Developing Indicators of Green Operation and Maintenance of Green Supply Chain Management in Construction Industry

Mochamad Agung Wibowo[1], Naniek Utami Handayani[2], and Nur Farida[2]

[1] Department of Civil Engineering, Diponegoro University, Semarang, Indonesia 50275
[2] Department of Industrial Engineering, Diponegoro University, Semarang, Indonesia 50275
agung.wibowo@ft.undip.ac.id

Abstract. Operation and maintenance (O&M) is the last phase of Project Life Cycle (PLC) that focused on releasing the final deliverables to the customer and followed by the use of facilities and the maintenance of the whole building. This phase is the longest phase because it covers the entire lifetime of the building. The building that is operated and maintained using the green principles will contribute to sustainability by reducing energy and resource emissions by ensuring the building facilities' durability and availability. Green Operation and Maintenance (GOM) programs as part of Green Supply Chain Management (GSCM) in the construction process consist of work implementation and control to conserve 'green' materials according to environmental needs in the project. GOM concept is important because O&M phase is the determinant of whether the building that have been initiated, designed and built with green processes can be maintained to keep contributing positively to the environment. To ensure that the O&M phase is run on the green principle, it is necessary to conduct a study to develop factors that can support the application of GSCM in the O&M phase. The aim of this study is to improve the GOM concept indicators as part of the GSCM construction. The model developed has two dimensions, 12 components, and 18 indicators for the implementation of GOM.
Keywords: Green Operation and Maintenance, Green Supply Chain Management, Project Life Cycle.

1 Introduction

Construction industry in developing countries has several characteristics include, first, construction has typically contributed to an average GDP of 5 – 9%. Second, the impact of construction affects the value of the distribution of construction materials and labor absorption, which reaches 5% of the total workforce and often work in this sector is a stepping stone for the manufacturing industry. Third, the impact of construction business is quite extensive, built from small companies that generate entrepreneurial opportunities in small businesses and play an important role for income distribution [1].

The construction industry is widely considered to have a high degree of waste in spite of its significant contributions. Waste consists of material waste at the project site

in the construction industry and is often related to various activities such as overproduction, waiting time, shipment of materials, inventory, and labor movement. Rework/repair, defects, waste in the form of materials, delays, waiting, allocation of material that is not suitable, and excessive transfer of material can be defined as the main categories of waste during the construction process [2]. The performance of this industry is also influenced by the characteristics of the construction industry, such as the high complexity and volatility, the temporary structure of the supply chain, the high degree of consumer control on the final product, the disjointed processes, and the complexity of stakeholder linkages [3].

It is possible to suggest implementing the Green Supply Chain Management System to form a productive and environmentally friendly construction industry. In every step throughout the Project Life Cycle (PLC), the initiation, design, construction, and operation and maintenance phase, this implementation is intended to bring the notion of eco-friendly [4].

In general, the commissioning and closure of a green building project are more complex than traditional projects. This is especially valid when developers or owners choose to receive Green Building Certification from third parties. The Green Building is the basis of an environmentally friendly and resource-efficient structure over the life cycle. It is also the task of current facility management teams and end-users to deliver an awareness of the green building system to maintain sustainability [5]. The commissioning process is part of the last stage of the PLC, the service and maintenance phase. The operation and maintenance process centered on the release to the customer of the final deliverables, the handing over of project documents, the termination of supplier contracts, the release of project resources, and the notification to all stakeholders of the project's closure [6]. This phase also focused on the use of facilities and the maintenance of the whole building. In general, the Operation and maintenance phase forms the major part of the life cycle [7].

Previous research on GSCM in the construction industry has established a framework consisting of five principles for GSCM implementation, i.e. Green Initiation, Green Product Design, Green Material Management, Green Construction, and Green Operation and Maintenance [8]. This framework represents all stage in PLC. Detailed indicator of every concept has developed in previous research about Green Initiation and Green Design [9], Green Material Management [10], and Green Construction [11]. As a continuation of previous studies, this study aims to classify the Green Operation and Maintenance indicators as part of the GSCM in construction.

2 Literature Review

2.1 Project Life Cycle

Construction projects are some activities that have multipart and various properties. The project follows a flow of stages, known as Project Life Cycle (PLC). In common, PLC involves several stages, i.e. initiation/conceptualization, planning/design, implementation/construction, and operation & maintenance [9, 12, 13]. All of the PLC phases

are less synchronized with one another in the conventional management model. This is what causes the fragmentation of construction projects. The initiation phase is related to the owner as key stakeholders in the process. Data collection, surveys, and feasibility studies are usually conducted in initiation phase. Feasibility studies are taken to decide whether a project is feasible and also to determine alternative possibilities that can be taken as a consideration in decision making. A project document that will be used as a reference to the next step is the production from the initiation stage [9].

The project planning documents are produced at the planning phase. These documents consist of Detail Engineering Design (DED), Gantt Chart (PERT), Work Breakdown Structure (WBS), and other planning documents (i.e. specification/quality and risk management). The construction phase is the process of executing the planning that has been generated from the previous phase. This process includes execution of plans, project resource management, monitoring, and reporting. The last phase is operation and maintenance phase that consists of handover project results and maintenance period. This phase can show the success of the project by conducting evaluation and assessment after completion of the project [9, 12, 13]

2.2 Green Supply Chain Management in Construction

Green supply chain management (GSCM) is a framework that assimilates environmental deliberation into supply chain management. There is some research that examines to adopted GSCM in manufacture to be applied in the construction industry. The GSCM structure in the construction industry, which includes five principles, is one of the research that is the key reference of this report, i.e. green initiation, green design, green material management, green construction, and green operation and maintenance [8].

This research is part of the overall framework for applying GSCM to the construction industry based on PLC. The previous research stated that there is GSCM in manufature industry that could be applied in the construction industry [8]. The roadmap of this research described in Fig. 1.

Framework for Implementing Green Supply Chain Management in The Construction Industry based on Project Life Cycle

Project Life Cycle	Initiation Phase	Design Phase	Construction Phase		Operation & Maintenance Phase
Green Supply Chain Management	 Developing Indicators of **Green Initiation** and **Green Design** of Green Supply Chain Management in Construction Industry: A Literature Review Published on 2019	 Developing Indicators of **Green Initiation** and **Green Design** of Green Supply Chain Management in Construction Industry: A Literature Review Published on 2019	 Developing Indicators to Implementing **Green Material Management** in Construction Industry: A Literature Review Published on 2018	 Developing Indicators of **Green Construction** of Green Supply Chain Management in Construction Industry: A Literature Review Published on 2019	**This Research** Developing Indicators of **Green Operation & Maintenance** of Green Supply Chain Management in Construction Industry: A Literature Review

Fig. 1. Roadmap research framework for implementing GSCM to the construction industry based on Project Life Cycle

Each of the research mentioned in Fig. 1 contains detailed concepts, dimensions, elements, and indicators of each concept that corresponds to the PLC stage. First and second stage of PLC corresponds to the research about developing indicators of green initiation and green design. Green initiation is related to project owner commitment and feasibility of development project. Owner commitment is the most essential thing to realize a sustainable project in the construction industry, because owners are the decision maker who can determine every step towards a sustainable project [9, 14]. Table 1 contains the translation of one of the dimension in Green Initiation concept to the indicator level [9].

Table 1. The example of translation the Green Initiation indicators

No	Dimensions	Elements	Indicators
1	Environment Conscious Design	Project owner commitment	Educating project team participants to achieve sustainable construction and building concepts.
			Provide vision statement on the reason to develop GSCM project.
			Facilitating the integration of other project participants.
			Introducing green intention early.
		Feasibility Study	Perform area, demographic, and neighborhood analysis.
			Perform site review analysis that evaluate the size, topography, amenities, and Governmental impacts.
			Perform market analysis.
			Perform financial analysis.
			Perform valuation analysis of propose development in project that calculated through a discounted cash flow

Green design, that corresponds to design stage in the PLC, is the most important phase because every choice that made in the design phase will have an impact on the lifespan of project system. Design should become a main consideration for detect the environmental impacts of project activities [9, 14]. Green design concept is translated into five dimensions, i.e. design, innovation capability, product safety, environmental control, and building & environment management [8, 9]. Table 2 contains the translation of one of the dimension in Green Design concept to the indicator level [9].

Table 2. The example of translation the Green Design indicators.

No	Dimensions	Elements	Indicators
1	Innovation Capability	Resource conservation	Using non-toxic or less toxic materials in design specification.
			Consider material durability in design specification.
		Design support for waste management implementation	Make coordination design to minimize excess cutting and jointing of materials.
			Make design with standard material dimension.
			Building element and material design easily disassembled.
		Appropriate site development	Percentage of basic green area.
			Placing sustainable building project within easy access of public facilities.

Green material management is a concept that covered to two stage of PLC, i.e. planning/design phase and implementation/construction phase. This concept is about how to take out hazardous material or harmful activities then replace with less harmful ones. Green material management concept is translated into five dimensions, i.e. material planning, packaging, green transportation, material storage, and material handling [8, 10]. Table 3 contains the translation of one of the dimension in Green Material Management concept to the indicator level [10].

Table 3. The example of translation the Green Material Management indicators.

No	Dimensions	Elements	Indicators
1	Material Planning	Using material that environmental friendly	Percentage utilization of recyclable construction material
			Percentage utilization of hazardous material
		Contract with supplier	Percentage of contract with suppliers
		Select supplier with ISO 14001 certificate	Percentage of suppliers with ISO 14001 certificate
		Quality control of material	Percentage of good material that received in site

The implementation/construction stage on the PLC is represent by Green construction concept. This concept consists of process engineering to diminish the use of resources and energy. This reduction aims to diminish total waste produced during the construction phase. There are four dimensions which are derived from green construction, i.e. on-site management & planning, site operation, environment society, and reverse logistics [8, 11]. Table 4 contains the translation of one of the dimension in Green Construction concept to the indicator level [11].

Table 4. The example of translation the Green Construction indicators.

No	Dimensions	Elements	Indicators
1	Site Operation	Accidents due to negligence	Number of work accident during a project.
		Equipment malfunction	Amount of broken equipment.
			There is equipment maintenance schedule.
			There is equipment calibration schedule.
		Use of wrong materials resulting in their disposal	Percentage of waste that caused by use of wrong material.
		Time pressure	There is countdown timer equipment for reminder project schedule.
		Poor work ethic	All work result meet the specification that has been stated in contract document.

The last concept, green operation and maintenance corresponds to the last phase of PLC, operation and maintenance. Green operations and maintenance consist of strategy about work practices and material observation in a project with environmental concern so that the green concept can still be applied during the operational phase of the building [8, 12]. This concept is closely related to the practice of green building principles.

BREEM (UK), LEED (US), BEAM (Hong Kong), CASBEE (Japan) and EDGE (UK) are the various of Green Building Rating System (GBRS) that have been developed around the world. The Green Building Rating Systems could help building owners in some concerns, which are base lining (i.e., establishing an initial measurement against which to calibrate future performance), benchmarking (i.e., presenting a basis for comparison with competitor), decision making (i.e.,creating a basis to select among different solutions), documentation (i.e., to capture evidence to fulfill the rules and regulations). According to the review, the most essential evaluation criteria in the various of GBRS are energy, water, material, indoor environment, site, land and outdoor environment, and innovation [5].

3 Research Methodology

This research is a descriptive study that develops a structure for green operation and maintenance implementation as part of the green supply chain management. The concept, dimensions, elements, and indicators consist of this framework. Data accumulated by observation through the execution of a literature review and interview with researcher, practitioner, and ministry experts. The literature review covered the project life cycle, the management of the green supply chain in the construction industry, and some prior studies on organizational and maintenance issues. The experts who become respondents are composed of four academic experts, two practitioner experts, and one Ministry of Public Work specialist. The goal of the interview is to compare the indicators established with the condition of the sector.

The previous study about issues in operation and maintenance phase are listed in Table 5.

Table 5. The previous study about issues in operation and maintenance phase.

No	Title & Authors	Objectives	Methods	Result
1	Critical Factors that Lead to Green Building Operations and Maintenance Problems in Malaysia: A Preliminary Study Zainol et al (2014) [15]	Identify the factors that lead to green buildings operation and maintenance problems in Malaysia	Literature review, questionnaire survey	• There are five factors that lead to green building O&M problems, in succession, i.e. technical defects, managerial problems, social & cultural problems, political & legal factors, environmental & biological effects. • These five factors are described in more detail into 15 sub factors that stated in the paper.
2	Green Maintainability Performance Indicators for Highly Sustainable and Maintainable Building Asmone et al (2019) [16]	Propose a set of critical green maintainability performance indicators for building projects	Literature review, expert interviews, DEMATEL	• The indicators of green maintainability are 13 indicators with 22 sub indicators that stated in the paper. • The critical indicators of green maintainability are green procurement, construction quality, building and construction standards, design for maintainability, and sustainable facilities management.
3	Factors for Implementing Green Supply Chain Management in the Construction Industry Wibowo, et al (2018)	Elaborate the concepts, dimensions, and elements of Green Supply Chain Management (GSCM) and develop the framework for	Literature review, Delphi method	• The framework for implementing GSCM consist of five concepts, 22 dimensions, and 82 elements. • Green Operation & Maintenance concept consist of 2 dimensions and 13 elements

No	Title & Authors	Objectives	Methods	Result
	[8]	implementing GSCM in the construction industry.		• The indicators is not yet developed.
4	Performance and Improvement of Green Construction Projects – Management Strategies and Innovation B.G. Hwang (2018) [5]	Identify and compare the various of Green Building Rating System that have been developed around the world to determine the most essential evaluation criteria in the various of GBRS.	Literature review, questionnaire survey, interviews, statistical analysis methods, fuzzy synthetic evaluation approach, risk criticality index	• The most essential evaluation criteria in the various of GBRS are energy, water, material, indoor environment, site, land and outdoor environment, and innovation.

A previous study by Zainol et al. [15] and Asmone et al. [16] has identified the factors and indicators that need to be considered to support the development of a sustainable O&M phase. From the previous stage of PLC, some of the factors and indicators, such as "technical defects," "construction quality," "building and construction standards," and "maintainability design," must be decided. It shows the interrelationship between phases in the PLC and a holistic approach is needed to ensure the achievement of sustainability throughout the PLC. This vision in line with the research vision of Wibowo et al [8] that carries the GSCM concept to try to solve the problem of waste and inefficiency in the construction industry with the aim of sustainable construction.

In previous study conducted by Zainol et al [15], Asmone et al [16], and Wibowo et al [8], the model developed still did not provide the indicators that could be measured directly in the project. This GOM study is the continuation of study that have been conducted by Wibowo et al [8]. So, based on this main reference and supported by factors that exist in previous studies, this study will develop the indicators of green operation and maintenance as part of GSCM in construction. Indicator generation is carried out by tracing other studies that have addressed related topics with the critical reference model elements. While the GBRS that stated in B.G Hwang research [5] will be used as additional reference and will be compared in the discussion section.

4 Result and Discussion

4.1 Developing Indicators of Green Operation and Maintenance as Part of GSCM in Construction

Green Operation and Maintenance (GOM) concept in Wibowo et al [8] consist of two dimensions and 13 elements. The dimensions are “Green Building” that breakdown to 9 elements and “Green Management Policy” that breakdown to 4 elements. The result of literature studies and interviews conducted with expert respondents are the indicators of GOM. Literature studies is conducted first, while interviews with experts are done as verification of the suitability of the literature study results with field conditions. The

questionnaire was used as a tool to simplify the interview process. The indicators of Green Operation and Maintenance as part of GSCM in construction are listed in Table 6.

Table 6. The indicators of green operation and maintenance.

No	Element	Indicator	Reference
		Dimension: Green Building	
1	Greenery (vegetation planning)	Percentage of basic green area	5, 17
2	Water infiltration & retention	Provide rainwater harvesting installation equipment	5, 17
		Use water from alternative resource to sanitation and irrigation activity	5, 17
3	Daily energy conservation	Measure energy used as a baseline for application better energy management	5, 17
		Doing OTTV (Overall Thermal Transmittance Value) calculation	5, 17, 18
		Amount of energy savings in building installed	5, 17
4	Water conservation	Measure water used as a baseline for application better water management	5, 17
		Amount of water savings in building installed	5, 17
5	CO_2 emission reduction	Using high efficiency lighting	19, 20
		Using solar thermal water heater	
6	Construction waste reduction	Using concrete residual to make nonstructural component (example : cansteen/curb and car stopper)	21
		Using ceramics cutting residual to filling floor pattern or decoration	
7	Sewage and waste disposal facility improvement	There are on site wastewater treatment system facility	5, 17, 22
		Perform organic waste processing (on site or third party cooperation)	5, 17
		Perform an-organic waste processing (on site or third party cooperation)	5, 17
8	Biodiversity	Percentage of vegetation landscape (include garden above basement, roof garden, terrace garden & wall garden)	5, 17
9	Indoor environmental quality	Indoor air quality meet the specification threshold (CO_2 = 530 – 1500 ppm; CO = 10 – 100.000 µg/m3; NO_2 = 40 – 5600 µg/m3; SO_2 = 20 – 5200 µg/m3; ammonia = 17.000 µg/m3)	23
		Dimension: Green Management Policy	
10	Green Corporate Social Responsibility	Number of company regulation that support green concept	24, 25
11	Green Customer Education	Publish the sustainability report company that extensively accessible	26, 27

No	Element	Indicator	Reference
12	Green Image Promotion	Installation green slogan board in project site	21, 26
13	Certificate of Building Proper Function	Building has certificate of building proper function	28

4.2 Discussion

Green operation and maintenance related with operation and maintenance phase in Project Life Cycle (PLC). This phase has the longest period in PLC that covered entirely building lifetime. From the description of the indicators above, most of the indicators at first dimensions i.e. Green Building refer to GREENSHIP rating tools as a model that is well known in Indonesia. The indicators referred to are indicators related to the building operational process. These indicators can still be continuously improved during O&M phase, such as water infiltration and retention, daily energy conservation, water conservation, CO_2 emission reduction, and sewage and waste disposal facility improvement. However, success in improving these indicators greatly depends on the application of green in the previous PLC phase. Thus, the GOM indicators cannot stand alone, but rather as a series of the entire GSCM framework.

Concepts that technically related with the GOM concept are Green Design (GD), Green Material Management (GMM), and Green Construction (GC). The GD elements that greatly influences the GOM are resource conservation, appropriate site development, occupational health and safety, indoor health and comfort, design support for energy conservation, design support for water conservation, and environment assessment [9]. All decision about these elements will determine success in carrying out the GOM indicators.

The GMM elements that directly influence the GOM are using material that environmental friendly, select supplier with ISO14001 certificate, and quality control of material [10]. The GC elements that directly influence the GOM are pollution control and quality control [11]. While GI became the basis for the implementation of all GSCM practices in the PLC, especially for the element of project owner commitment [9].

The second dimension of GOM concept is Green Management Policy which means effort to improve the foundation of environment management by building personal responsibility for eco-friendly activities and also modifying the policies, practices, and principles of management system [29]. This dimension is complementary to the first dimension, i.e. Green Building, where the elements in green building provide technical guidance, while elements in green management policy consist of decisions at managerial level that can support the achievement of a sustainable O&M phase.

This study has differences compared to study conducted by Zainol et al [15], Asmone et al [16], and Wibowo et al [8]. First, in term of concept, this study is a unity in a series of GSCM implementation model in the construction industry, which has integrated PLC into the model. This integration is expected to form a continuous model and represent all stakeholders involved in the PLC. In addition, this study has been able

to present model up to the indicator level that can be implemented or measured in a project.

In the past two decades, they were a rapid establishment of green building rating systems. The GBRSs is a systematic system built to assess and check the sustainability and greenness of buildings by construction authorities, foreign organizations, or private consulting companies [5].

Today, numerous GBRSs have been developed around the world to assess the sustainability of buildings. Most GBRSs are specifically adapted to suit the country's building industry in which they are built and to meet the unique needs of the buildings of that country. The GBRSs announces that a building is eco-friendly and environmentally safe, reflecting what widespread green components have been implemented and describes the sustainable values and practices used [5]. The comparison of the prevailing GBRSs evaluation criteria and Green operation and maintenance element stated in Table 7.

Table 7. The comparison of the prevailing GBRSs and green operation and maintenance.

No	Prevailing GBRSs (BREEAM,LEED, CASBEE, GM)	Green Operation and Maintenance	
	Aspects most considered	Dimension : Green Building	Dimension: Green Management Policy
1	Energy	Daily energy conservation	
2	Site	Sewage and waste disposal facility improvement	
3	Indoor Environment	Indoor environment quality	
4	Land and Outdoor Environment	Biodiversity	
5	Material	Construction waste reduction	
6	Water	Water infiltration and retention	
7	Innovation		Green Corporate Social Responsibility; Green Customer Education; Green Image Promotion; Certificate of Building Proper Function.

It can be seen that the prevailing GBRSs which are the most aspects considered are also mentioned as indicators in Green Operation and Management. The dimension of Green Building has five aspects that are similiar to the prevailing GBRSs that are energy, site, indoor environment, land and outdoor environment, material, water, and innovation. Moreover, the dimension of Green Management Policy has indicators that

are green corporate social responsibility, green customer education, green image promotion, and certificate of building proper function are considered as “innovation” in the prevailing GBRSs. This research is in line with some previous research by B.G. Hwang [5] .

5 Conclusion

The structure for the implementation of Green Operation and Maintenance as part of GSCM in construction consists of two dimensions, i.e. Green building and Green management policy. These dimensions are translated into 13 elements that consist of 9 elements of green building dimensions (Greenery (vegetation planning), Water infiltration & retention, Daily energy conservation, Water conservation, CO_2 emission reduction, Construction waste reduction, Sewage and waste disposal facility improvement, Biodiversity, and Indoor environmental quality. While the other 4 are the elements of Green management policy, i.e. Green Corporate Social Responsibility, Green Customer Education, Green Image Promotion, and Certificate of Building Proper Function. These elements are translated into 21 indicators that consist of 17 indicators of Green building dimensions and 4 indicators of Green management policy.

These indicators are ways to keep the building or deliverables environmentally friendly during O&M phase. Compared with other previous researches, this study is a unity with the framework of GSCM implementation in construction industry, which has integrated PLC into the model. This research also presents a structured model from concept, dimensions, elements, and indicators. Further research could develop the detailed measurement scale to completed the measurement tools. Furthermore, the research can also be done by conduct empirical studies in construction projects to validate the indicators and measurement tools.

Acknowledgement

This research is partially funded by the Indonesian Ministry of Education and Culture under the Basic Research of Higher Education Excellence Program, managed by Diponegoro University.

References

1. Hermawan, F.: Kapabilitas Dinamik Sektor Konstruksi Gedung di Daerah Menuju Keberlanjutan Pembangunan yang Realistis: Pendekatan Studi Kasus Kegagalan Konstruksi dan Bangunan di Jawa. In: Kumpulan Tulisan #UntukIndonesia. PPI UK, Unitied Kingdom (2014).
2. Alwi, S., Keith, H., Mohamed, S.: Non-Value Adding Activities: A Comparative Study of Indonesian and Australian Construction Project. In: Proceedings IGLC-10, Gramado (2002).

3. Aloini A., Dulmin R., Mininno V., Ponticelli S.: A conceptual model for construction supply chain management implementation. In: Smith, S.D (Ed) Procs 28th Annual ARCOM Conference, pp. 675-685, Edinburgh, Association of Researchers in Construction Management (2012).
4. Beamon, B.M.: Designing the green supply chain. Logistic Information Management 12(4), 332–342 (1999).
5. Hwang, B.G.: Performance and Improvement of Green Construction Projects – Management Strategies and Innovations.1st edn. Elsevier Inc, United Kingdom (2018)
6. Watt, A.: Project Management. Creative Commons Attribution (2014).
7. Hoeber, J.G., Alsem, D.M., Willems, P.H.: The management of information over the life cycle of a construction project using open-standard BIM. In: Proc of The 32nd CIB W78 Conference, Eindhoven (2015).
8. Wibowo, M.A., Handayani, N.U., Mustikasari, A.: Factors for implementing green supply chain management in the construction industry. Journal Industrial Engineering and Management 11(4), 73-89 (2018).
9. Wibowo, M.A., Handayani, N.U., Farida, N., Nurdiana, A.: Developing indicators of green initiation and green design of green supply chain management in construction industry. In: E3S Web of Conferences 115, 02006 (2019).
10. Farida, N., Handayani, N.U., Wibowo, M.A.: Developing indicators to implementing green material management in construction industry: a literature review. In: E3S Web of Conferences 73, 08009 (2018).
11. Farida, N., Handayani, N.U., Wibowo, M.A.: Developing indicators of green construction of green supply chain management in construction industry. In: IOP Conf. Series: Material Sciences and Engineering 598, 01201 (2019).
12. Kartam, N.A.: Making effective use of construction lessons learned in project life cycle. Journal of Construction Engineering and Management 122(1), 14-21 (1996).
13. Oberlender, G.D.: Project Management for Engineering and Construction. 2nd ed. McGraw-Hill, NewYork (2000).
14. Olanipekun, A.O., Chan, A.P.C., Xia, B., Ameyaw, E.E.: Indicators of owner commitment for successful delivery of green building projects. Ecological indicators 72, 268-277 (2016).
15. Zainol, N.N., Mohammad, I.S., Baba, M.: Critical factors that lead to green building operations and maintenance problems in Malaysia: a preliminary study. Advanced Material Research, vol. 935, pp 23-26 (2014).
16. Asmone, A.S., Conejos, S., Chew, M.Y.L.: Green maintainability performance indicators for highly sustainable and maintainable building. Building and Environment 163, 106315 (2019).
17. Green Building Council Indonesia.: GREENSHIP Untuk Bangunan Baru Versi 1.2 (2013)
18. Chan, A.L.S., Chow, T.T.: Evaluation of Overall Thermal Transfer Value (OTTV) for commercial buildings constructed with green roof. Applied Energy 107, 10–24 (2013).
19. Ng, S.T., Wong, J.M., Skitmore, S., & Alin, V.: Carbon dioxide reduction in the building life cycle: a critical review. In: Proceedings of the Institution of Civil Engineers-Engineering Sustainability (2012).
20. Levine, M., Ürge-Vorsatz, D., Blok, K., Geng, L.: Residential and commercial buildings. In: Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom and New York (2007).
21. Kementrian Pekerjaan Umum. Deskripsi Gedung Utama Kementrian Pekerjaan Umum.
22. Kautz, J.L. Green building with onsite wastewater treatment systems (2015).
23. Wei, W., Ramalho, O., & Mandin, C.: Indoor air quality requirements in green building certifications. Building and Environment 92, 10-19 (2015).

24. Brown, J.D.: Corporate Responsibility in the UK Construction Industry: A Study of Activities and Reporting. Thesis. University of Nottingham (2012).
25. Zhao, Z.Y., Zhao, X.J., Davidson, K., Zuo, J.: A corporate social responsibility indicator system for construction enterprises. Journal of Cleaner Production 29-30, 277e289 (2012).
26. Solvalier, I.: Green Marketing Strategies - Case Study about ICA Group AB. Thesis. Karlstad University - Karlstad Business School (2010).
27. PT PP (Persero Tbk.).: Green Building for Better Living - Pembangunan Berwawasan Lingkungan untuk Kehidupan yang Lebih Baik. Sustainability Report (2011).
28. Peraturan Menteri Pekerjaan Umum Nomor : 25/PRT/M/2007 Tanggal 9 Agustus 2007 Tentang Pedoman Sertifikat Laik Fungsi Bangunan Gedung.
29. Tam, H., Taruna.: Green management, road to sustainability and corporate efficiency. International Journal of Applied Research 2 (1), 586-590 (2016).