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Attentiveness of Building Commissioning in the Malaysian Construction Industry

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***Abstract*—**This paper provides some thoughts about the lack of attentiveness of building commissioning in the construction industry and the lack of handling in project commissioning as an integral part of the project life-cycle. Many have perceived commissioning as the problem solving process of a project, rather than the start up of the equipment, or the handing over of the project to the client. Therefore, there is a lack of proper attention in the planning of commissioning as a vital part of the project life-cycle. This review paper aims to highlight the benefits of building commissioning and to propose the lacking of knowledge gap on building commissioning. Finally, this paper hopes to propose the shift of focus on this matter in future research.

***Keywords*—**building, commissioning, construction, delay

I. Introduction

COMMISSIONING is a systematic process of ensuring that all building facility systems perform interactively in accordance with the design documentation and intent. Commissioning begins with planning and includes design, construction, start-up, acceptance and training, and should be applied throughout the life of the building [12]. According to an inspection manager, commissioning includes installing the equipment, checking the equipment is in good condition, making sure everything conforms and is in accordance with specifications [23].

Commissioning and handing over is described as a process rather than a check point. In essence, commissioning should be considered a less problem solving process, but instead as a preparing process for the handing over of the installation to the customer [13].

ASHRAE defines commissioning as the process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained to perform in conformity with the design intent. Commissioning has a systematic approach. It starts in the programming phase and ends when the building is turned over to the owner. The current commissioning process can be adapted to start during any phase of construction [28].

II. WHY COMMISSIONING HAS TO BE DONE?

A. The Benefits of Building Commissioning

According to U.S Department of Energy, building commissioning is the key to quality assurance in more than one way; it prevents problems from developing, anticipates and regulates system interactions, and implements a systematic method of meeting the buildings mechanical, electrical, and control requirements. A thorough commissioning effort results in fewer installation call backs, long-term tenant satisfaction, lower energy bills, avoided equipment replacement costs, and an increased profit margin for building owners.

The commissioning process was chosen as the central focus of the delivery chain as it typically constitutes the end phase from a supply side point of view. It can be considered as the point in the delivery chain where all the parts of the project come together and should be verified as a working whole [13]. Therefore, the whole chain of activities–ranging from sales and design to handing over and warranty – has been addressed [23].

Gadde and Jellbo [16] summarize their analysis of system sourcing approaches stating that the interplay between the system and its factors take place in a network context which sets the conditions for–and is affected by–the system definition, the activities in development and manufacturing and the capabilities of the buyer and the supplier. In the construction industry, the effects of interplay between these systems will be verified where all parts of the project come together and should be tested and commissioned as a working whole.

B. The Goal of Commissioning in the Malaysian Scenario

The ultimate goal of the commissioning process is to obtain the Certificate of Practical Completion (CPC). As outlined in Standard Form of Contract P.W.D Form 203A (Rev. 2007), Clause 39.3, within 14 days of receipt of such notice, the Superintending Officer (S.O.) shall carry out testing/inspection of the works. Pursuant to such testing/inspection, the S.O. shall:

a) Issue the Certificate of Practical Completion (CPC) to the Contractor if in his opinion the whole works have reached Practical Completion and have satisfactorily passed any test/inspection carried out by the S.O. The date of such completion shall be certified by the S.O. and such date shall be the date of the commencement of the Defects Liability Period as provided in Clause 48 hereof; or

b) Give instruction to the Contractor specifying all defective works which are required to be completed by the contractor before the issuance of the Certificate of Practical Completion (CPC).

If the S.O. has given instruction pursuant to Clause 39.3(b), no Certificate of Practical Completion (CPC) shall be issued to the Contractor until the Contractor has effectively carried out the remedial work within reasonable period to the

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satisfaction of the S.O. Building commissioning during project handing over is important as the issuance of the Certificate of Practical Completion also fixes the date for the release of the first moiety of the retention to the contractor. Therefore, any failure of the contractor to carry out the aforementioned work satisfactorily will eventually lead to delay in the project completion.

III. PROBLEM STATEMENT

The commissioning process, which begins in the earliest stages of a project and lasts through the first year of operation, is designed to eliminate problems and resolve issues before they become major problems. When the commissioning process is highly successful, the number of change orders, request for information, scheduling problems, conflicts, and other problems will be greatly reduced. When a project goes smoothly, the owner might doubt the needs of commissioning process. The commissioning authority must document their activities to remind the project team that the seemingly "perfect" project was a direct result of the commissioning effort [3]. For this reason, the industry players and the clients might have unintentionally overlooked the prudent of building commissioning in the construction industry.

Contrarily, if an issue is found later in the turnover phase, then there are at most two phases (including the turnover phase) in which cost can be avoided based on the resolution of that issue. Sometimes it is very difficult to resolve the issue when identified this late, so the owner are forced to "live with it" for an extended period, or even permanently, during the operation phase while paying for the cost over and over again [3].

In some way, the possible explanation for this was the risk management usage in the execution and planning stages of the project life cycle was found to be higher than in the conceptual or termination phases [34]. The lower usage of risk management in the conceptual phase is consistent with findings by Uher and Toakleys [29]. However, the result of Lyons and Skitmore [34] was contradict with Elkington and Smallman [14], for example, who found that 'the earlier that risk management was used in a project, the more successful it was'. It was then inferred that the lower usage of risk management in the termination phase could be the reason for delay when handing over the building. Therefore, it is the hope of this research to draw more attentiveness on building commissioning in the construction industry. Ultimately, this will assist the industry to anticipate the likelihood of the occurrence of delay during project handing over stage. This is why the commissioning process, which begins early in a project's timeline, can offer far more value to the owner than commissioning begun later during construction or startup [3].

The lack of commissioning summary documentation and unresolved building problems point to the use of commissioning as an umbrella term for a variety of activities [15]. This finding is supported by previous market research in California which identified that education is needed on the commissioning process, since the majority of owners define commissioning as primarily the testing of systems [18]. Each commissioning process encountered was defined differently. Troubleshooting activities during construction and simple checklists were referred to as commissioning. In the search for buildings participants, commissioning providers and owners often said of their project, "This was not a good example of commissioning", because the process was inserted late into the construction process or had a contentious end. In effect, the persistence of the entire commissioning process, from design phase to post-occupancy, was not investigated. Instead, the focus was the variety of ways in which commissioning is implemented in practice [15]. Subsequently, this research somehow aims to highlight the some of the factors for the overlooked of building commissioning in the Malaysian construction industry. It is further suggested that shift could be helped if definition for building commissioning is produced for the Malaysian construction industry.

IV. ATTENTIVENESS TO BUILDING COMMISSIONING IN THE MALAYSIAN CONSTRUCTION INDUSTRY

The lack of handling in project commissioning as an integral part of the project life-cycle has properly led to the lack of research on this issue [26], [27]. Commissioning is perceived by many as the problem solving process of a project, rather than the start up of the equipment, or the handing over to the customer [23]. Thus, there is a lack of proper attention in the planning of commissioning [13] as an essential part of the project life-cycle.

Lacking awareness on the impact of poor commissioning on building has affected the performance of many projects. Faulty construction, malfunctioning equipment, incorrectly configured control systems and inappropriate operating procedures have increased realization that many buildings do not perform as intended by their designers [19]. The problem has become more evident when the project commissioning is considered as a mere administrative formality to obtain the construction license for the party involved. This ignorance of what a project really is implies that quality is not the prerequisite of it, and it is deemed unimportant [24]. Lacking awareness of the commissioning party has negatively impact the building performance and this causes a continuum exists in the degradation of building performance [31]. Degradation reflects that a building has failed to perform or behave as anticipated by its designers [32]. A complete measure of productivity of design, construction and operations should take into account the efficacy with which the completed building serves the objectives of the organization sheltered within it [30]. The research done by Haasl and Friedmann [18] identified that education is needed on the commissioning process, since the majority of owners define commissioning as primarily the testing of systems. Therefore, the objective of the research is to identify the significance of delay during commissioning in the Malaysian construction industry from the perspectives of clients, contractors, consultants and others.

Accumulated delays from previous phases may lead to operational errors during execution of commissioning

procedures. Delays can result in time constraint and impose pressure that could affect project scheduling prior to final delivery to the customer [10]. The project organization is aware of that it has to carry out work more carefully in the previous project phases for preventing confusions and delays during commissioning. Still the commissioning activities are not meeting the desired level [13]. However, Cagno *et al.* [10] and Dvir [13] do not specify these commissioning problems are inherent from which previous project phases. The purpose of commissioning and its outcome, which appear to be major states of uncertainty for the delivery organizations at this point, need to be elucidated for being able to carry out the commissioning more effectively [13]. From these commissioning problems, the uncertainty on the significance of commissioning might be the conceptual basis for this inefficacy. Besides, there is a degradation of focal point on building commissioning as compared with previous project phases such as design and construction.

The basic commissioning process is integrated with the phases of construction and should begin in the pre-design phase and continue through construction and the warranty period. Commissioning enhances communication among project team members and ensures that they all understand the project goals. This allows the project team to identify problems early, before they can affect later phases of the project and cause delays [25]. Further research should be done in other countries other than Israel and in different industries other than defense development projects performed under the hospices of the Israeli Ministry of Defense at that period to study the termination and hand over phase of projects in order to develop better ways for introducing projects into service and ensuring their final users satisfaction, which is the ultimate proof of project success [13].

There is a rising recognition that many buildings do not perform as intended by their designers. Reasons include faulty construction, malfunctioning equipment, incorrectly configured control systems and inappropriate operating procedures [19]. The focuses of this study are commissioning problems due to faulty construction. Faulty construction can cause faults in building operation which is among the necessities for building commissioning [12]. Therefore, from the critical review of literatures, the research objectives for this review paper are:

1) To identify the lacking of knowledge gap for building commissioning in construction industry; and
2) To determine the benefits of building commissioning in construction projects; and
3) To identify the interface inconsistencies between construction and commissioning; and
4) To propose recommendations for future research in building commissioning in the Malaysian construction industry.

V. Interface of Construction and Commissioning

To ease the information loss and interface problem, the project information loses considerably between different project phases, such as concept phase, design phase, construction phase, and occupancy phase even in the same construction project. As shown in Fig. 1, the information in the last phase during occupancy phase loses much more than the other phases [21].

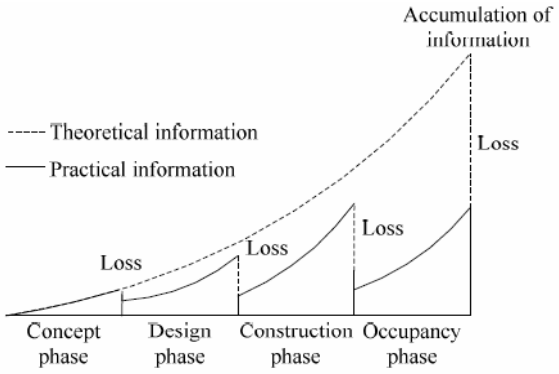

Fig. 1 Information loss in construction project lifecycle [21]

As an intermediate process between construction and occupation or operation, testing and commissioning which was carried out during handing over of the project integrate all the delivery systems for the first time. Therefore, the integration of all these items would be of necessity to ensure building performance and functionality. Professional inconsistencies at the project design and construction interface were identified by many researchers such as [9], [2], [1], [4] and [5] can be deemed as looking at projects from front forwards. In conjunction with this, little research has been done to identify inconsistencies at the project construction and commissioning (hand over) interface which implies a necessity to looking at projects from the end backwards. This will enable clearer visualization of outstanding works that hinder the project handing over and subsequently the interface of this outstanding work with construction. Therefore, social and technical integration of construction and commissioning (handing over) are needed to ensure complex interfaces for achieving customer satisfaction.

Eliminating the inconsistencies which exist can enable projects to be completed successfully. Inconsistencies at the interfaces between parties can either result in delay in project duration, compromise on quality, or increase in cost. Considering these disagreements which can ultimately affect any construction project, there is a need to institute better and comprehensive solutions to coordinate activities at the interface. It is important to determine the potential causes of inconsistencies in the project life cycle. These potential causes of inconsistencies can hinder the progress of a building project substantially [7].

To create multi-product solutions for customers, companies must therefore work through lateral networks–networks that simultaneously face different forms of structural complexity and different types of interdependencies among interacting

units [17], [11]. So do the construction project, high interaction is utmost important among the project life cycle and also among different parties involved.

It is quite obvious that the interfaces, no more than the products themselves, can be standardized or even specified to a high degree in project business where the products often can be classified as complex products and systems [20].

As the customers often experience uncertainty receiving the installation, these aspects of commissioning and handing over (or involvement of client into the project before beginning of the actual commissioning) require consideration prior to commissioning. This implies the urge for looking at projects from the end backwards, where it all starts from a customer need. This can be compared to the 'V-model' used in systems engineering [22]. The social integration again ensures the complex interfaces between suppliers and customers, which form the basis for achieving a satisfied customer. Secondly, forward integrating towards the following phase in the value stream, the operator and/or the customer into the project [23]. Hence, the identification of interface inconsistencies between construction and commissioning could be of necessity to mitigate the delay problems in the construction industry.

VI. CONCLUSION

Lacking awareness on the consequence of poor building commissioning has affected the performance of many projects. Consequently, the attentiveness in building commissioning has to be supported with further empirical study to emphasize the benefits of building commissioning in the Malaysian construction industry.

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