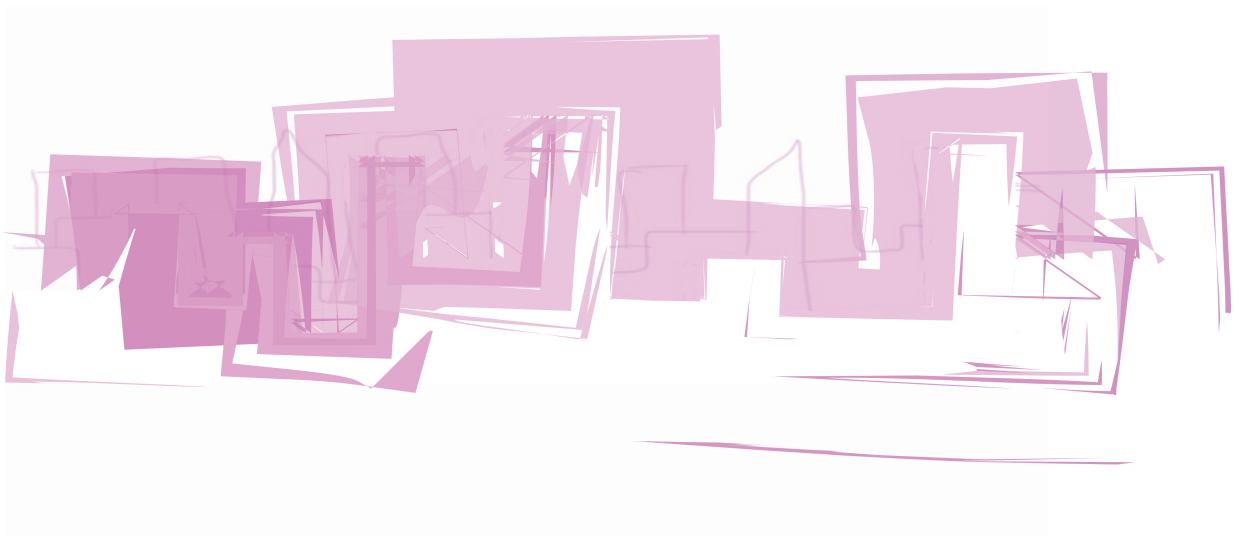


A Maturity Model for Maintenance Organisations in Public Sector



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Foreword

This report proposal is written for the second evaluation of graduation research development in order to accomplish the thesis report of Real Estate and Housing track, faculty of Architecture of TU Delft.

The growing awareness of public sector in providing a better service generate the need of an assessment tool in which can help them to improve their performances. Maintenance is one of the important parts in managing portfolio assets. Furthermore public sector has large amount of building asset portfolio in which professional maintenance are necessary. Commissioning the maintenance process then become crucial. Therefore, the development of maturity model for commissioning maintenance activities can have a better value for the organisations in order to increase the organisation professionalism and result the better qualities of maintenance services.

The following chapters of summary will explain briefly about the main results of this report. Then chapter 1 that discusses about the problem analysis, research questions, objectives, research design, and research method will follow it. In the chapter 2, the important factors of maintenance management and process are described. This is based on the literature study, of which each of key aspects of commissioning maintenance can be derived. In chapter 3, the general understanding about maturity model is explained. Followed by chapter 4, in which the Public Commissioning Maturity Model (PCMM) is discussed more in depth. Chapter 5 is the conclusion of the literature study. In this chapter, the integration between PCMM and aspects in commissioning maintenance activities is delivered. As a result, a preliminary set of commissioning maintenance maturity aspects, and maturity levels are presented. It is then followed by appendices that consist of provision of table and content of the final report, research plan, tables, and idea for interview protocol.

This proposal is a foundation for the next steps of this graduation research. Therefore, the preliminary results that are stated in this research will always be improved for the next step of the graduation report. I hope that you would enjoy reading it.

Farah Puspita Sari

REPORT P2

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Summary

Public sector is having complexity of managing their building assets. In order to provide better services, public organisations should have facilities that always in a good performance. Therefore, public organisations should maintain their building assets' qualities. In order to provide better service qualities, public organisations should have capabilities in delivering maintenance. Commissioning maintenance activities is valuable for controlling the qualities of process and outcomes of the maintenance department. This is related to the procedure for procurement, purchasing and contract model between maintenance organisations and maintenance suppliers. Thus, maintenance organisations need to have an assessment tool in which they can get a depiction of their own performances in commissioning maintenance activities. One of the tools to measure organisational performances is a maturity model. However, the specific maturity model for public commissioning maintenance has not yet presented. The existing maturity model related to commissioning public organisation is the Public Commissioning Maturity Model (PCMM) that developed by (Hermans, Volker, & Eisma, 2014). This maturity model aims for commissioning public organisation toward client of public sector in built environment. Nevertheless, the PCMM applicability has not yet tested to assess commissioning maintenance performances.

This research objective is to understand the relevancy of PCMM for assessing a maintenance department of public sector in commissioning activities. The main research question is: "What are maturity aspects of the Maintenance Commissioning Maturity Model?"

Therefore, the sub research questions are formulated as follow:

1. *What are the main elements of commissioning maintenance activities?*
2. *How is the process of commissioning maintenance activities?*
3. *What is the importance of commissioning maintenance for public sector organisations?*
4. *What are the aspects in the PCMM (Public Commissioning Maturity Model)?*
5. *How is the correlation between PCMM (Public Commissioning Maturity Model) and commissioning maintenance activities?*

The result from the literature study is important aspects of commissioning maintenance activities of public sector. Then these aspects are integrated and linked with the PCMM. The result is preliminary aspects of maintenance maturity model as described in the table below:

Aspect	Criteria	Sub criteria
1	Organisational strategy and policy	<ul style="list-style-type: none"> • Clear maintenance objectives • Maintenance policy
2	Culture and leadership	<ul style="list-style-type: none"> • Innovation • Technology used • Control in organisation
3	People and learning organisation	<i>Not applicable</i>
4	Decision models and portfolio	<ul style="list-style-type: none"> • Maintenance strategies • Object valuation, TCO/LCC, prioritisation

5	Stakeholder management	<ul style="list-style-type: none"> • Maintenance process • Knowing stakeholders objectives • Manage the collaboration
6	Public Values	<i>Not applicable</i>
7	Public rules of play	<ul style="list-style-type: none"> • Procurement process & regulation, contractual model • Encourage integrity, transparency, effectiveness, and legality rules.
8	Interaction with supply market	<ul style="list-style-type: none"> • Suppliers selection criteria • Setting suppliers goals • Understand maintenance market
9	Managing projects and assignment	<ul style="list-style-type: none"> • Short-term planning • Supervising maintenance projects
10	Creativity and flexibility	<i>Not applicable</i>

In order to gain more information about the valuable elements in commissioning maintenance of public organisations, interviews will be conducted as a research method. The result from this research will be a set of maturity model and maturity levels for commissioning maintenance in public sector.

Reflection

This research will increase an awareness of the public organisations especially in built environment industry to do self-assessment in order to enhance their professionalism. Nevertheless, maintenance departments of the public organisations can value the assessment results from the maturity model. The maturity model for commissioning maintenance is derived from the existing maturity model for public sector commissioning; it is Public Commissioning Maturity Model (PCMM). This maturity model is a result of the scientific research of Hermans et al., (2014).

This research based on the PCMM model and integrated to the aspects in maintenance management and process. Commissioning activities is significant to achieved better output of maintenance works. The ability of organisation to do commissioning for maintenance activities should be revealed. The output of this research can enrich the knowledge about the importance of maintenance organisation's professionalism toward managing public sector portfolio. Moreover, maintenance organisations can benefit from the maturity levels, of which they can design their strategies and decision to reach the next levels of maturity for commissioning activities. The higher the maturity level, the more capable is the organisation providing better services for public. In addition, maintenance has specific characteristics compared to other construction activities. Thus, specific maturity model for commissioning maintenance is essential to build.

The maturity model is simple and practical to use because it is a self-assessment tool. Therefore, organisation does not need an external assessor to understand their current situation. Finally, it is important to formulate relevant maturity aspects that suitable to build the maturity model for commissioning maintenance.

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CHAPTER 1 INTRODUCTION

1. Introduction

1.1 Personal motivation

Recently, there has been a change in the view toward portfolio assets. The view is not only having the building as an asset, but more about understanding the value of the building (The Institute of Asset Management, 2014). This means that the value of the building is not only tangible, that is about the physical condition, but also intangible that involving customer satisfaction, stakeholders objective, environment, etc. The key point is about the organisation's performances that manage the portfolio assets.

These terms in asset management and building portfolio are making me interested during my first year study in TU Delft. This intrigued me to chose the topic provided by Professor Marleen Hermans for thesis research, about commissioning public organisation in the construction industry. In order to enhance the quality of building assets owned by public organisations, it is essential to also enhance the organisation's performances that manage those portfolio assets. Therefore, public organisations should provide better service for clients and customer. One strategy in managing portfolio assets is maintenance.

Maintenance is part of the construction activities in which it can retain the building assets from deterioration. I chose maintenance to be my focus in this research because it is a specific activities where all organisations that managing its portfolio should incorporate it in their strategies. Furthermore, maintenance is specific activities that should be incorporated by the management through the whole building life cycle. The important part is the commissioning activities, in which public sector is having the tasks to perform it.

The development of assessment tools in management world has interested me, where some organisations can be generated to upgrade their abilities by using those performance tools. Moreover, in public sectors in which start to competitive in providing better services, an assessment tool can be necessary. Therefore, the maturity model developed by Hermans, et al. (2014) is motivating me to explore its applicability for assessing the maturity of commissioning maintenance organisations.

1.2 Problem analysis

Public sectors are organisations that provide services for public. The focus of public organisations giving better services nowadays is on the customer-oriented mind-set. There are several reasons why public organisations increase their professionalism in delivering services. Beside aiming for the individuals and customer satisfactions, public organisations want benefit from; cooperation between government agencies, building an effective organisational structure, and set benchmarks for private sectors (Ha & Lee, 2010). In order to provide good facilities and services, public organisations should professionally manage their assets. Asset management is defined as "a coordinated activity of an organization

to realize value from assets" (The Institute of Asset Management, 2014). In this research, the focus will be on the building assets.

Public building assets aim to provide facilities, such as schools, hospitals, prisons, government offices, etc. These different types of buildings, the buildings amount, and the building functions create complex problems for the asset management. Moreover, there are different stakeholders involved who have different interests. These situations are more complicated when the building assets are deteriorating, but at the same time, they should perform its function and qualities. If the public organisations fail to maintain buildings, it may affect their functions; moreover, it will reduce their value because of the deteriorations (Williamson, Williams, & Gameson, 2010). In Europe, some public assets are built after the World War and they are mostly defected (Volker, et al., 2013). In the Netherlands, there are more than 200 government building assets that are built before the World War era, and more than 550 building assets are built after 1950s are also needed good management (Central Government Real Estate Agency, 2014). These enormous amounts of building assets need good management. According to Audit New Zealand (2010) as cited in (Sapeciay, Wilkinson, & Costello, 2013) good asset management is a part of the public organisation's wider service, financial planning process, and will contribute to the management of a public entity business. Wordsworth (2001) as cited in (Mossel, 2008) mentioned that there are some construction activities for building assets for instance maintenance, alteration, conversion, replacement and additional. The building deterioration can be hold by doing maintenance.

Maintenance is a solution where it can retain the defects of building assets, and keep to its functionality over its whole building life cycle. Maintenance is defined by the British Standard (BS) EN 13306 (BSI 2011) as "The combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function". However to deliver maintenance, public organisations have other complexities because of the technical and organisational matter such as the hierarchical organisations that avoiding smooth process in providing maintenance, and the lack of knowledge in maintenance. Moreover, to perform maintenance for a lot of building assets is also challenging for public organisations. Public organisation has a specific department to manage the public asset maintenance. The maintenance organisation under the management of the public organisation should provide the best qualities of maintenance management.

Maintenance organisations should be able to perform professionally under the complexity of the building assets. A good maintenance management system is necessary. It is important for organisation in making decisions that are crucial to face the challenge in maintenance and for the continuity of the business (Tsang, 2002). Nevertheless, public organisations are the key role to determine the success of maintenance performances.

In order to bring good professionalism, it is important to understand the capabilities of the organisation in delivering maintenance. Capability according to Tsang, et al. (1999) is " the ability to perform a specific function within a range of performance levels that may relate to capacity, rate, quality and responsiveness". Capabilities of providing good maintenance services need to be measured. The purpose of measurement is to give information about the ability of organisation in

commissioning maintenance activities, in order to control it and to help the decision-making process. By identifying the commissioning weaknesses, they can focus to improve it. Moreover, by performance measurement it also provides a motivational tool that forcing actions to support strategies (Tsang, Jardine, & Kolodny, 1999).

Several tools are developed as a benchmark for the organisations to improve their performances, such as six sigma, performance benchmarking, maturity model, etc. Maturity model is one of the benchmarking tools that can reveal the elements of the organisations performances. By using maturity model, organisations can depict their current performances and plan strategy to reach the next level of maturity.

There are different types and function of Maturity model. According to Hermans, et al. (2014) there are several maturity models that related to the construction industry; for instance IM3 (Infrastructure Management Maturity Model), SCEMM (Supply Chain Excellence Maturity Model), MSU (Purchasing Excellence Publiek Model), IMT (Infra Maturity Tool), and Project Management Maturity Model. Schuh, et al. (2009) developed the maturity model for maintenance organisations mainly for small and medium-sized enterprises (SME). This maturity model is referring to the CMM (Capability Maturity Model), which is a maturity model that developed by Paulk, et al. (1993).

As public building assets maintenance in its commissioning activities becomes the focus of this research, the maturity model is preferably related to the Public sector organisations. One of the maturity models that assessing the performance of Public organisation is the PCMM (Public Commissioning Maturity Model) that is developed by Hermans, et al. (2014). The purpose of this maturity model is to investigate the level of competence of public construction clients and aiming to increase awareness of the construction client organisation of their commissioning task (Hermans, Volker, & Eisma, 2014).

According to (VAW, 2009), commissioning activities are as follows: assessing the need, identifying resources available, arranges service delivery, reviewing, and reassessing need. To get better results in maintenance, organisation need to deliver professional commissioning of maintenance activities. Hence, public organisation can use a maturity model to recognise their ability and professionalism in commissioning maintenance. By using the relevant maturity model, the results will be more significant. Therefore, the PCMM maturity model can be a tool to assess the public maintenance organisation because of its focus on commissioning the public organisations. However, it is not yet proofed that PCMM can ensemble for assessing commissioning in maintenance activities. In order to verify the applicability of PCMM for assessing maintenance, this research is conducted.

1.3 Research goals and objectives

The goal of this research is to find the important elements in the maintenance organisations and its management especially in the public sector of which will be valuable for commissioning maintenance activities. The focus of this research will be on the maintenance department of the public organisations. From those important maintenance elements, the build up of the commissioning

maintenance maturity model will be linked with the aspects of PCMM. Therefore, the applicability of PCMM can be revealed. As a result, the Maturity model for commissioning maintenance organisations in the public sector will be formed.

1.4 Research questions

The main research question is meant to answer the expected results. From the discussion about the important commissioning maintenance elements and the aspects from PCMM of public organisation, the main research question will be:

“What are maturity aspects of the Maintenance Commissioning Maturity Model?”

To develop more on the main research questions, more sub questions are generated to answer more detailed problems:

1. *What are the main elements of commissioning maintenance activities?*
The answers of this question are based on the literature study, and interviews. The answer of this question will be described in the chapter 6 and 9 of the final report.
2. *How is the process of commissioning maintenance activities?*
The answers for this question will be on the chapter 3 and 9 of the final report. The question will be answered based on the literatures, and interviews.
3. *What is the importance of commissioning maintenance for public sector organisations?*
The answer of this question will be answered in chapter 9 of the final report by interviews. The question will be answered based on interviews.
4. *What are the aspects in the PCMM (Public Commissioning Maturity Model)?*
This question will be answered in chapter 5 of the final report. Literature study will find the answers of this question.
5. *How is the correlation between PCMM (Public Commissioning Maturity Model) and commissioning maintenance activities?*
This question will be answered in chapter 6 of the final report. The answer is the results of the literature study, case study and interviews.

1.5 Research design

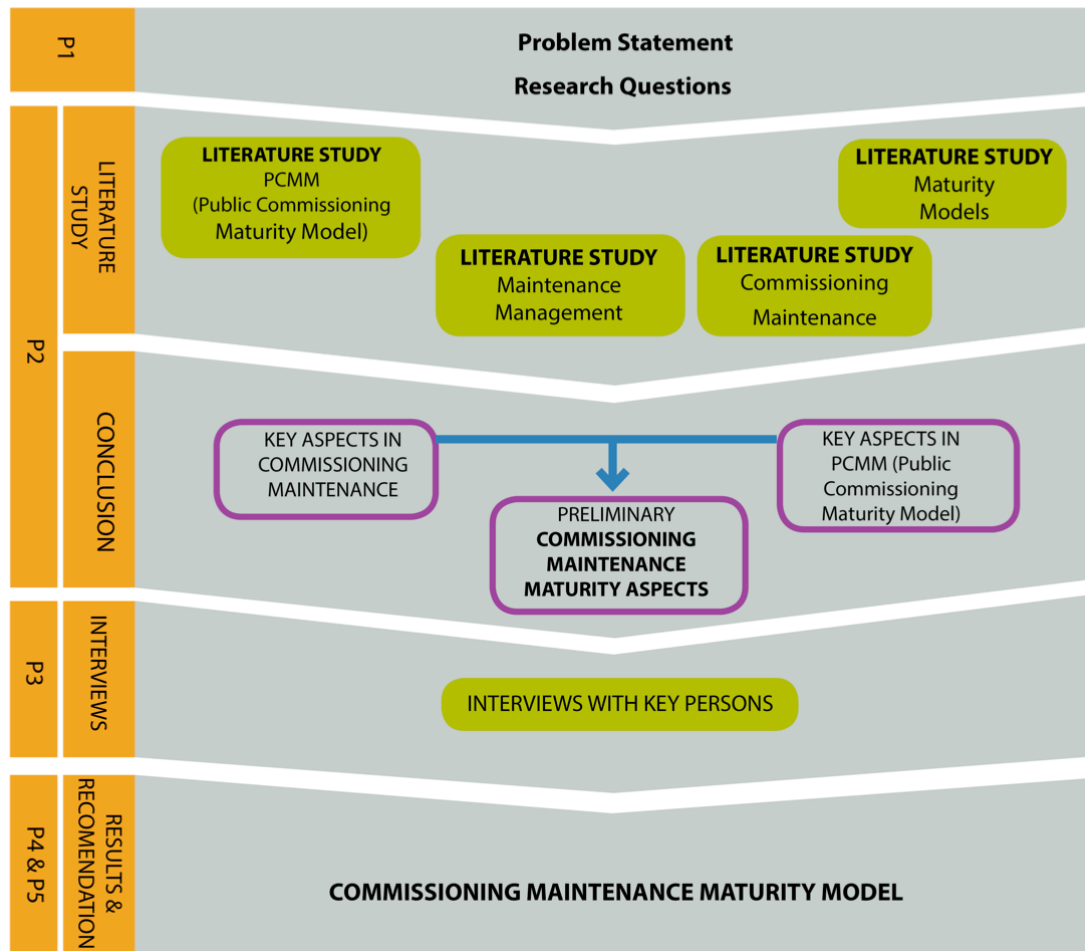


Figure 1 Research Design (source: own illustration, 2015)

1.6 Theoretical framework

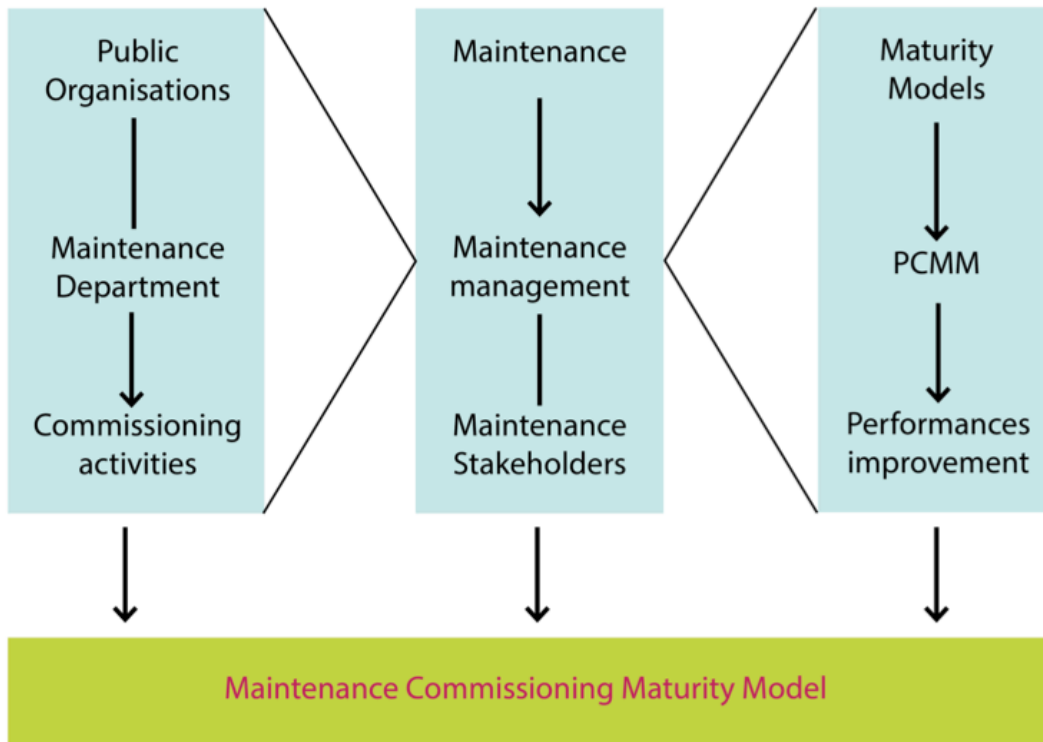


Figure 2 Theoretical framework (source: own illustration, 2015)

1.7 Research Method

To get a better depiction toward the important aspects of the maintenance maturity model, this research will use literature reviews and interviews as the methodology. Literature reviews aim to gain general views toward the maintenance management and maturity model, whereas the interviews objective is to obtain information from the practitioners of maintenance in public organisations.

A. Literature Reviews

The literature review will focus on three areas:

1. Maintenance management
On this literature review, the main concept of building maintenance will be described. This will also focus on the process of maintenance.
2. Maintenance organisations related to commissioning activities
His literature review is focusing on the organisation's activities. Moreover, it is also important to emphasise on the activity of commissioning maintenance organisations.
3. The Maturity Model of PCMM
The concept of the Public Commissioning Maturity Model should be explained in order to link it with the key aspects of maintenance.

There is addition for literature reviews toward organisation's professionalism. This will be incorporated in the three-focus area described above.

B. Interviews

The interviews will be conducted with the key persons from several institutions, for instance TU Delft, TU Eindhoven, Gemeente Delft, Gemeente Rotterdam, and Utrecht University. The interview questions will be derived from the key aspects of commissioning maintenance maturity resulting from literature reviews. The idea for interview protocols is described in [Appendix IV](#).

TU Delft

The key persons for interview are from the FMRE department. Facility Management and Real Estate of TU Delft (FMRE) is an organisation under TU Delft that is responsible for managing and maintaining buildings and grounds. The goals are to improve the quality of accommodations and facility encounters within university buildings, as well as on campus (TU Delft, 2014).

This organisation has its own Maintenance & Building Management department. This department is responsible for the process of technical management. The goal of this department is to ensure that technical condition and technical usability for buildings' users, building systems and infrastructures are in good conditions. This department consists of many teams of architectural, mechanical, electrical, green, energy, building facilities management, asbestos, building management teams, technical archives and business analyst (TU Delft, 2014).

The interview will focus on how this organisation commissions maintenance activities of TU Delft's building assets. Several key aspects that result from the literature review will be the focus of the interview. The key person for interview is The Manager Maintenance and Building Management, Rob Weststrate and the Director of FMRE, Anja Stokkers.

TU Eindhoven

The Real Estate Management Department (DH) in TU Eindhoven is responsible for the real estate development, park management, and the land around the TU Eindhoven grounds. For the TU Eindhoven itself, the organisation is responsible for the project management, management of all the buildings, installation and infrastructures (TU Eindhoven, 2015).

The Real estate department acts as advisor. Therefore, the key person to be interviewed is the director of the Real Estate department, Ms Ir. V.H.H. Marks.

Utrecht University

The Facilities Service Centre (FSC) is responsible for providing facilities services in Utrecht University. The organisation has several departments. The Building maintenance is under the FSC (Utrecht University, 2015). The FSC maintenance is responsible for building maintenance. The department provides maintenance services of the technical installations in the university buildings. The key persons to interview in the FSC are the director drs. I. van Oosten and the maintenance director W. Huijgens.

Gemeente Rotterdam (Municipality of Rotterdam)

The interview with the key person from the municipality of Rotterdam will discuss the important aspects in commissioning the maintenance of the municipality's assets.

Gemeente Delft (Municipality of Delft)

Municipality of Delft has Real estate department in its organisation's structure. The interview will be conducted with the key person to gain information about how organisation commissioning the maintenance activities toward the Delft municipality's assets.

CHAPTER 2 LITERATURE REVIEW

2.1 Maintenance Management and Commissioning

2.1.1 What is maintenance?

Maintenance is defined by (British Standards Institution, 1993) as “ The combination of all technical and associated administrative actions intended to retain an item in, or restore it to, a state in which it can perform its required function”. This research focuses on the building maintenance as a part of a public sector asset management. Therefore, the Building maintenance is defined as “ Work undertaken in order to keep, restore or improve every facility, i.e. every part of the building, its services and surrounds to a currently acceptable standard and to sustain the utility and value of the facility” (Chanter & Swallow, 1996). From the definition of building maintenance, it is obvious that the maintenance activities are meant to obtain the function and the value of the building facilities.

2.1.2 What are maintenance objectives and goals?

Maintenance objectives can relate to the economy. It aims to provide high performances using the lowest costs. The objectives of building conducting maintenance according to (Alner & Fellows, 1990) as cited in (Horner, El-Haram, & Munns, 1997) are:

- To make sure that the buildings and their associated services are in a good condition;
- To maintain the value of the buildings as a physical asset;
- To maintain the buildings in order to have good qualities to use, and meets all requirements.

Kans (2008) describes the maintenance objectives on tactical level and on a strategic level. On the tactical maintenance management level, the objectives of maintenance is optimising schedules and inventories, and carry out the prioritising activities in order to reach effective utilisation. At the strategic level, the objectives of maintenance are to reach cost efficiency and to reach general goals for the production, such as reliability, safety, etc.

In conclusion, the objective of maintenance management in general is enhancing plan and implementation using applicable materials and tools at the right time and minimising total life-cycle cost, in order to prevent, to reduce and to repair building defects (Horner, El-Haram, & Munns, 1997).

2.1.3 The Role of maintenance organisation

Maintenance organisation in this research focuses on the maintenance department as part of the public organisation. The function of the maintenance organisation is part of the maintenance management function; these are planning, organizing, implementing, and controlling activities (Haroun & Duffuaa, 2009). According to Haroun & Duffuaa (2009), the roles of maintenance organisations are:

- **Planning:** The maintenance organisations are setting performance objectives, and developing decisions on how to achieve them.
- **Organizing:** This means that the organisations should create a structure in which they dividing the tasks and manage resource allocation. Moreover, organisations coordinate their activities to conduct maintenance tasks.
- **Implementing:** The maintenance organisations executing the plans to meet the performance objectives.
- **Controlling:** The maintenance organisations measuring performances of the maintained equipment and taking the preventive or corrective in order to restore the desired specifications.

2.1.4 Organisations and Stakeholders

Maintenance planning and strategies are designed for servicing the stakeholder objectives. According to the standard ISO/IEC 15288(2002) as cited by Söderholm et al. (2007), "a stakeholder is an interested party who having a right, share or claim in the system or in its possession of characteristics that meet that party's needs and/or expectations". In maintenance, stakeholders who have an interest within the process are people who perform technical and administrative, and then there are external stakeholders who are interested in the required function of the building object. (Söderholm, Holmgren, & Klefsjö, 2007).

The stakeholders for maintenance in public sector:

a. Public organisations

The public organisations have an internal maintenance department that deliver the maintenance activities for their building assets. The purpose of public organisation in having their maintenance department is to ensure that the building assets can well-performed in facilitating clients and end-users. Public organisation monitors the performances of maintenance department in commissioning the maintenance activities. Moreover, the public organisation provides standard for the commissioning activities, for instance the regulations and the procurement law for being used. The maintenance department follows those standards in order to meet the requirements and fulfil the public organisation's objectives.

b. Client organisation

Client organisations are organisations that need the service from the public organisation. Thus, the clients can also from the internal organisation itself. Clients need the assistance of maintenance department in delivering maintenance services, because the clients want to satisfy the end-users.

c. Maintenance department

Maintenance department is responsible for the commissioning process of maintenance activities. The commissioning activities delivered by the maintenance department are including inventory, condition assessment, procurement, purchasing, and controlling. The objective of the maintenance department is to fulfil the tasks given by the public

organisations, as well as providing services for clients, and satisfying end-users. Maintenance department mostly outsources their works to the markets, unless the small activities.

d. Maintenance Suppliers

Suppliers are the contractors who provide the services to execute the maintenance works. The contractors are selected through procurement. In maintenance, the market of suppliers is fragmented. The maintenance suppliers that operate in the market are usually small company /SME (small-medium enterprise) that specialized in their works.

e. End-users

End users are the people who use the facilities provided by the public organisation. The end-users for public organisations are from the internal organisations and people outside of the organisations. End users have different requirements based on the facilities and performances needed by them.

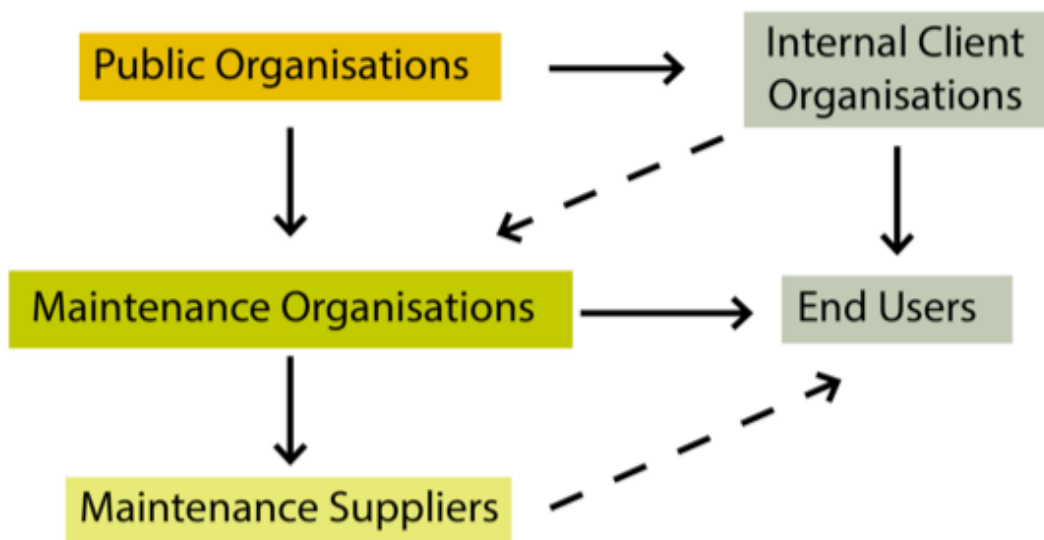


Figure 3 Stakeholders relationships (source: own illustration)

The relationship between the stakeholders is explained in the diagram. The public organisation has a direct relationship with the maintenance organisation and the internal client organisations. Public organisations serving the goals of the client organisations and satisfy end-users. On the other hand, the maintenance department is functioning the aims of the organisation. Besides executing the tasks given by the public organisation, the maintenance department also has ancillary relation toward the internal client organisation. Moreover, the process of commissioning starts with inventorying the building assets owned by the clients. At this point, the maintenance department is also responsible for it services toward the internal clients.

As part of the commissioning process, the maintenance department must execute the procurement and purchasing in order to perform the maintenance

activities. Thus, the maintenance department should select appropriate suppliers to fulfil the maintenance services. There are agreement and collaboration created between the maintenance department and maintenance suppliers. At the same time, both of the maintenance department and maintenance suppliers have relationship toward the end-users satisfaction. They should have customer-oriented mind-set in order to carry out good maintenance services.

2.1.5 Maintenance Strategies

Selecting maintenance strategies is part of the controlling role of the maintenance organisations. Maintenance strategy is defined by Dunn (2003) cited in (Lind & Muyingo, 2011) as “a long-term plan covering all aspects of maintenance management which sets the direction for maintenance management, and contains firm action plans for achieving a desired future state for the maintenance function”. These strategies are part of the maintenance process in which the decision makers choose the preferred strategies based on their organisation’s priorities.

Maintenance strategies can be categorized in many different ways. In Europe, the standard used is EN 13306. In European standard, the types of maintenance are divided into two types, the preventive maintenance that planned before a default detected, and the corrective maintenance that provided after defects are detected. Maintenance strategies in general are classified by (Horner, El-Haram, & Munns, 1997):

1. Preventive maintenance (PM)

Preventive maintenance is the planned maintenance to avoid failures (Lind & Muyingo, 2011). This strategy is planned at a regular time based on operating time (Horner, El-Haram, & Munns, 1997). The advantages of preventive maintenance are (Horner, El-Haram, & Munns, 1997):

- Avoiding extra costs by avoiding sudden damage;
- It is convenient for building users by the scheduled plan;
- Minimize the downtime.

On the other hand, preventive maintenance also has disadvantages, when the task should be performed based on schedule time, regardless the actual condition, it will carry out unnecessary works and costs (Horner, El-Haram, & Munns, 1997); (Saranga, 2002).

2. Corrective maintenance (CM)

Corrective Maintenance is a maintenance strategy that conducted only when the object of maintenance is broken or faults (Lind & Muyingo, 2011). This strategy is also described as unplanned maintenance or failure-based maintenance, furthermore this strategy can be expensive (Horner, El-Haram, & Munns, 1997). According to Lind & Muyingo (2011), the difference between The Deferred CM and the Immediate CM is that the deferred CM occurs because is not carried out immediately after the defect on the object is detected because of the maintenance rules. On the other hand, the Immediate CM is immediately performed after the defects are detected.

3. Conditioned-based maintenance.

Condition-based maintenance is performed based on the condition of the object building by monitoring and planned the building's element/units (Horner, El-Haram, & Munns, 1997). The condition-based maintenance will carried out based on a certain condition of the building object.

The model for maintenance strategies based on EN 13306 is provided in the figure below.

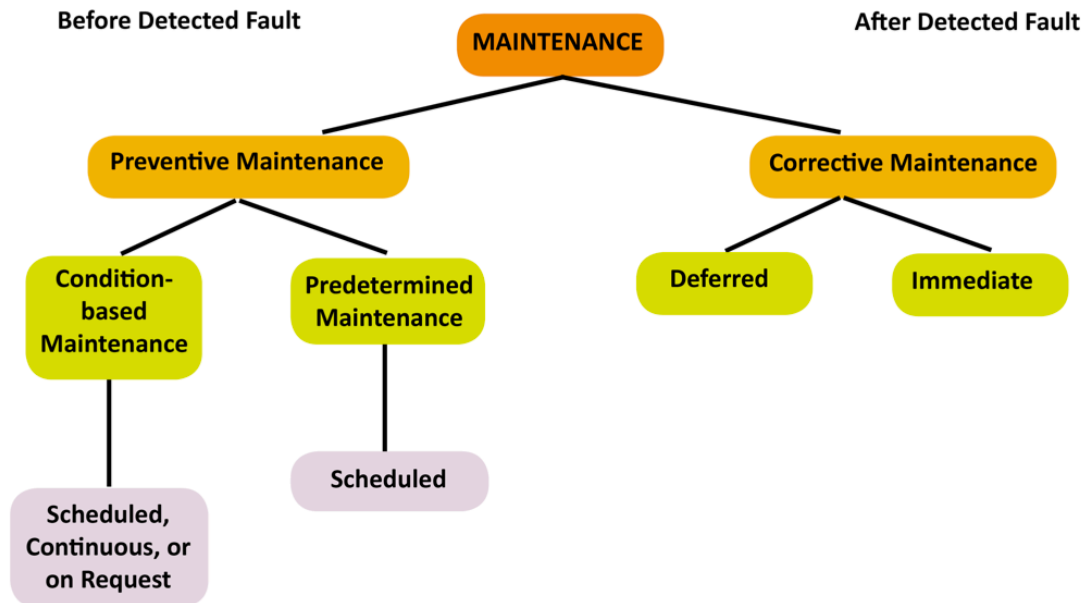


Figure 4 Maintenance strategies based on EN 13306 (2009) (source: Lind & Muyingo, 2011)

By understanding the concept of maintenance given above, maintenance organisations are expected to choose the best maintenance strategies for their organisations in order to provide better service and maintain the qualities of the building assets. As defined by EN 13306, a maintenance strategy is “a management method used to achieve the maintenance objectives”. Thus, it is important to in-line the objectives of maintenance organisations, the objectives of maintenance strategies and the objectives of the public organisations in order to coordinate the actions for public building assets.

2.1.6 Planning and Process in maintenance

As part of the planning role of the maintenance organisations, it is necessary to design a clear process in delivering maintenance. The design of the maintenance process will in-line with the performance objectives that should be obtained by the building object. The process of conducting maintenance should be planned. Maintenance planning has objectives to reduce costs, improve efficiency, and improve building performances (Lau & Ho, 2010).

The benefit of the maintenance planning is to make a standard of maintenance process that can be followed by all of the maintenance organisation’s

personnel. It also can determine the policy in maintenance by selecting strategies. Moreover, there are several stakeholders involved that should be taken into account for every decision-making. Currently there is a change of view toward the maintenance strategy from reactive and corrective maintenance to preventive maintenance planning (Straub, 2012). The planned condition-based maintenance is appropriate for the maintenance of public assets. Therefore, the process of maintenance is described on the figure below.

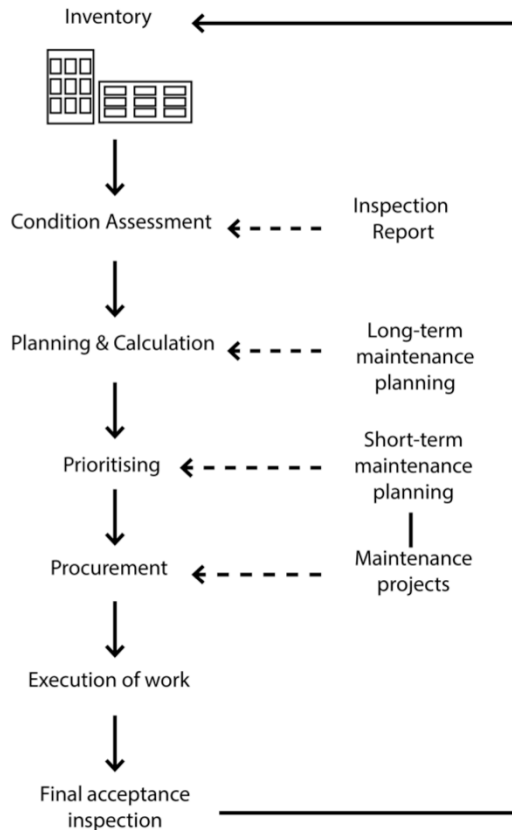


Figure 5 Maintenance Planning and process (Source: Straub, A., Maintenance and Repair, 2012)

A. Inventory

The first step of planned condition-based maintenance is inventorying the building elements that are necessary to be maintained. The results from inventorying can be used for the next step that is the condition assessment, where the building elements are being measured to get data of the level of defects.

B. Condition Assessment

The goal of the condition assessment according to Straub A. (2011) is to provide objective information about the technical quality of the building condition based on its defects. The condition assessment must be objective in order to get the best evaluation of the building assets and to determine the maintenance strategies. In the Netherlands, there is a condition assessment code that can be applied for building assessment, it is developed by the Netherlands Centre for Standardisation (NEN) in 2010 (Velde, Klatter, & Bakker, 2013). Moreover, the Dutch Government Building Agency recently provide a six-point scale to measure the

building condition, from 1 which is excellent to 6 which is very bad condition (Straub, 2012). These assessment methods can help the maintenance department and the maintenance personnel to plan the strategy and budgeting.

The object evaluation incorporates financial aspect and physical aspects. According to Straub (2011), the financial aspects in object assessment are including expected maintenance costs, energy costs, operational costs, etc. The data from financial evaluation is valuable in deciding the contractual types and decisions of the organisation's business.

The physical evaluations are assessing the building components, functions, its facilities provided, performances, maintainability, defects, remaining service life, etc. The data from physical evaluation are useful to determine the defects occurred in the building components and valuing the service standard of building qualities that should be provided. The management then evaluates this data in order to plan with the appropriate maintenance strategies. The characteristics of the building components are then be organised based on the priorities as stated in NEN 2767, such as critical, serious, or minor defects (Straub, 2011). Moreover, the data are grouped into the degradation process such as low, middle, and high. This building failure conditions are useful for prioritizing the strategies. It is also important to considering the Key Performance Indicator (KPI) and Service Level Agreement (SLA) during the building object assessment (Straub, 2011). This will align the need of the end-users or clients, and the current building conditions.

C. Planning and Calculation

The data derived from the condition assessment is valuable to make plan and calculation. Those data can provide the performance loss, the financial resources, and the appropriate maintenance strategies to achieve the expected quality of maintenance (Straub, 2012).

From this point, according to Straub (2012) the process that is starts from condition assessment, planning and calculation are principal for long-term maintenance planning and procurement of the maintenance activities.

According to Lind and Hellström (2006) and Lind and Lundström (2010) as cited by (Lind & Muyingo, 2011), the maintenance planning are preferably determined several aspects below:

- A good information system will provide better prediction for planning.
- Dividing building into the main building for preventive maintenance, while for the non-main building for corrective maintenance.
- Divide the elemental/components of the building so that the maintenance can be executed based on its decisive need. For example wall, ceiling, and HVAC, those need different maintenance actions.
- Planning in different time-span for different elements of buildings. For example, 20 years of plan or yearly plan. This can determine when will the main renovation are needed.

- Using technology to input information and data from building users. Thus, the information can provide updated building conditions.

The maintenance Organisation can incorporate the maintenance costs into the TCO/LCC strategy of their budget calculation. TCO (Total Cost of Ownership) is an analysis tool to discover the overall of lifetime costs that follow from owning a certain building assets (Schmidt, 2014). Maintenance costs is one of the TCO components. By reducing the maintenance costs through choosing the best maintenance strategies, public organisations can lower their TCO. The variables incorporate in maintenance costs are the maintenance warranty costs, maintenance labours, contracted maintenance services, etc. (Schmidt, 2014).

D. Prioritising

After the planning and calculation, the next step of the maintenance department is to prioritise the appropriate maintenance strategies, procurement methods, and the results of the maintenance activities that are expected. The priority of maintenance activities is based on the expected results of the building performances. This forecasted results are also being aligned with the financial calculation, and procurement methods. Therefore, organisation can choose the best plan, procurement, and agreement for their maintenance activities.

The short-term plan guides the maintenance projects that have to be delivered for the upcoming year (Straub, 2012). Nevertheless, the procurement can be derived from the kind of maintenance activities that will be performed.

E. Procurement and contract

The maintenance organisation must decide whether the maintenance should be executed by in-house contractors or outsources. The selection of preferred maintenance suppliers is then done by procurement. As the maintenance organisations are part of the public organisation, the procurement types and the contractual types should follow the rules and legislation.

The procurement law in the Netherlands is following the European procurement law. According to Mossel (2008), the procurement for public works has several thresholds. Moreover, there are distinction between the public works and public services. For the central government and the local government, the threshold is 5,15 million euros for public works. For public services and public supplies, the threshold for the central government is 133,000 euros, and for the local government is 206,000 euros. However, for the maintenance in which most of the activities are fragmented, what is the threshold and whether it is included in works or services (Straub, 2012). It is stated by Straub (2012) that the term of 'services' in maintenance activities are include regular planned maintenance, void repairs, and responsive maintenance. Meanwhile the 'works' is incorporate refurbishment and major maintenance.

According to Vijverberg (2005) as cited in (Mossel, 2008), the maintenance contracts that commonly used in the Netherlands are:

- Contracts for breakdown maintenance: it is often used for reactive maintenance.

- All-in contracts: the combine contracts for preventive (planned) maintenance and breakdown maintenance.

Straub (2011) describes about the two types of contract:

- Traditional contract:
The tender for maintenance projects based on competition and descriptive-based in order to gain the lowest price or best price-quality ration by means of competition.
- Performance-based partnering contract:
The client explicitly states the performance criteria. The performance-based specifications are based on the performance requirements, Key Performance Indicators (KPI) and Service Level Agreement (SLA). Moreover, this type of contractual relationships focuses on the long-term maintenance scenarios, such as the whole life costing. The contractors act as engineer and consultant. There is also deliberation about price, performances and risks.

F. Execution of work

To get better results of maintenance work, it is necessary to understand the supply of the maintenance activities. The maintenance department should monitor the performances of the suppliers. Moreover, the maintenance market is fragmented, which means that the types of work are different. Maintenance market according to The Dutch Economic Institute for the Construction Industry (EIB) are divided into different groups (Mossel, 2008), of which the main groups are:

- Installation maintenance: It covers the works of plumbing, central heating and AC, electrical and mechanical installations.
- Finishing maintenance:
 - First category: Paintwork, glass repair, and wall finishing
 - Second category: plastering, wall insulations.
 - Third category: activities involving hard material such as stones, ceramic tiles and terrazzo.
- Structural maintenance: general maintenance of the building structures.

To cope with those maintenance markets, the maintenance department can have the specific contract for different tasks. The quality of the supplier's services can be derived from the instruments such as certification, quality control, etc.

G. Final Acceptance Inspection

As the final step of the maintenance process, the final inspection aims to check the quality of the maintenance jobs. This also can determine whether the supplier's performance is fulfilling the requirements of the maintenance department. Moreover, there should be match between the maintenance project's results and the contractual agreement.

The process of planned condition-based maintenance then will repeated again to the first step of inventorying building elements.

CMMS (Computerized Maintenance management Systems)

The function of IT in the current situation is to help organisations in an effective a sustainable way to perform the maintenance jobs. One of the systems

for maintenance is called CMMS. CMMS is a computer software system that can help maintenance organisations to arrange their maintenance operations, database information, and plan the effective preventive maintenance program (Stanford, 2010). This software is helping the maintenance personnel with some of the following tasks (Stanford, 2010):

- Work orders: this includes scheduling maintenance procedures, recording costs, assigning personnel, downtime, etc.
- Preventive Maintenance: this software can schedule the Preventive maintenance by tracking the components of preventive maintenance.
- Asset Management: The function of the software can record the property information, lifetime expected, service contract, etc.
- Inventory control: the function of the software is to manage the tools and materials for particular jobs, tracking shipments, recording where the materials are stored, etc.

Operating CMMS for the maintenance organisations can be an option in which the organisations use technology to get building information, integrated the maintenance strategies, and manage the works in an efficient way.

2.1.7 Suppliers performances

To deliver good results of maintenance services, the maintenance organisations should reveal the suppliers' capabilities. This is inline with the view of modern maintenance organisations about the importance of continuous improvement of the maintenance personnel. According to Straub (2010), contractors should have knowledge in whole life costing, building components performances, and servicing the end-customers. Moreover, it is also crucial to provide significant training and knowledge improvement for employees in order to achieve development of services (Bamber, Sharp, & Hides, 2002).

According to Pasuraman et al. (1985) as cited by (Lai & Pang, 2010), there are five dimensions of service organisations:

- f. Tangible dimension: This is related to the resources, equipment and facilities; such as provide sufficient manpower and sufficiency of replacement components.
- g. Reliability dimension: This is the ability of contractor personnel to perform within the client's standard, for instances in providing services at the time they intended to work.
- h. Responsiveness dimension: This is the willingness of the contractors in delivering services to the internal customers of the building. The example of the action is setting up appointment quickly.
- i. Assurance: This is the knowledge and courtesy of the contractors to carry out the works and able to maintain trust and confidence to different stakeholders, for example corporate with clients.
- j. Empathy: This is related to understanding and sharing feeling to the clients and end-users, such as tidying up the area after repair works.

In order to gather the information on the services outcome and the organisational capabilities, assessment is needed. There are three different level of assessment for organisation (Bamber, Sharp, & Castka, 2004):

- Third party: There is an independent organisation who assesses the organisation
- Second party: A dependent body that is still related to the organisation conduct the assessment
- First party: the organisation or body assesses themselves

The assessment of an organisation can show the conformance to a specific benchmark, reveal opportunities for improvement or actions and show commitment to a professional approach to management (Bamber, Sharp, & Castka, 2004). The tenants as end users argue that the most important aspects in maintenance are the quality of the result of maintenance, the competence of maintenance workers, and completing maintenance activities in a single visit (in the case of housing) (Mossel, 2008). In providing services it does not only depend on the technological capabilities, but also human and organisational capabilities are similarly important (Straub, 2010). The capabilities of organisation and maintenance personnel will have an impact for the physical outcome of the maintenance projects and for the client satisfaction. In conclusion, assessment is valuable to control the performance of organisation's professionalism in delivering maintenance services.

2.1.8 Innovation

Innovation in maintenance organisations is imperative in order to enhance their capabilities and qualities of services. The current innovation relates to service qualities, thus the new concept of the service outcome that is initiated by the suppliers (Straub, 2011). The clients and suppliers are cooperating to produce their outcome. This approach is quite new compare with traditional tender.

Another possible innovation is the use of IT to augment the organisations performances. However to use the IT need knowledge understanding by the maintenance organisations' employees. Moreover, the more updated software for maintenance management does not guaranty that the works will perform better. It is significant to decide the technology in which it can improve the organisations performances, not because following the upcoming trend. Nevertheless, the spirit to innovate should be possessed by all of the personnel in maintenance organisation in order to encourage the maintenance organisations providing the best capability in delivering maintenance services. The culture to promote innovation in the organisation should arrive from the top management level.

2.2 Maturity model

In the previous discussion, there are needs to improve the qualities and capabilities of maintenance organisations toward commissioning activities. Moreover controlling the output of the organisations is also important for the continuity of the organisation's business. In order to achieve the goals, maintenance organisations should have an assessment tool in which they can figure out the elements that need to be augmented. It is also described before that third party can manage the organisational assessment. However, some approaches in benchmarking the organisations can be done by themselves. One of the self-assessment tools that apply is maturity model.

2.2.1 What is maturity model?

Maturity model is an approach to assess the organisation's performances in managing its business process that consists of several key process areas and several maturity levels (Meng, Sun, & Jones, 2011). According to Meng et al. (2011) the key process area refers to a cluster related activity that aiming a set of goals. The level of maturity describes the main characteristics of key business processes of organisations.

There are advantages of organisations using maturity models for assessment tool. According to Nesensohn et al. (2013) those advantages are:

- Allow organisations to measure their current organisational capability and allow them to apply a change or enhance strategy in an organised way
- Delivers guidelines for people and give information to select improvement actions, and starting a cultural change
- Direct and augment the ability within an organisation to exploit a culture of excellence
- Stipulate information that is important for organisations in planning and guiding their continuing transformation efforts.

There are different kinds of maturity models that is designed based on its purpose. The levels and the criteria of maturity are also varying. The Software Engineering Institute (SEI) of Carnegie Mellon University originally developed the maturity model in 1991 (Paulk, Curtis, Chrissis, & Weber, 1993). The first maturity model was intended to assess software development. Their maturity model is consisting of five levels. Currently other models are varied in determining their maturity level, such as the Software Maintenance Maturity Model (SM^{mm}) that consists of six maturity levels.

2.2.2 How to develop maturity model

Maturity model contains two different representations that is stage and continuous. Meng et al. (2011) stated that stage representation explain the required process area out of the total number at each maturity level. The continuous representation assesses all of the process areas against each maturity level.

According to (April, Hayes, Abran, & Dumke, 2004) the first step to develop their maturity model was identifying specifics organisation's activities. The second step was surveying the standards, explores the literatures and other maturity models. In addition, as the result the proposed maturity model was introduced. In

developing the maturity model, it is also important to first define the definition of the mature and immature organisations (Paulk, Curtis, Chrissis, & Weber, 1993).

2.2.3 How to use maturity model



Figure 1 The levels in maturity model (source: own interpretation, based on CMM by Paulk et.al, 1993)

The first concept to use maturity model is to understand the criteria of each level. Here is the example of five maturity levels. As it explained in the figure above, each level has a name on it in order to make it simpler to categorise and state to the current organisation’s situation.

	INITIAL Chaotic Condition LEVEL 1	REPEATABLE Policy is established to guide the processes LEVEL 2	DEFINED Consistent and standardised LEVEL 3	MANAGED Processes are well defined, goals are set. LEVEL 4	OPTIMIZING Integrated management, focusing on improvement LEVEL 5
Criteria					
Aspect A		○			
Aspect B			○		
Aspect C				○	

Figure 2 An example of five maturity level and its criteria (source: own interpretation, based on CMM by Paulk et.al, 1993)

The five levels above should be linked with the indicator/aspects of organisations performances. For instance the aspect A of an organisation is currently on the maturity level two, while the aspect B is already in level three. The important thing is not on which level the organisation is, but more on the strategies and decision in order to increase the level one step above. The approach of maturity model is a step-by-step improvement (Paulk, Curtis, Chrissis, & Weber, 1993).

2.2.4 Existing maturity models specific for maintenance

Based from the literature study of journal research, most of the maturity models are purpose for assessing the software organisations such as Capability Maturity Model (CMM) and Software Maintenance Maturity Model (SM^{mm}). There are also maturity models for construction industries such as Project Management Maturity Model (PMMM) and Construction Project Management Maturity Model (CPM3). Nevertheless, the specific maturity model for commissioning maintenance organisations in the public sector is not yet discussed.

2.3. Public Commissioning Maturity Model (PCMM)

In order to link between commissioning maintenance activities and public sector, the Public Commissioning Maturity Model (PCMM) is used as the main reference for this research. This maturity model is developed by Marleen Hermans, Leentje Volker and Peter Eisma. This model is used to assess public organisation capabilities related to construction clients' roles in term of commissioning of successful construction projects (Hermans, Volker, & Eisma, 2014).

This maturity model consists of 10 aspects of which are divided into several sub aspects. These 10 aspects will be explained in the further sections.

2.3.1 Aspects and sub aspects of PCMM

The 10 aspects of PCMM are divided into sub aspects. The first three aspects, according to Hermans et al. (2014) are resulting from the concept of EFQM maturity models and Business process management (BPM). Those are reflecting on the sub aspects as general preconditions of successful organisations.

The Business Process Management (BPM)

The Business Process management is recognised widely as a foundation for modern management approaches by analysing the business process of an organisation (Rosemann & Bruin, 2005). The BPM maturity model was developed based on Capability Maturity Model (CMM). The critical success factors in BPM are (Melenovsky & Sinur, 2006):

- Strategic alignment: the continued linkage of the business process and organisational priorities that will enable the goals of the business.
- Culture and Leadership: values and beliefs that form process-related attitudes and behaviours.
- People: the person and groups who continually augment and apply their process related knowledge
- Governance: relevant and transparent accountability, decision making and reward process to guide actions
- Methods: the approaches and techniques that support the process and outcomes.
- Information Technology (IT): the information, software and hardware system of management that support process activities.

The levels of organisational maturity of BPM starts from Acknowledge Operational Inefficiencies, and then followed by Process Aware, Intra-Process Automation and Control, Inter-Process Automation and Control, Enterprise Valuation Control, and the final maturity level is Agile Business Structure.

The EFQM (European Foundation for Quality Management)

The EFQM is a framework model that can help organisations to continually innovate and improve (EFQM). The model is practical and pragmatic to stimulate continuous improvement by allowing people to reveal the cause and effect relationship between their organisation does and the results that they achieves. The fundamental concepts of excellence organisations in EFQM are (EFQM):

- Adding value for customers
- Creating a sustainable future
- Developing an organisational capability
- Harnessing creativity and innovation
- Leading with vision, inspiration and integrity
- Managing with agility
- Succeeding through the talent of people
- Sustaining outstanding results

In PCMM, the enablers in EFQM are being used for the first three aspects (Hermans, Volker, & Eisma, 2014). Those enablers related to the organisations and its governance. Those enablers are; Leadership, People, Strategy, Partnerships & resources, Process, Products & Services (ww.efqm.org, 2014). These enablers are resulting in people, costumer, society, and business results.

It is important to remember that the PCMM aims to assess the public organisations within their role in commissioning a construction project. Hence, the aspects and sub aspects are related to the organisation type in the public sector.

1. Organisational strategy and policy

Aspect 1	Sub aspects
Organisational strategy & policy	Objective and policy Improving and Innovation Change strategies

The first aspect is the organisational strategy and policy. According to Hermans et al. (2014) this aspect emphasizes on how the organisational capabilities in applying their strategy and policy for the role of commissioning the construction project in public sectors. This aspect also points out the importance of improving and innovating their strategies and policies. Thus, when the role of organisations is changing, the strategy and policies might change as well. (Hermans, Volker, & Eisma, 2014)

2. Culture and Leadership

Aspect 2	Sub aspects
Culture & leadership	Governance and appraisal Culture related to innovation and professionalism

Organisational culture is the organisation’s learned way of responding to the different demands of its core task (Oedewald & Reiman, 2002). The problem with the culture in organisations is they are resisting change. Therefore,

organisations that want to improve and innovate should incorporate the culture as an important aspect in their strategies. As it stated by Sani et al. (2011), The performances of the organisations related to the action and behaviour of the organisation’s employees. Therefore, the culture in an organisation should encourage the general awareness of work in maintenance organisation.

The culture in the organisation is related to the leadership factor. As it stated by EFQM (2014), excellent organisations have leaders who can form the future and realise it, acting as role models for its values and ethics. Thus to generate a good culture that can adapt with the continuously improving organisation, a leader must have the capabilities.

The second aspect of PCMM emphasizes on how the organisations having the quality of culture and leadership that can encourage organisations to be professional and have good governance. Moreover, a leader should have appraisal ability which means able to judge the quality of individuals and project teams within organisations.

3. People and Learning organisations

Aspect 3	Sub aspects
People and learning organisation	Knowledge, capacities and competences
	Teams
	Learning organisations

According to Chinowsky et al. (2007) Learning organisation means that continuous knowledge enhancement and process improvement become fundamental in the organisation. Moreover, there are five characteristic of learning organisation:

- Leadership
The ability to lead the organisation, encourage knowledge enhancement, and proactive.
- Processes and infrastructure
This is the combination of management and technical processes in providing facilities to encourage learning organisation.
- Communication
Free-shared knowledge between individuals within the organisation.
- Education
Management encourages employees to pursue education and bringing the new knowledge into the organisation, in order to raise competencies.
- Culture
The developments of a culture that open to the new ideas, changes, desire to improve, and to pursue every individual to do better.

In the third aspect of PCMM, the focus is on how the organisations are able to always learn and having people or teams that also having competencies, knowledge and capacities. The qualities of the human resources in the organisations can enhance the capabilities and the improvement of the organisation.

4. *Decision models and portfolio*

Aspect 4	Sub aspects
Decision models and portfolio	Decision models for commissioning options
	TCO/LCC (total cost of ownership /Life cycle cost)
	Project vs. portfolio

The fourth aspect is about the decision models and portfolio. According to Hermans et al. (2014) this aspect is about the capability of an organisation to make decisions related to their portfolio management. There is option to outsource or in-house decision making for the project or assignment. Moreover, the organisation’s competency in making decisions is also incorporating the contract type, the tendering method, and choosing the suitable collaboration (Hermans, Volker, & Eisma, 2014). This means that the organisation should make effective decisions in order to gain better results for their organisation.

This fourth aspect also incorporates the TCO/LCC as part of the ability of organisations managing their portfolio. This sub aspect means that the organisations incorporate the TCO/LCC calculation in managing their assets, because by doing so the organisations can make strategies to reduce the lifetime costs of the object portfolio.

The sub aspect of the project vs. portfolio is assessing the competence of organisations to consider the portfolio performances to be consistent with the requirement of the projects and tasks (Hermans, Volker, & Eisma, 2014).

5. *Stakeholders*

Aspect 5	Sub aspects
Stakeholder management	Consequences of political context
	Safeguarding interests and position of users and stakeholders
	Trend and developments in stakeholder organisations

In public construction projects, there are many stakeholders involved that are coming from internal and external organisations. They have different roles, aims and responsibilities. The fifth aspect according to Hermans et al. (2014) is the competences of public organisations in fulfilling the needs of stakeholders, users, and political party. This is also includes understanding the positions and interaction of the stakeholders as part of the commissioning process. Furthermore, the public organisations also have ability in delivering the needs of the internal organisations through the life cycle of the built environment.

6. Public values

Aspect 6	Sub aspects
Public Values	Public values in commissioning Launching customer ship and setting an example

Public values in this aspect are means that the public organisations should have the values such as social mission. The public construction client should have ability to provide a good example for the less experienced construction clients (Hermans, Volker, & Eisma, 2014). Public construction projects mostly have higher scale compared to the private projects. Moreover, the public construction projects involving several built environment standards, such as the sustainability standard and certification. By initiating those approaches, the public construction projects can be a role model for others.

7. Public rules of play

Aspect 7	Sub aspects
Public rules of play	Acting according to integrity Transparency, effectiveness, legality rules Procurement regulations

In order to execute the public construction projects, the organisations should have capabilities in conducting the process of tendering. The process of procurement should within the regulations and rules. Moreover it is important that the public organisations have integrity, initiate transparency and effective process. Public organisations should be able to show the knowledge of the tendering according to the applicable procurement law.

8. Interaction with the supply market

Aspect 8	Sub aspects
Interaction with supply market	Market knowledge Effective selection processes Using the market's innovating power and knowledge Interaction, partnership, collaboration

To obtain the desired results that satisfying clients and stakeholders, public organisations should have the knowledge of the market supply. This knowledge is about the appropriate partnership model and the selection process, in which the public organisations should have the ability in assessing the quality of the suppliers. Moreover, the organisations should discover the ability of the supplier's innovation.

9. *Managing projects and assignments*

Aspect 9	Sub aspects
Managing projects and assignment	Stability and firmness of role
	Professional variation in commissioning Specifying, procuring, contracting, contract management

This aspect is about how organisations can manage the specific tasks professionally within its commissioning role (Hermans, Volker, & Eisma, 2014). This is more about the ability of the internal organisation itself in understanding and having knowledge of their roles within commissioning activities.

10. *Creativity and flexibility*

Aspect 10	Sub aspects
Creativity and flexibility	Combining compliance and creativity: thinking out of the box

The last aspect in PCMM is about the performances of organisations in having creativity and flexibility of delivering commissioning for public clients constructions.

CHAPTER 3 CONCLUSIONS

3. Conclusion and relationships between Maintenance and PCMM

From the previous discussion, it can be concluded that aspects in Public Commissioning Maturity Model (PCMM) can valuable for commissioning maintenance activity. The following sections will discuss the relationships between the aspects in PCMM and the important elements of maintenance.

3.1 Key aspects in Maintenance Organisation

Several key aspects have been drawn from the literature reviews of building maintenance and maintenance organisations. This will be described in the table below:

Code	Building Maintenance topics	Important aspects of mature commissioning organisation for maintenance
A	Maintenance objectives	<ul style="list-style-type: none"> • Clear Maintenance objectives • Having good leaderships • Good culture toward commissioning maintenance • Encourage creativity
B	Role of maintenance organisations	<ul style="list-style-type: none"> • Understanding the organisation roles in planning and controlling • Understanding the maintenance commissioning tasks
C	Maintenance Strategies (Preventive maintenance, Corrective maintenance)	<ul style="list-style-type: none"> • Options for maintenance strategies • Selecting best strategies • Strategies correlate with output and values of organisations • Incorporating maintenance policy in organisation's activities
D	Planning and Process	<p><i>Object valuations:</i></p> <ul style="list-style-type: none"> • Building's elements inventory • Objective condition assessment • Applying standard code for assessment • Understand components of building assets <p><i>Appropriate strategies:</i></p> <ul style="list-style-type: none"> • Select appropriate strategies • Having the desired results of maintenance performances • Having enough skills and knowledge • Incorporate TCO/LCC • Make prioritisation • Having strategies for building

		<ul style="list-style-type: none"> management options Having rule and regulations for procurement and purchasing
		<p><i>Procurement and contract:</i></p> <ul style="list-style-type: none"> Following procurement procedures Deciding contractual model Having the selection criteria Conducting procurement Collaboration and agreement model Setting goal for suppliers Final inspection Assessing the supplier's performances Selecting appropriate suppliers Flexibility in contract
E	CMMS	<ul style="list-style-type: none"> Using technology for decision making benefit for commissioning tasks
F	Stakeholders relationships	<ul style="list-style-type: none"> Understand the duties and the role of stakeholders Capture the client's requirements and end-users satisfaction Maintain the whole process that involving stakeholders Maintain partnerships and collaborations
G	Maintenance Market	<ul style="list-style-type: none"> Managing the fragmented market for multi criteria of maintenance projects Designing contracts to incorporate the fragmented markets
H	Supplier performances	<ul style="list-style-type: none"> Measuring supply market performances Reveal the capabilities of the maintenance suppliers
I	Innovation	<ul style="list-style-type: none"> Always innovating and incorporate innovation for organisation's performances Mind-set toward innovation for procurement methods
J	Controlling outcomes	<ul style="list-style-type: none"> Controlling the qualities of maintenance outcomes Conduct assessment for internal organisation's performances

Table 1 Important aspect of maintenance organisations

The important aspects of commissioning maintenance activities for building assets have similarity with the Public Commissioning Maturity Model. By having the similarity, the important aspects can be grouped into the same maturity aspect. The uncovered aspects can group under the new criteria.

3.2 Correlation between PCMM and commissioning maintenance activities

On table 1, it is explained that the name of each commissioning maintenance aspects starts from A to J. The relationships between the important aspects of commissioning maintenance activities and PCMM can be seen in the table in [Appendix III](#). The similarity are described as follow:

1. Aspect A in commissioning maintenance is related to aspect 1 of PCMM. Both of the elements describe about the importance of an organisation having objectives in order to make clear all of the activities and decision-making.
2. Aspect B is related to aspect 7 and 9 of PCMM aspects. This because the role and responsibilities in commissioning maintenance, related to the tasks of maintenance department as part of public organisation in commissioning maintenance projects.
3. Aspect C in commissioning maintenance is connected to aspect 4 of PCMM aspects. Maintenance strategy decision for corrective or preventive maintenance is part of commissioning activities, in which it can affect the planning and budgeting by the public organisation.
4. Aspect D is connected with aspect 4, 7, 8 and 9 from PCMM. In aspect D, the planning and process in commissioning maintenance is covering all of the activities related to managing maintenance activities that starts from making decision for maintenance strategies, suppliers selection, and control the maintenance projects.
5. Aspect E is related to the aspect 2 of PCMM. Using CMMS as a tool for maintenance decision-making is part of the culture and leadership in maintenance department. Thus can affecting the organisation style of commissioning maintenance activities.
6. Aspect F is connected to aspect 5 and 8 of PCMM. It is obvious that stakeholder's relationship is related to the supply market interaction and stakeholder management, in which maintenance department should understand how is their position and to acts towards other maintenance stakeholders.
7. Aspect G in maintenance organisation is related to aspect 8 and 9 of PCMM. In commissioning maintenance activities, the maintenance department should have knowledge about the maintenance market, supplier that will benefit for managing maintenance projects.
8. Aspect H is connected to aspect 8 and 9 of PCMM. Supplier performances will affect the relationships between the maintenance department and the supplier market, and also affecting the qualities of maintenance outcome.
9. Aspect I connect to aspect 2 of PCMM aspects. Innovation is related to the organisation culture and leadership. In commissioning maintenance it is important that the organisation encourage the maintenance department to innovate in order to reach the best results of maintenance activities.
10. Aspect J is related to aspect 2, 5, 8 and 9 of PCMM. To control the outcome of maintenance performances, maintenance department can start from assessing its own organisation toward its culture and leaderships. Then maintenance department should have ability to control the quality of maintenance activities by revealing the suppliers capabilities, managing

stakeholders relationships, manage the procurement process, and control the results of maintenance projects.

As a general conclusion base from literature study, PCMM is applicable for commissioning maintenance activities in the public sector. However, some of the elements in the maintenance are specifics, in which it can be different with the PCMM goals in general. Further research will use interview method to reveal the commissioning maintenance activities more in depth.

3.3 Specifics aspects in Building Maintenance

Specific aspects of maintenance that related to PCMM but there are some elements in the maintenance that specifics in which can be different from the commissioning in construction activities. Those elements are:

1. Condition assessment
This term is important in the first phase of the maintenance process. In object valuation, the condition assessment process has benchmark or standard for assessing building objects that will affect the prioritising in maintenance strategies. This process does not exist in commissioning activities for built environment.
2. Fragmented market
The types of supplier market in maintenance sector are different with a construction project. The maintenance market is more fragmented if compared to the construction market. The contractual model will be unique. Moreover, it has to be clear how to manage the market in terms of interaction, partnership, and collaboration that might differ with the construction.
3. Maintenance strategies
It is so specifics that maintenance organisations having options in doing preventive or corrective maintenance. The selection of strategies is important in deciding the plan for maintenance cost valuation and procurement method. It will also affect on the procurement law used and the contractual model.
4. CMMS
CMMS is specifically for maintenance activities. Moreover, basing on literature study, not every maintenance organisations are using it. Thus, the importance of using technology based to support the commissioning of maintenance activities is questioned.

3.4 Preliminary Maintenance Maturity Aspects and sub aspects

According to the previous discussion, a set of preliminary maintenance organisations maturity aspects can be formed.

Aspect	Criteria	Sub criteria
1	Organisational strategy and policy	<ul style="list-style-type: none"> • Clear maintenance objectives • Maintenance policy
2	Culture and leadership	<ul style="list-style-type: none"> • Innovation • Technology used • Control in organisation
3	People and learning organisation	<i>Not applicable</i>
4	Decision models and portfolio	<ul style="list-style-type: none"> • Maintenance strategies • Object valuation, TCO/LCC, prioritisation • Maintenance process
5	Stakeholder management	<ul style="list-style-type: none"> • Knowing stakeholders objectives • Manage the collaboration
6	Public Values	<i>Not applicable</i>
7	Public rules of play	<ul style="list-style-type: none"> • Procurement process & regulation, contractual model • Encourage integrity, transparency, effectiveness, and legality rules.
8	Interaction with supply market	<ul style="list-style-type: none"> • Suppliers selection criteria • Setting suppliers goals • Understand maintenance market
9	Managing projects and assignment	<ul style="list-style-type: none"> • Short-term planning • Supervising maintenance projects
10	Creativity and flexibility	<i>Not applicable</i>

Table 2. Preliminary maturity aspects for maintenance organisations

These aspects of maintenance commissioning maturity can be changed based on the further research method through interviewing experts.

3.5 Preliminary levels of Maintenance Commissioning Maturity Model

The maturity level of commissioning maintenance is originally from the Capability Maturity Model (CMM) by (Paulk, Curtis, Chrissis, & Weber, 1993) that has five levels. In order to be applicable for maintenance, the preliminary levels will refer to the levels of maintenance maturity by (Schuh, Lorenz, Winter, & Gudergan, 2009). They provide five levels for maintenance organisations in which refer also from CMM. Those levels are (Schuh, Lorenz, Winter, & Gudergan, 2009):

- First level: The condition of maintenance organisation that still disorganised. The concept of improvement in maintenance is already introduced irregularly. There is no integration between the maintenance department and the company.

- Second level: There has been awareness of the maintenance organisations to always improve their service performances. Individual employees initiate this improvement.
- Third level: There are benchmarks to improve the maintenance performances, and all of it is documented well, evaluated and standardised. Moreover, it will form operational instruction.
- Fourth level: High level is already achieved. The continuous improvement is only small steps, and need large inputs of efforts.
- Fifth level: There is integrated maintenance management that performs high efficiency and effectiveness. Every employee is ready for continuous improvement and always enhances their ability and performance.

According to (Schuh, Lorenz, Winter, & Gudergan, 2009), the changing in maturity levels of maintenance organisations is a process in which every step in different level is valuable. Every level are support each other.

This preliminary maturity level for commissioning maintenance will be different with the maturity levels for maintenance organisation. However, this can be a based to support the further research through interviews. From which the final maturity levels for commissioning maintenance activities can be derived.

3.6 Conclusion from literature study

From the literature study, it can be concluded that the PCMM is applicable for assessing the maturity level of commissioning maintenance activities. The maintenance organisations in this research are specific to the organisation/department inside the body of public organisations. The preliminary aspect of Commissioning Maintenance Maturity Model is derived from the elements in maintenance organisations and PCMM. The preliminary maturity levels are referring to the previous research by (Schuh, Lorenz, Winter, & Gudergan, 2009). However, those researches were not specifically for commissioning maintenance activities for public building assets. Nevertheless, there are specific issues in maintenance that are differing with other construction activities. In order to make it more reliable, the elements in maturity levels in commissioning maintenance activities should be explored more in depth to get better information from the interviews.

4. Appendices

Appendix I

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Appendix II

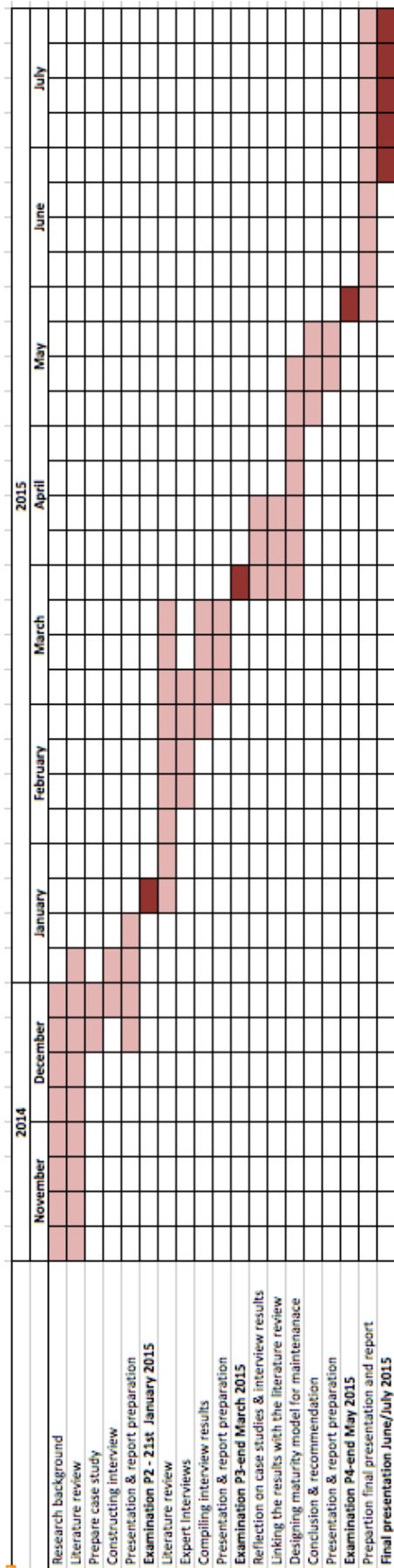


Figure 6 Research Schedule

Appendix III

Public Commissioning Maturity Model (PCMM)	Aspect 1 Organisational strategy & policy	Aspect 2 Culture & Leadership	Aspect 3 People and learning organisation	Aspect 4 Decision models and portfolio	Aspect 5 Stakeholder management	Aspect 6 Public Values	Aspect 7 Public rules of play	Aspect 8 Interaction with supply market	Aspect 9 Managing projects and assignment	Aspect 10 Creativity and flexibility
Maintenance Aspects										
Aspect A Maintenance objectives	✓						✓			
Aspect B Role of maintenance organisations									✓	
Aspect C Maintenance Strategies				✓						
Aspect D Planning and Process				✓			✓			
Aspect E CMMS		✓								
Aspect F Stakeholders relationships					✓			✓		
Aspect G Maintenance Market								✓		
Aspect H Supplier performances								✓		
Aspect I Innovation		✓								
Aspect J Controlling outcomes		✓			✓			✓		✓

Figure 7 Relationship table between PCMM and maintenance organisations

Appendix IV

Idea for interview protocols:

- Does the maintenance department have specific maintenance strategies? If yes, how to manage the strategies? (Preventive maintenance, corrective maintenance)
- Does the maintenance department using specific technology or application to plan and control the maintenance activities, such as CMMS?
- How does your maintenance organisation view toward object valuation?
- How does the object valuation adding value for the maintenance department in making decision?
- What is the maintenance department strategy to cope with the fragmented market in maintenance?
- What is so specific with the fragmented market related to the maintenance process, procurement, and contractual model?
- How does the organisation control the qualities of outcomes from maintenance department?
- Do you incorporate TCO/LCC calculation in your organisation?
- How does the maintenance department manage the stakeholder relationships for maintenance projects, and portfolio clients?
- Does stakeholders relationships impact on the maintenance performances, budget and strategies?
- Does the maintenance department concern with customer ship and provide an example for maintenance sector?
- How do the maintenance department valuing the integrity, transparency, and regulation in the maintenance procurement process?
- Are there any more detailed or specific focus, and activities of commissioning maintenance activities that you can describe?

Appendix V

	February			March			
Making interview appointment							
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Interview with keyperson from Gemeente Delft							
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Figure 8 Interviews schedule

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