

# Potential of Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing Projects

Siti Nur Liyana Abd Hamid<sup>1</sup>, Narimah Kasim<sup>1,2\*</sup>, Rozlin Zainal<sup>1,2</sup>, Sharifah Meryam Shareh Musa<sup>1,2</sup>

<sup>1</sup> Department of Construction Management, Faculty of Technology Management and Business (FPTP), University Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, 86400, MALAYSIA

<sup>2</sup> Centre of Project, Property & Facilities Management Services, Faculty of Technology Management and Business (FPTP), University Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, 86400, MALAYSIA

\*Corresponding Author: [narimah@uthm.edu.my](mailto:narimah@uthm.edu.my)

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## Abstract

Affordable housing is one of the needs of people nowadays. Particularly in big cities, the housing market has seen a rise in property prices. The purpose of the study is to seek the potential of solid wall panel implementation for enhancing construction practices in affordable housing projects. Therefore, the objectives of the study are to investigate the potential, effectiveness, and improvement suggestions for solid wall panel implementation in affordable housing projects. To achieve the objectives, this research was conducted using qualitative methods for primary data collection and literature review by gathering information from books, journals, and proceedings, as secondary data. In addition, semi-structured interviews were conducted with G5 and G7 contractors, manufacturers, and developers of solid wall panels and the focus spots were in Selangor, Johor, Kuala Lumpur, and Melaka which are IBS expertise. Furthermore, the data was analysed using content analysis to provide data information related to the project. The significant findings from this study provide the potential of solid wall panel implementation, as key criteria to investigate, analyse and develop solutions, also propose and improve the implementation. In conclusion, this research contributes to a better understanding of the potential of solid wall panels as they can be implemented in construction practices in affordable housing.

## 1. Introduction

This section provides an overall context of the chapter. In addition, this chapter presents the overview of the introduction of the research, research background, problem statement, research objectives, scope of the research, research methodology, significance of the research, expected findings, and thesis outline. Lastly, the summary of the chapter is included in this chapter.

### 1.1 Research Background

Affordable housing is characterized as being of a sufficient standard of quality and location while not being prohibitively expensive for its residents to meet other essential needs. Having less interest in developing medium and low-cost dwellings in metropolitan areas might potentially cause housing issues. This is due to the

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low margin or profit realized (Bujang *et al.*, 2020). In other words, a home's location, quality, and construction are just as crucial as its affordability from a financial standpoint (Ling *et al.*, 2017). Most of the property in large cities and towns is owned by private home developers who are interested in developing expensive or luxurious housing to increase their profit margin. The immigrants discovered that the cost of the homes available in the city was out of their budget range. According to Revizto (2021), many lacks in construction practices exist in the construction industry. One of the lacks is in the construction industry's lack of skilled workforce.

The problem is essentially global in nature, and the need keeps steadily rising. It is conceivable for genuine building companies to try and lessen the effects of this issue for themselves, even though certain initiatives are made to address it on that level. The solid wall panel is one of the Industrialised Building System (IBS) types in construction modern work. Solid wall panel simply means that there is no inherent insulation and that the walls are built of solid concrete. The term "construction practice" refers to good engineering practices as well as other practices, methods, equipment, and procedures that construction contractors typically use in engineering, design, construction, completion, and commissioning. It also refers to the level of skill, diligence, caution, and foresight that one could reasonably expect to be observed by a skilled and experienced contractor carrying out activities like or identical to the IP Works under the same or similar center.

## 1.2 Problem Statement

By its very nature, the construction practices in affordable housing have several issues and needs. Construction waste is another problem that frequently arises in construction projects. The construction practices must be in a good flow to enhance the work in this field. In construction projects, waste is a severe issue that directly affects productivity, material loss, and project completion time. Construction waste output increased due to the need for housing and major infrastructure projects, which had an unfortunate impact on illegal dumping (Aziz *et al.*, 2012). According to The Contractor (2022), groundwater recharging is blocked by the pollution of water supplies by closed-off and not renewable construction materials. The natural cycle of water is significantly changing because of the pollution and loss of water resources.

Solid wall panels issue that needs to be taken into consideration is the leakage problem on solid wall panels. Defects may result from poor installation or flawed design. Water leaking at flaws can have several worse impacts on the building fabric that could lead to the joint waterproofing or other elements of the envelope failing sooner than expected. For cracks in the wall panel, serious problems always existed. Despite wall cracks are ugly, they can also be a sign that a house is experiencing major structural issues. Therefore, this study seeks to investigate the potential, effectiveness, and improvement steps of the solid wall panel implementation for enhancing construction practices in the affordable housing project.

This research will give more details on the benefit of solid wall panel implementation for affordable housing among developers and contractors in the construction industry. Contractors, suppliers, and developers in the construction sector should raise standards of work overall while lowering the use of unskilled labour and foreign labour. Additionally, this study can serve as a guide for future work handling the implementation of solid wall panels for inexpensive housing. This research will give construction parties a clear grasp of how to use solid wall panels to retrain and upskill the current skilled personnel to produce larger profits. To avoid structural damage that could happen during use or as the building matures, good construction practices and techniques should be used. This study also needs to suggest strategies and steps for improving the solid wall panel in affordable housing projects.

## 2. Literature Review

This section aims to achieve specific topics from various data sources that are related to this research. This chapter discusses the potential of solid wall panels for affordable housing. Furthermore, this topic will discuss the effectiveness of solid wall panels for affordable housing. Then, this research also focuses on strategies for improving solid wall implementation in affordable housing projects.

### 2.1 Affordable Housing Project

#### 2.1.1 Issues in Affordable Housing

The most reliable measure of life satisfaction has been identified as being related to services and infrastructures (Gan *et al.*, 2016). Communities should have access to essential housing support infrastructures such as sanitary and drainage systems, lighting systems, waste collection and recycling facilities, and firefighting facilities. Additionally, stated as essential components of proper housing are the quantity and placement of lifts as well as the state of the road systems. Affordable housing also has issues in many aspects. Lack of funding for Research

and Development (R&D) is probably to blame for its failure, which calls for an investment with a potentially lengthy development period (Daud *et al.*, 2022). Private businesses stress producing money now rather than later since they are profit-oriented and concerned with their interests. Additionally, developers are doubtful of the potential of modern construction methods.

### 2.1.2 Importance of Affordable Housing

Affordable housing improves physical and mental health by lowering stress, pollutants, and infectious diseases. Living in excellent, cheap housing also means less stress since worries about foreclosure and eviction are reduced this, in turn, results in fewer physical and mental health issues as well as decreased absences from work. It certainly satisfies a fundamental human need for shelter, but it also advances the welfare of the community. Naturally, access to affordable housing benefits people of all ages, including the young. It offers a variety of health advantages that may not be immediately apparent. Spending less on accommodation allows you better access to food, and healthcare including mental health, experiences, and other things.

### 2.1.3 Overview Implementation of Construction Process

The best practices in the building are those that are expected to be followed by the industry and that will provide an ideal result and profit. These procedures, policies, or entire systems can be implemented over a specific period. The methods that work well for one project won't be very useful for another. However, there are several standard procedures that, when carried out flawlessly, will benefit every building job. Over the past decade, new technologies have emerged, and the methods for project procurement and management have also changed.

## 2.2 Solid Wall Panel

### 2.2.1 Definition of Solid Wall Panel

The wall panel is a single piece of material, typically flat and cut into a rectangular shape, that serves as the visible and exposed covering for a wall (Li *et al.*, 2021). Wall panels are functional as well as decorative, providing insulation and soundproofing, combined with uniformity of appearance, along with some degree of durability or ease of replaceability. Precast solid wall panels are a more affordable alternative to on-site concrete pouring. These can be utilized on any kind of construction, from residential to commercial, institutional to industrial, and can be panelized and erected either horizontally or vertically.

Wall panels can be made to support floor and roof loads as well as lateral loads, or they can be made to support loads only (Cruz, 2019). Every thickness that is statically required can be produced. Smooth surfaces can be found on one side or the entire surface of solid walls. To save additional post-processing on the construction site, the second side of solid wall pieces that are smooth on one side are manually or mechanically struck off and smoothed. Fig. 1 shows an example of a solid wall panel used in the site.



**Fig.1** Example of solid wall panel produce by Upwards Vision Sdn. Bhd.

### 2.2.2 Advantages of Solid Wall Panel

Installing solid wall panels does not require many workers and labours (Vijay *et al.*, 2021). To install the panels, just need to simply lift them to an upright position and cement them together to the floor and the ceiling. Everything is factory manufactured, brought to the location on pallets ready to install, and hand-constructed on concrete floors. Highly adaptable and quick to build only two ordinary construction personnel are needed for installation the installation of wall panels is up to six times faster than the use of traditional construction methods, such as brickwork or laying block walls. The ease of maintaining wall panels is a significant and useful

benefit. Nothing complicated is required to preserve wall panels, all you need is a moist towel. They are considerably simpler to maintain than painted walls. Finding practical alternatives for traditional building materials is crucial in the construction sector due to environmental limitations, strong demand, and the high transportation costs of these raw resources (Bandgar and Kumthekar, 2016).

### 2.2.3 Disadvantages of Solid Wall Panel

Solid wall panels also have various disadvantages in managing and installing work. Although using sustainable materials in homes is gradually becoming more common, the majority of the wall panelling's components are not yet sustainable (Bui *et al.*, 2021). Despite significant advancements in our understanding of polymers, wood, and plastic, the production process is sadly not entirely environmentally friendly. Working with recycled materials or seeking for ones that have the seal of approval about their sustainability.

Next, the other disadvantages are sensitive connection works. One of the important components to guaranteeing strong structural behaviour is assembling the precast parts (Jeewantha, 2019). To guarantee that connections between several structural parts behave as planned, such as simple, semi-rigid, or stiff connections, they must be appropriately overseen and installed. Additionally, precast concrete with poor connections runs the risk of developing leaks and losing its ability to insulate against noise.

The precast concrete facility may be some distance away from the construction site. In that instance, trailers must be used to transport the precast members to the construction site. Precast concrete's lower costs are frequently made up by higher shipping costs. This is because transportation issues are one of the issues and disadvantages of solid wall panel delivery. Transporting even larger components on sometimes requires managing oversized transport (Horinkova, 2021). The modules might, however, be produced in increasingly bigger sizes, making transit even more challenging. The conclusion is that the dimensions of the modules are constrained by their transportability.

## 2.3 Potential of Solid Wall Panel

### 2.3.1 Faster Installation Work

The time or length that needs to be cut down by activity overlapping or the use of current engineering methodologies is directly tied to fast-track projects. The creation of acceptable designs and the choice of the proper techniques and materials will enable construction to proceed more quickly (Kassim *et al.*, 2005). The solid wall panel gives more chances in housing projects. Solid wall panel installation work is quicker construction will benefit contractors by saving time and money on labour (Saikah *et al.*, 2020). The opportunity for developers to obtain discounted housing prices from the developer will increase with the lowering of labour cost, which is the second-largest building cost. Therefore, the faster installation work of solid wall panels can give more advantages in installing the panels and saving the time completion. Customers that employ this method may benefit from the ability to purchase homes for less money. The opportunity for developers to negotiate lower house prices from the developer will increase with the lowering of labour costs, which are the second-largest building expense. As a result, this tactic may enable clients to purchase the home for a reduced cost.

### 2.3.2 Physical Appearance

Typically, a person will purchase a thing based on its outward appearance. When choosing a home, customers will be interested in physical contact, appearance, size, and pricing. The development of visually appealing, contemporary homes will pay close attention to the needs of the potential customers (Saikah *et al.*, 2020). The capability and competence of the manufacturer or supplier, the building's occupants' perceptions of the building's team or clients, the preference for industrial capacity, and the choice of the building's colour and texture all contribute to client satisfaction. The wall panel's numerous designs and colours provide customers with more options.

Customers frequently complained to developers about cracking issues with the walls and roofs. These contribute to the problem of leaks and detract from the aesthetic appeal of the home. Additionally, there have been developments in IBS precast construction that have worried IBS manufacturers about market reputation, commercial potential, technology, and production quality. This issue has been given a bad review of the solid wall panel installation method. Leaks in the walls can cause other issues, such as humidity and rust, which can give the property a horrible physical aspect. As a result, several nations have developed beautiful wall metal panels and extrusion trim configured in clip type into a variety of connectors (Mydin *et al.*, 2014).

### 2.3.3 Faster Installation Time

The construction sector has a reputation for being labour-intensive, hazardous, and polluting. The construction operations mainly rely on in-situ construction techniques that involve formworks and a significant quantity of wet trades (Bari *et al.*, 2012). Workers who are competent and semi-skilled are crucial to the output quality. The biggest number of accident fatalities and injuries occur in this sector. Additionally, construction activities are intrinsically bad for the environment since they produce environmental annoyances including noise, dust, muddy runoffs, and large amounts of waste. To shorten construction times and lessen the industry's reliance on foreign manpower, IBS adoption is heavily encouraged in Malaysia. Solid wall construction projects can shorten the duration of the construction phase, which can assist save time (Mydin *et al.*, 2014). This is because prefabricated component constructions are concurrent constructions, meaning they can continue even when foundations at construction sites are surveyed or when earthwork is being done. After that, solid wall panel installations will only be conducted in the locations.

The time it required to assemble and erect the precast panels on site was significantly less. Each construction unit's installation cycle takes an average based on how many panels may be delivered to the site on any given day (Abdullah *et al.*, 2012). To avoid unnecessary storage, the panels were quickly attached after arrival. The entire job was finished in less time overall than with the traditional approach. This resulted from the removal of formwork, manufacture, and installation of reinforcement bars, pouring of concrete, and deconstruction of formwork. Table 1 shows the summary of previous studies and discusses the potential of solid wall panel implementation in affordable housing projects.

**Table 1** Potential of solid wall panel implementation for enhancing construction practices in affordable housing project

No	Potential of Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing Projects	Author
1.	Faster Installation Work	<ul style="list-style-type: none"> <li>• Kasim <i>et al.</i> (2005)</li> <li>• Saikah <i>et al.</i> (2020)</li> <li>• Haponava (2010)</li> <li>• Noor <i>et al.</i> (2022)</li> <li>• Kadir <i>et al.</i> (2015)</li> </ul>
2.	Physical Appearance	<ul style="list-style-type: none"> <li>• Saikah <i>et al.</i> (2020)</li> <li>• Mydin <i>et al.</i> (2014)</li> </ul>
3.	Faster Completion Time	<ul style="list-style-type: none"> <li>• Bari <i>et al.</i> (2012)</li> <li>• Mydin <i>et al.</i> (2014)</li> <li>• Abdullah <i>et al.</i> (2012)</li> </ul>

## 2.4 Effectiveness of Solid Wall Panel in Affordable Housing

### 2.4.1 Reduce Maintenance Work on Affordable Housing

Buildings for houses are constantly exposed to all types of weather, including hot and cold climates. Houses become outdated, inappropriate, difficult to use, and expensive to maintain because of changes in cold and hot weather climates (Saikah *et al.*, 2020). They may also no longer meet needs and regulations and go out of style. Solid wall panel surface is exposed to the sun and rain. It leads to many hazards and needs regular maintenance because of mold growth due to cold conditions. Because many individuals choose to preserve their homes each year to live comfortably, doing so costs a lot of money. However, by picking home renovation goods that are simple to keep, maintenance expenses can be reduced.

The use of wall panels has been widespread, and their presence is evident in many aspects of daily life. Wall panels are useful and are a favourite among many. By cutting back on unnecessary costs and home maintenance before selling the house, the performance of a solid wall panel system can be optimised within an affordable housing project. Developers frequently discovered that contractors delayed submitting the finished house because of additional costs, especially when using the traditional approach.



## 2.4.2 Energy Efficiency

Any government of a developed nation always has reducing energy usage and carbon dioxide (CO<sub>2</sub>) as one of its top priorities. It is the responsibility of researchers, construction key players, and professionals to engage in this agenda (Ali *et al.*, 2019). The primary focus of this study is energy conservation to improve energy efficiency (EE), which is defined by the Green Building Index (GBI), a measure for green building ratings. The final wall panels' exceptional quality ensures that the building enclosures will function well and be energy efficient. Commercial structures developed with passive house techniques have employed wall panels successfully. Lower energy costs are the main advantage of efforts to make buildings more energy efficient, but there are typically additional advantages as well. Energy-saving solutions are intended to reduce energy consumption while preserving or raising the standard of the building's services. Precast concrete products are and will be more energy efficient than their counterparts in the vastly energy-consuming construction industry (Gupta *et al.*, 2018). Customers choose these items because of the wide variety of patterns, colours, and structural possibilities they offer.

## 2.4.3 Cleaner and Safer Construction Site

Construction sites are cleaner and better managed (Mydin *et al.*, 2014). The component usage can save on wet work at construction sites. Waste of time and resources on transitory projects like wood. This encourages building sites to be more orderly, lowers associated hazards for health and wellbeing, and promotes a safer working environment. Since fewer formworks are utilised on sites and are consequently less dangerous to employees, solid wall panels can deliver building sites that are cleaner, neater, and safer (Wong and Lau, 2015). Due to fewer site materials and construction activity, this indirectly results in better and more organised site administration. Walls, floors, beams, and staircases are among the construction elements frequently employed in IBS projects. The IBS building process not only gives customers high-quality outcomes but can also prevent resource waste (Mydin *et al.*, 2014). This kind of construction involves an industrial procedure in which building components are created, delivered to the job site, and then constructed as planned. Table 2 shows the summary of the effectiveness of solid wall panel implementation discussed by previous studies.

**Table 2** Effectiveness of solid wall panel implementation for enhancing construction practices in affordable housing

No	Effectiveness of Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing	Author
1.	Reduce Maintenance Work	<ul style="list-style-type: none"> <li>• Saikah <i>et al.</i> (2020)</li> <li>• Yusof (2013)</li> </ul>
2.	Energy Efficiency	<ul style="list-style-type: none"> <li>• Shamsudin <i>et al.</i> (2013)</li> <li>• Ali <i>et al.</i> (2019)</li> <li>• Gupta <i>et al.</i> (2018)</li> <li>• Ibrahim <i>et al.</i> (2022)</li> <li>• Hafiz <i>et al.</i> (2023)</li> </ul>
3.	Cleaner and Safer in Construction Site	<ul style="list-style-type: none"> <li>• Mydin <i>et al.</i> (2014)</li> <li>• Wong and Lau (2015)</li> <li>• Mydin <i>et al.</i> (2014)</li> <li>• Taib <i>et al.</i> (2014)</li> </ul>

## 2.5 Strategies for Improving Solid Wall Panel Implementation

### 2.5.1 Construction Waste Management

Construction wastes have increased because of insufficient waste management techniques used in construction projects. The construction industry is the most dynamic and difficult business sector, according to Bal *et al.* (2013), nevertheless, the sector is a significant source of waste. Construction wastes are linked to major environmental difficulties such as harming the habitat and ecology, causing pollution, and generating waste in addition to contributing to waste, as was previously noted. The main cause is the substantial amount of concrete trash that causes problems with landfilling. Additionally, we found that most Malaysian construction industry participants are aware of the problems with managing construction and demolition materials. In outcome, it is widely known that the building business generates a significant quantity of trash and is associated with environmental problems. The Malaysian government has promoted the 3R concepts initiative to the building

industry. Reduce, recycle, and reuse, or the 3R idea has been widely accepted as a guide for managing construction and demolition waste.

### 2.5.2 Adding More Aesthetical Value on Solid Wall Panel

Solid wall panels are one of the materials that need to be improved. The diversity of items has recently increased because of manufacturers incorporating new design aesthetics of various forms and finishes (Rahim *et al.*, 2012). With panels that are swiftly installed at the site, year-round construction is achievable giving you the chance to quickly enclose a building and accelerate construction. However, there is still a disconnect between the manufacturing and construction industries because most structures are still made with the old-fashioned method. The insulation and soundproofing that wall panels offer, along with the consistency of look, some degree of longevity, and ease of replacement, make them practical as well as aesthetic. According to Bostik (2018), the advantages of an exterior system are also perfect for retrofitting the exteriors of already-built structures as well as for smaller or more aesthetic projects that can enhance an existing structure or design. The overall appearance of any building can be drastically altered by using panels in a wide variety of sizes and materials that can duplicate or complement the appearance of different building types.

### 2.5.3 Using Breathable Insulation Materials

Large composite pieces that are like the panel that was displayed are currently being produced on an industrial basis. It is reasonable to assume that an enclosure structure with integrated thermal insulation and ornamentation will provide the project with several benefits in terms of eco-friendly features and building energy efficiency (Shi *et al.*, 2019). Internal wall insulation can be placed on its own or with other energy-saving measures as part of a package. It is essential to use efficient systems and renewable energy sources while also increasing the energy efficiency of buildings through insulating measures (Price *et al.*, 2021). The largest exposed surface in a structure is frequently its walls. Therefore, increasing their insulation level might significantly affect a building's refit. Internal wall insulation (IWI) is a different option that is available to boost wall insulation levels in existing buildings, even if external wall insulation is preferred for the preservation of the building fabric and decreased moisture concerns. IWI provides flexibility and fewer installation restrictions, but it can also create technical concerns that need to be controlled. If recommendations are not considered, there may be a significant danger of intermittent condensation and mould growth. Table 3 highlights the strategies for improving solid wall panel implementation by previous studies.

**Table 3** Strategies for improving solid wall panel implementation for enhancing construction practices in affordable housing projects

No	Strategies for Improving Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing Projects	Author
1.	Construction Waste Management	<ul style="list-style-type: none"> <li>• Bal <i>et al.</i> (2013)</li> <li>• Wong and Roslan (2019)</li> </ul>
2.	Adding More Aesthetical Value	<ul style="list-style-type: none"> <li>• Rahim <i>et al.</i> (2012)</li> <li>• Bostik (2018)</li> </ul>
3.	Using Breathable Insulation Materials	<ul style="list-style-type: none"> <li>• Shi <i>et al.</i> (2019)</li> <li>• Price <i>et al.</i> (2021)</li> </ul>

## 3. Research Methodology

This section explains and describes the methods that have been used in this study. The method used must ensure that the purpose and scope of this research can be achieved. Methodology plays an important role in this research, and this chapter discussed data collection methods. This chapter reviewed the study on the Potential Solid Wall Panel Implementation for Enhancing Construction Practices in the Affordable Housing Project. This chapter introduces the research design, research process, research population and sampling data collection methods, and data analysis methods for accomplishing research objectives.

### 3.1 Research Design

First off, a qualitative research approach results in a lengthy description of participants' thoughts, feelings, and experiences as well as an interpretation of the motivations behind their behaviour (Rahman, 2016). Qualitative research techniques are becoming more and more common, notably in the fields of public health and international development. Structured, semi-structured, and unstructured research interviews are the three main categories. In essence, structured interviews are verbally given questionnaires that ask a set of prepared questions with little to no variation and no room for follow-up inquiries in response to answers that call for more in-depth discussion (Gill *et al.*, 2008). To achieve the objectives of this research, secondary data will be obtained by analysing using the source of the data such as books, online journals, articles, and any related to the study on the implementation of solid wall panels in affordable housing. Table 4 below shows the research design that will be adopted throughout the research process.

**Table 4** Research design method

No.	Research Objectives	Method
1.	To investigate the potential of solid wall panel implementation for affordable housing projects.	<ul style="list-style-type: none"> <li>Literature Review</li> </ul>
2.	To analyse the effectiveness of solid wall panel implementation for the affordable housing project.	<ul style="list-style-type: none"> <li>Qualitative (Semi-structured Interview)</li> </ul>
3.	To suggest the improvement steps of the solid wall panel housing project.	

The structure of a qualitative research design which is an interactive approach is flexible since it can be built and rebuilt to a larger extent. Thus, using qualitative research methodologies can result in detailed and appropriate evaluations of a problem, giving participants enough choice to choose what is consistent for them. As a result, it is simple to comprehend difficult situations.

### 3.2 Data Collection

Data collection is accurate data is gathered and analysed from a variety of sources to solve research problems, identify patterns and probabilities, and assess potential consequences. According to SimpliLearn (2023) the act of obtaining, measuring, and analysing precise data from a range of pertinent sources to address issues in research, provide answers to queries, assess results, and predict future trends and probability is known as data collection. To assure quality assurance, keep research integrity, and make educated business decisions, accurate data collecting is required. The researchers must specify the data sources, data types, and methodologies used during data gathering.

### 3.3 Data Analysis

For this study, qualitative content analysis was used as this is an excellent qualitative sampling approach. Data analysis is the process of giving a huge quantity of gathered data organisation, order, and significance (Raheja *et al.*, 2017). Only once all necessary data has been gathered is the process of data analysis started. After that, it becomes vital to saturate the data with errors and remove any undesirable information that may be there. It is best to gather data in its unprocessed, detailed form before noting patterns. In addition, there are many benefits of data analysis collection data which are to organise the cluttered data that is now available in a manner that helps the decision-making process and is simple to understand, more readable, and decisive. Asking the right questions helps a researcher identify the primary goal that the analysis should focus on (Bhatia, 2017). The substance of the texts, the author, the target audience, and even the culture and period in which the work was written can all be inferred by researchers.

### 3.4 Pilot Study

To overcome the interview questions, a pilot test was conducted to find out the problems in the interview questions including the weak questions, incomplete instructions, understandable questions, and the questions that could not be answered by the respondents. A pilot study also can be defined as a tool to measure the relevance of a question's instrument. Otherwise, this pilot study was also the last phase of reviewing the



questions before data collection began. The respondents involved in the pilot test were four (4) respondents and there were three (3) lecturers and a G7 contractor. After the interview questions were collected from the pilot study, corrections were made as shown in Table 5. A pilot study was conducted to ensure that the real respondents understand the interview respondents understood the questions and make it easier to answer the questions.

**Table 5** *The improvement from the pilot study*

No.	The Fault	The Improvement
1.	The general questions about the knowledge of solid wall panel are not clear. (Section B)	Filter the questions and make it clear and simple and easy to understand the questions. (Section B)
2.	The questions are not clear because the respondents do not understand the questions. (Section C)	Rephrase the questions and make the questions clear. (Section C)
3.	Lack of explanation on questions. (Section D)	Add the phrase on the questions that are not clear. (Section D)
4.	Grammatical error.	A grammatical error has been corrected.

#### 4. Result and Discussion

The method used to collect the data is qualitative method was used to conduct the interview session with the selected respondent and that was G5 and G7 contractors and manufacturers. Data for this study was gathered using both in-person and virtual interviews, which also included communication via Google Meet, WhatsApp, mobile phones, and any other tool that helped with the hybrid technique of data collecting. One piece of software that was utilised to transcribe the data was Microsoft Word. The interview was held in October 2023 until the middle of December 2023. It was held the same as collecting data analysis to prevent inserting wrong information. The interview questions were answered by the respondents represented as data collections and analysed by using the content analysis method using Microsoft Word. The respondents for this study are G5 and G7 contractors and manufacturers that expertise in handling IBS. These interviews were conducted face-to-face with the selected respondents. The six respondents were participants in this research through the study methodology that was used and carried out, and they represented the construction companies.

##### 4.1 Respondent’s Background

Respondents are very important for this qualitative method approach because it will ensure that all data gathered from the respondents are accurate and genuine. Also, it allows the respondents’ background including the company’s name, company type, CIDB class registration, the position of the respondents, years of experience, and scope of work in the construction field which contributed to determining the respondent’s contribution. Table 6 below summarises the details of the respondents in the construction industry. According to the analysis, the respondents have adequate experience and knowledge to engage in this study. Some of the respondents (R1, R2, and R3) know the solid wall panel from the previous project (refer to Table 6). They just know about the characteristics and the installation method of the solid wall panel because they are contractors. The other respondents (R4, R5, and R6) produce the solid wall panels as manufacturers and suppliers. So, they know more about the solid wall panel in terms of materials used, characteristics, production methods, and the quality of the products. They also held the testing about the solid wall panel in the factory or off-site.

**Table 6** *Respondents’ background*

Respondents (R)	Organisations	Grade	Positions	Years of Experience	Scope of Work
R1	Company A	G5	Managing Director	15 years	<ul style="list-style-type: none"> <li>• Managing the Project</li> <li>• Involved Directly in the Project</li> <li>• Industrial Project Advisor</li> </ul>
R2	Company B	G7	Project Manager	7 years	<ul style="list-style-type: none"> <li>• Planning and Scheduling</li> <li>• Implement Project</li> <li>• Managing Site</li> <li>• Managing the Site</li> </ul>

R3	Company C	G7	Site Engineer	10 years	<ul style="list-style-type: none"> <li>• Manage the Workflow</li> <li>• Controlling Project Cost</li> </ul>
R4	Company D	G7	Senior Manager	12 years	<ul style="list-style-type: none"> <li>• Manage Order</li> <li>• Manage Product</li> <li>• Manage Cost</li> <li>• Manage the Operation</li> </ul>
R5	Company E	G7	Executive Director	8 years	<ul style="list-style-type: none"> <li>• Responsible for Contract Related Work</li> <li>• Involve in Procurement Work</li> </ul>
R6	Company F	G7	Operation Manager	7 years	<ul style="list-style-type: none"> <li>• Manage the Operation</li> <li>• Manage the Product Quality</li> </ul>

#### 4.2 Introduction to Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing Project

To achieve the objective, it is important to find out and assess whether the responders have knowledge and experiences crucial to achieving the goal of potential solid wall panel implementation for enhancing construction practices, for them to comprehend and grasp the questions, as well as how the respondents' data responds to the questions. The purpose of this is to confirm and validate that the participants possess an understanding and viewpoints regarding the concept of hybrid project management. During the interview, a few questions on their backgrounds in the knowledge of solid wall panel potential and implementation in affordable housing projects. All the respondents provided information and completed the questions, showing that all of them were using hybrid project management in the building sector. Based on their experience and expertise, most of the respondents knew the solid wall panel information and characteristics. Respondents R1, R2, and R3 responded to the introduction in the same way. This proves that the respondents knew about the solid wall panel through the project they were involved in. The respondents R4, R5, and R6 know about the panel in more detail because they produce, and the solid wall panel is the main product of their company. Because of that, they can explain the solid wall panel more than the respondents from the contractor side. The introduction of solid wall panel implementation for enhancing construction practices in affordable housing projects, all respondents (R1, R2, R3, R4, R5, and R6) agree that the solid wall panels are lightweight and not easy to crack and can make installation work easier. Based on the answers from all the respondents, a summary of the results and analysis have been collected and analysed. Table 7 shows the summary of the introduction of the solid wall panel.

**Table 7** Introduction of solid wall panel implementation for enhancing construction practices in the affordable housing project

Statement	R1	R2	R3	R4	R5	R6
<ul style="list-style-type: none"> <li>• From previous project</li> </ul>	✓	✓	✓			
<ul style="list-style-type: none"> <li>• Produce the panel</li> </ul>				✓	✓	✓
<ul style="list-style-type: none"> <li>• Can make the work easier</li> </ul>	✓	✓	✓	✓	✓	✓
<ul style="list-style-type: none"> <li>• Lightweight and not easy to crack</li> </ul>	✓	✓	✓	✓	✓	✓

### 4.3 Potentials of Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing Project

The potentials of solid wall panel implementation for enhancing construction practices in the affordable housing project section were answered well by the respondents where the four factors included have been discussed as faster installation work, physical appearance, faster completion time, and reduced labour. The solid wall panel’s surface is very important for the potential to attract user attention to purchase as a main wall on their building. A smooth surface is the main reason for the choice of the panel. Other than that, another physical appearance also needs to be considered in the selection of materials such as cracks and leaks. Also, this can improve the engagement of solid wall panel purchases and can increase the potential for physical appearance in the construction industry.

*“Solid wall panel is one of the IBS features that faster installation work that makes work done in a shortened time. The panel installation is quicker because it is installed by the panel, not by the brick, normal or unskilled workers will be slow in handling the installation work. Other than that, the solid wall panel is easy and faster to install compared to laying brickwork.” (R1, R2, R3, R4, R5, and R6)*

To get the best implementation of the installation of solid wall panels in enhancing construction practices, the installation time needs to be faster than the conventional method. The solid panel itself has advantages in installation time. It can make the installation time faster and quicker than laying the brick wall. Table 8 shows the summary of the respondents given on the potential of solid wall panel implementation for enhancing construction practices in affordable housing projects. The faster installation work, faster completion time, and reduced labour in potentials of solid wall panel implementation were the most agreed upon by all the respondents. Because the potential of a solid wall panel that the respondent always gives attention to is always about time and labour. The solid wall panel as per observation by the respondent can reduce labour and can make the work faster than laying brickwork. But, as the physical appearance only R1, R3, R4, and R6 agreed about the potential of solid wall panels. Because physical appearance does not much affect the potential of solid wall panels.

**Table 8** Potentials of solid wall panel implementation for enhancing construction practices in the affordable housing project

Statement	R1	R2	R3	R4	R5	R6
• Faster Installation Work	✓	✓	✓	✓	✓	✓
• Physical Appearance	✓		✓	✓		✓
• Faster Completion Time	✓	✓	✓	✓	✓	✓
• Reduce Labour	✓	✓	✓	✓	✓	✓

### 4.4 Effectiveness of Solid Wall Panel Implementation for Enhancing Construction Practices in Affordable Housing Project

The effectiveness of solid wall panel implementation for enhancing construction practices in the affordable housing project section was answered well by the respondents. It has included the five factors that have been discussed including reduced maintenance work on affordable housing, energy efficiency, sustainable construction, cleaner and safer construction sites, and environmental sustainability. As per data shown in Table 9, the effectiveness of solid wall panels for enhancing construction practices in affordable housing projects, all respondents agree with the factors of reduced maintenance work, energy efficiency, sustainable construction, cleaner and safer site, and environmental sustainability.

*“The solid wall can absorb energy because the characteristics itself can absorb heat. It is also can minimize water leaks and improve the insulation that can reduce environmental impact. Wall panels contribute to enhanced energy efficiency, resulting in a smaller carbon footprint.” (R1, R2, R3, R4, R5 and R6)*

*“By using sustainable building materials, we can reduce the waste produced during construction, just a little dust in cutting the panel, as well as the building’s energy and carbon footprint. It can also result in stronger and low-maintenance structures and better indoor air quality. Utilising recycled materials in solid wall panels contributes to resource conservation and waste reduction, both of which improve environmental sustainability and can save the environment.” (R1, R2, R5 and R6)*

The effectiveness of a solid wall panel can affect the quality of installation work. All the respondents also agreed that solid wall panels can affect environmental sustainability and cleaner and safer sites because they do not need to use any cement and water that can make the work dirty and contaminate the environment. Also, the solid wall panel can contribute to energy efficiency such as absorbing heat and sound waves.

**Table 9** Effectiveness of solid wall panel for enhancing construction practices in the affordable housing project

Statement	R1	R2	R3	R4	R5	R6
• Reduce Maintenance Work	✓	✓	✓	✓	✓	✓
• Energy Efficiency	✓	✓	✓	✓	✓	✓
• Sustainable Construction	✓	✓	✓	✓	✓	✓
• Cleaner and Safer Site	✓	✓	✓	✓	✓	✓
• Environmental Sustainability	✓	✓	✓	✓	✓	✓

#### 4.4 Strategies for Improving Solid Wall Panel Implementation for Enhancing Construction Practices in The Affordable Housing Project

The strategies of improving solid wall panel implementation for enhancing construction practices in the affordable housing project section also were answered well by the respondents where it has included the five factors that have been discussed such as construction waste management, rain penetration control system, adding more aesthetical value, improving weatherproofing and sound resistance and using breathable materials. As per data shown in Table 10, the effectiveness of solid wall panels for enhancing construction practices in affordable housing projects, all respondents agree with the factors of reduced maintenance work, energy efficiency, sustainable construction, cleaner and safer site, and environmental sustainability.

*“As it shows, the traditional method of construction produces more construction waste on-site because the traditional method uses cement to lay brick, compared to the solid wall panel method which just uses panel and glue and is less messy. The brick wall method uses a lot of cement mixture that becomes waste.” (R1, R3, R4, R5 and R6)*

*“Insulating solid walls can significantly lower heat loss and raise a building’s energy efficiency. This can offer several advantages when used in conjunction with other energy-saving techniques. Enhanced relaxation and warmth. Exterior wall claddings protect the property from exterior elements such as rain and chemical pollution”.* (R4, R5 and R6)

The effectiveness of solid wall panels can affect the quality of installation work. All the respondents also agreed that solid wall panels can affect environmental sustainability and cleaner and safer sites because they do not need to use any cement and water that can make the work dirty and contaminate the environment. Also, the solid wall panel can contribute to energy efficiency such as absorbing heat and sound waves. However, only one respondent (R3) did not agree with adding more aesthetical value as the strategies for improving the solid wall panel implementation for enhancing construction practices. Because appearance is not very important for the strategies but also can be added in improvement and strategies to the manufacturers

**Table 10** Statement accepted by the respondents on the strategies for improving solid wall panel implementation for enhancing construction practices in the affordable housing project

Statement	R1	R2	R3	R4	R5	R6
• Construction Waste Management	✓	✓	✓	✓	✓	✓
• Rain Penetration Control System	✓	✓	✓	✓	✓	✓
• Adding More Aesthetical Value	✓	✓		✓	✓	✓
• Improving Weatherproofing and Sound Resistance	✓	✓	✓	✓	✓	✓
• Using Breathable Insulation Materials	✓	✓	✓	✓	✓	✓

## 5. Conclusion

One of the sectors that is continually growing is the construction business since demand for technology in this sector is high and it is constantly developing. Almost yearly, several buildings and constructions experience different problems brought on by on-site waste management. To provide manufacturers and contractors with a method and exposure to solid wall panel application on affordable housing projects in the construction sector, this research was done. A discovery in affordable housing projects is the solid wall panel project, which can assist manufacturers and contractors in implementing innovative combination methods. Participants in G5 and G7 contractors and manufacturers in construction projects registered and approved by Malaysia's Construction Industry Development Board (CIDB) are among the respondents in this study. Six respondents were contacted and approached by different companies to conduct the interview sessions. The researcher analysed the data provided by the respondents using Microsoft Word. Apart from that, the qualitative approach was employed to meet the researcher's objectives since, according to the data needed, the respondents provided comprehensive answers to all the questions on the use of solid wall panels to improve construction techniques in affordable housing projects.

Every research study that was conducted has shortcomings. Research limits are defects or constraints in the study that are not within the researcher's control. When conducting research, researchers need to be aware of and aware of the gaps in the field's knowledge. Writing about the limitations of the research that was done for this study will also be helpful for future research. In summary, this study's goals were to study the current practices of solid wall panel implementation in affordable housing projects, identify the potential for solid wall implementation, assess the effectiveness of solid wall panel implementation, and identify strategies for improving solid wall panel implementation for improving construction practices in affordable housing projects. All of these goals were completed and obtained. Despite several limitations and issues during the study's execution, sufficient data was gathered and retrieved to allow for analysis and the achievement of the study's goals. Ideally, the information gathered would increase manufacturers' and contractors' knowledge of the solid wall panel's potential to improve construction methods.

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Siti Nur Liyana Abd Hamid, Narimah Kasim; **data collection:** Siti Nur Liyana Abd Hamid; **analysis and interpretation of results:** Siti



Nur Liyana Abd Hamid; **draft manuscript preparation:** Siti Nur Liyana Abd Hamid, Narimah Kasim, Rozlin Zainal, Sharifah Meryam Shareh Musa. All authors reviewed the results and approved the final version of the manuscript.

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