Enhancing mechanical component performance with development of web-based maintenance guidelines for green buildings

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Abstract. Mechanical components namely HVAC system, piping, plumbing and vertical transportation on green building has major impact namely emission and energy reduction. The purpose of maintenance on mechanical components is to maintain achieved mission on green building performance. Failure in maintaining mechanical components can highly affect the cost of maintenance. Problems that occur in this study is maintenance nowadays still using paper-based document affecting undocumented data that slow down maintenance report, guidelines nowadays still focused on conventional building not focused to green building. Therefore, massive budget spent in construction phase will be worthless. The purpose of this study is to improve maintenance guidelines on mechanical components that will enhance maintenance response. To enhance maintenance response this study will make web-based information system named e-maintenance that can reduce maintenance response time and get rid of undocumented maintenance data. The research method are surveys, questionnaire and literature reviews. This study will develop maintenance guidelines from ministry regulation number 24/M/PRT/2008. The result in this study explained that web-based information system using developed maintenance guidelines can enhance maintenance response time and performance of mechanical components in green building

1. Introduction
Jakarta as a city that has high rate construction growth contribute to environmental and natural resource problem, one of solution for that is construct a green building [1]. Building maintenance is essential in preserving building’s performance, It has been found that the cost for housing maintenance is high due to poor maintenance practices [2]. Failure on maintenance can cause damage on mechanical components. So the performance of mechanical components such HVAC, piping and plumbing, and vertical transportation doesn’t meet green building purposes [3]. According to data from the Recapitulation of Fire Events in Jakarta, there were two fires and three elevator damages on last year caused by lack of maintenance. Unreported failures and lack of timely maintenance can lead to failure outcome in mechanical components [4].

Ministry Regulation number 29/M/PRT/2006 regulated building reliability requirements in Indonesia, it consist of four requirements, which are safety, health, comfort and convenience. Building maintenance activity have become more complex due to more complex on functionaly.

This research aims to identify mechanical components that are significantly effect green building performance based on ministry regulation number 24/M/PRT/2008, also mechanical damages, its causes
and maintenance activities. The result of this research is maintenance guidelines using web-based information system to improve building performance requirements.

2. Literature study

2.1. Maintenance work on mechanical components
Mechanical Components on green building provide suitable environment by controlling energy efficiency, water conservation and indoor air quality [5]. Green Building maintenance work aims to maintain the reliability of the building and to maintain greenship certification from Green building Council Indonesia (GBCI) [6]. There were four main components needs to maintained on mechanical, that are air system, sanitary, plumbing and human transportation. Ministry regulation number 24/M/PRT/2008 declare 3 main work that were, air system has to be periodically maintained due to fulfil indoor air quality for health safety, on water distribution or sanitary it needs to periodically cheked and transportation system needs to checked periodicaly and maintained properly as not to be damaged.

2.2. Green building
Green Building is a building that is responsible for the environment and efficient resources from planning and implementation of construction and maintenance phase. The technical requirements for green buildings for new buildings includes energy and water efficiency, indoor air quality, land and waste management and construction activities. For existing building it includes conservation energy and water efficiency, indoor air quality, thermal comfort and operational maintenance management. According to Green building Council Indonesia (GBCI), green building is a building that is its design, construction and operation can reduce or eliminate negative impacts, and can create positive impacts on climate and natural environment. Green buildings can preserve valuable natural resources and improve the quality of human life [7].

2.3. Web-based information system benefits
Information system is an integrated set of comonent for collectionig, storing and processing data for profiding information. Various information and communication technologies have been introduced to the industry to overcome information management problems, promote communication and collaboration, and achieve advanced practices [8]. The development of information systems at building maintenance stage is useful for managing information relating to physical descriptions, function descriptions, troubleshooting, maintenance, component list, managing images, and managing specific information about equipment [9].

2.4. Elements of web-based information system
To provide the existence of a website, it must be some available supporting it which are, URL- Uniform Resource locator is an unique address in internet used to identify a website, Web hosting is space for storing data, file and image for website, Script Program is a script used to translate the entire command on website when accessed, Web Design used to make a website beauty and comfortable, and website maintenance [10].

3. Research methodology
This study used research methods that are literature study and case study for information system development. First step of questionnaire are used to validate all data which are, mechanical component contained on ministry regulations number 24/M/PRT/2008, components damage and its category, cause of failure, maintenance activities and schedule. Second step of questionnaire are used to validate web-based system information maintenance.

After all component damages, its cause, maintenance activity and schedule are validated, the next step is development web-based system information for green building maintenance. Web script is created by Phyton and CSS for its design. Flow chart this research method and website development is illustrated in figure 1.
4. Result and findings
First validation results for mechanical components is there were 33 valid components of green building out of 47 from Ministry regulation number 24/M/PRT/2008 which are condenser, metering device, AHU, Refrigerant Pipe, Drain Pipe, Chiller Pipe, Cooling Tower, and etc. next results of this research are shown in table 1.

Table 1. Research results.

| Components      | Components Damage | Damage Level | Causes of Damage            |
|----------------|-------------------|--------------|-----------------------------|
| Condenser       | Clogged up        | Medium       | Lack of Maintenance         |
|                 | Refrigerant leakage | Medium       | Pipe clogged up             |
| Metering Device | Reading Error     | Heavy        | Life span has passed        |
| AHU/FCU         | Dirty             | Medium       | Lack of maintenance         |
|                 | V Belt Broken     | Heavy        | Life span has passed        |
| Pump            | Leakage           | Light        | Lack of maintenance         |
|                 | Short Pump        | Heavy        | Protection system broken    |
| Refrigerant Pipe| Leakage           | Medium       | Lack of maintenance         |
|                 | Clogged up        | Medium       | Lack of maintenance         |
| Drain Pipe      | Clogged up        | Medium       | Lack of maintenance         |
|                 | Broken Gauge      | Medium       | Life span has passed        |
| Air Condenser Ducting | Dirty | Medium       | Lack of maintenance         |
|                 | Ducting leakage   | Medium       | Life span has passed        |

Table 2. Research result (continue).

| Components      | Components Damage          | Damage Level | Causes of Damage            |
|----------------|----------------------------|--------------|-----------------------------|
| Cooling Tower  | Corotion                   | Light        | Weather effect              |
|                 | Hot and Cool Basin         | Light        | Lack of maintenance         |
|                 | Clogged up                 | Medium       | Lack of maintenance         |
| Passenger Elevator | Broken Motor          | Medium       | Overload                    |
| Service Elevator | Broken Motor             | Medium       | Overload                    |
| Escalator       | Broken Motor              | Medium       | Lack of maintenance         |
| Transfer Pump   | Debit Capacity overdesign | Medium       | Clearence pump is down      |
|                 | Noise on bearing pump      | Medium       | Less lubricating bearings   |
This new guidelines provides mechanical components maintenance that significantly affect green building performance in EEC (Energy Efficiency and Conservation), WAC (Water Conservation) and IHC (Indoor Health and Comfort), Including all conventional purpose. After that we build web-based information system integration for green building maintenance, we use domain that named http://www.isgb-emaintenance.com.

5. Conclusion

- There were 33 valid mechanical components significantly effect green building performance out of 47 named on ministry regulation number 24/M/PRT/2008.
- Most causes of damage is lack of maintenance.
- Maintenance using web-based information system can get rid of undocumented data, reduce maintenance response time on mechanical components.

References

[1] Hatmoko J U D, et al 2014 Kajian Penerapan Green Building Pada Gedung Bank Indonesia Surakarta JIPTEK 7(2)
[2] Komalasari I R, et al 2014 Green Building Assessment Based on Energy Efficiency and conservation (EEC) Category at Pasca sarjana B building Diponegoro University, Semarang American Journal of Energy Research 2 No 2
[3] Zaimah et al 2016 Operations and Maintenance Cost for Stratified Buildings: A Critical Review (MATEC Web Conf. Volume 66)
[4] Zakiyudin M Z, Fathi M S, Tobi S U and Rambat S 2016 Building Maintenance Information Systems: The Adaptation of Context Aware Technology International Journal of Research in Chemical, Metallurgical and Civil Engineering 3 (1)
[5] Naser A 2017 Comparative Study of Conventional and Green Residential Building International Journal of Innovative Science and Research Technology 2(4)
[6] Latief Y, et al 2017 Premium Cost Optimization of Operational and Maintenance of Green Building In Indonesia Using Life Cycle Assessment Method (AIP Conference Proceedings Vol 1885, issue 1)
[7] Green Building Council Indonesia 2016 Greenship Rating Tools for Existing Building (Divisi Rating dan Teknologi, GBCI)
[8] Xiaozhi M A, et al 2018 Conceptual Framework and Roadmap Approach for Integrating BIM into Life Cycle Project Management Journal of Management in Engineering 34 (6)
[9] Edoardo Pati et al 2017 Information Modeling for Virtual and Augmented Reality IT Professional 19 No 3
[10] Utama Y 2011 Sistem Informasi Berbasis Web Jurusan Sistem Informasi Fakultas Ilmu Komputer Universitas Sriwijaya Jurnal Sistem Informasi 3 No 2