Perception of Key Stakeholders on the Internal Wall Quality Inspection Process for High-Rise Residential Building Construction Projects in Thailand

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Abstract

This study aims to explore the perception of stakeholders on an internal wall quality assessment during the process of quality inspection prior to delivery of high-rise buildings in Thailand. In this research, qualitative research is conducted on eight purposive interviewees, with the collected data analyzed using content analysis. The findings indicate that owners, consultants, designers, main contractors, and sub-contractors agree that the quality of internal walls in high-rise buildings are measured by the discretion, knowledge, ability, experience, expertise, and satisfaction of each inspector. Internal wall quality emphasizes flatness, alignment and evenness, angle, cracks, and range. The acceptable tolerance of work is not over 3 millimeters per wall side. The measurement of internal wall quality of each project will execute differently depending on each project. However, there is a lack of clear prescriptive standards for this type of work, which could be adopted in every project nowadays, such as tolerance acceptance, tools, and measurement methods. Therefore, to make a consistence of quality of work assessment between deliverers and inspectors, a reliable quality assessment guideline should be developed, presenting the principal criteria, acceptable tolerances, and measurements process and suitable tools for involved stakeholders.
Keywords: Real Estate, Residential Project, High-Rise Building, Internal Wall, Quality Inspection Process

High-Rise Residential Building's Construction Industry in Thailand

Construction industry growth has greatly affected Thailand. The property sector contributes approximately 7% to Thailand's GDP. More than 50% of real estate investment involves residential building construction (Thailand Industry Outlook 2017-2019 Housing in BMR, 2017). The current proportion of high-rise residential buildings in major cities is likely to increase. Economic growth is contributing to a surge in land costs for large cities, allowing low profitability and difficult price management, not suitable for customers with the ability to cope with the high price of real estates. The higher the project value is, the higher the price, and the higher the customer's expectation. The quality of a construction project is an

important factor in the current market and of particular interest to investors. In general, a construction project consists of three main work divisions: structure, electricity and plumbing, and architecture. Wall construction lies under architecture and is the work that has the most total areas, both internal and external walls of the building. The internal wall work focuses heavily on precision, since it is aesthetically o r i e n t e d, consuming the most time. Furthermore, customers can assess the quality of the wall itself by sight or touch. Hence, the construction of internal walls is a specific task and subjected to the customer's personal perception and judgment. Moreover, it involves many aspects and differing requirements to complete customer's goal. The project owners want a high-quality project that is completed under a certain budget within a specific time-frame; the project designers usually wish to design something remarkable within the customer's budget; the consultants hope that the work produced will meet the customer's quality requirements; lastly, the contractors want to maintain quality and complete the project within the customer's given budget. High-quality construction projects and excellent services are valued on the basis of the customer's perspective and should follow the agreement they made with the project contractor. In addition, the customers are likely to be satisfied when the work quality is better than expected, and dissatisfaction occurs when the performance falls short of the standard (Kärnä, 2014). To measure quality with customer requirements is very hard in practice because customers have different levels of satisfaction. For example, a customer might want a high-quality project, but he or she still wishes to pay a lower price. This often results in the main contractor hiring a sub-contractor to carry out partial or stage tasks to reduce the wage costs and production risk. Consequently, in such a case, the quality of the construction project might be lower than the customer's expectations. According to Yang and Peng (2008), customer satisfaction in the construction industry depends on the contractor's performance in accordance with contractual duties, obligations, and responsibilities. On the other hand, contractors face changing orders from customers, causing rework and project delay (Assaf and Al-Hejji, 2006). Moreover, Sutheeraphat (2000) also pointed out that a lack of document management, such as working without properly updating the necessary data and failure to establish a proper guideline for work inspection during the handing-over period, are the main causes of project failure in Thailand. However, there are limited studies on quality inspection and evaluation of architectural work such as internal wall construction in the high-rise building construction projects in Thailand. Therefore, this study focuses on the perception of internal wall quality from key quality inspectors. Hopefully, the results of this study will help to clarify what quality is and how it should be measured to achieve the necessary requirements and project excellence.

Construction Project Management

According to ISO 21500:2012 (Zandhuis and Stellingwerf, 2013), project management refers to the application of methods, tools, techniques, and competencies for a project. Project management includes the integration of various phases of the project life cycle, accomplished through processes. To manage a project, it is necessary to thoroughly understand the five processes involved: initiating, planning, implementing, controlling, and closing. Specific knowledge of each process is also required such as in the area of integration, scope, time, cost quality, human resources, communication, risk, procurement, and stakeholder (Drob and Zichil, 2013).

Construction management is activities that are very important in real estate development process and related to the management of resources in construction work, such as man, material, money, machine, construction technique and management. The purpose of construction management is to complete the construction project according to the target under the three constraints (Triple Constraints) of the project, namely time cost and quality. The

construction manager must try to complete the construction according to the standards specified in the contract, in which the construction time should be less than or equal to what is stated by using the lowest cost in order to maximize project profit. (Tochaiwat, 2012)

Stakeholders in a Construction Project

According to the Engineering Institute of Thailand, stakeholders in a construction project are consisted of clients or owners, designers, project management consultants, construction management consultants and contractors, including main contractors and sub-contractors. There are many previous studies on the causes of construction project delay. The stakeholder issue was one of the causes directly impacting on the project's success. For example, Toor and Ogunlana (2008) found problems relating to consultants, designers and contractors, such as multicultural and multilingual environments, a large number of project participants, and the involvement of several foreign designers and contractors. Assaf and Al-Hejji (2006) investigated the perception of three major parties in a construction project: owners, contractors, and consultants. Their findings show that all three parties agreed that the owners changing orders during construction was the main problem. Both owners and consultants pointed out that labors and contractors were causes of delay, but the contractors argued that owners and consultants contribute to the project's delay and effected to quality of works.

Quality Inspection Process

Quality of work is very important because it is an indicator of project success. Most clients are satisfied if they receive high-quality work, especially if it is higher than expected. Therefore, unclear quality specification and measurement in the construction project may easily lead to unexpected problems during the quality inspection process because each client has his or her own perception of quality.

Therefore, each party should understand the customer's definition of satisfaction. Previous research has made a considerable contribution toward quality and customer satisfaction in construction. For example, the findings indicate that public and private customers need contractors to improve their performances on quality assurance, handover procedures, and materials. Public customers were found to be less satisfied with the performance of contractors than private customers, but contractors mainly considered high customer satisfaction achievement in order to maintain their customer relationships (Kärnä, 2014). In addition, Sutheeraphat (2000) presents that problems among owners, construction management consultants, and contractors occur during the phase of project delegation in Thailand. Such issues include document management, where the necessary data was not updated and inspection acceptance of criteria was unclear.

Related Regulations

The Construction Quality Assessment System (CONQUAS), introduced in Singapore during 1989, has been undergoing development. In 2014, the eighth edition of CONCUAS was adopted. This system aims to serve as a standard for evaluating the quality of building construction. There are three components in the building, which is consisted of structural work, architectural work, and mechanical and electrical work. CONQUAS is widely applied in many construction projects such as housing, commercial buildings, high-rise buildings, and so on. Moreover, CONQUAS could also help the stakeholders involved in the construction project to standardize not only the specification and quality of labor work but also customer expectations. Developers can use this guide to specify product and service quality, while the contractor can satisfy customer's expectations regarding quality at a reasonable cost. Internal wall work in this system is consisted of five main criteria: product's finish, alignment and

evenness, cracks and damage, hollowness and delamination, and jointing. (Building and Construction Authority, 2014)

Quality Assessment System in Construction (QLASSIC) has been adopted from CONQUAS in 2006. The Construction Industry Development Board (CIDB) launched a quality evaluation system, namely Quality Assessment System in Construction (QLASSIC). Therefore, both quality assessment systems are similar in terms of their main elements (Construction Industry Development Board Malaysia, 2006) . The aforementioned data presents that, in other countries, standards and criteria have been established to assess the quality of construction projects. However, this is not the case in Thailand. Although each project might have its quality standard or set of specifications to assess the work quality, a commonly widespread accepted standard has not been established yet.

Research Questions

This study consists of three research questions:
1) What constitutes quality in an internal wall?
2) How can the quality of an internal wall be measured?
3) What standards or guidelines are being used in practice by Thai experts?

Research Objectives

The objectives of this research are to investigate the possible conflicts arising during the quality inspection process of high-rise building construction projects and to clarify what quality is and how it should be measured to achieve the necessary requirements and project excellence.

Research Methodology

This study uses qualitative research methodology to gain insight into key stakeholders' perspective of internal wall quality as they inspect the quality of high-rise buildings in Thailand. Data was acquired from in-depth interviews with eight respondents from different groups of key stakeholders. Eight experts on high-rise building construction projects in Thailand were purposively selected to acquire detailed information. The experts were divided into four groups: owners, consultants, main contractors, and sub-contractors. There were one, three, two, and two samples in these groups, respectively. Moreover, set requirements were established for interviewees: the project management consultant or project manager should have a degree in civil engineering, architecture, or other fieldwork, respondents should have at least five years of experience of internal wall quality inspection on no less than 10 residential high-rise buildings, and owners and consultants must be from listed companies in the Stock Exchange of Thailand.

Research instrument

Semi-structured questions were used to collect data based on the concept of the internal wall inspection process. The final semi-structured questions were prepared and proven to work well in gathering the required information. Data analysis involves a content analysis with a combination of inductive and deductive approaches.

Research Results

Perception of key stakeholders on the internal wall quality inspection process for high-rise buildings

1) Quality of internal wall

A: The quality of the project depends on the project owner, who determines the satisfaction level. The wants and goals of the project owners are important. Therefore, a contract is necessary to ensure a level understanding in quality level.

B: An Interior wall work must have a higher quality, due to the more expensive cost. A higher price leads to higher qualities, therefore it cannot use general cost appraisal as specified in reality for interior wall work.

C: To assess the flatness of the wall, the wall should have no defect, no concavity, convexity, and no ridge. Since this is not a raw wall, there are other methods to make the wall look better. Even the finished precast wall panels still cannot be cast to smooth out the entire sheet, therefore the wall work will not be modified. There is no level of quality but it is based on customer satisfaction, which depends on the judgment of the main contractors whether or not customers will accept each type of wall. Usually, customer should be able to accept an error of wall work not over 3 millimeters.

D: The wall is smooth, not wavy, not cracking, and not falling. The walls must form right angles and have dimensions according to the blueprint. The tolerance level is within 3 millimeters per wall panel.

E: The wall has to be smooth as it forms a right angle with the floor and ceiling, and contain no cracks by visual inspection. The project owners or customers are demand for high quality work. Especially for those without knowledge in the construction field, they will demand perfection from contractors, since they lack an understanding of the limitations of construction projects due to the materials and other issues. This challenges the delegation process, as contractors have to satisfy their customers. The characteristics of the wall depend on the desired quality standard, which should have an error of less than 2 millimeters everywhere on the wall. This is because 2 millimeters is related to the limitation of skim coat work of the wall, which contributes to creating a beautiful finish for the final product.

F: The surface is smooth, angled correctly, and does not fall nor slither. The acceptable tolerance of works is not over 3 millimeters.

G: The wall is smooth, not wavy, not cracking, not falling, angled correctly, and has dimensions according to the blueprint. The quality depends on the owner and the price level.

H: The surface is smooth, does not fall down nor slither. The wall should have a standard angle, not be swollen, not be wavy, not be cracked, and be aligned vertically and horizontally. The tolerance level is less than 3 millimeters.

2) Measurement of internal wall quality

A: Currently, inspectors use their sense of touch and vision to determine the wall's quality.

B: Visual senses should be enough to determine the quality of walls. However, for high-value projects and demanding for higher quality, some tools might be used.

C: The wall alignment is checked by sight, particularly the examination of the completed tiled floor, baseboard and ceiling. An angle bar can be used.

D: There is no clear standard for internal wall quality inspection process. When assessing the quality of an internal wall, inspectors often consider a project's specification list. A mock-up room has been made to facilitate the inspection process. When inspecting, a visual inspection is first conducted, and if there is any uncertainty, tools will be involved.

E: An aluminum box assesses the smoothness of the wall. Inspectors check the walls and floors to assess the verticality of the wall. It must be leveling and in alignment. To check the angle of the wall, inspectors should use an angle bar.

F: To assess the flatness of the wall, an aluminum box size 24 with length from 2-2.5 meters or spirit level will be used. Regarding the spirit level, if the gap is less than 3 millimeters, then it passes because this value comes from skim technicians. To check for the right angle of

the wall, a steel angle bar will be placed at the wall's corner. Random inspections will be used to check the top, middle, and bottom parts of the wall.

G: Sight and touch, an aluminum box, and aluminum plaster trowel are used to assess for evenness and alignment. The acceptable tolerance of work is not over 3 millimeters. Verticality of wall can be measured by sight with a plumb bob, an aluminum level or a laser level. The acceptable tolerance of works is not over 3 millimeters. Angle is checked by sight and examination of the completed tiled floor, baseboard and ceiling or using an angle bar. The height and weight of the wall must match the design plan. The acceptable tolerance level is not over 3 millimeters, using measure tape or laser level.

H: Inspectors use laser level to measure verticality of the wall. To measure the wall distance and dimensions, inspectors can use a measuring tape. But to check the flatness of the wall, an aluminum plaster trowel that is two meters long or spirit level will be used.

3) Standards or guidelines used

A: The standards or guidelines for an internal wall nowadays do not exist or could not be found. It depends on the responsibilities of the project manager. Contractors should be responsible for delivering high quality to projects, since they have the license to do so.

B: It possibly exists, but inspectors still have to check with the Department of Public Works and Town & Country Planning.

C: It does not exist.

D: There is a lack of a clear wall inspection standard, due to the different specification of each project. Mostly, the quality of work depends on the project's value. In each project, a mock-up room has been set up to serve as a model for the real project during both the construction and the inspecting procedures.

E: There is no standard for this type of work. A mock up room has been used to assess the quality of work, which all participants can use as a standard for quality measuring or assure that different parties share the same understanding.

F: There is no standard or guideline from any regulators in Thailand for internal wall construction. Each project may create and use its own specifications and work guidelines. Visual inspection is conducted by inspectors. The higher the project value, the higher standard for quality is imposed.

G: There is no standard but a mock up room is used to demonstrate the internal wall construction and quality assessment guidelines in the project.

H: There is no standard for this type of work. But the work guideline, the project schedule, the duration and quality inspection procedures are mostly same everywhere. However, the errors or the tolerances of work may vary.

The researcher can summarize the opinions of experts according to a group of experts. As shown in Table 1

Table 1 Conclusion classified by key stakeholder groups

Point of view	Owners	Consultants	Main contractors	Sub-contractors
Quality of internal wall	- Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right-angled. - There is no set quality level for internal wall construction. - The quality of work is dependent on customer satisfaction.	- Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right-angled. - The wall must be aesthetically pleasing to sight and touch. It should help to reduce defective work and easier to complete. - There is no set quality level for internal wall construction. - The quality of work is dependent on the owners and cost. - An Acceptable tolerance level is within 3 millimeters.	- Wall finishing must be smooth with no cracks or waves. The wall must be aligned, flattened, leveled, and right-angled. - There is no set quality level for internal wall construction. - The quality of work is dependent on the owners, consultants, and inspectors. - An Acceptable tolerance of work is not over 3 millimeters or less than 2 millimeters	- Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right-angled. - The quality of work is dependent on the inspectors. - An Acceptable tolerance of work is less than 3 millimeters.
Measurement of internal wall quality	- Evenness and alignment: Checked using sight and touch or a level. - Verticality of wall: Checked by sight with a plumb bob and measuring tape used to check alignment of the wall from top to bottom. - Angle: Checked by sight and examination of the completed	- Evenness and alignment: Checked using sight and touch or an aluminum plaster trowel. - Verticality of wall: Checked by sight with a plumb bob and measuring tape or level used to check alignment of the wall from top to bottom. - Angle: Checked by sight and examination of the completed tiled	- Evenness and alignment: A square aluminum tube is used. - Verticality of wall: The walls and floor must be level and in alignment. A laser level or spirit level can be used to check. -Angle: An angle bar is used to check the angle.	- Evenness and alignment: A square aluminum square tube is used. - Verticality of wall: A laser level, measuring tape, and spirit level are used. The air bubbles must remain still in the - center of two lines.

	tiled floor, baseboard, or ceiling. An angle bar can be used to check the angle.	floor, baseboard and ceiling. An angle bar can be used.		- Angle: An angle bar is used to check the wall from top to bottom.
Standards or guidelines used	- There is no standard or guideline from any regulators in Thailand for an internal wall construction.	- There is no standard or guideline from any regulators in Thailand for this type of work or if there are, they might not be complete. - Mostly, it is dependent on the experience of inspectors. Each project has its own specification and work guideline. - A mock up room could be used to demonstrate the required standard of work.	- There is no standard or guideline from any regulators in Thailand for this type of work. - Each project has its own specification and work guideline. - It is dependent on the inspector's experience. - A mock up room is used to demonstrate the required standard of work.	- There is no standard or guideline from any regulators in Thailand for this type of work. - It depends on the inspector's experience.

Table 1 shows that different groups agree that the wall finishing must be smooth with no cracks or waves, in alignment, flattened, leveled, and right-angled. Although, the parties involved demand wall work with consistent quality and attributes, the quality of the interior wall work depends on the inspectors' judgment at the end. The project could be finished after the project owners and consultants achieve their satisfaction and customer satisfaction. However, for the workers, such as contractors, the work quality depends on the discretion of the owners, consultants, and inspectors, mainly. In addition, it was found that internal wall quality inspection of project owners and consultants will use discretion, especially the eyes and hands touching primarily, while the main contractor and subcontractor will use various tools to check the quality of the interior wall. This is probably due to the fact that the main and sub-contractors are the workers as indicated by the construction contract. Thus, this emphasizes the quality inspection process. If the work quality is not same as the customers or owners' expectations, the main and sub-contractors would have to waste time and money in reworking.

The study discovered that nowadays, there is only a guideline of the quality assessment of interior walls, created by individual organization that is specified for specific projects. The guidelines exist as a case-by-case basis. A mock-up room has been set up to demonstrate the quality assessment guidelines. Moreover, it found that for internal wall quality inspections, involvers would designate the tolerance level to be within 3 millimeters. From this, there are discrepancies in accepted tolerance levels among different parties. Consultants allow errors to be within 3 millimeters, whereas main and sub-contractors prefer errors to be less than 2

millimeters or not over 3 millimeters because in practical owners and consultants may change their acceptable tolerance of work, depends on their satisfaction. For this reason, the regulations center of government construction should be developed a quality assessment in a particular for an internal wall construction to serve as a standard for guiding an evaluating the quality of work in country, which all involved stakeholders in building construction can utilize.

Discussion and Conclusion

The results show that stakeholders involved in the inspection process of internal wall work for high-rise building construction projects all agree that a good quality wall has a smooth, flat, even surface, perfectly aligned and right-angled, with no cracks and holes. Currently, the quality standards are not clear with different methods and tools used to measure work quality. The owners commented that wall work quality depends on customer satisfaction, while consultants stated that wall work quality dependent on the owner's opinion and cost. The main contractors commented that the quality of the wall work depends on the views of the owners, the consultants, and the inspectors. However, the sub-contractors stated that wall work quality is mainly dependent on the inspector's view.

When assessing the quality level of interior walls from this research, the following components are addressed:

1) Evenness and alignment: Owners and the consultants generally inspect the quality of work by using the senses of sight and texture as well as tools such as a level and aluminum plaster trowel. The group of contractors (both main and sub-contractors) mostly use tools such as an aluminum plaster trowel and a square aluminum tube.

2) Verticality of wall: Consultants should conduct a touch-screen test using pure vision or wall inspection tools such as a plumb bob, level, and measuring tape to check the surface of the walls from top to bottom. On the other hand, the main contractors and sub-contractors should use inspection tools such as laser level or spirit level. Vertical alignment of the wall and floor should be checked at the corners.

3) Angle: The consultants should examine by sight, use an angle bar at the corner, or alternatively view from the completed tiled floor, the baseboard, and ceiling. The main and sub-contractors should place the angle bar in the corner, randomly checking the top, middle, and bottom to see if it forms a right angle.

As indicated by the aforementioned data, main contractors and sub-contractors should focus on the inspection using the appropriate tools, mostly selected according to the aptitude and expertise of inspectors. This will ensure greater accuracy than when work is inspected with pure eyes. Job failures often result in non-delivery, delay, increased costs, and reduced profits. Tools can be used to reduce uncertainties since the majority of owners do not participate in the quality inspection process but hire a consultant executive to deal with the issue instead. The consultant team will randomly select points for quick visual inspection. If a mistake occurs, the contractor can immediately correct them. Moreover, this study shows that even projects have a good quality assessment guideline for an internal wall quality inspection but it was created and used differently its own specifications and work guidelines, which might not be cleared and fully detailed enough to use and acceptable by stakeholders in other high-rise building construction projects. The varieties of a quality assessment guideline may cause easily conflicts and misunderstandings between inspectors and workers during the internal wall quality inspection process. Nowadays, stakeholders use a mock-up room to illustrate the required standard for quality inspection in practice.

The results of this study support the previous research on conflict issues during the quality inspection process for construction projects, especially concerning aesthetic of works. Such conflicts are often caused by the absence of standardize guideline, created by the mutual

agreement of stakeholders during the examination process that show and indicate clearly how interior wall inspection procedures, and tolerance acceptance are (Nititerapad et al, 2019). The acceptable quality of an internal wall mainly depends on the experience and discretion of inspectors, which often differ. Therefore, in this research all stakeholders agreed that a standards of quality assessment for an internal wall should be developed by the center of regulations of government construction.

Thus, this research attempts to explore the perception of stakeholders during the process of internal wall quality inspection prior to delivery of high-rise buildings in Thailand. It is essential to understand the current conditions of internal wall quality, including problems and gaps in the inspection process for setting and offering guidelines to incorporate wall quality evaluation for high-rise buildings. In addition, a development of precision measuring instruments, which is trustable and reliable for a quality assessment might be essential for stakeholders in building construction.

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