

Reviewing Retrofitting Potential for Factory Warehouse from Owner Perspective in Johor

Saidatul Aisyah Che Suhaime¹, Mohd Hafizal Ishak^{1,2*}

¹ Department of Real Estate Management, Universiti Tun Hussein Onn Malaysia (UTHM, Parit Raja, Johor, 86400, MALAYSIA

² Centre of Project, Property and Facility Management Services (PROFMs), Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, MALAYSIA

*Corresponding Author: mhafizal@uthm.edu.my

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Abstract

Retrofitting has been commonly used to improve old structures so that they can be used for a long time. Revitalization includes adding new features to old buildings, bridges, historic sites and other constructions in addition to residences. Existing structures, especially retrofitted warehouses, can be retrofitted to strengthen their resistance to damage and structural failure. Factory warehousing has evolved into one of the most important supply chain activities. However, many studies reveal that building owners and occupants do not know how, when, or why structures should be sustainably adapted. Therefore, there are still many buildings that have not yet used the retrofit concept. The objective of the study is to determine the elements for factory warehouses in Johor and analyse the retrofitting potential of factory warehouses from the owner's perspective. This research is focused on warehouses in Batu Pahat and Johor Bahru districts, Johor only. The methodology of this study is a qualitative approach that is by interviewing three warehouse managers to answer both research questions and has used content analysis. Researchers can determine retrofitting elements such as reducing energy consumption, renovation technology, renovation can save costs and occupy & build health used by warehouse owner and the potential of the renovation concept is very widely used by factory warehouses in Johor.

1. Introduction

The adoption of retrofits has been widely used to strengthen existing buildings so they can be used for a long time. Existing buildings can be retrofitted to increase their resistance to damage and structural failure. The primary distinction between these concepts is that whereas retrofit refers to an enhancement of performance prior to damages, repair, refurbishment, or renovation are carried out on buildings after damage has already happened. Additionally, rehabilitation and retrofitting strengthen the building's structural integrity more than repair does (Jamiu, 2022). With the spread of severe and fatal infections, the Covid-19 pandemic has shaken the world. Everyone on the entire world is being required to stay at home to "flatten the infection curve." People are compelled to make purchases online because of this situation. This resulted in an increase in e-commerce, and the demand for additional warehouse space appeared to breathe new life into the "less attractive" logistics sub-sector (Khairi, 2017). Warehousing has evolved into one of the most important supply chain activities. The primary role of a warehouse is to accept things, store them, and then collect and ship them when requested by the customer. Factory warehousing has evolved into one of the most important supply chain activities. The

primary role of a warehouse is to accept things, store them, and then collect and ship them when requested by the customer. A factory warehouse can be defined as a manufacturing or industrial warehouse, is a facility used to store raw materials, continuous goods, and finished products related to manufacturing and has machine tools to produce goods. (Frida & Lisa, 2021). Warehouse retrofitting has expanded around the world. Retrofitting a warehouse is a process that must be carefully thought and planned for the years to come. The adoption of the measures during ongoing operations must also be meticulously planned to avoid disrupting or even interrupting warehouse operations. Johor has many warehouses for industrial use since the state attracts both domestic and foreign investors, which boosts the state's economic activity. As a result, the warehousing business has grown to become one of the most important industries in Johor.

According to UNCTAD Secretary General Mukhisa Kituyi (2020) said "The COVID-19 pandemic has accelerated the transition to a more digital world. The changes we are making now will have long-term consequences when the global economy recovers". This can be seen from the increase in warehousing activities which contributed 1.6% to the Transportation and Storage Subsector, in line with the increase in the Service Sector following the increase in logistics operations related to transactions resulting from direct and online sales. As the warehouse business in Malaysia is dominated by SMEs, most warehouses lack specialized services such as cold storage, pick and pack facilities, and pre-retail services. Conglomerates and multinational companies are common providers of value-added services. As a result, the warehouse industry strives to improve efficiency and productivity (Norsham,2022). However, many studies, show that building owners and occupants are unaware of how, when, and why a building should be sustainably adapted (Benzar, 2020). Due to this, there are still many buildings that have not yet used the retrofit concept. Many individuals may not know the concept of retrofitting or its application. If they are not exposed to information or education about retrofit, it is natural for them to lack knowledge in this area. To address this lack of knowledge, it is important to raise awareness of the Retrofitting through educational initiatives, public campaigns and outreach programs. Governments, educational institutions and industry organizations can play an important role in disseminating information about retrofitting, their benefits and their relevance in various sectors.

The research focuses on investigating two primary questions concerning the retrofitting of factory warehouses in Johor. Firstly, it aims to identify specific retrofit elements applicable to these facilities, considering factors such as structural integrity, energy efficiency, and technological upgrades. Secondly, it seeks to evaluate the potential for retrofit adoption from the perspective of warehouse owners, assessing their willingness, motivations, and perceived benefits in implementing retrofit measures. By addressing these questions, the research aims to offer insights into practical strategies and the feasibility of retrofitting initiatives in Johor's factory warehouse sector, thereby contributing to sustainable development and economic efficiency.

The research objectives revolve around elucidating the concept of retrofit elements and their practical application in factory warehouses, particularly within the context of Johor. It aims to identify and delineate specific retrofit elements pertinent to enhancing the functionality, sustainability, and efficiency of factory warehouses in the region. This involves examining structural, technological, and environmental considerations to establish a comprehensive understanding of retrofit requirements. Additionally, the research seeks to analyze the potential for adopting retrofit methods from the perspective of warehouse owners, delving into their attitudes, motivations, and perceived barriers or facilitators to implementation. Through achieving these objectives, the research aims to provide valuable insights into strategic planning and decision-making processes surrounding retrofit initiatives, thus advancing sustainable infrastructure practices and economic development in the region.

The study's scope is within Malaysia, specifically focusing on the districts of Johor, namely Batu Pahat and Johor Bahru, due to financial constraints. Three warehouse factories have been selected for examination, and the study aims to delve into the concept of retrofitting factory warehouse-type buildings. The research narrows down to four elements deemed suitable for warehouse use, considering the limited existing research on retrofit concepts for factory warehouses compared to commercial buildings. The significance of the study lies in assisting warehouse owners and managers in identifying potential retrofitting elements for their warehouses, ultimately aiding in reducing energy consumption, upgrading facilities, saving costs, and extending the lifespan of warehouses to make them more environmentally friendly.

1.1 Research Question

- What are the retrofit elements for factory warehouse in Johor.
- What is the potential for retrofit adoption in factory warehouse from owner perspective.

1.2 Research Objectives

- To determine retrofit elements for factory warehouse in Johor.
- To analyse retrofit adoption potential for factory warehouse from owner perspective.

1.3 Scope of Study

The scope for this study is in Malaysia, specifically in the districts of Johor namely Batu Pahat and Johor Bahru.

1.4 Significant Research

The study's findings are intended to assist factory warehouse owners and managers in identifying potential retrofitting and elements of retrofit for their warehouses. The 6 purpose of this research was to go deeper into the concept and potential of retrofitting to assist warehouse owners in understanding how the idea of retrofitting affects their warehouse. The findings of this study can help warehouse owners and managers decide which retrofit elements to use in their warehouse, particularly to reduce energy consumption, upgrade the warehouse, save money, and extend the warehouse's lifespan to make it more environmentally friendly. According to the findings of this study, the notion of retrofit can assist Malaysian warehouses.

2. Literature Review

A retrofit is the addition of new technology or features to an old system. Retrofit can happen for several reasons specific to a building. Different renovation measures may have different effects on related building subsystems due to various interactions, therefore, the selection of renovation technologies becomes very complex (Luther & Rajagopalan, 2014). There are many other repair methods that might be used to fix the damages brought on by all of these potential methods, and the most efficient one will be selected in every particular case. (Janni et al., 2017) These methods are used according to what the entrepreneur wants based on the desired elements. There are four retrofit principal which is reduce energy consumption, retrofit technology, retrofit can save cost and profit occupying & building health.

(a) Reduce Energy Consumption

The concept of energy-saving has become increasingly popular as a solution to this problem due to the issue of climate change, retrofitting existing buildings to increase energy efficiency is a highly significant demand (Danial et al., 2023). Energy efficiency retrofitting for existing structures is seen as a great way to meet the goals of energy reduction and sustainable development (Benzar et al., 2020).

(b) Retrofitting Technology

According to the website Service Channel (2019), says that investing in "smart" building technology has the greatest influence on facility management of any technology trend. With technologies ranging from improved climate management to smart parking garages and self-cleaning toilets, as well as many additional use cases known and still conceivable, this multi-billion-dollar business is growing rapidly. Retrofitting the building by making changes to the internal systems and machines using advanced technology is the right choice. Retrofit requires the modernization of current legacy machines without sacrificing functionality.

(c) Retrofitting Can Save Cost

One of the most cost-effective methods is retrofitting an existing structure. A practical way to cut energy use and reliance on fossil fuels is to retrofit existing structures for energy efficiency. It drastically lowers the energy usage and increase the overall sustainability of built environment by making little adjustments to the way that buildings are planned and managed. It improves remodelling processes with the aid of generative AI, leading to higher energy savings and a more sustainable future for all.

2.1 Important and Benefit of Retrofit

Depletion of natural resources, global warming, economic uncertainty, and health difficulties all contribute to the global sustainable development movement (Oh et al., 2010). The need for techniques or approaches to reduce the negative environmental impact of development, construction and urbanization. One of the most environmentally friendly, sustainable and efficient alternatives is to strengthen existing buildings (Kok et al., 2012). Therefore, the importance of the concept of retrofitting on existing buildings is the most effective method because existing buildings are a large part of the building stock that has great potential to use the concept of renovation in the future. The benefit of retrofitting including long-term cost saving, increased comfort and wellbeing, lower greenhouse emissions and improve water self-sufficiency, future proof buildings, preserve cultural and heritage significance, higher resale value and retrofitting with automation can solve staffing challenges.

2.2 Challenges and Barriers to Retrofit

The largest barrier to implementing the retrofitting idea for existing structures is the concern of building owners and occupants about energy usage and their familiarity with retrofitting procedures (Gholami et al., 2015). Next, the difficulty will be in persuading owners and developers that additional capital investments for restoration initiatives are not all pricey and costly. Based on a survey conducted by Harris et al. (2000) The payback period was determined to be the main factor influencing the firm's decision to invest in energy efficiency. The largest barrier to implementing the retrofitting idea for existing structures is the concern of building owners and occupants about energy usage and their familiarity with retrofitting procedures (Gholami et al., 2015). Next, the difficulty will be in persuading owners and developers that additional capital investments for restoration initiatives are not all pricey and costly. Based on a survey conducted by Harris et al. (2000) The payback period was determined to be the main factor influencing the firm's decision to invest in energy efficiency. Another issue is that property owners worry that retrofitting might interfere with how their buildings are run (Xing et al., 2011).

2.3 When to Retrofit

The time to renovate a building is a decision influenced by many variables, such as what is required from the retrofitting, the condition of the building, available resources and expected results. Currently, most of these buildings have been abandoned and are slowly being phased out to make way for the development of new urban buildings as they have reached the end of their expected service life. (Peng et al., 2021). The next the right time to retrofitting the building is before it loses a significant tenant or a number of tenants and experiences extended periods of vacancy due to the difficulty in finding a replacement tenant. In addition, the owner can retrofit an existing property to increase the value of their portfolio of properties.

2.4 Factors Influencing Successful Building Retrofit

Several factors can influence the success of a building retrofit. A building retrofit program's success depends on a variety of variables, including client resources and expectations, uncertainty, retrofit technologies, and building-specific information.

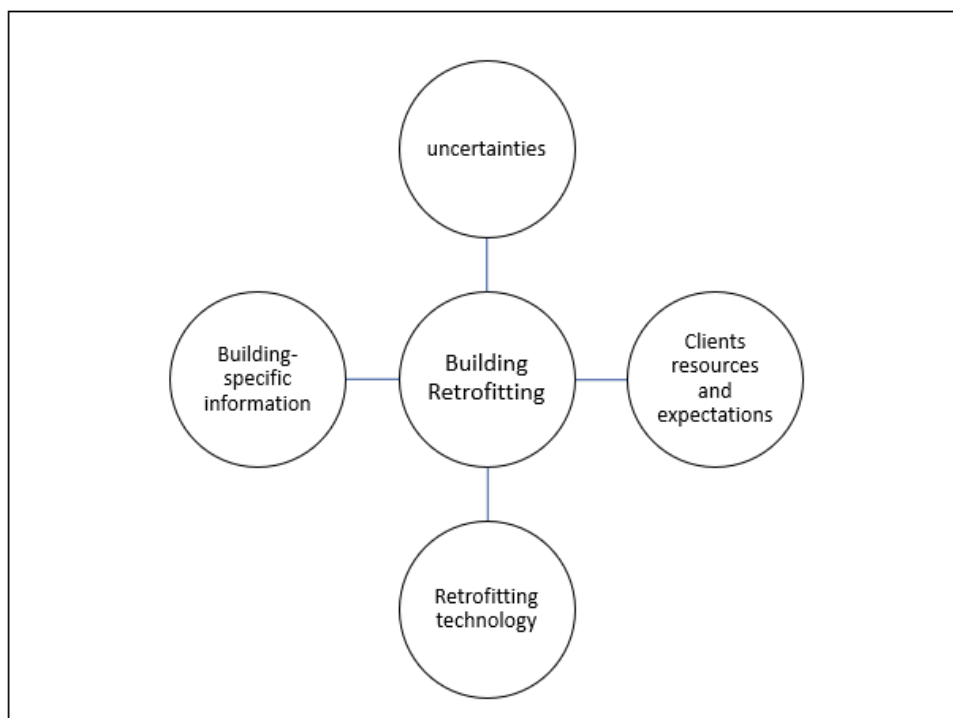


Fig 1 Key factors affecting building retrofit packages (adapted with permission from Ma et al., 2023)

a) Client Resources and Expectations

This aspect is yet another crucial component of a good building retrofit strategy. Sufficient financial resources are essential for a successful retrofit. Retrofitting projects often require significant upfront investments, and

securing the necessary funding is crucial. This can involve accessing government incentives, grants, or financing programs, seeking private funding sources, or exploring energy performance contracting (EPC) arrangements.

b) Uncertainties

A few ambiguous elements, in addition to these complex drivers, also influence how building retrofit procedures are used. These uncertainties include occupant behaviour change, policy change, and climate change. Additionally, because building subsystems interact heavily, different retrofit techniques may have a big effect on one another.

c) Retrofit technologies

A successful refit can be greatly assisted by keeping up with technological developments in building systems, materials, and retrofit solutions. The efficiency and long-term performance of the retrofit can be improved by evaluating the viability of cutting-edge technologies such as advanced building management systems, smart controls, renewable energy integration, and energy-efficient HVAC systems.

d) Building-Specific Information

The availability and accessibility of building information also has an impact on the success of building retrofit procedures in addition to the considerations. The crucial data needed for retrofit packages includes building typologies, age, orientation, energy sources, and building fabric and envelope structures.

2.5 Retrofit Factory Warehouse

Retrofitting a warehouse refers to the process of making modifications or upgrades to an existing warehouse facility to improve its functionality, efficiency, safety, or compliance with new regulations or technological advancements. It involves making changes to the building's structure, systems, equipment, or layout to meet the evolving needs of the business or industry. In the Future construction of the warehouse won't be done "just to store a bunch of stuff." Firms won't develop systems where a lot of assets are idle for extended periods of time. Different types of facilities are starting to emerge because of thinking about the role that the warehouse plays in the larger supply chain. There will be an increase in flow-through distribution centres. After being processed, containers are swiftly delivered to other warehouses or retail establishments. These new facilities' function will be to get inventory in and out as quickly as possible while becoming more closely connected with the transportation, purchasing, and other supply chain activities (Warehouse of the Future n.d., 2017).

2.6 Retrofitting in Terms of Knowledge in Malaysia

To lead an excellent performance improving decision-making from the retrofits, the owner and tenant should possess the fundamental knowledge of sustainable retrofit and technological approaches. However, numerous studies reveal that owners and tenants are unaware of the how, when, and reasons why a building needs to be sustainably adapted. The building's owner is typically the one who decides whether to adapt the structure sustainably.

2.7 Retrofitting in Terms of Acceptance in Malaysia

During the Tenth Malaysia Plan 2011-2015, New government structures were built with energy-efficient designs, and some older ones went through energy-saving retrofitting. The government buildings in Putrajaya were previously retrofitted between 2011 and 2014 with the goal of reducing electricity use by 4% to 19% monthly, or RM7,000 to RM130,000 in savings, according to the Eleventh Malaysia Plan 2016-2020. The goal of the Eleventh Malaysia Plan, which runs from 2016 to 2020, is to increase the number of existing structures that have undergone renovation. While retrofitting acceptance in Malaysia is growing, there are still challenges to overcome, such as limited financial resources, lack of technical expertise, and the need for more streamlined processes. However, with continued government support, increased awareness, and advancements in retrofitting technologies, the acceptance and adoption of retrofitting practices are expected to further improve in Malaysia.

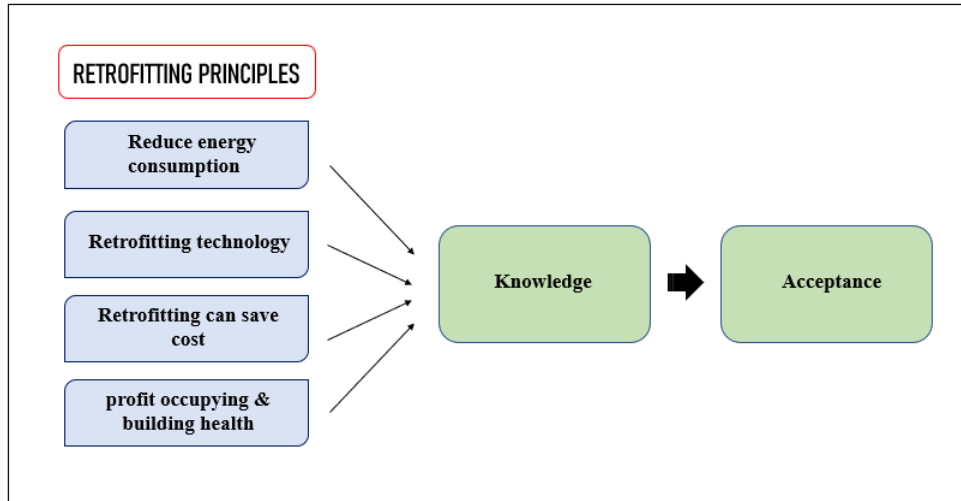


Fig 2 Conceptual framework

Based on figure 2.2, shows the flow of the approach that the researcher wants to study in this study. The researcher wants to know the extent of the warehouse owner's knowledge about the concept of retrofitting based on the principles shown, namely reduce energy consumption, retrofitting technology, retrofitting can save cost and profit occupier and building health. This trend will also be used to help the researcher develop questions for interviews with warehouse owners.

3. Research Methodology

The research will use literature review in writing as well as interviews to obtain data information. This study has three methodological levels. The first stage is about background research which is choosing the study location, appropriate and relevant research issues. The second stage focuses on objective 1 which is determinate element retrofitting for warehouse, and the third stage focuses on which is potential retrofitting form owner perspective.

Table 1 Methodology table

Objective	Methodology	Variable	Tools	Outcomes
To determine retrofitting elements for factory warehouse in Johor	Qualitative	1)Reduce Energy Consumption 2)Retrofitting Technology	Content analysis	To give exposure and understanding to warehouse owners about the concept of retrofitting that they can use for their warehouse later.
To analyses retrofitting adoption factory for industrial warehouse from owner perspective in Johor.	Qualitative	3)Retrofitting can save cost 4)Profit occupying & Building Health	Content analysis	To find out the extent to which the potential of this retrofitting concept is accepted and will be used for buildings in Johor based on its elements.

3.1 Stage One

The study was conducted in the first stage to identify the main issues through comments related to the statement of the research problem and then followed by the initial discussion title and the scope of the study on the issues that arise in the study area. As a result, the collection of information, the selection of accepted topics, the statement of the research problem, the identification of simple objectives and the scope of the study. Following that, the study will proceed by doing a literature review to identify any concerns that may arise. Book reviews, bibliographies, articles, the internet (including electronic journals), journals, periodicals, and these are all possible sources for a literature review. Furthermore, sources from media and mass communication, such as seminars, reports, bulletins, films, newspapers, or previous studies, may be used.

3.2 Stage Two

The second stage is for the first objective which is to determine retrofitting element for warehouse in more detail. In this stage, the researcher will use qualitative methodology to cover survey questions related to element retrofitting for warehouse to achieve the first objective. A qualitative approach is a method of data collection that can provide in-depth and accurate answers to research questions. The researcher uses this method because the researcher does not want to receive a large amount of data but important and quality information from the results of interviews with selected people. The sample respondents selected for the interview are three warehouse owners located in Batu Pahat. Respondents were chosen because the researcher wanted information related to the warehouses they owned and would be linked to the concept of retrofitting. The design of the research question is using a Likert scale that covers part A, part B and part C. The analysis used in this study is through Atlas software to get the results of the study. To collect data on determining the retrofit elements that were used in the warehouse, the researcher interviewed three warehouse managers from the industry PWO Industries SDN.BHD, Almer Malaysia Sdn Bhd (A Kerry Group firm), and Ucon Enterprise (BP) Sdn Bhd. The researcher transcribed the information gleaned from the interviews. ATLAS.ti 9 Software will be used to examine the data. The researcher goes over each sentence from the respondent and highlights the key information. The researcher has created groups for each crucial piece of data to be discussed.

3.3 Stage Three

The third stage, the achievement of the second objective is to analyse adoption retrofitting potential for factory warehouse form owner perspective. To achieve objective two, a qualitative methodology was used in the form of an interview session to obtain information. A good interview session has been done with the selected respondents. The results from the interview can fulfil the second objective where to get information from in several warehouse owners in Batu Pahat and Johor Bahru about their acceptance of the concept of retrofitting for their warehouse in the future.

4. Result and Discussion

All the respondent backgrounds that have been interviewed are a total of three warehouse manager from different companies namely PWO industries Sdn Bhd, Almer Malaysia Sdn Bhd (A Kerry Group company) and Ucon Enterprise (BP) Sdn Bhd. All these companies are in Batu Pahat and Johor Bahru, Johor. All respondents have more than 2 years of experience.

4.1 Achieving Objective One

The first finding from the analysis is the knowledge group. From this group, the researcher found out that 2 of the respondents knew about retrofit while the other 1 did not know about it. Respondents who did not know had less experience compared to the other 2 respondents. Overall findings can be seen in Table 2.

All three respondents (R1, R2, and R3) expressed a unanimous belief about the benefits of retrofit elements aimed at reducing energy consumption. According to R1 and R3, retrofitting aimed at energy savings are considered very beneficial for warehouses, especially considering the large energy consumption inherent in large facilities. R2 also agreed on the positive impact of change to reduce energy consumption and gave an example of this through the transition from bolt-on lighting to LED lighting in the warehouse. R2 emphasizes the cost-saving advantages of change. The group's perspective is in line with the findings of the study, as quoted from Benzar et al. (2020). The research emphasizes that improvements in energy efficiency for existing structures, including warehouses, represent the most effective solutions to achieve energy reduction goals and promote sustainable development. Approaches to improving energy efficiency in existing structures are considered pragmatic and sustainable, addressing both environmental concerns and economic considerations. Takalani (2011) is cited to support the claim that building retrofitting is essential to reduce energy consumption. the study suggests that the renovation of warehouses can lead to a reduction in energy consumption, and the strengthening of existing structures is highlighted as one of the most environmentally friendly, sustainable and cost-effective solutions to improve the energy performance of buildings. This supports the notion that retrofitting is a profitable strategy to reduce energy consumption in structures such as warehouses.

The second key of this element already has a plan. R1 expressed the desire to install a solar system for their warehouse due to high energy consumption. On the other hand, R2 stated that their warehouse has several plans to reduce energy consumption. The discussion is supported by a recent study from Kenanga (2023), which projects an increase in power consumption from 1.8% to 2.8% in 2023. The study shows that without plans to reduce energy consumption, this trend is likely to continue. Mohareb et al. (2017) advocate a proactive approach to future building retrofitting, aligned with long-term sustainability goals, energy-efficient financial and regulatory planning and the evolving technological landscape. The importance of having a specific retrofitting plan is highlighted, with considerations based on the building's characteristics, use and available budget.

Consultation with an energy efficiency specialist is recommended to adapt the view to the specific situation. Buildings that do not have a retrofit plan may face challenges, especially if they do not meet current energy efficiency and sustainability standards. Citing Nazri et al. (2015), the document states that retrofitting can lead to long-term cost savings, better market competitiveness, and a more sustainable and resilient built environment. As a result, the changes implemented to reduce energy consumption are described as an alternative and profitable strategic approach.

The third key is that "increased energy use increases the cost of electricity." R1 states that the large size of the warehouse contributes to high energy consumption, driven by many lights and machines, which leads to increased electricity expenses. R3 added that energy consumption increased due to increased consumption. This is in line with research findings, as highlighted in Kenanga's (2023) study, which shows that lighting and air conditioning, driven by erratic weather, contribute significantly to energy consumption. Ayres et al. (2012) support this by stating that larger buildings indeed consume more energy, given the production of more products, which in turn require the use of tools and machines. The study refers to Malaysia's hot and humid climate, emphasizing the frequent use of air conditioning as the main factor in the increase in electricity consumption. Studies, such as D2 (2016), reveal that lighting accounts for a large proportion (15 to 60%) of total energy use in buildings, with factors such as building type, function, technology and climate influencing the range. The type of lighting used also plays a role, with high-voltage lighting contributing to increased electricity costs. To address this issue, the study suggests retrofitting the warehouse by switching to low-voltage lighting and implementing measures to reduce overall energy consumption. This is in line with the idea that retrofitting lighting systems can contribute to more efficient energy use and cost savings. Overall findings can be seen in Table 2.

There are four main points from the modern technology group which are "expensive equipment", "increase production", "increase safety" and "technology is very helpful". Of the four contents below, three contents show that they have the same base and the other one does not. R1 acknowledged the benefits of technology retrofits but expressed concern about high costs, particularly in acquiring machinery. R2 agreed with the advantages of smart technology but noted unexpected or excessive costs associated with certain instruments. R3 highlighted the overall expense of upgrading existing equipment to modern technology as a barrier, leading to the continued use of old machines in many warehouses. The concerns raised by the respondents are in line with the study by Lee et al. (2019), emphasizing the large cost of basic materials and technology. Despite the high initial cost, Lee et al. argue that superior technology offers long-term benefits, including advanced equipment and building longevity. Takalani (2011) supports this by suggesting that technology improvements can contribute to reducing life cycle costs, as retrofits using high quality technology require less annual maintenance. Hristova et al. (2019) also confirmed that although modern technologies used for retrofitting may have high initial costs, the long-term benefits often outweigh these expenses. The study highlights the potential for a significant return on investment over time through reduced energy consumption and operating costs. This aligns with the idea that, despite higher upfront costs, energy-efficient retrofitting can produce financial benefits in the long run.

According to R1, using product-friendly machinery can enable the production of multiple items within a minute, saving energy and time. R2 emphasizes that advanced technology has the capacity to reduce production costs, and R3 claims that using the current machinery in the warehouse has led to a threefold increase in production. quoting from a study by Keshav et al. (2022), who introduced the concept of "smart" retrofitting involving virtual tools such as smart glasses to control the manufacturing process. Keshav et al. demonstrated that new and improved technologies can improve operations across multiple industries, maintaining functionality while increasing productivity. The notion that modern technology can significantly increase productivity is further supported by Appiah Ene et al. (2018). The study suggests that implementing robots and automated systems in the manufacturing process can increase speed, accuracy and efficiency, reduce production time and minimize errors. However, the document acknowledges that the use of such technology requires careful planning, investment and staff training.

The third key point stated that R2 highlighted concerns about warehouse security due to the high number of machinery and commodities. However, through technological changes and the addition of safety mechanisms to robots, safety can be improved, leading to minimized warehouse accident rates. R3 supports this perspective, suggesting that smart technology changes can contribute to warehouse security by incorporating features such as CCTV that can be monitored and controlled remotely by phone. citing previous research by Nadhim et al. (2018), emphasized that retrofitting projects can improve building safety by addressing issues such as outdated electrical systems or inadequate fire protection. Additionally, robust cyber security measures are considered essential to protect sensitive data, as shown by a study from Azmy et al. (2016). The implementation of retrofit technologies is recognized as important to protect occupants and assets, but the document emphasizes the importance of conducting a thorough risk assessment and consulting with security experts to tailor solutions to specific challenges. In addition, compliance with local building codes and regulations is emphasized to ensure the effectiveness of retrofit measures. The study further states the importance of improving security in warehouses to protect workers, assets and inventory. The improvement of modern technology, such as

implementing a Warehouse Management System (WMS) and safety guards on machinery, is highlighted as an important contributor to the improvement of safety measures, in line with the study by Olofsson & Rylander (2021).

For fourth key point, all three respondents expressed unanimous agreement about the important use of technology in the coordination of warehouse management. R1 emphasized the extreme usefulness of technology in increasing output, while R2 agreed, emphasizing that modern technology helps in accepting new advances and adapting to increasing changes. a study from Hmidah et al. (2023) emphasized the importance of Building Information Modelling (BIM) in building management. BIM is described as a set of technologies, rules and processes that facilitate the management of important project data in digital format throughout the life cycle of a building. Researchers and users consider BIM as a software tool or technique for creating and recording building information. In addition, the concept of Industry 4.0 was introduced, signifying the development of systems, devices and procedures. Maciej Sowik & Honorata Sierocka (2023) support this by stating that Industry 4.0 is driving exponential growth in technology applications, including smart manufacturing, cloud data and big data processing. The document states that data from various sensors, most of which are connected to the Internet, is important in this context. Advances in technology, such as the increased availability of sensors, cloud computing, data storage and machine learning and artificial intelligence techniques, are highlighted as contributing factors to the ability of smart technology to facilitate warehouse management. Overall findings can be seen in Table 2.

The third element can save cost. There are two fillings from this group namely "cost saving" and also "rebuilt very costly". grounded for "cost saving" looks longer than "rebuilt very costly". R1, R2, and R3 collectively emphasize the cost-saving benefits of retrofitting. R1 states that using the retrofit can reduce costs by 30% of the original value, highlighting the importance and benefits of such savings. R2 further supports this, stating that significant money can be saved through retrofitting, emphasizing that it not only saves energy and benefits the environment but also results in cost savings. R3 echoed similar sentiments, noting the benefits of reducing expenses by up to 30%, especially for historic structures. Previous studies cited Lee et al. (2020), confirmed that designers and builders are increasingly required to carry out energy retrofits to improve the energy performance of existing buildings, ultimately saving operating costs for a prolonged building life. The study suggests that retrofitting can lead to cost savings through multiple means, emphasizing that although the initial investment in technological retrofitting may seem large, the long-term benefits and return on investment can outweigh these costs. Further studies state that overhauling processes and equipment for greater efficiency can better result in reduced operating costs. Modern technology, with lower maintenance requirements, contributes to additional cost savings over the life of the technology. Gustavsson & Piccardo (2022) are cited, stating that a thorough cost-benefit analysis is essential when considering retrofitting projects, taking into account specific conditions, goals and potential returns. Despite the higher initial investment, the document concludes that long-term cost savings and additional benefits make retrofit a financially sound decision. Categories where retrofit can save costs include rebuilding costs, bill paying costs, operating costs and more.

The second key point of this element is rebuilt really costly. R1 expressed the view that demolishing and rebuilding old structures would incur significant costs, a sentiment echoed by R3, who highlighted the high costs associated with rebuilding large buildings such as warehouses. This perspective is in line with the findings of Lee et al. (2019), who analysed the construction sector and noted a shift in demand from new construction to maintenance and repair of existing buildings. The study suggests that restoring existing structures is less constrained than building new, making retrofitting a more convenient and cost-effective option. journal from Ali et al. (2018), pointed out that retrofitting which involves improving existing structures rather than starting from scratch, provides a cost-effective alternative to rebuilding. Retrofitting projects typically have a shorter construction timeline, resulting in lower labour costs and a faster return on investment. The integration of modern technology and energy-efficient systems without the need for complete reconstruction is also highlighted as an advantage. The overall cost of retrofitting, even with various improvements, is considered much lower than demolishing and rebuilding the entire building. Overall findings can be seen in Table 2.

Only one key for element Profit Occupying & Building Health group, which is maintenance. all three respondents agreed that a building needs maintenance to remain strong. R1 emphasizes the need for regular maintenance to ensure a building is durable and healthy, noting that neglecting maintenance can lead to an outdated appearance. R2 supports this, stressing that insufficient maintenance can lead to simple breakdowns, making the lifespan of a building irrelevant if not properly cared for. R3 adds that improvements for better building health can contribute to increased income for occupants, because regular maintenance prevents significant damage and associated high costs. a study from Sowik and Sierocka (2023), which suggests predictive maintenance and anomaly detection is a method which is effective for early identification of undesirable changes in process or machine parameters, emphasizing that maintenance can be applied not only to buildings but also to machines. Reassembly, as mentioned, extends the life of the machine and contributes to sustainability. In addition, a study from Au-Yong et al. (2016), emphasizing a holistic approach to building health. These include retrofitting strategies. The integration of these retrofitting strategies aims to create a building that optimizes profits while prioritizing the health, comfort and satisfaction of occupants. This holistic approach, according to

the quote, contributes to a sustainable and resilient built environment. Overall findings can be seen in Table 2.

4.2 Achieving Objective Two

In response to the interview questions, all three respondents expressed unanimous agreement with the idea of improving their warehouse efficiency. R1 expressed the belief that the retrofitting was beneficial and outlined specific plans to install solar panels for energy reduction and upgrade outdated machinery for better production. R2 shares a similar perspective, acknowledging the need for continuous improvement in the energy efficiency of their warehouses, especially in lighting. R3 not only advocates a retrofitting approach for their warehouse but also emphasizes the frequent application of retrofitting, have many advantages associated with this strategy. Overall, respondents demonstrated a collective commitment to the concept of retrofitting for continuous improvement in their warehouse operations. Overall findings of objective two is in Table 2.

Table 2 Analysis data

Groups	Respondent		
	R1	R2	R3
Knowledge			
Doesn't know about retrofit	What is retrofit? We never heard. We don't know about retrofits or things like that."	-	-
Know about retrofit	-	I know bout retrofit, but I didn't know the details of retrofit but I know actually you renovate your warehouse, your process or your machine and whatever without higher cost	Yes, I know about retrofitting but not much. I know because I heard about this retrofit from my friend.
Reduce Energy Consumption			
Retrofit reduce energy consumption I good	Energy consumption after you explained, for me it is good. Does this mean that we can use this retrofit to reduce the cost of the warehouse or the building itself? If that's the case, this system is very good	Energy consumption does exist; we just have some plans. Example of using electricity, we use LED instead of last time we used normal bolt. Which is more cost saving, energy cost	And like you said earlier about retrofits can reduce energy consumption, that's a very good thing.
Already have a plan	Want to install solar systems for buildings because here the cost of energy is high. We will run it later. We have a plan to reduce energy	About the energy consumption, basically this is for our path as a player in industry. We also have some, what we called it plan for reduce the energy consumption	-

<p>Increased energy consumption makes electricity costs high</p>	<p>As we already know that the Warehouse is a large and spacious building, so the electricity consumption is also large</p>		<p>Energy consumption is currently high due to high demand. So, when energy consumption is high, the cost of electricity bills is also high.</p>
<p>Modern technology</p>			
<p>Expensive equipment</p> <p>Increase production</p> <p>Increase safety</p> <p>Technology is very helpful</p>	<p>But there is also something we are worried about because to get a product-friendly machine, the cost is also high</p> <p>Use a product-friendly machine that can produce a lot of products per minute, it will save time</p> <p>-</p> <p>Yes, now the world uses advanced technology to maximize production and minimize costs."</p>	<p>My opinion about smart, sophisticated technology, yes, it's true. It really helps us a lot but, in certain areas, the technology we invest in requires cost and some of the cost, is higher than we expected</p> <p>Advanced technology and all the best advanced machines, so that's why now we run in minimum cost</p> <p>Just a few other costs which are direct like the warehouse it will be direct on involves in terms of safety cost and then more to safety</p> <p>But overall, I agree with the term of technology. New development, new enhancement as long as we have technology that helps us."</p>	<p>But to change all the original equipment to a good and more sophisticated one requires a high cost. So many warehouses are still using old machines. It's not that they don't want to change but the cost used is not low So, if they change their equipment to a more sophisticated and modern one, which can produce their production 2 times more than the previous equipment, they will get to reduce time and also increase production</p> <p>Smart technology can also improve the security level of the warehouse itself.</p> <p>Retrofit technology also has many benefits</p>
<p>Can save cost</p>			
<p>Cost saving</p>	<p>The cost when using retrofit can go down by up to 30% which is a lot</p>	<p>But there is a room for us to make the kind of element you are talking about. And it helps us a lot in cost saving. This retrofit not only saves energy but also saves the environment."</p>	<p>Can save up to 30% in cost, right? So, this retrofit is very good for old buildings</p>

Rebuilt very costly	To rebuild the building, the cost is high	Yes, rebuilding a warehouse does require a large cost	
Profit Occupying & Building Health			
Maintenance	If you want the building to stay long and healthy, you have to do maintenance regularly	If we don't take care of this structure, it will be easily damaged, it will not last long even if the warranty from the old supplier, 30 years or 40 years	Retrofit to maintain the health of the building and the profit of the occupants for me, it is more about the way they manage the building itself."
Adoption potential			
Acceptance	For me this retrofit is good and like I said but we also have a plan to install solar and we are also in the process of changing some machines in our warehouse to more sophisticated ones so that we have a warehouse to save costs	We have standards. It keeps moving and ongoing. for improvements in terms of lighting, new things that we install in Almer, we make sure that it is energy saving, environmentally friendly	For our warehouse, maybe we will use this concept because of what you said earlier, it will bring many benefits. But it is not in an immediate time because a change requires a high cost. Maybe little by little."

Indication:

	Content
	Key point

5. Conclusion

Through this study, the researcher has studied both objectives which are to determine retrofit elements for factory warehouse in Johor and to analyse retrofit adoption potential for factory warehouse from owner perspective. From this study, high integrity is important for a warehouse manager. This is because, managing the warehouse internally and externally is not an easy job and requires a lot of patience. This shows that a warehouse manager must be strict and not be influenced in carrying out a retrofitting on the warehouse by using the concept of retrofit because it is very useful for the warehouse itself. For people who do not know retrofit, it will think that doing warehouse retrofitting using the concept of retrofit is a wasteful thing. However there a lot of benefit using retrofitting concept.

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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:** Saidatul Aisyah Che Suhaime, Mohd Hafizal Ishak; **data collection:** Saidatul Aisyah Che Suhaime; **analysis and interpretation of results:** Saidatul Aisyah Che Suhaime; **draft manuscript preparation:** Saidatul Aisyah Che Suhaime, Mohd Hafizal Ishak. All authors reviewed the results and approved the final version of the manuscript.

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