, the validity factor test is performed for each construct an indicator that meets the value in the convergent and discriminant to represent the same value level.

The concept of the E-SCM value model (Figure 1.) has been tested and evaluated for validity test by performing CFA (Confirmatory Factor Analysis) with GFI value (0.763), RMSEA (0.075), TLI (0.875), CFI (0.856), and p-value 0,000). These initial results indicated that the model is inadequate. Hence, it is essential to conduct the congeneric factor test model for each individual construct. Its findings show that there is one item removed. The item deleted on IT human resources is A4. Meanwhile, there is no item deleted in IT infrastructure. The results of this congeneric factor analysis test can be seen in Tables 4 and 5. This model is redefined by standardized factor loading, standardized residual covariance matrix, and modification Indies. Table 6 shows the GOF results from e-SCM value model testing. The GOF results showed that the test results are received with RMSEA (0.05), GFI (0.95), TLI (0.98), AGFI (0.92) and CMIN/DF (1.23). To complete the convergent validity test, CR value is calculated in every construct. As shown in Table 7, all constructs have values within the accepted range. This can be seen by the AVE value of each greater than 0.5. The SFL value for each indicator of the final model test showed above a critical value of 0.5.

Table 4. Evaluation *Criteria for Goodness of Fit* variable IT Human Resource

The goodness of fit index	Cut-off Value	Model Results	Information
X^2 - *Chi-square*	*Expected to be small*	10.842	Pretty good
Probability	<0.05	0.00 4	Well
CM IN / DF	≤ 2.00	1.221	Well
GFI	≥ 0.90	0 . 975	Well
AGFI	≥ 0.90	0 .973	Well
TLI	≥ 0.95	0 .949	Well
CFI	≥ 0.95	0 .983	Well
RMSEA	≤ 0.08	0, 014	Well

Source: Primary Data After Processing

Table 5. Evaluation of the criteria for *Goodness of Fit Indices* of IT Infrastructure

The goodness of fit index	Cut-off Value	Model Results	Information
X^2 - *Chi-square*	*Expected to be small*	24,168	Pretty good
Probability	<0.05	0.00 0	Well
CMIN / DF	≤ 2.00	1.08	Well
GFI	≥ 0.90	0 . 94	Well
AGFI	≥ 0.90	0 .92	Well
TLI	≥ 0.95	0 .98	Well
CFI	≥ 0.95	0 .96	Well
RMSEA	≤ 0.08	0, 06	Well

Source: Primary Data After Processing

All constructs of this model that have passed the convergent validity test are validated for discriminant validity test. Discriminant validity among other factors of this model is examined by using Farrell (2010 model. The results reveal that the discriminant validity in each pair of constructs with AVE square root is greater than the estimated correlation between them.

Factorial validity test is conducted to assess whether the factors passing the convergent and the discriminant ones showed the same level of the construct, and to detect and remove items that having

cross-loading (Molla et al. 2009). The results verify that the factorial model has sufficient validity. The GOF of the final measurement model is also within an acceptable range. CMIN (X2) of 154.435 with and CMIN / df 1,23 indicated that it is quite in accordance with the value suggested by Hair, et al. [38]. In addition, the p-value for the model is 0.05 very closed to an acceptable p-value (Pb 0.08). Furthermore, the fact that GFI (0.95) reached 0.95 indicated that this model is an adequate match. Similarly, both TLI (0.98) and CFI (0.97) are greater than 0.95, indicating that it is near perfect. Moreover, RMSEA (0.05) is equal to 0.05.

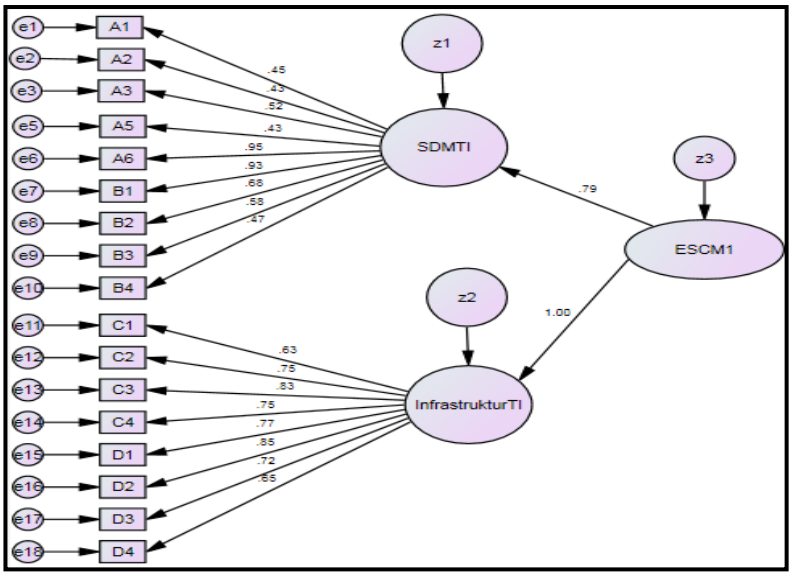

Figure 2. Final measurement model

This is strong evidence as an appropriate final model and could be maintained. Figure 2 shows the final measurement model. The structural model of Figure. 2 indicates that strong support is essential for evaluating factors for E-SCM value through IT human resources and IT infrastructure. In addition, the result also shows the relationship between the E-SCM value → IT human resources and E-SCM → IT infrastructure paths with coefficient values of 0.79 and 1.00 lines in each. Models account for 79% of variance in IT human Resources and 100% in IT infrastructure. This shows that IT human resources and IT infrastructure are critical factors in evaluating E-SCM value.

All constructs that had assessed the convergent validity test are validated for the discriminant validity test. Discriminant validity among other factors of this model is examined by using Hair et al. (2010 model. The findings reveal the discriminant validity in each pair of constructs with AVE square root is greater than the estimated correlation between them.

Table 6. Evaluation of criteria for a *Goodness of Fit Indices* for all variables

Goodness of fit index	Cut-off Value	Model Results	Information
X^2 - *Chi-square*	*Expected to be small*	156,435	Pretty good
Probability	<0.05	0 000	Well
CMIN / DF	≤ 2.00	1. 23	Well
GFI	≥ 0.90	0. 95	Well
AGFI	≥ 0.9 0	0. 92	Well
TLI	≥ 0.95	0. 98	Well
CFI	≥ 0.95	0. 97	Well
RMSEA	≤ 0.08	0, 05	Well

Table 7. Convergent Validity Test Results

Construct	CR	AVE	Indicators	SFL
IT human resources	0.60	0.51	A1	0.45
			A2	0.43
			A3	0.52
			A5	0.43
			A6	0.95
			B1	0.93
			B2	0.68
			B3	0.58
			B4	0.47
IT infrastructure	0.66	.055	C1	0.63
			C2	0.75
			C3	0.83
			C4	0.75
			D1	0.77
			D2	0.85
			D3	0.72
			D4	0.65

From the evaluation of the proposed model n shows that the evaluation of the model for the construct as a whole turns out that there are no critical violations from various criteria so that it can be stated that the model is relatively acceptable

Finding and Discussion

IT Human Resources are human resources with technical skills. Especially in the field of IT Relates to both hardware system and employee software and the important factors for E-SCM organization, from the result of testing IT human resource variables qualify as an E-SCM factor using the RBV theory. The variables have nine indicators switch will be explained in the next section.

Business knowledge (A1) ; Lee et al. (1995) and Benitez-Amado et al. (2010) reveals that the organization's business knowledge is very important because the knowledge of an organization can develop a strategy for the success of the organization. Each person in the organization either superiors or subordinates obliged to share their knowledge. All ideas contained will produce an input of information and become information that must be implemented or applied. Knowledge management can help organization to gain knowledge about business process, the problem that occurs in each work unit plays on business important role in the progress of the organization because of the superior knowledge of organization and human resources, the higher competitiveness of organization in the global market. By organization knowledge technology and business process (A2) A knowledge to help organization determine the technology designed to complement human resource capabilities and help someone to apply their knowledge so that technology adoption in the organization can support one's skills in the business competence in the organization. Knowledge regarding producers and regulations in the organization (A3) also needed to determine and decide on IT investment in the organization, must be supported by all elements, by communicating, learning or training, involving employees or individuals in the latest application of procedures, human resource management organization to place and assign employees to positions and project according to ability and vice (Chaffey 2009; Ray et al. 2004). Understanding the division of tasks in the organization (A5); the organization will be good if the human resources in it have been able to carry out their respective work, specifically, and do not have a dual role that can hinder the process of archiving. Task analysis needs to be done in order to design the organization and determine the division of work, job specification, and job evaluation (Karimi et al. 2004; Saunders 1995). The ability to carry out routines and system that are implemented in the IT department (A6). It intends the ability of human resources in IT competencies to run a system requires to have a level of expertise in the organization in implementation and operational practices such as

product development, management of raw material suppliers, production control planning and distribution through the system that has been implemented (Soo Wook 2006; Stephan and Robert 2006).

The other side of the IT human resource factor is Technical Ability (B1) which is an important point in implementing e-supply chain management in the organization. This is because technical ability is the skill of using knowledge of methods, techniques, and equipment needed to carry out tasks, and organization in accordance with the work units of each so that the ability of this technique is in line with the organization strategic goals (Ravichandran et al. 2005). Ability to learn and apply new technology (B2). Berkhout and Hertin (2004) and Worley et al. (2010) argue the importance of studying and implementing new technologies, the demands of work that can change due to changes in the work environment, strategies and emergence of new technologies or the emergence of new methods. For organization to increase competitiveness and improve productivity, organization can no longer rely solely on assets in the form of capital they have but must be the most important element of Human Resources, because Human Resources are the main determinant aspects of competitiveness. IT project skills and knowledge (B3). It is an important capability for Human Resources in supporting the operational performance of organization that have integrated business processes with technology. Activities that include management and planning of development of application systems, infrastructure, computer networks, workstation units or any entity related to IT applications are implemented by organization, with the ability to describe various obstacles in IT projects and IT Strategies that are good for building products and services (Liu 2002; Zinaida 2005). The ability to manage and integrate IT in business (B4) the technical ability of Human Resources that is capable of carrying out the tasks / procedures of E-SCM work as the integration of business processes from end-users through suppliers that provide products, services, information, and even increase in value for consumers and employees.

The second variable is the IT infrastructure that a sharing technology resource that provides a platform for detailed application of organization information systems (Liu 2002). Information technology infrastructure includes investment in hardware, software, and services such as consulting, education and training that is spread throughout the organization or spread throughout business units within the organization. Based on the results of variable testing and analysis IT Infrastructure fulfills the requirements as an E-SCM factor using the RBV variable theory has 8 indicator items including, as follows;

Availability of IT infrastructure to connect business units (C1). By the supply chain, an organization can build cooperation through the creation of computer networks coordinated in providing information on goods and services to consumers efficiently (Guiyi and Hanxiao 2008). The next factor is the existence of an IT infrastructure to connect with business partners (C2). This information technology media is one of important technology that plays the role in creating business networks, Transactions in business partnerships include the exchange of information between suppliers, sellers and distributors that including order management, inventory and sharing documents (Antoni et al. 2018; Becher et al. 2001). The existence of infrastructure to support business operations (C3), according to Adela et al. (2008) IT infrastructure as part of the organization's strategy to transform business processes towards a more efficient. Furthermore, it also needs changes and the creation of a new business model for a business organization by utilizing the opportunities of existing technology to create something new and can be accepted by the customers through IT. The application E-Supply Chain Management is a suitable value applies because its system has an excess value which is that able to manage the flow of goods or products in the supply chain such as the process of purchasing raw materials, fulfilling customer orders and distributing finished goods. Infrastructure computer network capacity (C4), according to Dao et al. (2011), The information technology existences is the part of information of technology as a means or organization media in operations, Monitoring and Control, Planning and Decision, Communication, and Inter organization that improving coordination in developing new products or organization services.

Infrastructure network speed (D1), the use of information technology incorporate activities is an alternative opportunity for organization because through the application of technology organization can save costs and operating time of the organization, create high work productivity, accelerate the delivery of products and services to customers, and the ability to produce valuable products and services for customers (Ngai et al. 2014).

Data distribution within the organization (D2), Jakkhupan et al. (2011) describe Is a manifestation of the implementation of the business network system strategy in building relationships between organizations based on coordination or dissemination of information on work units in the organization. The implementation of information technology is very important to facilitate the exchange of information in the flow of information both in terms of scheduling, production, demand estimates, and sales estimates. Modularity of application systems (D3), Antoni and Jie (2012) The modularity system that organization applies in the Organization in the utilization of information technology provides a framework, the strategy of organization in using IT to review, monitor, evaluate and collaborate between business partners through both electronic media and communication, so that can be provided benefits increasing competitive advantage, reducing operational costs, and more cooperation and coordination among business partners in the supply chain. Standardization of infrastructure components (D4), Information technology provides a framework for cooperation between business partners through both electronic media and communication, so that it can provide benefits in increasing competitive advantage, reducing operational costs, and achieving better cooperation and coordination among business partners in the supply chain. The development of inter-organizational information systems has shifted the role of information technology from competitive weapons into weapons to achieve good cooperation (Lee at al., 2000). The implementation of information technology is very important to facilitate the exchange of information in the flow of information both in terms of scheduling, production, demand estimates, and sales estimates.

Conclusion

Based on the results of the E-Supply Chain Management factor analysis using the Resource-Based View Theory, a number of things can be summarized as follows:

This study produces two critical factors E-SCM using the theory of RBV in the Palm Oil Industry, namely the factors of IT Human Resources and IT Infrastructure. That the main concern of the organization is the resources and capabilities to achieve competitive advantage, by identifying factors Human Resources IT and IT Infrastructure are interrelated and mutually supportive, factors Human Resources IT is the ability of human resources to do work on IT competencies, and infrastructure factors IT is a technology resource that provides a platform for information system applications in organization.

IT Human Resource Factors consist of Managerial dimensions and Analysis based on research data of qualified Human Resources, especially those in charge of IT competencies has an important role in the development of the organization. On indicators of managerial and interpersonal abilities with criteria for items namely (A1) Knowledge of business, (A2) knowledge of technology and business processes of the organization, (A3) Knowledge of procedures and regulations in the organization, (A5) Understanding of the division of tasks within the organization, and (A6) Ability to run routines and systems applied in the IT department. On the Technical Ability indicator and Analysis with item criteria, namely (B1) Engineering Capability, (B2) Ability to learn and apply new technologies, (B3) IT project skills and knowledge, and (B4) Ability to organize and integrate IT into the business. This is evidence that IT Human Resources are important factors in the success of a business unit in implementing information technology, especially in the supply chain (E-SCM).

IT Infrastructure Factors consisting of Network and Data dimensions based on research data that IT Infrastructure resources play an important role in the organization in the use of information technology. On Network and platform indicators with item complexity, namely (C1) Existence of infrastructure to connect business units, (C2) Existence of infrastructure to connect with business partners, (C3) Presence of infrastructure to support business operations, and (C4) Infrastructure network capacity. On the Data and Application indicators with the item frequency, namely (D1) Infrastructure network speed, (D2) Data distribution within the organization, (D3) Modularity of application systems, and (D4) Standardization of infrastructure components improves that Technology is an adopted facilitator in achieving the organization's business goals and achieve competitive advantages

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Designing Enterprise Architecture of The Smart Governance of Bogor

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Abstract

Bogor is one of the cities which are expected to implement Smart City. To realize Smart City is the implementation of e-government through the use of Information Technology (IT) through the Smart Governance to be able to harmonize the implementation of the Bogor ICT integration strategy with the existing ICT masterplans. This study was aimed to make an application of the Enterprise Architecture (EA) framework to support the Smart City Masterplan in Bogor City. In addition, a comprehensive of gap analysis was carried out in this study. The TOGAF Architecture Development Method is used to design the Bogor City EA. The study provides recommendations for the design of Smart Governance Enterprise. Based on the results of a gap analysis of enterprise architecture, the need for an integrated system, interoperability, budget amount, ICT human resources, and ICT infrastructure needs to be improved, as well as the need for regulations and standards.

***Keywords**: Enterprise Architecture, Masterplan, Smart City, Smart Governance, TOGAF*

Introduction

Smart City is a city which connects several infrastructures, i.e. physical, information technology, social and business infrastructures, to utilize the intelligence of the city collectively Harrison et al. (2010). The development of Smart City in Indonesia is based on people's needs for good and transparent public service access (Annisah 2017). Based on the Masterplan of Smart City, the architectural design of the development of Smart City consists of several dimensions, which are Smart Governance, Smart Branding, Smart Economy, Smart Living, Smart Society, and Smart Environment (Diskominfostandi Kota Bogor 2017).

One of the implementations of e-government is the usage of Information Technology (IT) which plays a very significant role in realizing Smart City in supporting government services. This is a part of the dimension of Smart Governance (Annisah 2017). According to Scholl & Scholl (2014), Smart Governance is the basis of a smart, open, and participatory government, where Information and Communication Technology (ICT) is the main key in realizing a smart government. Furthermore, Nam & Pardo (2011) also argues that a smart innovation requires a level of information and knowledge sharing, so that integrated information and interoperability to cross the borders between agencies in government is very necessary. Smart Governance service with open data system is very important to support integrated and transparent public services (Annisah 2017).

According to Nurhadryani et al. (2017), 60% of the population of Bogor is digital native and 52% is digital immigrant who can access internet every day. It shows that ICT usage is relatively high, so e-government as the main foundation of Smart Governance in Bogor is very necessary, without neglecting offline services.

This study is important because Indonesia is in the design phase of the National Enterprise Architecture or Sistem Pemerintahan Berbasis Elektronik with the Presidential Regulation No.95 of 2018 involving several ministries, including the Ministry of Administrative Reform and Bureaucracy Reform. Meanwhile, the regional government of Bogor City and other cities such as Riau (Pemkot Bogor 2010) (Diskominfo Provinsi Riau 2016) prepared an e-government master plan with reference to Presidential Regulation No. 3 of 2003, which is evident from the application of corporate architecture in the initial stages.

The Ministry of Communication and Information of RI in 2017 launched "Action toward 100 Smart Cities in Indonesia" and chose 25 regencies/cities to implement Smart Cities in Indonesia. One of the cities is Bogor. Through this program, the preparation of Masterplan of Smart City of Bogor involves all stakeholders in Bogor. The current Masterplan of e-government of Bogor (Pemkot Bogor 2010) is used as a guideline for the implementation and achievement of the target of e-government to support ICT program and public services of Bogor. Using the ICT masterplan Bogor already has, more detailed EA designing is required to develop the Masterplan of Smart City, especially the dimension of Smart Governance which is an important company, so that it can be a recommendation in the implementation of Smart City in Bogor (Diskominfostandi Kota Bogor 2017).

The preparation of Masterplan of Smart City requires a good framework to manage a complex system and harmonize business and IT in the future. Rouhani et al. (2015) state taht EA is a strategy to harmonize business and IT in an organization. Within the scope of Smart Governance, EA framework and information have some benefits, including driving government services, providing necessary insights to balance the review of needs, and facilitating translation from implementation of ICT masterplan. It will drive national ICT initiatives, especially to realize Smart City program.

The present study aimed to produce EA recommendation as the basic framework of the Master-plan of Smart City of Bogor, especially for the dimension of Smart Governance. Gap analysis was required to review the condition of information technology architecture in Bogor, so that stakeholders could know how far the EA was implemented. The present study focused on the dimension of Smart Governance which was implemented using the framework of TOGAF Architecture Development Method which is described in the principles of architecture based on TOGAF ADM Phase Preliminary (The Open Group 2011). TOGAF in the present study was implemented until Phase E Opportunities and Solutions.

Methodology

The first stage in the research method was collecting data and analyzing documents related with Smart City in Bogor, e.g. Draft of Masterplan of Smart City, Masterplan of e-government (Diskominfostandi Kota Bogor 2017) (Pemkot Bogor 2010) 2015-2019 Regional Medium Term Development Plan

(Bappeda Bogor 2015), and Regional Regulation Draft (RAPERDA) on Smart City and e-government in Bogor. Analysis was performed on national regulation on ICT framework of local governments and literatures on Smart Cities in the world.

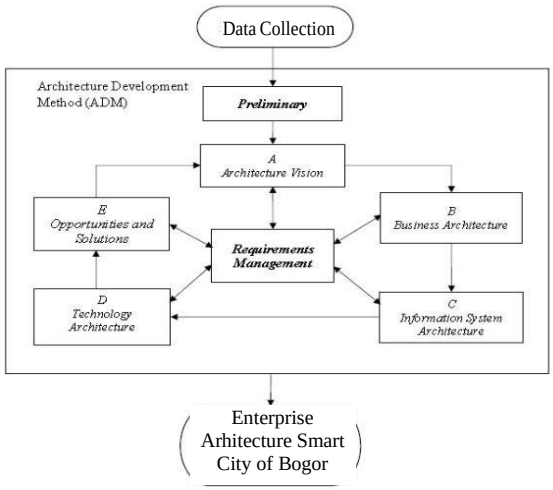

Figure 1. Research method

The next stage was TOGAF Architecture Development Method (ADM) (The Open Group 2011) (Figure 1). The present study only used the first five stages of ADM. The first four stages aimed to define architecture strategy and establish parts of the architecture which are to be designed and have been adjusted with the needs of Bogor, e.g. architecture vision, business architecture, information system architecture, technology architecture, and the final stage which is, opportunities and solutions to analyze the existing gap.

The stages of TOGAF Architecture Development Method ADM used (The Open Group 2011), were:

Preliminary Phase which was preparation to determine framework and principle. Architectural framework was defined as architectural vision, while architectural principles were defined as principles in the domains of business process, data, application, and technology;

Phase A (Architecture Vision) defined scope, vision, and mapped overall strategy based on the principles of EA;

Phase B (Business Architecture) described the current business architecture, developed the target of business architecture, and analyzed existing gap;

Phase C (Information System Architecture) described the current information system architecture, developed target architecture for data architecture and application architecture, and then analyzed the existing gap;

Phase D (Technology Architecture) established the current technology architecture, then targeted the ICT infrastructure target and the whole architecture to be implemented in the next stage, and analyzed the existing gap; and

Phase E (Opportunities and Solutions) analyzed gap using TOGAF Gap Analysis Matrix to reach the stage of implementation strategy.

Requirements Management of this stage explore organizational requirements and document the users' requirements to provide management of architectural needs throughout the stages in the ADM cycle.

TOGAF is used to develop enterprise architecture, where it existsdetailed methods and tools for implementing it, this is what distinguishes it from the framework another EA.

Result and Discussion

The result of this study was EA recommendation consistent with the vision of Smart City of Bogor which is "Efficient, Transparent, and Participatory Heritage City" (Diskominfostandi Kota Bogor 2017) which would be the basic framework of Masterplan of Smart City of Bogor, especially in the dimension of Smart Governance which consists of business architecture, application architecture, data architecture, and technology architecture. The recommendations of the analysis were described as the following principles of enterprise architectures using TOGAF ADM:

a) Business Architecture

Business architecture in Indonesia consists of 3 services, i.e. administrative service, public service and partnership (Ghozali & Sucahyo 2012). Public services in Bogor should be improved in terms of integration strategy and interoperability. It's because not all services among OPD are integrated. One-stop government service system or Smart City website which can synergize and integrate all public services in Bogor so that the data can be analyzed for decision making, was necessary. Furthermore, people could access public services in ways which were easy to understand, so that fast, efficient, transparent, and participatory public services could be provided, consistent with the vision of Smart City of Bogor.

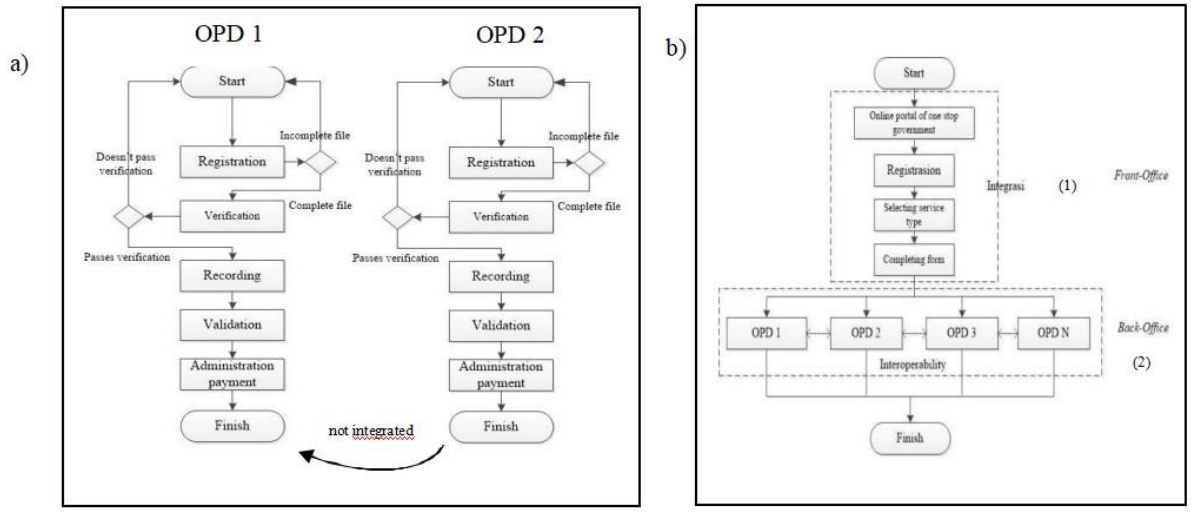

Figure 2. a) Current public service process and b) Design of integrated public service process (adopted from Djalal & Pandji 2018)

The business process related with administrative function and public services is presented in Figure 2. According to Rubhasy et al. (2010), a common issue in the administrative process is repeated process. For example, in demographic data (name, address, ID number, etc.) should be able to be verified by related agency. Based on the extant problem, the business principle could be achieved by integrated system and interoperability. It could be achieved by designing a online-one stop government and one data system for all OPDs in Bogor.

According to Djalal & Panji (2018), online-one stop government integrates digital data from various organizations to one government service web portal, although they're on different networks to provide ease of access through a single sign-on. Data interoperability aims to harmonize different data models and query languages. Departments in a single organization should share information from a heterogeneous system to create cooperation (Janssen & Charalabibis 2011). Data and information could be exchanged, combined, and made available. In other words, public services could be accessed through one door, although provided by different public authorities.

b) Application Architecture

Figure 3 shows the design of application architecture adopted from Hidayat (2014), who has studied Smart City in Bandung. The study explains that the service efficiency target enables sharing for other services, so that there's no duplication of service which is built functionally. The scope of this study was limited to the dimension of Smart Governance, so the observed applications were existing public services in Bogor consistent with government electronic services regulated in the Electronic-based Government System (SPBE) (Kementrian Sekretarian Negara RI 2018) (Kemenpan RI 2018).

Table 1 is the result of gap analysis of the application architecture proposed for Smart Governance, i.e. 1) increasing budget for ICT, HR and management infrastructures, 2) application integration and interoperability, 3) utilization of digital signature, 3) information security, 4) legal protection and SOP of application utilization and 5) utilization of application programming interface (API) and data warehouse to analyze data to predict urban issues and make decisions in Bogor.

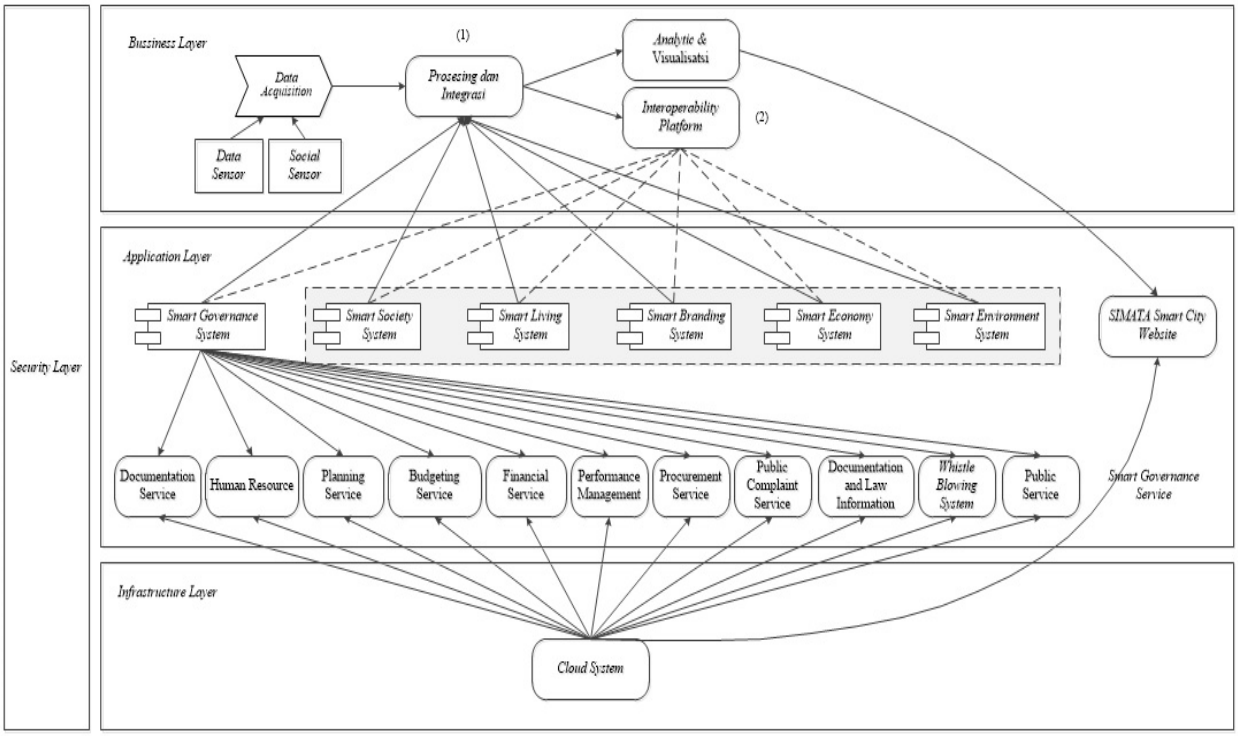

Figure 3. Design of application architecture

c) Data Architecture

The current application and database in Bogor weren't entirely integrated or smart management hadn't been realized as a part of Smart Governance. One of the ways to realize Smart Governance in Bogor consistent with the principle of architecture, i.e. integrated data and interoperability by designing a one data portal and one-stop government in Bogor. Integrated and centered one data portal with the data of the city government through open data enabled the public to access and utilize it widely.

The integrated data system allowed online management from several OPDs and vertical agencies. Data openness showed the accountability and transparency of Bogor, thus encouraging public trust. It was consistent with the vision of Smart City of Bogor. Based on observation, the data architecture of Bogor didn't all have integrated databases in the data warehouse of Bogor City Government. According to the data, only 12 OPDs were integrated with the data warehouse of Bogor, but there was no data analytic which utilized data warehouse.

Table 2 is the result of gap analysis of the data architecture phase. Based on the result of gap analysis, there were seven things which should be the main focus of Bogor city government, i.e. 1) commitment of decision makers to support the utilization of e-government by increasing the budget of ICT infrastructures, especially to develop data warehouse; 2) development of integrated system and interoperability among OPDs for better public services; 3) increase of the capacity and number of ICT human resources in every OPD; 4) regulation of data ownership and data sharing and implementation of SOP of data consistent with ISO; and 7) development of data analytic to predict city development in the future.

Table 1. Gap Analysis Of Application Architecture

* Architecture Target	**Current condition	***Gap	Suggestion
1 Improvement of Public Services (p. 71)	1 The improvement of e-government application for public services in Bogor which still had silos	1 Based on observation and interview, application development was still at each OPD and standardization of application development regulated in the ICT masterplan, but the implementation wasn't comprehensive and digital signature wasn't used to accelerate bureaucratic process on the application	1 Integrated business process or one door services supported by digital signature and standardized ICT management
2 Integrated Management and Interoperability	2 Only 12 OPDs in Bogor had data integration on SIMATA application which consisted of 28 applications. Data warehouse was suboptimal due to lack of storage	2 Limited storage of data warehouse to develop data integration and ICT human resources in every OPD	2 Additional storage infrastructure for data integration and data warehouse utilization, central government data center utilization, and human resources support for ICT development and management
3 The development of e-government application for (G2C), (G2B and (G2E) services regulated in SPBE [13]	3 Services met criteria in SPBE	3 Similar business functions on PATEN, Regional Driving License and urban village and sub-district level Adminkel applications	3 Implementation of standardization of development of service- sharing application (interoperability) and evaluation of ICT management
4 Utilization of Open source	4 Integrated business process or one door services supported by digital signature and standardized ICT management	4 Open Source was required for application	4 Policy of utilization of open source through open source- based management design
Sources: (*) target and roadmap of smart city (p. (87) [3]; (**) results of evaluation of Table 1 and (***) interview on August 2017 and November 2018 and observation of book of masterplan of smart city [3]			

Table 2. Gap Analysis Of Data Architecture

(*)Architecture Target	(**)Current condition	(***) Gap	Suggestion
1 Data integration of all OPDs	1 Data integration hadn't covered all OPDs	1 Data integration using API hindered by limited storage and ICT human resources	1 Increase of infrastructure budget for data warehouse or utilization of central government datacenter and number of ICT human resources
2 Single data by developing one data portal	2 No one data portal for all public services, SMART licensing application couldn't be integrated in real time with the central Online Single Submission (OSS) application	2 Lack of one data portal and minimum utilization of population data for public services	2 Data integration and interoperability of database system among OPDs by developing a one data portal
3 Standard metadata and interoperability data of all OPD	3 Standard metadata for interoperability hadn't been implemented	3 SOP didn't run well, so application development in each OPD was synergized with the existing masterplan	3 Clear regulation on data ownership and sharing and implementation of ISO for data standard
4 Data analytic	4 Data analytic was displayed on Command Operation Center via SIMATA website using API	4 Infrastructure supporting data warehouse couldn't process data analytic	4 The necessity of data analytic from (big data), which was modeled to produce prediction of city development in the future

Sources: (*) target and roadmap of smart city (p. (87) [3]; (**) results of evaluation of Table 1 and (***) interview on August 2017, November 2018 and observation of book of masterplan of smart city [3]

Figure 4 shows the targets of recommendations of data architecture design for public services in Bogor using cloud database technology. The data architecture design was necessary to connect services among OPDs in Bogor. It was consistent with the government commitment on Openness of Public Information and Open Government Partnership as the initiatives of the Indonesian government to improve the quality and utilization of government data. Integrated database was used by several system which was divided into six application groups supporting the Smart Governance of Bogor.

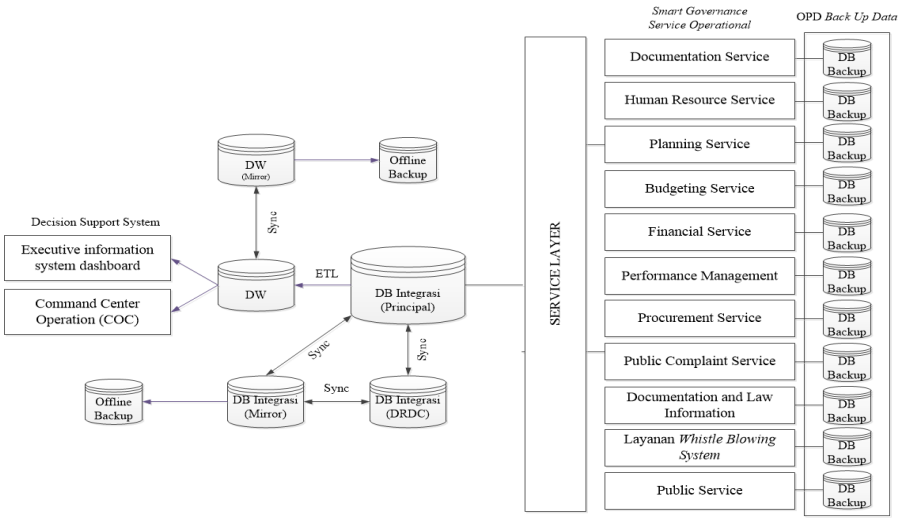

Figure 4. Design of data architecture

d) Technology Architecture

Based on observation, 22 urban villages weren't connected to fiber optic (FO) networks in 17 points connected to FO network. Bogor City Government set a target that in 2019 all urban villages are connected to FO network and the bandwidth capacity is increased.

Some of the current issues were lack of budget for ICT infrastructures, e.g. server, internet, and network asset maintenance. This was why OPD often had slow internet connection, impacting administrative service process. Moreover, network issues were handled slowly due to long bureaucratic processes.

Based on these issues, there should be an ICT infrastructure management which could support efficient public services consistent with the infrastructure targets. One of them was the support of network infrastructure budget by developing network architecture which suited the topology of Bogor and reinforced by human resources which had good ICT capacity and special helpdesk to respond to network issues quickly, thus not inhibiting the existing services. The proposal of design targets based on the targets of network architecture of Bogor to support public services consistent with the vision of technology architecture, is presented in Table 3.

Table 3. Gap Analysis Of Technology Architecture

(*) Architecture Target	(**)Current condition	(***) *Gap*	Suggestion
1 Improvement of Efficiency of Government Bureaucratic Management with the support of ICT infrastructures	1 ICT infrastructure to support the efficiency of government bureaucracy management was quite good but should be improved	1 ICT budget should be increased	1 Leader's commitment to increase budget to improve infrastructures which supported public services was necessary
2 Provision of backbone fiber optic to all OPDs	2 Fiber optic network reached 69 points of all OPDs	*2* Some OPDs weren't connected to fiber optic network	2 Prioritization of improving fiber optic network for OPDs which provided public services and help desk of network service
3 Development of Data Center and Data Recovery Center	3 Lack of standardized data center and data recovery center and small budget to develop data center infrastructure	3 Support of datacenter infrastructure development budget or utilization of datacenter infrastructure from the central government	3 Standardized data center to support integrated public services (G2C, G2G and G2E)
4 Development of intranet for all OPDs	4 Lack of cloud computing system which supported public services and intranet services so that application development and data integration took a long time	4 Cloud computing technology for public services and intranet service ISO standard should be implemented for data security. SSO server should be developed to support e- government application	4 Development of cloud computing infrastructure and standardization of data security
5 Improvement of bandwidth and bandwidth management for all OPDs	5 Internet Bandwidth was 500 Mbps, not all OPDs had adequate internet services, so services were often hindered by slow internet connection	5 Bandwidth should be increased to improve public application services in every OPD	5 Prioritization of *bandwidth* increase in OPDs in Bogor
Sources: (*) target and roadmap of smart city (p. (87) [3]; (**) results of evaluation of Table 1 and (***) interview on August 2017, November 2018 and observation of book of masterplan of smart city [3]			

Cloud computing technology can be used to implement Smart Governance which can increase speed and provide transparency and accountability in government (Clohessy 2014). In Figure 5, the Topology of Bogor was designed using cloud computing technology with two computer network models, i.e. hierarchical model (layered concept) and campus enterprise model (modular concept) (Cisco 2014).

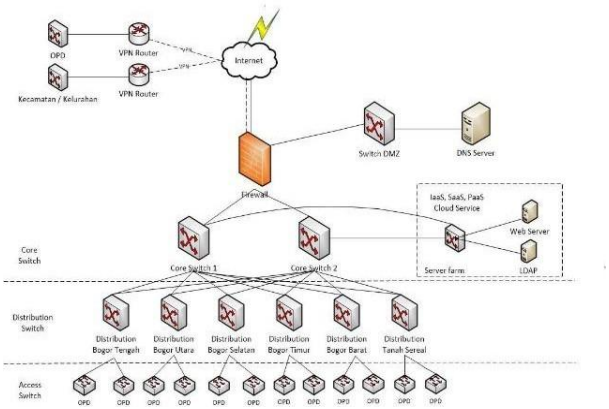

Figure 5. Network technology architecture design

Opportunities and Solutions

This stage produced implementation strategy to be used based on the gap analysis. Based on the gap analysis matrix of the business architecture, application architecture, and technology architecture, it was found that to reach Smart City supported by good public services in Bogor, there should be an integrated and interoperable service system among OPS, sub-districts, and urban villages in Bogor. The proposal of module development based on gap analysis matrix of application architecture, data architecture, and architecture is presented in Table 4, Table 5 and Table 6. The development proposal recommended (1) Newness, if there was no system and it should be improved (2) Improvement, if there was a system and the features should be improved (3) Maintenance, if there was a system (4) Removal, if the system was unnecessary.

Table 4. Proposal of Implementation Strategy For Application Architecture

Business function based on SPBE service (*)	Public service application based on SPBE (**)	Name of Bogor application (***)	Suggestion
1 Electronic-based Government Administrative Service (G2E) (G2G)	Official Script Service	E-Surat Simardi	Improved
	Human Resource Service	Simpeg	Maintained
	Planning Management Service	Simral	Maintained
	Budgeting Management Service	Simral E-Bugeting	Maintained
	Financial Management Service	Simral	Maintained
	Performance Management Service	Esakip	Improved
	Procurement Service	EProcurement	Improved
2 Electronic-based Public Service (G2C) (G2G)	Public Complaint Service	Aspirasi	Improved
	Documentation and Legal Information Service	JDIH	Improved
	Whistle Blowing System Service	Bisa	Improved
	Population Public Service	Sitanduk	Maintained
	Licensing Public Service	Smart	Maintained
	Tax Public Service	Sim Bphtb	Maintained

Business function based on SPBE service (*)	Public service application based on SPBE (**)	Name of Bogor application (***)	Suggestion
	Health Public Service	Simpus	Maintained
	Sub-district Public Service	Sim Paten	Maintained
	Urban Village Public Service	Sim Wilayah Adminkel	Maintained Removed
	City Website	Web Kota Bogor	Improved
	Data Warehouse Service	Simata	Maintained

Sources: (*) Electronic-based Government System [17]; (**) on Guideline of Evaluation of Electronic-based Government System [18] (***) Masterplan of Smart City of Bogor [3]

Table 4 is the mapping of application based on Electronic-based Government System (SPBE) service which is regulated in Presidential Regulation No. 5 of 2018, the mapping based on the application of Bogor and had been evaluated and produced analysis based on e-government maturity level. Based on the mapping, Bogor already had applications based on SPBE services, i.e. Electronic-based Government Administrative Services and Electronic-based Public Services which met the target of application architecture, which was developing e-government application for Government to Citizen (G2C), Government to Business (G2B and Government to Employee (G2E) services [3, 12].

Table 5. Proposal of Implementation Strategy for Data Architecture

	Target of Architecture based on the target and roadmap of e-government of Bogor [3]					
	Data	Data Integration of all OPDs	Single Data (Data warehouse)	Data Interoperability of all OPDs	Data Standard	Data Analytic
	1 Data not completely integrated	Improved				
Current Condition	2 Data ownership in silos among OPDs		New			
(*Baseline*)	*3* Data Interoperability			Improved		
	4 Data standards				New	
	5 Data analytic					New

Table 5 is a proposal based on the architecture target to be achieved, i.e. improving data integration and interoperability among OPDs so that all applications in Bogor are connected. Moreover, data warehouse should be developed to develop single data and data standardization for every e-government application service. The development of data warehouse also could be accompanied by the development of data analytic for decision making at executive level. The strategy was performed at data architecture phase to support the implementation of Smart Governance which helped the achievement of the vision of Smart City of Bogor.

Table 6. Proposal of Implementation Strategy For Technology Architecture

	Target of Architecture					
	Technology	Fiber optic points to all OPDs	Data center and DRC which met standard	Cloud Computing technology to improve public services	Increased bandwidth in all OPDs	Implementation of ISO-based Security Standard
Current Condition (Baseline)	1 Fiber optic in 69 points	Improved				
	2 *Data center* not standardized		New			
	3 Cloud Computing Data analytic			New		
	4 500 Mbps Bandwidth Internet				Improved	
	5 Security standard not implemented					New

Table 6 produced proposal of implementation strategy on technology architecture which consisted of the necessity to improve fiber optic and increase bandwidth to all OPDs to support existing e-government application services. The development of datacenter, DRC which supported cloud computing was also necessary to have efficient public services in Bogor. The development of the technology architectures also should implement good safety standard to maintain data security and information in public services.

Conclusion

The present study produced an EA design, i.e. business architecture, information system architecture, and technology architecture using TOGAF ADM framework which could support Smart Governance development program to realize Smart City program in Bogor. Based on the gap analysis, there were five things which should be the focus by Bogor city government, i.e. 1) the necessity of system integration and interoperability to improve the quality of Smart Governance ; 2) the production of gap analysis at information system phase and technology phase which were proposed for future implementation strategy; 3) the production of recommendations to support the utilization e-government in the form of the increase of ICT infrastructure budget; 4) the increase of capacity and number of ICT human resources to develop data warehouse and ICT human resources in every OPD to improve e-government services; and 5) the necessity of regulation of standard for all ICT. The scope of this journal is limited to smart governance. Future research can extend the scope to cover other dimensions of smart city.

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Strategy to Use Local Government's Facebook Page to Improve Public Services

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Abstract

The population of social media users in Indonesia increase continuously from year to year along with the development of information technology infrastructure in Indonesia. Government agencies could communicate with citizens through social media such as Facebook as two-way communication and to disseminate information to citizens. This study aims to assist local governments in maximizing Facebook management based on at posts and comments, to be right on target and get a good response from citizens. There were 30 Facebook local governments that have been analyzed on posts and comments in the past 2 months. This study collects 30 words which often appear in posts and comments, then found 12 posting categories and 11 comments categories. Based on those categories, this study propose what content needs to be improved on their official Local Government's Facebook account to collaborate with citizens and to improve public services.

Keywords: ***s****ocial media; facebook government's; categorization; strategy improvement*

Introduction

Social Media is form of electronic communication (such as websites for social networking and micro blogging) through which users create online communities to share information, ideas, personal messages, and other content (such as videos). The population of internet users in Indonesia continuously increase from year to year, along with the development of information technology infrastructure in Indonesia and the emergence of government programs introducing internet facilities to every corner of Indonesia. Based on the report released by "We Are Social and Hoot" suite in July 2017, Indonesia ranked at 4th with the most active number of Facebook users with 126 million users in the world (Kemenpora, 2014)

According to Regulation of the Minister of Administrative Reform no. 83 of 2012 the use of social media has shaped and supports new ways of communicating, interacting, and collaborating. Social media offer a faster and more precise way to participate in the exchange of information online. By looking at the effectiveness of social media in building communication and interaction with the citizens, the government public relations should be able to utilize social media to grab the attention and support of the public and no longer solely survive in conventional ways of communication. This transition towards e-Government not only improve participation, transparency and integration but it will also speed up the pace of innovation through collaboration and consultation (Drogkaris, 2012). Social media becomes the bridge between the government and the citizens in general. The form of trust between the government and citizens is closely related to the way of delivering information and its communication. The use and utilization of social media is one way in promoting and disseminating government programs and policies, also for interacting and gaining aspirations of the citizens to achieve mutual understanding of the common interest between government and the society (Baeza-Yates, 1999) (Farizi and Button, 2011).

The government sector can communicate with the society through social media such as Facebook as a form of direct communication to disseminate information for people who do not use print media, newspapers and radio as the main news source. This type of communication certainly does not require a third party in distributing information to the public because it accessed directly by the user. Facebook pages represent significant potential to improve communications between citizens and authorities (Lev-on, 2015). This facilitates the active users of social media and the government websites be able to contribute constructively to advancing the region. Users can communicate interactively without any intervention from mass media. Through current government social media accounts, it could be seen that intensity of the posting official government Facebook accounts were still rare. Every information delivered gets different responses from users, so the government must be able to clearly set the strategies in managing the posting and information to be delivered.

Social media has proven to be a medium of information dissemination that is quite effective for many people. Due to the rapid penetration of information on social media, some information that is not clearly confirmed yet, frequently spread beyond the control of the parties concerned. Under these conditions, Public Relation of the Government is required to have the ability to manage social media so that the information related to certain institutions can be delivered properly. In addition, the Public Relations of the Government should be able to manage various sources of information and communication channels effectively, so that the information that should be known by the public can reach the public appropriately. They should be able to communicate government policies and programs clearly and easily understood by the public. Not only can it convey a policy or program, but rather seek background on why action is taken, what its purpose is, and what is important to society. In this way people can understand, accept, support, and participate in the policies and programs that run (Kurniasih, 2013) (Moro, 2016)

Facebook announced the number of its users which had been reached 500 million users, and will continue to grow to date. Study on how social media impact on stakeholder engagement and its positive impact on public sectors is still very limited. Several studies have shown that people who use social media to interact with government get higher level of satisfaction than through conventional interactions such as meetings directly or through other media In July 2010 (Cohen, 2009). The uses of

social media within the scope of government leads to the opportunities in the development of information technology today with the participation and involvement of users, the need to continuously improve information, services and innovation to develop the latest public issues (Bertot, 2010). Many posts published by the government use hypertext features such as URLs to external content, but governments do not tend to use the Facebook Page to market their services (Ahmed, 2014) (Hoffmann, 2013). Communication between Government and citizens through social networks eliminates many barriers and provides a freer way of communication favoured by citizens. Governments should use social networks in the best possible way as they can improve transparency, responsibility and efficiency, anti-corruption, trust and citizen participation (Grujic, 2014).

The interaction analysis of other social media accounts of the users against each post of the official government account aims to find out the extent to which the information conveyed through social media is acceptable to the public. A study from Moro analyse other users' interactions with Facebook to predict what types of posts would be a forward trend through a data mining approaches. This study uses a data mining approach to perform a modelling and evaluation of the data categories that can be obtained from the posts and comments on some Facebook accounts (Moro, 2016). In Reddick's study applied a conceptual framework to evaluate Malaysian social media participation, in which the framework is used to analyse and visualize social media text mining in the form of post and comment, so that it can be used as learning for the government (Reddick, 2017). In study conducted by Monika learned what is communicated through the posts and through their user post on the government's Facebook page (Monika, 2015). In another study Bertot also categorizes the types of post contained on the Facebook page, which is used as learning of the government in improving communication with its citizens (Bertot, 2012).

Based on previous studies, no one has been discussed the use of official Facebook accounts owned by governments in Indonesia and also there has been no study that has produced recommendations for improving public services through social media by maximizing the management of Facebook content based on analysis of existing posts and comments. Thus, the two-way interaction between the government and citizens through Facebook will work well. So, this will be beneficial for the government in improving the quality of public services through social media and increasing the satisfaction of its citizens.

Theories

Social Media in the Government

Online media created and managed by the government are websites, blogs, and social media (Hong, 2013). Over the past few years, the local governments have adopted social media as an effort to innovate in interacting with the public (Criado et al., 2013). There are several social media used by the government, includes Facebook, Twitter, YouTube (Criado et al., 2013).

The usage of social media in government was considered effective in the process of dissemination of information to the citizens along with the increasing use of social media because of it is easy to create interaction between citizens and government (Bertot, 2010). Social media is a communication channel for promoting democratic values, providing information, responding to citizen questions responsively, and providing a forum for citizens to provide feedback to the government (Hong, 2013) (Eom et al., 2016).

This study took a case study of social media usage: Facebook that owned by local government in Indonesia. Facebook is a popular social media. In 2012, Facebook announced the number of its users which had been reached 1 billion actives users bigger than twitter (Mergel, 2013), and it will grow up continuously. Besides that, Mergel (2013) stated that in 2012, 698 government departments in U.S. The Federal Government has 2956 Facebook pages, 1016 Twitter accounts, 695 YouTube channels, and 498 Flickr pages (Mergel, 2013). This concludes that Facebook is considered as the social media

that is most easily used by citizens and trusted by government agencies can bind its citizens with the interaction and collaboration through Facebook efficiently.

The Contents of Government's Social Media

In Facebook social media, there is some information related to public services, news related to government, citizen questions, government responses, citizen feedback on related government posts / responses (Hong, 2013) (Eom et al., 2016). In addition, there are also several Facebook features that can be used by citizens, including: visit only, like buttons on Facebook, posting ratings and reviews, comments, Facebook shares, downloading videos and documents (Mergel, 2013). It can be concluded that most of the content from social media: Facebook by the local government consists of posts from the Facebook page manager and comments from residents of the area.

Categorization of The Contents Government's Social Media

Margel's research, 2013, classified the social media mechanism into 3 categories. these categories include: transparency, participation, collaboration. Transparency categories include number of followers and viewers, number of likes. Participation categories include posts, reviews, comments, hash tags, post ratings and reviews. Whereas the collaboration category includes conversations, Facebook shares, feedback (Mergel, 2013). Posts and comments are Facebook content that shows the existence of participation and interaction in two directions, or what is called collaboration between citizens and their government.

Reddik (2017), categorizes posts and comments on government Facebook pages based on the types of posts and comments. The categorization of posts includes announcements and reminders, information, tips, quotes, greetings, congrats, feedback, contest, advocacy. While for comments categorization includes suggestion replies, statements, request, name, link, instruction, hash tags, fact, expression, inquiry, description, complaint, awareness, address, acknowledgment (Mergel, 2013). Besides that, Alam (2012) also assess the online participation of social media users and categorize posts and comments on Government's Facebook pages into five categories, such as providing information, requesting information, positive comments, negative comments, and miscellaneous. Facebook page content is analyzed to view behavioral statistics such as posting frequency, number of likes, and feedbacks or reactions to submitted content (Alam, 2012).

Improvement Services Strategies

Social media can improve public services because they not only provide participation, collaboration, and transparency, but also openness, good governance, or cost savings (Alam, 2012). The usage of social media is an innovation that is used to improve communication with the community. Study on how social media impact on stakeholder engagement and its positive impact on public sectors are limited. Several studies have shown that people who use social media to interact with government get higher level of satisfaction than through conventional interactions such as meetings directly or through other media (Cohen, 2009). In Reddick's study, the use of social media in government is more effective in providing information and increasing citizen participation in responding to the information provided and current government policies (Reddick, 2017).

The usage of social media within the scope of government leads to the opportunities in the development of information technology today with the participation and involvement of users, the need to continuously improve information, services and innovation to develop the latest public issues (Bertot, 2012). In addition, the interaction generated through social media is expected to be influential in the government policy decision-making process.

Many posts published by the government use hypertext features such as URLs to external content, but governments do not tend to use the Facebook Page to market their services (Hoffmann, 2013). Content

that seems less interesting like a government-related topic, published by writing short text teaser and adding URLs to external content causes more negative comments than posts without URL. These results could indicate that the government should stick to one platform to provide information and not divert citizens to other platforms. The Facebook's Government should be viewed as an appropriate communication channel because it is different from other conventional media such as letters, press releases, and static websites because Facebook can support two-way communication and realize transparency between government and citizens.

Communication between Government and citizens through social networks eliminates many barriers and provides a freer way of communication favoured by citizens. Governments should use social networks in the best possible way as they can improve transparency, responsibility and efficiency, anti-corruption, trust and citizen participation (Grujic, 2014). In addition, the usage Facebook for Government development will supports the existence of two-way communication.

Research Method

This research uses a case study approach in analyzing users interact two ways (collaboration) through social media of local government, especially Facebook. The analysis was done through categorization of posts and comments within the last two months to see how citizens as social media users responded and gave feedback to local government Facebook posts. In addition, this study also focuses on designing what strategies are needed so that the use of Facebook can develop and active citizens to follow the government related Facebook pages. So, research questions from this study are:
RQ 1: How to categorize posts and comments on Facebook?
RQ 2: What are the strategies used to improve the quality of social media-based Facebook services?

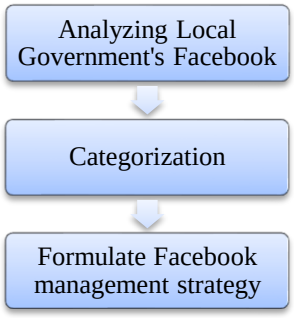

Figure 1. Methodology on Research

Analyzing Local Government's Facebook

First decide which Local Government Facebook page will be analysed. Criteria marked with an asterisk (local government page data) are automatically analysed through the Facebook API. First get an official token from Facebook to get access to the Facebook API. In determining the object of research, a selection of active Facebook pages in the last two months (period of September 1to November 1, 2017) takes place. After obtaining the Facebook ID of the local government of the page to be analysed, then the frequency data is taken of the top 30 most common words appear by using R. Selection of words is done by removing the word connectors and words that are less meaningful so the results obtained are really accurate.

Categorization

In categorization, determine the trigger underlying the categorization first. Trigger serve as a reference in grouping posting and comment categories. Triggers are obtained through captured frequencies through text mining of the top 30 often-used words using the R Programming Language and R Studio software. Before engaging in the text mining, first eliminates the word connectors and less meaningful words to get the appropriate word. After that we get the word trigger for status and comment categorization.

Formulate Facebook Management Strategy

After executing the categorization of posts and comments during the last two months, followed by ranking so that it will appear how the difference between posts, such as which posts that get more responses from Facebook users. This will be the basis for creating a social media management strategy to increase trust and public service to the Local Government.

Results and Discussion

This section will explain the results of the research methodology. First, the researchers displayed statistics on the number of posts and comments for each local government account in Indonesia. The research used 30 local government accounts as samples, by analysing posts and comments uploaded from September 1 to November 1, 2017.

Ranking The Number of Post and Comment

Overall, researchers found comments on the post of the 30 Local Government Facebook accounts. However, if it is examined separately, each account has different percentage of comments and posts posted Shown from the following Figure 2. It is known that Singaraja district has the largest number of posts and comments compared to other Local Governments. This may indicated that the Singaraja District Government Facebook account was active in uploading posts and also the citizens themselves actively participated in using the Facebook. The table shows the top 10 most post ranking.

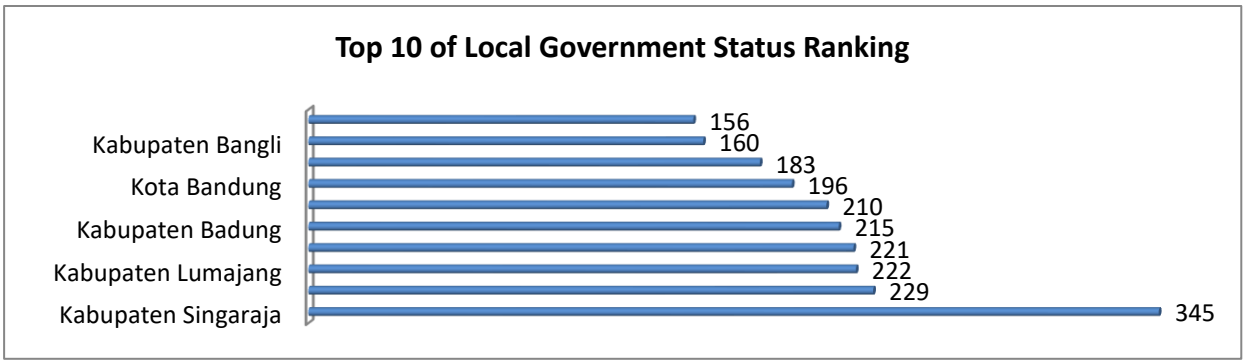

Figure 2. Local Government Posting Ranking

Beside the number of status posted, the participation of Singaraja citizens on commenting the post itself gives major impact on the ranking. Figure 3 shows the top 10 most comments.

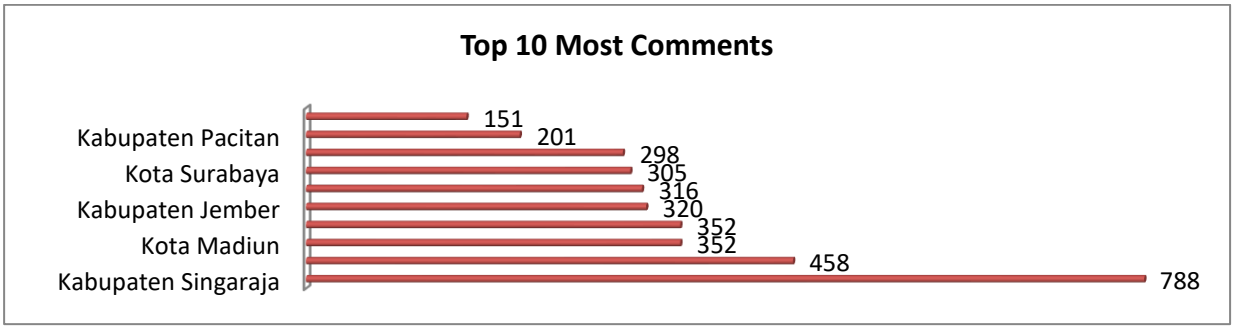

Figure 3. Comment Ranking

Analyze and Define The Category of Posting and Comments

Analysis is done on each post and comment to determine the types that are in each post and comment. The type of post and comment refers to Reddik's research (2017). After analysis, this study shows that there are post and comments that could be categorized based on the categories specified in the previous section. Categorization for every post and comment could be determined by looking at the triggers that have been defined for each category. Table 1 is showing 11 categories for posts and 12 categories for each comment. The Table 2 and 3 showing the words trigger of posts and comments :

Table 1. Categories for Posts and Comment

Category Posting	Category Comments
Actual Information	Information Sharing
Event	Statement
Reminders	Achievement
Suggestion	Wishes
Promotion	Expression
Greetings	Complaint
Congratulation	Name
Feedback Request	Question
Tips	Description
Quotes	Request
Quiz	Hash tag
	Link

Mapping Categorization of Posting and Comments.

Table 2. Comment Categorization Trigger

No	Category	Trigger
1	Information Sharing	knowledge, information, data, facta, reality
2	Complaint	bad, ugly, less, yet, performance, repair, improvement, improve
3	Expression	like, happy, sad, concerned, spirit
4	Statement	according to, opinion, based, to, see, hear
5	Achievement	good, commendable, top, steady
6	Request	add, service, give, get up
7	Description	Like as, visible, illustration, clear
8	Name	name of person, regent, government, officer, policy
9	Hash tag	Hash tag, #
10	Link	http, www, https, click, link
11	Wishes	hopefully, the future, forward, forward
12	Question	what, where, why, how, when, who

Table 3. Post Categorization Trigger

No	Category	Trigger
1	Event	tomorrow, date, invite, day, event, witness, event, citizen, city, village, celebration, anniversary, "pilkada", held
2	Reminders	do not forget, remember, watch, please
3	Actual Information	now, facts, coming, welcome, progress
4	Suggestion	check, watch, practice, donate, cycle, repeat
5	Tips	ideas, use, how, do
6	Quotes	spirit, gratefulness, hope
7	Congratulation	Congratulations, say, thank you, hopefully, better
8	Greetings	hi, hello, person's name, morning, noon, afternoon, night
9	Quiz	mention, explain, why, where, how many, prizes, quizzes
10	Promotion	buy, follow, promo, discount, sell, buy, rent, guarantee
11	Feedback Request	please, ask, can, help, response, answer, reply, message

In the following sections, the categorization results for post and comment based on trigger are shown on the Table 4 and 5.

Table 4. Result of Post Categorization

No	Category	Total Status
1	Actual Information	562
2	Event	175
3	Reminders	56
4	Suggestion	47
5	Promotion	19
6	Greetings	16
7	Congratulation	6
8	Feedback Request	6
9	Tips	3
10	Quotes	0
11	Quiz	0

Table 5. Result of Comments Categorization

No	Category	Total Comments
1	Information Sharing	450
2	Statement	202
3	Achievement	61
4	Wishes	54
5	Expression	29
6	Complaint	27
7	Name	23
8	Question	17
9	Description	12
10	Request	9
11	Hash tag	0
12	Link	0

Based on Table 4 and 5, posts with the category "*Actual Information*" are posts that are often uploaded on the Local Government Facebook account, as well as the category "*Sharing Information*" indicates that citizens often comment on this category. From the results of the categorization, researchers propose to the local government on how to increase the active participation of citizens in using their social media. The local government needs to improve the content of each post category, especially for the category that has the lowest rank. The post should contain useful information needed by citizens. In addition, Local Governments can improve their public services by looking at categories that have the highest percentage. Comments can show what issues are being addressed and what people want. The government social media managers should be able to use the best possible way as they can improve transparency, responsibility and efficiency, anti-corruption, trust and citizen participation (Grujic, 2014). In addition, the uses of Facebook for e-Government development should be able to continue to be improved because it supports the existence of two-way communication.

Conclusion

Social media has been considered capable in building communication and interaction between the Government and the citizens. In this case, the government should be able to utilize social media to grab the attention and support of the wider audience. But in the reality, people still do not fully utilize social media as a means of communication with the government, seen from the low interaction between Local Government Facebook manager with the citizens. Social media becomes the bridge between the government and the citizens in general.

The form of trust between the government and citizens is closely related to the way of delivering information and its communication. Increased interaction between citizens through social media, can be done by categorizing to analyse the extent to which people give feedback to Government social media accounts. The research used 30 local government accounts as samples, by analysing posts and comments uploaded from September 1 to November 1, 2017. Analysis is done on each post and comment to determine the types that are in each post and comment. The type of post and comment refers to Reddik's research (2017). After analysis, this study shows that there are post and comments that could be categorized based on the categories specified in the previous section. Categorization for every post and comment could be determined by looking at the triggers that have been defined for each category. There are 11 categories for posts and 12 categories for each comment with each tringger.

This research contributes from the results of the categorization, researchers can propose to the local government on how to increase the active participation of citizens in using their social media. The author provides a special Facebook fans page to provide information to the government by mentioning the government concerned. This is confirmed by giving criticism and suggestions through a Facebook messenger or telephone listed on the government's Facebook fans page so that the information will be right on target. The local government needs to improve the content of each post category by posting useful information from many aspects in a balanced manner in accordance with the needs of today's society.

The study is limited of the data collection, so for the future research can using more data to support the accuracy of the results. In addition, strategic steps need to be done in managing social media accounts, but can be criticized in terms of timeliness in sending information to the public. It is hoped that there will be an increase in the number of interaction between the citizens and the post in the Local Government Facebook page.

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Data Quality Management in Educational Data: A Case Study of Statistics Polytechnic

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Abstract

Educational data of varsities in Indonesia are used by the Ministry of Research, Technology and Higher Education for implementing higher-education quality assurance system and policymaking. The data are so important that the government regulate every varsity to ensure educational data quality, especially the completeness, validity, accuracy, and currency. Previous research indicates that educational data in Statistics Polytechnic did not comply with those data quality dimensions. The data quality problems are due to policies, human, process, and technology. The root cause is that they have not implemented data quality management. This study aims to propose the data quality management recommendations starting with measuring existing data quality management maturity using Loshin's Data Quality Maturity Model. Interview and document study is used as the data collecting method in this qualitative study. The result shows that data quality management maturity is in level 1 to level 2. There are eight recommended data quality management activities based on DAMA-DMBOK.

Keywords: Data quality management; data quality management maturity; higher education data

Introduction

The quality of higher education must always be maintained and improved to increase the competitiveness of the nation in facing globalisation in all fields. Based on Law Number 12 of 2012 Republic of Indonesia, higher education quality assurance in Indonesia is held by the government through the Higher Education Quality Assurance System (SPM Dikti) (Republik Indonesia 2012). The enforcement of SPM Dikti depends on data and information stored in the Higher Education Data Base (PDDikti) (Kementerian Pendidikan Nasional Direktorat Jenderal Pendidikan Tinggi 2010). PDDikti consists of a collection of facts related to the implementation of higher education and the fulfilment of higher education standards collected from all universities in Indonesia (Kementerian Pendidikan Nasional Direktorat Jenderal Pendidikan Tinggi 2010). The data and information stored in PDDikti must have high quality as they affect the higher education quality assurance in Indonesia. Besides, PDDikti is also the primary source of information for the Indonesia government to monitor, evaluate, and develop higher education policies (Republik Indonesia 2012).

High-quality educational data is needed to determine the direction of the educational policies and to compare the nation's education position among the other countries (Republik Indonesia 2012). Realising the importance of PDDikti quality, Indonesia government issues several regulations requiring universities to guarantee the quality of the data sent to PDDikti. The regulations are Law Number 12 of 2012 on Higher Education Article 56 Section 4, Regulation Number 50 of 2014 concerning Quality Assurance System Article 8, Circular Letter of the Directorate General of Higher Education No. 226 / E4.5 / 2015, and Regulation Number 61 of 2016 on Higher Education Data Base Article 12. Those regulations require all universities in Indonesia to periodically report their educational data to PDDikti. The reported data must be complete, valid, accurate, and up-to-date.

Statistics Polytechnic is a vocational tertiary education in applied statistics and statistical computing located in Jakarta. The technical guidance is carried out by the Ministry of Research, Technology and Higher Education (Kemenristekdikti) while its functional and administrative guidance is carried out by Indonesia Bureau of Statistics (BPS). Like other universities in Indonesia, Statistics Polytechnic must periodically report the complete, valid, accurate, and recent data to PDDikti. Unfortunately, data quality assessment conducted by (Wijayanti et al. 2018) shows that this institution has not fulfilled those PDDikti data quality requirements. There are several data quality problems in Statistics Polytechnic. The study shows that about 80% of the mandatory attributes contain null or space (" "). The currency of the data is also not known because information about the last modified time was not recorded by the system. Poor data conditions will disturb the performance of the organisation (Even and Shankaranaryanan 2009) and disturb the operational effectiveness and efficiency (DeLone and McLean 1992). Poor data quality will also lead to wasted resources and harm the organisation's relationships with the external data costumers (Lucas 2010).

(Wijayanti et al. 2018) stated that there are several causes of data problems in Statistics Polytechnic, such as the absence of policies and standards related to data quality. Some data are not managed well using a specific information system. The existing information systems are also not integrated. However, the root cause of the problems is that Statistics Polytechnic has not implemented data quality management (DQM). Based on the root cause, a research question comes up, which is how to conduct data quality management on Statistics Polytechnic. Therefore, this research was conducted to propose DQM quality management in educational data either in Statistics Polytechnic or in other universities. This research can also be a reference for relevant research on educational data quality management and improvement.

There are several previous studies proposing DQM recommendations for an educational or government institution. Research conducted by Van Den Berghe and Van Gaeveren shared experiences in educational data migration and quality management at Vrije Universiteit Brussel (Van Den Berghe and Van Gaeveren 2016). Penning and Talburt compared the quality of academic data at the University of Arkansas before and after the execution of data quality improvement projects (Penning and Talburt 2012). There is also research conducted by Malange, Ngassam, Ojo, and Osunmakinde (Malange et al. 2015) with a case study on a government institution in South Africa. Another relevant study is conducted by Wibisono, Hidayanto, and Nugroho (Wibisono et al. 2018) with a case study of BMKG, a government institution in Indonesia. But, almost no prior studies with an educational institution in Indonesia as the case study.

The next section of this paper explains the theory related to this study. Section 3 contains the methodology. Section 4 presents the findings obtained from this research, followed by the discussion and implications. The rest sections are suggestions for further research and conclusions.

Theory

Higher Education Data

Educational information is all information related to the three missions of universities which consist of learning, research, and community service (Tahvildarzadeh et al. 2017). According to (Kementerian Ristekdikti 2016a), higher education data are the collection of facts about higher education implementation. The data are used for the development of higher education. Higher education data, processed for a particular purpose, is called higher education information. Higher education data from all universities in Indonesia are collected in PDDikti. It forms the basis for publishing higher education statistics for the stakeholders. It is also the only reference for the government to make decisions related to higher education.

The higher education data are divided into higher education basic data, higher education reference data, and higher education transactional data (Kementerian Ristekdikti 2016a). The higher education basic data are related to people, organisational units, or objects in the implementation of higher education such as study programs, lecturers, education staffs, students, and the activities of 3 missions of universities. It longitudinally records all the entities of higher education and the relationship among the entities. The higher education reference data include data used to compile other data so that there is uniformity of meanings such as reference to regional data, reference to operational data, and reference to identity numbers. The higher education transactional data record or manage changes in status, mutation, evaluation process, evaluation results, and the flow of money or goods involving higher education basic

data, for example, changes in status, transfer, evaluation process, evaluation results, finance, and procurement.

The scope of the data in this study is limited to the higher education basic data, not including higher education reference and transactional data. The higher education basic data contains the entities and attributes, as shown in Table 1.

Table 1. Entities and Attributes of Higher Education Basic Data (Kementerian Ristekdikti 2016a)

Entities	Attributes
University	identity, location, complementary, spatial, image, facilities, and infrastructure.
Study Program	identity, education level, scientific field, degree, capacity, competency, learning achievement, location, complementary, spatial, image, facilities, and infrastructure.
Resource Management Unit	identity, resources, organizational structure, location, complementary, spatial, image, facilities, and infrastructure.
Lecturer and Education Staff	identity, population number, address, staffing, education history, research publication, competence, qualifications, certification, and awards.
Student	identity, population number, family, financing, participation in study programs, and achievements.
The substance of Higher Education (science, knowledge, technology, and art that is taught and developed in higher education)	competency data, material and achievements of learning, assessment, curriculum, research, and community service
Three Mission Activities of Higher Education	the process of learning, guidance, assessment, research, cooperation and community service

Data Quality Management Maturity Model

Referring to (Carratero et al. 2016),(Wibisono et al. 2018), and (Malange et al. 2015), the forming of DQM recommendations is preceded by assessing the current DQM maturity in the organisation. Data quality management maturity model (DQM3) provides methodology, technique, and tools to assess the maturity level of DQM in an organisation (Lucas 2010). The DQM3 that have ever been used in previous studies were Loshin's DQM3 (Wibisono et al. 2018) and MAMD (Malange et al. 2015). MAMD consists of the process reference model and assessment-and-improvement model. Unfortunately, the questionnaire and checklist for the assessment were not explained in (Malange et al. 2015). The advantage of using Loshin's DQM3 compared to MAMD is the availability of instrument or checklist which is very helpful for researchers in conducting self-assessment of DQM maturity. Also, the Loshin's DQM3 was successfully used to measure the DQM maturity at one of a government institution in Indonesia, the Meteorological, Climatological and Geophysical Agency (Wibisono et al. 2018). Hence, Loshin's DQM3 is used in this study to assess existing DQM maturity level.

Loshin's DQM3 measures the maturity level of DQM on eight components (Loshin 2011). The components are:

1) Data Quality Expectations. This component measures the maturity of the organisation in defining the characteristics of the data that want to be achieved by the organisation, aligned with the user needs and the business goals. Data quality expectations can be stated explicitly or implicitly in the form of rules and policies.
2) Data Quality Dimensions. This component assesses the maturity of an organisation in defining and using data quality dimensions. The data quality dimensions itself is the data quality expectation being translated in a measurable, assessable, and improvable form. It provides steps to evaluate

the data quality expectation of the organisation. The examples of data quality dimensions are accuracy, completeness, consistency, validity, and currency.

3) Information Policies. Along with the maturity of the organisation, information policy in an organisation transforms from informal policies to limited documentation, to fully integrated with business activities. Policies on data quality are made to manage data certification, data privacy, data usage limitations, data search, and data source reliability.
4) Procedures. Organisation DQM maturity can be seen from how processes and protocols to ensure information quality are defined. Data quality procedures are operational aspects to validate the existence and effectiveness of data management activities. The procedures include data quality service level agreement (SLA).
5) Data Governance. This component measures how structure, roles, responsibilities, data stewardship, and workflow in managing data quality are defined in the organisation. It also ensures that the DQM activities are consistent and standardised.
6) Data Standards. The maturity of the organisation is reflected in the way it defines and implements data standards. Data standards include data naming standards, data exchange standards, data requirements specification standards, data modelling standards, database design standards, data architecture standards, and procedural standards for each data management function.
7) Technology. Along with the increasing maturity of DQM in an organisation, the technology used in carrying out the DQM activities is also developed. This component assesses the technology used in carrying out data quality protocols and processes as well as fulfilling the quality of data such as data validation, data parsing, and data standardisation.
8) Performance Management. This final component assesses how the organisation scheme in monitoring and auditing data quality based on the defined data quality expectations, how the results of monitoring and auditing are stated in the report, how the organisation identifies negative impacts arising from bad data and tracks the root causes.

The maturity level of each component is divided into five levels. The levels are adapted from the Capability Maturity Model (CMM) made by the Software Engineering Institute of Carnegie Mellon University.

1) Level 1 (Initial). At this level, DQM activities are mostly ad hoc and reactive to a certain data problem. Organisations at this level usually have only one or several individuals who care about data problems. Information or experience sharing about data problems is very limited.
2) Level 2 (Repeatable). At this level, there are basic DQM activities in the organisation which is diverse in each organisational unit. This level is also characterized by the emergence of fundamental activities regarding data governance with limited documentation of processes, planning, and standardisation of data quality practices. Some technological components are available but not standardised or synchronised.
3) Level 3 (Defined). Organisations that are at this level already have a structured team to lead the DQM activities. Documentation of DQM activities, data governance, information policies, technology components are available across the organisation and consistently used.
4) Level 4 (Managed). At this level, the organisation has implemented DQM activities by combining business impact analysis and data quality expectations so that the organisation can measure the suitability of the current data quality with those expectations. DQM activities are proactive.
5) Level 5 (Optimized). This level indicates that data quality management is at the highest level as the organisation can identify the opportunity for improved data quality. Data Quality Management Framework.

The result of the assessment using Loshin's DQM3 is the current existing level of DQM maturity. The next step is comparing the existing level to government expectation. This comparison will produce gaps between the current level of maturity and the expected level of maturity. For each gap, recommendations for improvement will be given according to the particular DQM framework. Following is the explanation and comparison of several DQM framework used in prior studies.

Data Quality Management Framework

The formulation of DQM recommendations refers to particular DQM framework so that the organisation can get the benefits from adopting a series of DQM activities listed in the framework (Loshin 2011).

Several DQM framework used in previous studies are DAMA Guide to Data Management Body of Knowledge Guide (DAMA-DMBOK) (Van Den Berghe and Van Gaeveren 2016)(Wibisono et al. 2018), Total Data Quality Management (TDQM) (Penning and Talburt 2012), and the Technology-Organization-Environment (TOE) Framework (Malange et al. 2015).

TDQM is a framework for maintaining the quality of information introduced by (Wang 1998). TDQM consists of four phases, known as The TDQM Cycle. The first cycle is defining the characteristics and needs of information in the organisation. Second, measuring the quality of information based on needs and instruments that have been prepared in the previous phase. Third, analysing the root causes of information quality. The last is arranging steps to improve information quality.

The TOE framework, first introduced by Tornatzky and Fleischer, consists of three contexts called technology, organisation, and environment. The technological context includes the equipment, processes, security and reliability of technology for managing data in organisations. The technological context also includes equipment used in recording and managing data in organisations. The organisational context includes managerial structure, human resources, and the scope of data in the organisation. The environmental context is related to regulations, the economy, partners and competitors that affect organisational data.

The third DQM framework, DAMA-DMBOK, includes more aspects than the other two. DAMA-DMBOK consist of 12 DQM activities as follows (Mosley et al. 2009):

1) Develop and promote data quality awareness (DQM 1)
2) Define data quality requirements (DQM 2)
3) Profile, analyse and assess data quality (DQM 3)
4) Define data quality metrics (DQM 4)
5) Defines data quality business rules (DQM 5)
6) Test and validate data quality requirements (DQM 6)
7) Set and evaluate data quality service levels (DQM 7)
8) Continuously measure and monitor data quality (DQM 8)
9) Manage data quality issues (DQM 9)
10) Clean and correct data quality defects (DQM 10)
11) Design and implement operational DQM procedures (DQM 11)
12) Monitor operational DQM procedure and performance (DQM 12)

The scope of activities in DAMA-DMBOK is more comprehensive than TDQM and TOE that it can enrich the recommendations. DAMA-DMBOK itself has been proven successfully used to improve the data quality in Vrije Universiteit Brussels (Van Den Berghe and Van Gaeveren 2016). For those reasons, the framework used in this study is DAMA-DMBOK.

Methodology

Research Stage

The stages of formulating DQM recommendations are shown in Fig. 1. The first stage began with assessing the current DQM maturity level. Then, the current DQM maturity level was compared with the expected maturity level. For each identified gap, improvement recommendations were proposed in the form of DQM activities. The proposed recommendations were confirmed to the authorised person in Statistics Polytechnic to ensure that they are valid and applicable.

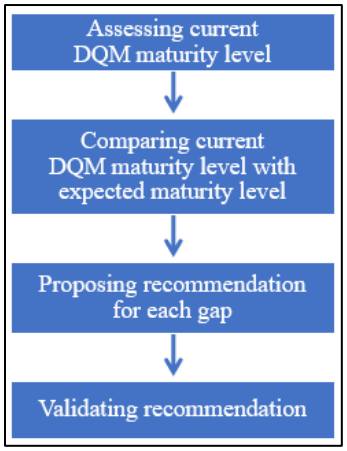

Figure 1. Research Stages

Assessing Current DQM Maturity Level

The current DQM maturity level is collected by filling out the checklist adopted from Loshin's DQM3. Several employees who had the responsibilities and experience of administering and managing higher education data at Statistics Polytechnic were selected to fill out the form (Table 2). Interviews were also conducted with those employees to obtain more in-depth evidence and information about the answers on the form. The process of filling in the checklist and interview took place from November to December 2018.

The example of the checklist and how to fill it can be seen in Table 3. As Loshin's DQM3 measures the maturity level of DQM on 8 components, the checklist consists of 8 assessment components also. Each component has several characteristics. Each characteristic represents the maturity level criteria of each component. However, the method of assigning scores for each characteristic is not explained in detail in Loshin's DQM3. Therefore, the method of assigning each characteristic adopts the answer choices in the Software Process Assessment Questionnaire-Capability Maturity Model. Based on the questionnaire, there are 4 choices of answers or responses for each characteristic, which are (Zubrow et al. 1994):

1. "Yes (Y)", if the characteristic has been well established and performed consistently. Characteristics are performed almost always and consistently as standard operating procedures.
2. "No (T)", if the characteristic is not well established or is inconsistently performed. Characteristics are performed sometimes, or even often, but are not done under challenging circumstances.
3. "Does Not Apply (TB)", if the interviewee has the required knowledge about the characteristic being asked, but the interviewee feels that the characteristics do not apply or are not suitable for Statistics Polytechnic.
4. "Do not Know (TT)", if the interviewee is not sure how to answer the characteristics.

Table 2. List of Respondents

No.	Position	Age	Working Experience	Expertise
1.	Chair of Information Technology Unit	48	30 years	Has responsibilities and understanding in data management, information systems, and technology at Statistics Polytechnic.
2.	Chair of Internal Quality Assurance Unit	55	33 years	Has responsibilities related to internal quality assurance including the quality of higher education data
3.	Secretary of Statistics Study Program	32	9 years	Has the responsibility and deep understanding of the educational business processes especially in Statistics study program. Also has experience as Academic and Student Administration Section staff.

No.	Position	Age	Working Experience	Expertise
4.	Secretary of Statistical Computation Study Program	31	8 years	Has the responsibility and understanding of the business processes especially in Statistical Computing study program. One of the developers of academic information systems.
5.	Staff of Academic and Student Administration Section (BAAK)	28	6 years	Has a fairly long experience as a staff. Has an understanding of lectures business processes, academic data, and student affairs.

Each component has reached a certain level of maturity if all the characteristics at the maturity level are marked "Yes (Y)" (Kneuper 2009). If one of the characteristics at the maturity level is marked "No (T)", then the maturity level of the component is at the previous maturity level. The characteristics marked "Does Not Apply (TB)" or "Do not Know (TT)" are not analysed any further. Because the checklist is filled out by 5 people, the value of each characteristic is determined from the highest number of answers.

From the example of answers in Table 3, characteristic number 1 is “Y” meaning that at least 3 of the 5 respondents answered “Y”. Conversely, characteristic 9 is “T” because at least 3 of 5 respondents answered “T”. All characteristics at level 2 in Table 3 have been fulfilled. However, one of the characteristics at level 3, number 9, has not been satisfied. Thus, the maturity of DQM from this example are at level 2. This method is repeated for eight components of assessment, so there will be a maturity level for each component.

Table 3. Example of The Checklist and How to Fill

No.	Characterization	Y	T	TB	TT	Maturity	Description
1.	Data quality activity in Statistics Polytechnic is still reactive.	✓				1	
2.	Statistics Polytechnic has limited capability for identifying data quality expectations.	✓				1	
3.	Data quality expectations have been documented.	✓				1	
4.	There is limited anticipation of specific data issues.	✓				2	
5.	Expectations associated with data quality dimensions, including data values, can be articulated.	✓				2	
6.	Simple errors can be identified and reported.	✓				2	
7.	Dimensions of data quality are identified and documented.	✓				3	
8.	Expectations of data quality dimensions associated with data values, formats, and semantics can be articulated using data quality rules.	✓				3	
9.	There is the capability to validate data using defined data quality rules.		✓			3	
10.	Methods for assessing business impact have been explored.	✓				3	

Comparing Current and Expected DQM Maturity Level

Expected DQM maturity level by the government is figured out through documents review. All documents of regulations related to the implementation of higher education and the higher education quality assurance system are comprehended. The regulations are:

1) Law No.12 of 2012 on Higher Education (Republik Indonesia 2012).
2) Minister of Education and Culture Regulation No. 62 of 2016 on Higher Education Quality Assurance System (Kementerian Ristekdikti 2016b).
3) Minister of Research, Technology, and Higher Education No. 44 of 2015 on National Standards for Higher Education (Kementerian Ristekdikti Republik Indonesia 2015).
4) Minister of Research, Technology, and Higher Education No. 61 of 2016 on Higher Education Data Base (Kementerian Ristekdikti 2016a).
5) BAN-PT Regulation No. 59 of 2018 on Guidelines for Preparation of Self Evaluation Reports, Guidelines for Preparation of Higher Education Performance Reports, and Assessment Matrix in Higher Education Accreditation Instruments (Badan Akreditasi Nasional 2018).
6) Assessment matrices form and self-evaluation of higher education institution accreditation.
7) Assessment matrices for accreditation programs for diploma study programs.
8) Statute of Statistics Polytechnic contained in Head of Central Bureau of Statistics No. 87 of 2018 (Badan Pusat Statistik 2018).
9) Strategic Plan for Statistics Polytechnic (including the vision and the missions of Statistics Polytechnic) (Sekolah Tinggi Ilmu Statistik 2014).
10) Statistics Polytechnic internal quality assurance regulations.

Those ten regulations were reviewed to find all the points relevant to the characteristics of 8 components Loshin's DQM3. These points then determined as the expected DQM maturity level in the future. The expected DQM maturity level was confirmed to the Chair of Information Technology Unit and Chair Internal Quality Assurance Unit Statistics Polytechnic to ensure the validity. After the expected DQM maturity level has been figured out, the gaps between the current maturity level and the expected maturity level were analysed.

Proposing and Validating DQM Recommendations

For each gap found, recommendations are formulated to reach the expected maturity level. The recommendations were proposed by referring to the DAMA-DMBOK framework. From the example of answers in Table II, the most appropriate activities from 12 DQM activities of DAMA-DMBOK were proposed to fulfil the character number 9. Then, the proposed recommendations were confirmed by the Chair of the Information Technology Unit and Chair of the Internal Quality Assurance Unit to ensure the feasibility of the recommendations and conformity with organisational conditions.

Result

Current DQM Maturity Level Assesment Result

The result of current DQM maturity level assessment is presented in Table 4. The maturity level of each component is between level 1 and level 2. There are three components at level 1, which are data quality expectations, information policies, and data standards. The other five components are at level 2.

Table 4. Current Data Quality Management Maturity Level

No.	Component	Current Maturity Level
1.	Data quality expectations	1
2.	Data quality dimensions	2
3.	Information policies	1
4.	Procedures	2
5.	Data governance	2
6.	Data standards	1
7.	Technology	2
8.	Performance management	2

1) Data Quality Expectations. Current data quality assurance activities are still reactive. Statistics Polytechnic already could identify data quality expectations, but not yet documented.
2) Data Quality Dimensions. Activities to identify data quality problems have already started. Data problem identification was conducted at the end of every semester. The problem of this component is that there are no data quality rules containing data quality dimensions, data domain, and data format.
3) Information Policies. Existing information policies are still informal and have not been documented. There are no written rules for data and information management — for example, the policy regarding data access. For example, there is no policy regarding data access in the academic information system. Based on the results of interviews, the access rights allocation has been initiated. However, due to no written policy, so the access rights allocation is not implemented well.
4) Procedures. This component relates to the operational aspects of DQM activities, including the formulation of data quality SLA. The operational DQM activities have been conducted systematically, for example, in handling data problems, identifying the causes of data problems, and coordinating between work units in handling data problems. Like the previous components, DQM operational procedures have not been documented also. There were standard operating procedures for managing data quality made in 2010-2011. However, the standard operating procedures were not implemented well and are no longer applicable to the current state of the organisation.
5) Data Governance. Related to data governance, Statistics Polytechnic already has a division of responsibility in managing data problems. The division is based on the main tasks and functions of each work units. Data stewardship has already initiated in several work units. The organisational structure and work principles for DQM have also been developed.
6) Data Standards. Statistics Polytechnic has begun to define the standardisation of data. Student registration number and course codes have been standardized. The component of student grades has also been standardised which consists of midterm exam, final exam, and assignments. Reference data has also been identified. Similar data has been displayed in a uniformity. However, the standard of metadata has not been managed in work units.
7) Technology. The technology is powerful enough to support the implementation of DQM at Statistics Polytechnic. The information technology unit has carried out its duties regularly and does not avoid any complaints related to data problems. The technology for checking and repairing data is conducted using direct queries from the database management system. The weakness in this component is that the technology component is not standard for all lines of the organisation.
8) Performance Management. This last component of maturity is level 2. The impact of data problems on the educational business process has been able to be identified. However, analysis of the impact of these problems has not yet referred to a specific framework or guideline.

Expected DQM Maturity Level

According to the ten related regulations, several items were found to be under the characteristics of the Loshin's Data Quality Maturity Model.

1) Data Quality Expectations. According to Permenristekdikti No. 61 of 2016 Article 12 Paragraph 1 and Article 23 Paragraph 2 (Kementerian Ristekdikti 2016a), each university is expected to have the ability to validate its educational data based on the standards set by thePDDikti. These regulations are in line with one of the characteristics at the level 3 maturity level which is capable of validating data using defined data quality rules. Still in the same regulation, Article 22 (e) states that university has the duty and responsibility to examine the impact of data that has been reported through PDDikti. This point is also relevant to one of the characteristics at the level 3 maturity, a method for assessing the impact of data quality on businesses has been explored. Therefore, the expected level of maturity for this component is at least level 3.
2) Data Quality Dimensions. Based on Permenristekdikti No. 61 of 2016Article 22 (f) (Kementerian Ristekdikti 2016a), varsities have the responsibility to guarantee the completeness, validity, and currency of its educational data sent to PDDikti. To evaluate these dimensions, varsities must have the ability to formulate assessment criteria for each dimension. It is related to maturity level 2 characteristics. In other words, maturity level for this component is expected to reach maturity level 2.
3) Information Policies. One of the criteria for assessing higher education accreditation as contained in the attachment to BAN-PT Regulation No. 59 of 2018 is the assessment element C.2.4.c) about management. The regulation requires universities to have valid documented evidence about the

implementation of policies and guidelines for data and information system management (Badan Akreditasi Nasional 2018). For that reason, information policies are expected to reach level 2.

4) Procedures. One of the evaluation criteria in the accreditation form evaluation element 2.4.2 is that quality assurance has been running in all work units which includes planning, implementation, analysis and evaluation cycles, improvement actions as evidenced in the form of monitoring and evaluation reports. Quality assurance includes data and information system quality assurance. That evaluation criterion is consistent with the characteristics of managing data quality at every level of work units and the overall organisational level. These characteristics are at the level 3 maturity level. Hence, the data quality procedure component is expected to reach level 3.
5) Data Governance. Permenristekdikti No. 61 of 2016 Article 22 (c) states that university has the duty and responsibility to manage educational data with clear team and responsibilities. Furthermore, article 22 (d) states that the university has the task and responsibility of preparing permanent employees, facilities, infrastructure and incentives for work units that manage educational data (Kementerian Ristekdikti 2016a). These two points of regulations regulate universities in terms of organisation and management of educational data which can be related to one of the characteristics at the level 3 maturity level, namely the organisational structure for supervision and data management has begun to be defined.
6) Data Standards. Maturity level for data standards component is expected to reach maturity level 2. It is expected that the data elements and reference data have been identified from organisation's information needs that can be identified from several regulations including BAN-PT regulation No. 59 of 2018 Element D.1, the assessment matrix for higher education institution accreditation element 2.4.5, and the STIS Statistics Polytechnic Article 68.
7) Technology. The technological components are expected to reach level 3 with technological components are available and standardised in all lines of the organisation for data validating, checking, and reporting. These characteristics are related to BAN-PT regulation No. 59 of 2018 Element C.5.4.b) which assesses the availability of information and communication technology systems in university to collect accurate, accountable and confidentiality data (Badan Akreditasi Nasional 2018).
8) Performance Management. The target for this component is access right to data and information has been distributed according to staff role and blueprint of the data flow system, and data access authorisation has been created (level 4). It refers to one of the strategic objectives of Statistics Polytechnic contained in the 2015-2019 Statistics Polytechnic Strategic Plan that the institution must be supported by adequate sources and access to data to ensure performance achievement (Sekolah Tinggi Ilmu Statistik 2014). It also refers to the element 6.3.8 the assessment matrix for higher education institution accreditation that higher education institutions must have a complete blueprint for developing, managing and utilising a complete information system, one of which includes a data flow system and data access authorisation.

Overall, the expected maturity level for eight components ranges from level 2 to level 4. Table 5 presents a summary of the expected DQM maturity level. Two components are expected to reach level 2 maturity levels. Four components are expected to reach level 3. The other two components, information policies and performance management, are expected to reach level 4 of maturity.

Table 5. Expected Data Quality Management Maturity Level

No.	Component	Expected Maturity Level
1.	Data quality expectations	3
2.	Data quality dimensions	2
3.	Information policies	4
4.	Procedures	3
5.	Data governance	3
6.	Data standards	2
7.	Technology	3
8.	Performance management	4

Discussion and Implication

Maturity Level Gap

From the eight components of DQM, only 1 component has reached the expected target which is the data quality dimensions reaching level 2 of maturity. The other seven components have not satisfied the expected target. More precisely, there are 41 characteristics of those components have not been satisfied. Fig. 1 shows the gap between the current and the expected DQM maturity level.

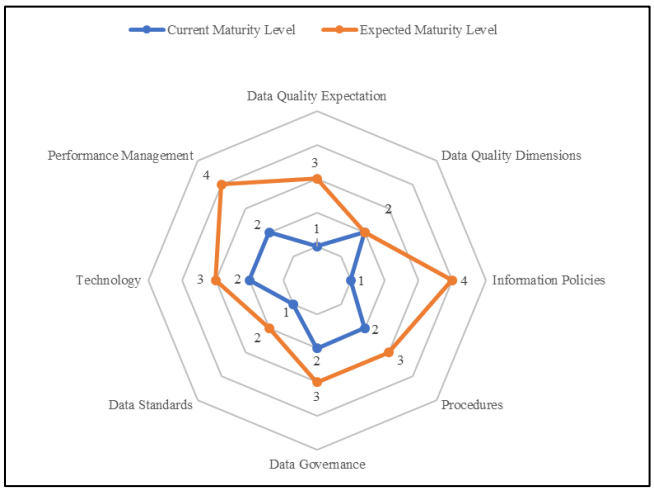

Figure 2. Statistics Polytechnic DQM Maturity-Level Gap

The results of existing DQM maturity assessment range from level 1 to level 2 shows that most DQM activities in Statistics Polytechnic are ad hoc and reactive to specific data problems. Data quality expectation, information policies, and data standards have not been formulated in written documentation. Only one or several individuals who care about data problems, not all people in the entire institution. While what is expected by the government, through regulations relating to higher education data management and higher education quality assurance, DQM activities including data governance and technology are well documented, available across the organisation, and consistently used. Even DQM activities on the information policies and performance management components are expected to be able to include an impact analysis on institutions' core business.

DQM Activities Recommendation

If we return to the research question, then to conduct DQM on Statistics Polytechnic is with prioritising conducting DQM activities related to 41 characteristics on seven components which have not been fulfilled. Each of the 41 characteristics was analysed to determine the most suitable activities of 12 DAMA-DMBOK activities. The results of mapping each characteristic with the most appropriate DQM activities can be seen in Table 6. The mapping results have been validated by the Chair of Information Technology Unit and Chair of the Internal Quality Assurance Unit Statistics Polytechnic to ensure that the recommended DQM activities are applicable at Statistics Polytechnic.

Table 6. Mapping of Unfulfilled Characteristics with DAMA-DMBOK DQM Activities

Component	Level	No.	Characteristic	DQM Activities
Data quality expectations	Initial	1	Has documentation of data quality expectations.	DQM2
	Repeatable	2	Has documentation of data quality expectations. The ability to anticipate data problems is still limited.	DQM9
		3	Data quality expectation, including certain data quality dimensions and data values are available although limited.	DQM2

Component	Level	No.	Characteristic	DQM Activities
		4	Simple data errors can already be identified and reported.	DQM9
	Defined	5	Dimensions of data quality have been identified and documented.	DQM2
		6	Data quality expectations are contained in data quality rules.	DQM2, DQM5
		7	Able to validate data using established data quality rules.	DQM3
		8	Methods for assessing the impact of data quality on businesses have been explored.	DQM3
Information policies	Initial	9	Information policy has been documented	DQM1
		10	Data correction actions taken by many staff and coordinated.	DQM7
		11	Institution tries to consolidate data in one single source of truth.	DQM2
	Repeatable	12	Privacy policies and restrictions on data use already exist but are still rigid.	DQM2
		13	A basic policy on the mechanism for handling data problems has been established.	DQM7
		14	Guidelines for achieving data quality management objectives are available.	DQM11
	Defined	15	The certification process is available for qualifying data sources.	DQM2
		16	Best practices have been adopted from data quality practitioners.	DQM1
		17	Data quality SLAs have been designed to see compliance with information policies.	DQM7
		18	Information policies have been established and coordinated throughout the organization.	DQM1
	Managed	19	The history of data exchange is recorded in detail.	DQM2
		20	Data quality management is based on information policy.	DQM11
		21	One of employee performance achievements is driven by information policy.	DQM12
		22	Data quality SLAs have been established and are used to see compliance with information policies.	DQM7
Procedures	Defined	23	Inspection procedures have been established and documented to check the accuracy and validation of the data.	DQM9
		24	Data quality management is implemented at the work unit level and at the overall organizational level.	DQM7
		25	Data validation is done automatically and only problematic data is checked.	DQM9
		26	A backup data creation procedure is available.	DQM11
Data Governance	Defined	27	Stewardship program has been run and entire institution have the same point of view of the program.	DQM1
		28	Data management operational procedures have been defined	DQM11
Technology	Defined	29	The technology component is standard for all lines of institution in terms of service and implementation.	DQM11
Data Standards	Repeatable	30	Meta data standards are managed in all work units.	DQM1

Component	Level	No.	Characteristic	DQM Activities
		31	Guidelines for standard exchange formats have been defined.	DQM2
Performance Management	Defined	32	A framework for analyzing the impact of data problems is already available.	DQM3
		33	Data quality service components are available and are able to detect data errors early.	DQM7
		34	The data quality service component has been defined.	DQM7
		35	Data problem tracking system is available to record every problem and also the solution.	DQM9
	Managed	36	Data quality matrices are contained in managerial reports.	DQM12
		37	An audit has been conducted based on compliance with data quality rules.	DQM12
		38	There is regular reporting on data quality management.	DQM12
		39	Dashboard for monitoring the performance of data quality management is available.	DQM12
		40	Access rights to data and information is divided according to the employee's role.	DQM2
		41	The contribution of data quality components to institution core business can be described well.	DQM1

If we summarise, there are eight proposed DQM activities. Eight DQM activities recommended to Statistics Polytechnic are:

1) Developing and promoting awareness of data quality. This activity is related to ensuring the stakeholders are aware of data quality problems and support the success of DQM programs. According to (Lee et al. 2006), one effective way to increase stakeholders awareness is by showing them an analysis of the contribution, cost loss, and competitive advantage of data quality components to the organization. A kind of support from the stakeholders to data quality programs is by initiating a program for data quality improvement (Hazen et al. 2017) followed by the dissemination of data quality strategies and frameworks to all Statistics Polytechnic work units (Mosley et al. 2009).
2) Define data quality requirements. Data quality requirements are defined according to the context of "fitness for use" to support an organization's business processes. In Statistics Polytechnic context, the data is expected to assist decision making and contain indicators to support internal quality assurance. The data quality requirements should be aligned with the needs of BPS and Kemeristekdikti.
3) Profiling, analyzing, and evaluating data quality. This activity includes data validation using predefined data quality rules and assesses the impact of data quality problems on business using previously explored methods or specific framework. Profiling, analysing and evaluating data quality can be done with a bottom-up assessment approach and top-down assessment (Mosley et al. 2009). Bottom-up assessment includes checking duplicate data, orphan-child data, and data redundancy as done in (Wijayanti et al. 2018). The top-down assessment approach emphasises more on evaluating the impact of data quality on business.
4) Define business data quality rules. This activity is the following activity of defining data quality requirements. Data quality requirements already defined are specified in more specific formatting rules, value domains, and descriptions of each attribute. Rules regarding data formats, value domains, and attribute descriptions are needed in the data standardisation process to streamline handling, storage, retrieval, and updating of data (Gagliardi 2015).
5) Establish and evaluate data quality SLA. According to (Mosley et al. 2009), data quality SLA contains guidelines in responding and correcting data problems found in the organisation, roles and responsibilities in fixing data problems, procedures for responding to data problems, schemes for data problems remediation, and time limits for fixing problems data. The SLA also regulates the DQM mechanism at the work unit level as well as at the organizational level and indicators to assess compliance with information policies (Mosley et al. 2009). The procedure for preparing data quality SLA can be seen in (Nascimento et al. 2015) who designed data quality SLA (DQSLA) in providing cloud infrastructure services to run data quality algorithms.

6) Manage problems related to data quality. One of the DQM characteristics that must be fulfilled by Statistics Polytechnic is having the ability to anticipate data problems, data accuracy, and data validity automatically using an issue tracking system. Identification of data problems is carried out following a documented procedure. The results are also documented in the form of reports.
7) Design and implement operational procedures for DQM based on information policies. The operational procedures should include instructions for achieving quality management objectives, backup data procedures, data governance, operational procedures, and technology standards for all organisation lines. In (Effendi 2012), operational procedures include procedures for managing student registration data, parents data, and student academic data. The procedures are integrated into an information system that supports daily routines.
8) The last recommended activity is to monitor the performance and implementation of DQM operational procedures from the previous activity. Monitoring can be done using a dashboard. The results are documented in routine managerial reports, scorecards, or trends. The report also contains conformity of data quality with established business rules, employee performance in reacting to data quality problems, and individual performance achievements in complying data quality rules.

Future Works

The next step following this study is to apply the eight recommended DQM activities one by one. Unfortunately, the detailed technical guidance for each recommendation has not yet been formulated in this study. Further work is needed to break down in detail data quality requirements, data quality rules and metrics for evaluation, data quality SLA, and automatic data cleansing and monitoring for Statistics Polytechnic. Also, the objects of this research are the basic higher education data in STIS Statistics Polytechnic. It needs to be studied further whether the recommended DQM activities can be applied to the reference and transactional higher education data.

Conclusion

The data quality management maturity level of Statistics Polytechnic ranges from level 1 to level 2 for eight components. The maturity measurement adopted Loshin's Data Quality Management Maturity Model. Whereas, it is expected that data quality management maturity of Statistics Polytechnic reaches level 2 to level 4. There is only 1 data quality management component achieving the expected maturity level that is the data quality dimensions component at level 2. The other seven components have not met the expected targets.

From this study, there are 8 data quality management activities recommended for Statistics Polytechnic to improve its higher-education data quality. The recommendations are proposed based on the DAMA-DMBOK framework and gap analysis between current maturity level and expected maturity level of data quality management. The recommendations are validated by the Chair of the Information Technology Unit and Chair of the Internal Quality Assurance Unit.

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