Evaluating Maintenance Policy and Implementation Strategies to improve Building Functional Performance in Government Building: A Case Study in Jakarta, Indonesia

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Abstract

Several government's building in Jakarta are in bad conditions. Maintenance policies have been made by the government in an effort to keep the performance of the building remain good. In implementing the policies that have been made, appropriate strategies are needed to enable the policy to proceed as planned. Although the budget was increased for maintenance activities, the implementation didn't go well as planned in government's building. This study aims to improve building functional performance by evaluating the maintenance policy and strategic implementation. Several method were adopted to identify policy, strategy and the factors of functional performance which affected through questionnaire survey and Delphi technique. The results should show that maintenance performance could be improved by evaluating the maintenance policy and its strategic implementation. The originality of this research could identify the factors in maintenance policies and strategies, which affect the functional performance of government buildings that necessary including security and environmental aspects which is not included in past research.

Keywords
Evaluate, Policy, Strategy, Maintenance, Functional Performance, Government Building, Reliability

1. Introduction

According to regulation of the Minister of Public Works no.24 of 2008, building is defined as physical form of construction process for human doing their activities. In order to maintain the reliability of the building and its infrastructure and facilities, maintenance work is needed. The less importance of reliability performance, the less the level of application of work on related elements in the building (Aksah et al, 2015). Based on Indonesia regulation, functional performance as reliability is include technical requirement such as safety, health, comfort, amenity and environmental sustainability. Poor maintenance is one of the biggest cause of problems in an organization (felice et al, 2014). Poor maintenance may lead to additional repair costs, significant loss of production and safety disasters (Shafiee, 2015).

Policies have been formulated by the government in an effort to maintain the condition of existing buildings in Indonesia still feasible in function, at least for government buildings. Policy defined as the direction or action taken by the central or local or city government to achieve the objectives. After policy is formulated, then the implementation of the policy is needed to overcome the problems (Tangkilisan, 2003). Nevertheless, long-term maintenance strategies with long-term inspection without considering the possible variations in the systems used and available technologies, may lead to implementation without appropriate strategies will not be effective. Some policy issues that occur in

maintenance work lie in resource allocation, performance requirements, executions, administrative activities and maintenance department positions in the organization (Chanter and Swallow, 2007). An inappropriate strategy selection can impact on maintenance budgets and reduce productivity and profitability (Shafiee, 2015). According to Pintelon et al (2006), in the literature, the definition of a maintenance strategy is still too shallow and too floating. Silva et al (2016) explains that the problem that causes the difficulty of defining an optimal maintenance policy is due to the many interests of various sectors such as technical, political, environmental, and even investment in banking. According to Zairi (1999), many of the strategic plans, which are recorded, fail to materialize because they are only designs that are ultimately stored at the executive level.

Thus, according to Olanrewaju and Aziz (2015), an organization can increase its profit margins, productivity and user satisfaction by using systematic maintenance management. Efforts to improve the performance of maintenance and maintenance of buildings in the context of appropriate use of resources need to be accompanied by policy steps that are in line with the strategy in realizing building structures that ensure technical reliability in terms of safety, health, comfort and convenience as provided for in the Indonesian Law 2002 no.28. So it takes the right policy and strategy for maintenance and maintenance of government building building to improve performance feasibility of building function.

This work is part of broader research aiming to observe maintenance work in government building. The key question in this research is whether it is possible quantify the policy that have been made to affecting the building functional performance. This paper is organised as follows. In section 2, literature on maintenance policy and building functional performance is reviewed to clarify the proposed idea. In section 3, the proposed idea and sampling procedure are applied to a realistic case study in Jakarta, Indonesia. Finally, section 4 about the findings and our contribution.

2. Literature review

2.1 Maintenance Works in Government Building

According to the Minister of Public Works Regulation No. 24/2008 on guidelines for building maintenance, Maintenance is an activity to maintain the reliability of buildings and infrastructure and facilities so that the building is always functional. While the maintenance of buildings is the activity of repairing and / or replacing parts of buildings, components, building materials, and / or infrastructure and facilities for building buildings remain functional. According to Henayaningsih et al (2006), the maintenance of building and office facilities aims to maintain or optimize the life of the building or office facilities so as to provide satisfaction or comfort from those served.

The guidance in to the Minister of Public Works Regulation No. 24/2008 includes maintenance management, procedures and methods, systems and programs, equipment, equipment and performance standards for maintenance of buildings and guidance. In the minister's regulation, the scope of building maintenance is defined as architectural, structural, mechanical, electrical, outdoor spatial, and housekeeping. While in the scope of building maintenance is described as follows; Rehabilitation, Renovation, Restoration, Damage Level. As for the purpose and objectives in the attachment of the Ministerial Regulation there are additional technical requirements namely environmental sustainability.

ng to the British Standard (BS.3811), maintenance is defined as a combination of activities from the initial formation of ideas, financial related activities, organizational and physical maintenance activities undertaken to safeguard and / or maintain goods in appropriate conditions, in accordance with specified requirements. The following is the description and definition of maintenance (Department of Housing and Public Works, 2017);

    - restore the physical condition of the building according to the requirements set
    - prevent further failures in buildings
    - restore proper management with specific parameters
    - replace the component at the end of the useful life with the latest components
    - mitigating the consequences of natural disasters
    - assess the need for maintenance on buildings

Meanwhile, Maintenance management is defined as any management activity that defines the maintenance objectives or priorities, strategies and responsibilities and implements them in the form of maintenance, control and supervision plans and some improvement methods including economic aspects within the organization (Marquez, 2007).

2.2 Building Functional Performance

According to the Regulation of the Minister of Public Works No. 25 of 2007, certificates of functionality are certificates which are controlled by the local government except for special functional buildings by the government to declare the functionality of a building either administratively or technically prior to its utilization. The definition of functionality is not described in the regulation, but the definition of the reliability of building buildings, namely conditions of safety, health, comfort and amenity that meet the technical requirements by building performance. In the attachment to Regulation of the Minister of Public Works no. 25 of 2007 on the part of the procedures for the issuance and renewal of certificates worthy of the function of building buildings, explaining that the scope of inspection of the feasibility of building functions include; a) Inspection of administrative requirements (identification of completeness, validity and correctness of data in documents), b) Examination of technical requirements (layout, building reliability).

In planning a smart building there are performance criteria that must be considered such as health, safety, security, function, efficiency, workflow, psychological, social and cultural (Wolfgang et al, 2002). According to Khalil (2016), the performance of elements of the building is divided into three, namely the function, technical and internal environment. Performance of functions in buildings include space, orientation, infrastructure, access, circulation, ergonomics, sufficiency signs, exit routes, to ease. According to Antao (2016), performance in buildings at ports can be seen in aspects of OHSS, namely user health, safety, security and the environment.

2.3 Maintenance Policy

In understanding the evaluation of policies and strategies of maintenance work in order to improve the performance of government building functionalities, a literature study of policy and strategy definitions is required, as well as a policy framework that can form the basis of the establishment of maintenance and maintenance work policies. According to Law No. 25 of 2004 on the national development planning system, strategy is defined as the steps containing indicative programs for realizing the vision and mission. Policy is defined as the direction / action taken by the central / local government to achieve the goal. According to Bagal (2016), a strategy is a specific plan designed to achieve the position and to achieve the goals and objectives of the organization. While the policy refers to the norms / rules made by the organization to rationalize decision-making. According to the Queensland Maintenance Management Framework (2017), maintenance policies are divided into three categories: planning and development, implementation and information systems.

According to Murthy et al (2002), maintenance management includes 3 (three) main steps: understanding the tools that need to be maintained, perform optimal planning, and implement optimal maintenance. The optimal planning related policy is described as follows;
• Collecting related data
• Analyze data to assess tool condition
• Develop models for predicting alternative maintenance and operational consequences
• Choose the optimal maintenance action

Maintenance management process is divided into two parts, namely understanding strategy and strategy in implementation (Marquez, 2007); a) Understand the maintenance strategy, b) Implementation strategy. In maintenance and maintenance work, an optimal planning effort is required to ensure appropriate maintenance (Murthy, Atrens, & Eccleston, 2002). In the planning and development of maintenance there are at least four influential policies, among others (Department of Housing and Public Works, 2017); a) Documenting the internal maintenance policy, b) Determine the standard index conditions, c) Prepare a departmental strategy, d) Develop a strategic maintenance plan.

According to Murthy et al (2002), it is necessary to implement optimal measures of maintenance. According to Queensland Maintenance Management Framework (2017) in the implementation of maintenance maintenance there are six policies including; a) Develop a condition assessment, b) Make a maintenance needs assessment, c) Allocate sufficient budget maintenance, d) Develop Annual maintenance program, e) Develop maintenance supervision, f) Monitor and observe maintenance performance.

According to the Queensland Maintenance Management Framework (2017), systems and information are among the things that need to be done in maintenance work. In system and maintenance information there are four policies among others; a) Gather relevant asset information, b) Ensure proper data collection, c) Using a computer maintenance management system, d) Establish maintenance reporting capabilities. In order to carry out maintenance activities in the right way, maintenance management system is required in the form of manual or computerized system (Muhtadi, 2009).

According to Marquez (2009), the last stage in the maintenance management model is an increase in ongoing maintenance with the use of updated techniques.

3. Research Design

3.1 Conceptual model

The conceptual model in this research uses the approach of the synthesis between variables with the framework of the concept of assessing;
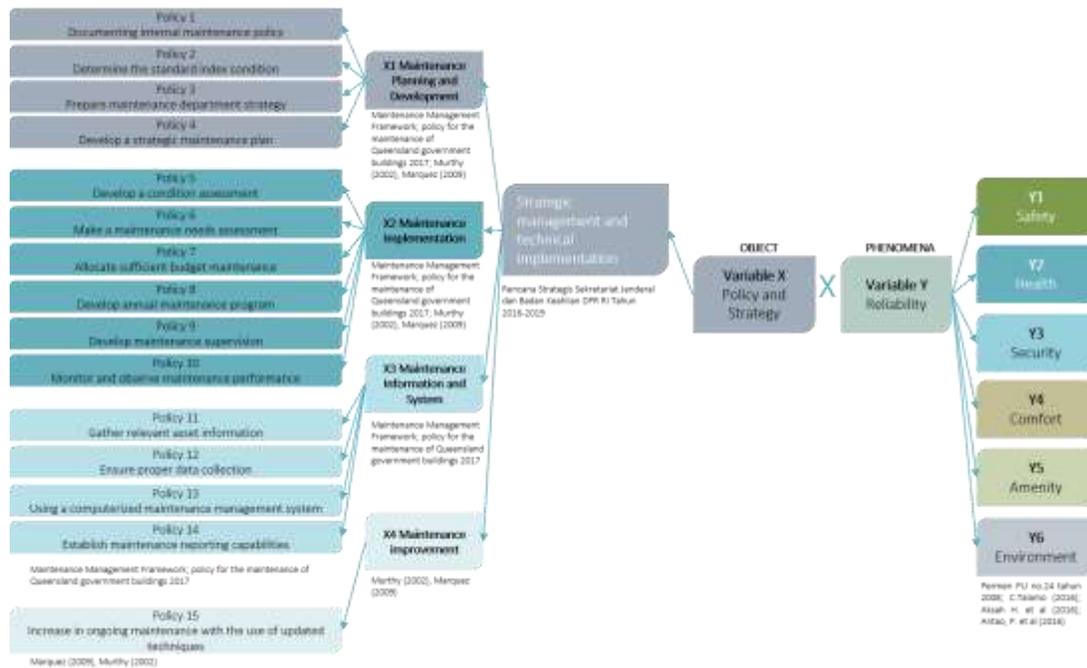

Figure 1. Research Operational Model

This research proposes a models of maintenance policy that are relevant to building functional performance as reliability performance. In research operational model (see Fig. 1), researcher correlate between maintenance policy and building functional performance based on literature review.

3.2 Methodology

To achieve the aim of this research, the contributor using several method to answer the research question as mentioned before. In research question 1, a study of literature has been used to
- Identification of the issues contained in the object of research. This object of research is maintenance policy which affecting building functional performance.
- Researcher doing a study of literature and archive analysis about the existing maintenance policy use in government building.
- Maintenance policy variable and building functional variable based on study of literature. The process of validating the construct and the content using delphi method by asking five experts in maintenance of government building in Indonesia.
- Data collection by pilot survey to find out whether the questionnaires is understandable for respondents.
- Data collection by respondents to find out the result and analyzed by PLS-SEM (Partial Least Square – Structural Equation Model) and SPSS for homogenity test.
- Finding the result of study and discussing the result to determine research conclusion.

4. Discussion and conclusion

This final section surveys the findings of the present work, summarises the contribution and forwards some concluding remarks. The first phase of this study literature to generate variables and indicators of research as listed in the table below.

Table 1. Indicator/ variable measurement for PLS-SEM Analysis

No	ID	Indicator/ Variable	Laten Variable
1	X1.1	Documenting internal maintenance policy	Planning and Development (X1)
2	X1.2	Determine the standard index condition	
3	X1.3	Prepare maintenance department strategy	
4	X1.4	Develop a strategic maintenance plan	
5	X2.1	Develop a condition assessment	Implementation (X2)
6	X2.2	Make a maintenance needs assessment	
7	X2.3	Allocate sufficient budget maintenance	
8	X2.4	Develop annual maintenance program	
9	X2.5	Develop maintenance supervision	
10	X2.6	Monitor and observe maintenance performance	
11	X3.1	Gather relevant asset information	Information and System (X3)
12	X3.2	Ensure proper data collection	
13	X3.3	Using a computer maintenance management system	
14	X3.4	Establish maintenance reporting capabilities	
15	X4.1	increase in ongoing maintenance with the use of updated techniques	Improvement (X4)
16	Y1.1	Structural foundation	Safety (Y1)
17	Y1.2	Roof and floor	
18	Y1.3	Column	
19	Y1.4	Pre-cast	
20	Y1.5	Evacuation path dimension	
21	Y1.6	Width, length, distance between stair	
22	Y1.7	Door quality and emergency stair size	
23	Y1.8	Routine maintenance in emergency stair	
24	Y1.9	Safety in fire stair	
25	Y1.10	External lightning protection system	
26	Y1.11	Internal lightning protection system	
27	Y1.12	Fire emergency active protection	
28	Y1.13	Fire emergency passive protection	
29	Y2.1	Natural air ventilation	Health (Y2)
30	Y2.2	Artificial ventilation	
31	Y2.3	Natural light	
32	Y2.4	Artificial lighting	
33	Y2.5	Emergency lighting	
34	Y2.6	Clean water system	
35	Y2.7	Waste water system	
36	Y2.8	Drainage system	
37	Y2.9	The use of not dazzling material	
38	Y2.10	The use of material causing high temperature	
39	Y2.11	The use of green material	
40	Y2.12	The use of material align to environment	
41	Y3.1	Investment in protection	Security (Y3)
42	Y3.2	Parking	
43	Y3.3	Safety fence	
44	Y3.4	Emergency lamp	
45	Y3.5	CCTV	
46	Y3.6	Utilites	
47	Y3.7	Security outpost	

No	ID	Indicator/ Variable	Laten Variable
48	Y3.8	Storage building	
49	Y3.9	Electronic safety system	
50	Y4.1	Room function for accessibility	
51	Y4.2	Accessibility in room	
52	Y4.3	Number of user for accessibility in room	
53	Y4.4	Furniture in room for accessibility in room	
54	Y4.5	Safety and health requirement for accessibility in room	
55	Y4.6	Room function within room	
56	Y4.7	Access within room	
57	Y4.8	Number of user within room	Comfort (Y4)
58	Y4.9	Furniture in building	
59	Y4.10	Safety and health requirement within room	
60	Y4.11	Stair and corridor access	
61	Y4.12	Humidity condition	
62	Y4.13	Visual condition	
63	Y4.14	Noise	
64	Y4.15	Air condition	
65	Y5.1	Door access horizontally	
66	Y5.2	Corridor access horizontally	
67	Y5.3	Stair access vertically	
68	Y5.4	Ramp access vertically	
69	Y5.5	Lift access vertically	
70	Y5.6	Escalator access vertically	
71	Y5.7	Travelator access	
72	Y5.8	Way to emergency exit	
73	Y5.9	Emergency sign	Amenity (Y5)
74	Y5.10	Prayer room	
75	Y5.11	Change room	
76	Y5.12	Baby room	
77	Y5.13	Toilet	
78	Y5.14	Parking area	
79	Y5.15	Recycle bin	
80	Y5.16	Communication facility	
81	Y6.1	Energy consumption	
82	Y6.2	Water consumption	
83	Y6.3	Food waste	
84	Y6.4	Paper waste	
85	Y6.5	Plastic waste	Environment (Y6)
86	Y6.6	Garden waste	
87	Y6.7	Air Condition	
88	Y6.8	Water condition	
89	Y6.9	Soil condition	

4.1 Discussion of the maintenance policy and strategic implementation

Based on literature review on maintenance policy to identify maintenance policy in government building in Indonesia, conclude in this table below;

Table 2. Maintenance Building Policy in Indonesia

NO	Rules and Policy	Information		
		Building	Maintenance	Reliability
1	Law no.28 of 2002	✓	✓	✓
2	Government Regulation no.36 of 2005	✓	✓	✓
3	Government Regulation no.27 of 2014	✓	✓	-

4	Rule of the Minister of Public Work no.24 of 2008	✓	✓	✓
5	Rule of the Minister of Public Work no.45 of 2007	✓	✓	✓
6	Rule of the Minister of Public Work no.5 of 2016	✓	✓	✓
7	Rule of the Minister of Public Work no.6 of 2017	✓	-	-
8	Rule of the Minister of Public Work no.6 of 2007	✓	-	-
9	Rule of the Minister of Public Work no.29 of 2006	✓	-	✓
10	Rule of the Minister of Public Work no.25 of 2007	✓	✓	✓
11	President Decision no.73 of 2011	✓	✓	✓

According the literature review conducted through the process of division between norms, standards, guidelines and criteria (government regulation no.38 of 2007), it is found that almost all policy variables have been regulated in these laws. But on information and system variables, there is no policy that regulates the IT-based maintenance management system

Table 3. Maintenance Building Policy related to Variable

Factor	Variables	N	S	P	K
Planning and Development (X1)	Documenting internal maintenance policy	✓	-	✓	-
	Determine the standard index condition	-	✓	✓	✓
	Prepare maintenance department strategy	✓	-	✓	✓
	Develop a strategic maintenance plan	✓	-	✓	-
Implementation (X2)	Develop a condition assessment	✓	✓	✓	-
	Make a maintenance needs assessment	✓	-	✓	✓
	Allocate sufficient budget maintenance	✓	-	✓	-
	Develop annual maintenance program	✓	-	✓	-
	Develop maintenance supervision	✓	✓	✓	-
	Monitor and observe maintenance performance	-	✓	✓	-
Information and System (X3)	Gather relevant asset information	✓	✓	✓	-
	Ensure proper data collection	-	-	✓	-
	Using a computer maintenance management system	-	-	-	-
	Establish maintenance reporting capabilities	✓	-	✓	-
Improvement (X4)	increase in ongoing maintenance with the use of updated techniques	✓	-	✓	✓

4.2 PLS-SEM Analysis

In this research model, reliability testing uses three types of path models. Model 01 is a model with interrelated and latent interrelated policy and functional linkages (see Fig. 2). Model 02 is a model with a policy relations path in any latent functionality feasible, but between latent policies unrelated, whereas the latent interconnected functionality is related. The 03 model is the simplest with an unrelated policy latent path, and latent functionality unrelated, except in some latent. Reliability Test Results shows the existence of 31 variables that are considered not reliable. It appears that the first analysis indicates that the measured variables of preparing the maintenance strategy (X1.3) and the short and long term strategic plan (X1.4) are not sufficiently reliable in describing the policy variables in the planning. The results of the data also show that the variables of maintenance needs assessment (X2.2), budget allocation (X2.3), routine maintenance program (X2.4), and supervision and performance evaluation (X2.6) on latent variables of policy implementation quite reliable. Furthermore, on latent variables Information and System shows that computer management system (X3.3) and maintenance reporting (X3.4) is not reliable enough.

In the latent variables of safety, it appears that the roof and floor structure (Y1.2), column structure (Y1.3), pre-pressed concrete connection (Y1.4), evacuation line dimensions (Y1.5), emergency ladder treatment (Y1 .8), the external lightning protection system (Y1.10), passive fire protection system (Y1.13), are not sufficiently reliable to describe latent safety variables in functional functions. In the latent variables of health, it appears that emergency lighting (Y2.5), the use of energy-efficient building materials (Y2.11), and the use of harmonized building materials (Y2.12) are not sufficiently reliable to describe health in building functional functions.

In the latent security variables, it appears that the safety fence (Y3.3), guard post (Y3.7), and building penyimpannan (Y3.8) are not reliable enough in describing the security on the functional of the building. In the latent variable of comfort, it can be seen that the space function of the space (Y4.1), the number of occupants between spaces (Y4.8), the intermediate safety and health requirements (Y4.10), and the visual conditions (Y4.13) quite reliably in describing the convenience of building functionality. In the latent variables of ease, it appears that horizontal access corridors (Y5.2), roads leading to the emergency stairs (Y5.8), worship space (Y5.10), and dressing room (Y5.11) are not reliable enough to describe ease of use building function. And on latent variables environmental sustainability shows that energy consumption (Y6.1) and soil conditions (Y6.9) are not reliable enough to describe environmental sustainability in functional functions.
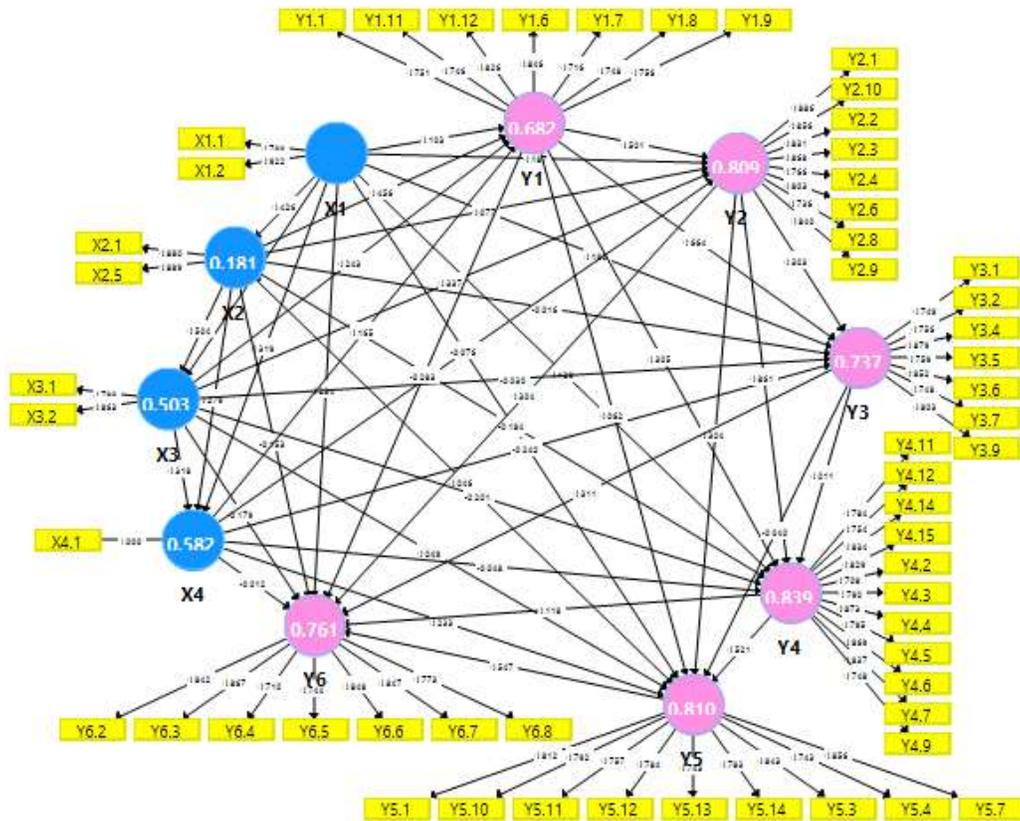

Figure 2. PLS Algoritm – Full Process model

Table 4. Smart-PLS Bootstrapping Analysis

	Original Sample	Sample Mean	(STDEV)	T Statistics	P Values
Implementation -> Information & System	0.504	0.495	0.152	3.320	0.001
Implementation -> Safety	0.456	0.424	0.140	3.268	0.001
Information & System -> Health	0.337	0.321	0.140	2.400	0.017
Health -> Comfort	0.861	0.825	0.178	4.826	0.000
Safety -> Security	0.664	0.629	0.197	3.367	0.001
Safety -> Health	0.501	0.515	0.152	3.294	0.001
Planning & Development -> Implementation	0.426	0.439	0.180	2.372	0.018
Planning & Development -> Information and System	0.328	0.310	0.163	2.013	0.045

Based on literature to support PLS-SEM result (see Table. 4), In order for a successful maintenance implementation one can be achieved using Computerized Maintenance Management Software (CMMS) (Wienker,

Henderson, & Volkerts, 2016). Information systems in the medical world can help facilitate implementations that may lead to improved patient safety in hospitals (Weiner, Alexander, Baker, Shortell, & Becker, 2006). According to Krishnan and Singh (2007), the basic assessment of information needs is in the form of what features are needed, concern for safety and customization required with the system offered. For example, with the use of information and systems it can be seen that maintenance work has health-related impacts of implementing maintenance activities. Health can be affected when the physical comfort of the environment does not meet the minimum requirements (Ali, Chua, & Lim, 2015). Safety and beauty of building are often difficult to achieve simultaneously, but the combination of plant use as a substitute for fencing can improve safety sense (Schroeder & Anderson, 1984). In the food processing industry, process and outcome safety is one of the important things needed to ensure public health (Lin, Huang, & Wahlqvist, 2009). People who survive to come home from work every day are not necessarily healthy, but healthy people get home from work accident (Duma, Husodo, Soebijanto, & Maurits, 2011). According to Issa and Abu-Eisheh (2017), the implementation of maintenance work can be carried out according to plan if supported by various aspects such as allocation of funds, and others and recommended to plan priorities on maintenance work. Issa and Abu-Eisheh (2017) recommends that planning be accompanied by software development that can transform maintenance work into easy-to-use computerized systems. All the connection that contribute significantly into reliability variable shows below (see Fig. 3).

Figure 3. PLS Algoritm – Full Process model

4.2 Improvement

In order to contribute to the development of the scientific world, the authors make improvements by developing the results of a significant variable related to functional factors. The development scheme is as follows to evaluate low building functional performance ;

a) If No Policy

It is recommended to formulate policies based on maintenance policy factors (X1-X4) that have a significant influence on functionality. Based on regulation review in Indonesia, it is recommend to formulate policies related to IT-based maintenance management systems that do not exist today. The use of computer-based maintenance management systems can improve overall efficiency (Eva & Kateřina, 2013). E-maintenance is the synthesis of two major trends of the present: the increasing need for maintenance and the rapid development of communication and information technology (Borissova and Mustakerov, 2013). Some standards could be use in formulate IT-based maintenance management system as follows;

• IEEE 802.11x, EN457:1992-ISO7731.
• IEC 62264 (enterprise—control system integration) based on ANSI/ISA S95.
• ISO 15745 (industrial automation application integration framework).
• MIMOSA6 (Machinery InformationManagement Open System alliance)-IEEE 1232.7
• ISO 13374 (condition monitoring and diagnostics of machines).
• EN60204-1:1997/IEC60204-1 (safety of machinery).
(Muller, Marquez, Iung (2007)

b) If Policy has been made

Controlling and improving the performance of existing policies based on significant factors influences. Examine compliance with policy implementation on maintenance work. Another way by improving

government policy by adding criteria and standard for maintenance performance measurement could help increase functional building performance.

4.3 Conculsion

Based on the results of research, in government buildings there are now various policies that guide maintenance work and also policies that regulate the functionality both in the law, the rules of the minister of public works, government regulations to presidential regulations. In general, the Minister of Public Works Regulation no.24 of 2008 is sufficient to describe the maintenance policy required. In detail, existing regulations is not contain maintenance policies that using computer-based maintenance management systems. Future research could be develop computer-based maintenance management system for governement building. The current Maintenance policy mentions that maintenance reports are the basis of consideration in the extension of a functional-worthy certificate, but no policy clearly defines maintenance report standards as references to be associated with function eligibility.

Based on statistical analysis, the most dominant factor or influence the functional function of government building is planning and development policy, implementation policy and information and system policy. This is also supported by the results of analysis on PLS-SEM model. All the factors obtained require policies in order to implement appropriate strategies for the feasibility of building functions. So it is important that factors related to it can be controlled and monitored as consideration determines the maintenance policy. For the government policy that doesn't exist as indicator shown before, it is recommend to create a policy based of these indicator.

Based on the results of the identification of the maintenance policies studied have significant effect but not on all aspects of functionality, such as environment and amenity. The aspects of functionality that are significantly related to the policy studied are aspects of safety, health, security and comfort.

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