AN EXAMINATION OF HIGH-RISE BUILDING CONSTRUCTION TECHNOLOGY: A RESEARCH STUDY CONCENTRATED ON HONG KONG.

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ABSTRACT

Time, money, and resource utilisation are common points of contention when discussing production performance in the construction sector. This article examines the impact of adopting different construction methods or techniques on production performance within the setting of a high-rise public housing block in Hong Kong. The investigator compared three separate floor layouts that had the same "Harmony" layout. Each system has its own unique procedure for constructing floor slabs and material processing plant inputs. The cycle times, labour utilisation, and expenditures of three systems are examined and analysed. The most labour- and money-efficient option was Scheme 2, which has a six-day floor cycle. Scheme 3, with its four-day floor cycle length, is suggested since speed is highly valued in Hong Kong. Space and budget limitations necessitated the implementation of many technology solutions in Hong Kong. Meanwhile, a number of mishaps occurred as a result of people misusing the technology. So, the government of Hong Kong establishes a number of rules and guidelines for the construction industry. In order to maintain control over construction projects, the government enacts several laws and regulations. The researcher meticulously planned the project by creating detailed drawings, specifications, practical notes, and directions to ensure a safe and high-quality completion. Multiple tests were carried out to ensure top-notch workmanship in response to staff misconduct and mistakes. For example, the TDR test was implemented to guarantee that the soil nail length is in accordance with the plan. Cube, core, and hammer tests were used to evaluate the concrete's quality and workmanship. The quality of the steel was determined by doing the tensile test. A bleeding test and a flow cone test were used to evaluate the quality of the cement.

Keywords: Modern Methods in Building Construction, Hong Kong, Unique Floor Plans, Tall Structures, Cement Standards.

INTRODUCTION

Hong Kong is characterised as a city by buildings with several stories of varied heights. However, in terms of energy use, skyscrapers are absolute monsters. Researchers contribute to climate change, energy resource depletion, local and regional pollution, harm to natural ecosystems, and excessive power consumption during building and operation, which in turn releases several greenhouse gases. While the researcher may assist with societal necessities and boost GDP,

the negative environmental repercussions that accompany construction projects get a lot of attention. Some are concerned about possible shortages, resource depletion, and negative impacts on the environment due to the increasing global usage of energy. Green building and sustainable development have inspired many involved in the construction industry to do their part to preserve the environment. The Hong Kong building sector is no different. Professionals in the construction sector are always seeking for new technology with the potential to increase site safety, decrease building time, and save costs. There has been a noticeable drop in the accident rate in Hong Kong with the use of modern technology. One example is the substitution of steel sheet piling for wood planking. Bore piles are being used in place of hand-dug caissons. It was illegal to use hand-dug caissons in foundation design (Liu & Lee, 2020).

Sheet piling is set up using hydraulic pressure rather than a drop hammer. Building models and internal load patterns were used to produce an energy-performance evaluation approach for high-rise residential buildings in Hong Kong. This method is based on the survey study's primary results, which were used to anticipate energy usage in residential structures. A voluntary review system aiming to improve the environmental performance of buildings in Hong Kong, the Hong Kong Building Environmental review Approach is presently undergoing modifications and extension. It incorporated this method. The survey results for energy end-use and building attributes are summarised in this article (Ansah et al., 2021).

BACKGROUND OF THE STUDY

Hong Kong, which is one of the most populated cities in the world, is well-known for having an extremely high population density. Combined with the limited quantity of land that is now available, the primary reason for this is the strong demand for both residential and commercial space. Developing space to meet the expanding population and economic activities of the city may be accomplished via the building of high-rise structures, which is both a realistic and required way of land development. This is as a result of the fact that buildings with several floors are able to accommodate a greater number of people. The high elevation of the city is associated with a multitude of environmental difficulties, some of which include increased energy consumption, heat islands, and limited ventilation. These are only a few of the numerous problems. These concerns stem from the fact that the metropolis is showing signs of vertical expansion. In an attempt to solve these challenges and develop buildings that are safer, more energy-efficient, and friendlier to the environment, Hong Kong has been using an increasing variety of cutting-edge construction technologies (Ma & van Ameijde, 2022). As a result of these efforts, the objective is to construct buildings that are less detrimental to the environment. The modular integrated construction method is one such strategy that has lately gained popularity. This method has the potential to cut down on the amount of time spent on construction, the amount of labour performed on-site, and the amount of manufacturing done off-site, all while simultaneously enhancing the quality of the final result. As a result of the use of intelligent building systems, environmentally friendly materials, and building information modelling, there have been modifications made to the design and construction of high-rise structures. These

adjustments are directly attributable to the use of these technological advancements. In the Hong Kong Science Park, there is a project called InnoCell that is now underway. This project is an example of the possible practical uses of these technologies. This not only reduced the amount of time required to complete the activity, but it also had a less impact on the surrounding environment. Nevertheless, there are problems that need to be addressed, such as interruptions in the supply chain, limits that make it difficult to develop new commodities, and the difficulty of persuading people to adopt new construction methods. It is going to be important to overcome each and every one of these challenges (Cai et al., 2020).

PURPOSE OF THE STUDY

The purpose of this gathering is to discuss some of the most common issues, incidents, and technical advancements that are occurring in the Hong Kong construction industry. The researcher has been doing study to uncover methods to improve the technology that is already in place in order to make the workplace safer and healthier for everyone. In addition to this, the researcher does the required study in order to deliver a solution that is both quick and economical. A description of the building works is going to be included in this article by the researcher. The researcher also discusses the benefits and drawbacks of the works that fall under this category. Included in this list are a few items of construction equipment that are often used in the building and construction sector. In the last part of the study, the researcher will discuss the subject of government monitoring of construction projects. The measures that need to be taken for the formation of the site, the foundation, the excavation, the lateral support, and the superstructure will be discussed here by the researcher. Conversations on safety and training are often used in the construction business in Hong Kong in order to lessen the probability of accidents occurring. An investigation was also carried out by the government in order to ascertain the factors that led to the disaster. It is possible for the state to develop laws and standards of behaviour in order to rein in activities that might possibly be damaging.

LITERATURE REVIEW

The life cycle energy analysis method takes into consideration all of the energy inputs that a building experiences throughout the course of its existence. It is possible for the life cycle of a structure to take the following shapes, depending on how it moves through each stage: cradle to grave, site to operation, cradle to gate, or gate to operation. The life cycle energy of a structure is comprised of both the embodied and operational energies of the building. The majority of the time, the total embodied energy is equal to the sum of the combined energies of the original and repeated embodied states. From the perspective of the Hong Kong building business, contractors are regarded to be developers. As a consequence of this, contractors will make use of cutting-edge technology in order to reduce the amount of time required for building and to aid the developer in reducing the overall cost of construction. The formation of these collaborations is used by a number of businesses in order to initiate cutting-edge advances in innovation. As an example, consider the top-down building method with precast concrete components.

Modern technology has the ability to cut down on the amount of time and money needed to construct a structure. Having stated that, there is the potential for a wide variety of problems (Manzoor et al., 2021). Take, for example, the possibility of water seeping in through the gap where the precast facade and the concrete component meet during the building process. As a consequence of this, AP and RSE, the developer and contractor, will devise an innovative strategy for resolving the problem. Developers and contractors are seeking for a strategy that may bring about improvements in the safety, speed, and quality of the construction site while simultaneously reducing costs. The amount of accidents that occurred in Hong Kong was decreasing as a result of the utilisation of contemporary technology. One example of this would be the use of steel sheet piling in lieu of wood planking. The usage of bored piles is being used in place of the hand-dig caisson strategy. Caissons that were dug by hand were not allowed to be used in the design of foundations. The use of hydraulic pressure is used in the construction of sheet piling rather than the use of a drop hammer. Comprehensive builders, who are responsible for both the design and construction stages of a building project, are receiving an increasing number of orders for construction projects (Du et al., 2020).

RESEARCH QUESTION

What is the impact of building information modeling on high-rise building in Hong Kong?

RESEARCH METHODOLOGY

Research design: The quantitative data analysis was conducted using SPSS version 25. The strength and direction of the statistical association were evaluated by calculating the odds ratio and the 95% confidence interval. The researchers established a criterion of $p < 0.05$ as statistically significant. A descriptive analysis was performed to obtain pertinent information from the data. Data altered by computing tools for statistical analysis, in conjunction with information gathered from surveys, polls, and questionnaires, is often evaluated using quantitative approaches.

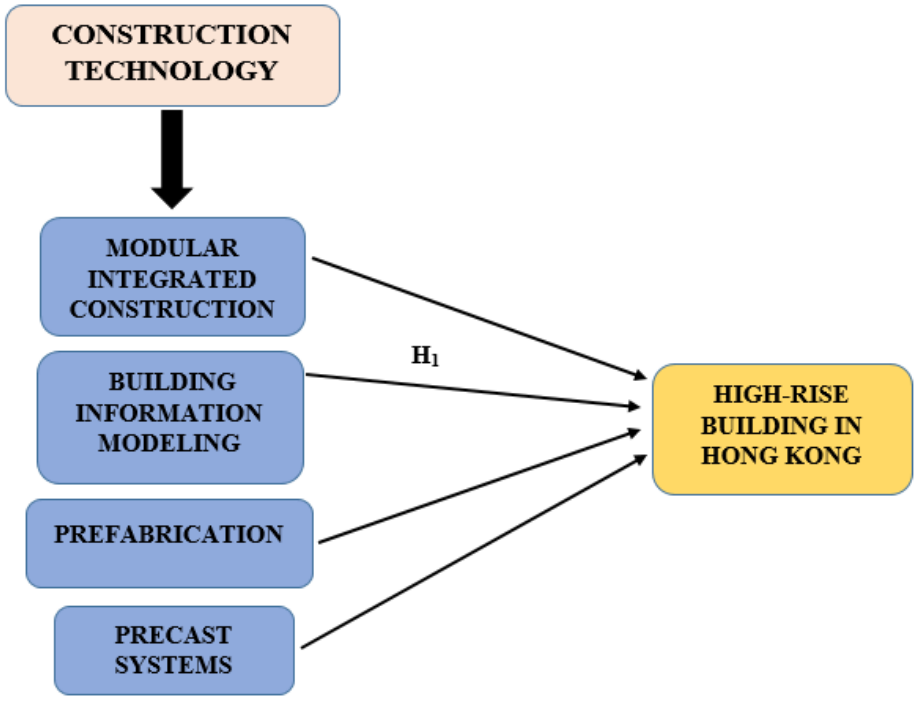
Sampling: After an initial study with 34 Chinese researchers, a total of 1,002 Rao-soft students were included into the final group of investors. Researchers of both genders were randomly chosen and given a total of 1,226 questionnaires to complete. A total of 1015 questionnaires were used for the study after receiving 1040, with 25 eliminated due to incompleteness

Data and Measurement: A questionnaire functioned as the principal instrument for data collection in the research. The survey had two sections: (A) General demographic information and (B) Responses on online and offline channel features assessed using a 5-point Likert scale. Secondary data was collected from many sources, mostly from online databases.

Statistical Software: The statistical analysis was conducted using SPSS 25 and MS Excel.

Statistical Tools: Descriptive analysis was used to understand the fundamental characteristics of the data. The researcher must analyse the data using ANOVA.

CONCEPTUAL FRAMEWORK



RESULT

Factor Analysis: A prevalent use of Factor Analysis (FA) is to identify hidden variables within visible data. In the absence of clear visual or diagnostic signs, regression coefficients are often used to assign ratings. In FA, models are essential for success. The aims of modelling are to detect flaws, intrusions, and clear linkages. The Kaiser-Meyer-Olkin (KMO) Test is a technique for assessing datasets produced by multiple regression analyses. The researcher confirms that the model and sample variables are representative. The data demonstrates redundancy, as shown by the figures. Decreased proportions enhance data understanding. The KMO output varies from zero to one. A KMO value between 0.8 and 1 indicates an adequate sample size. These are the permissible levels, according to Kaiser: The following approval criteria set out by Kaiser are as follows:

A regrettable 0.050 to 0.059, inadequate 0.60 to 0.69.

Middle grades often span from 0.70 to 0.79.

Demonstrating a quality point score ranging from 0.80 to 0.89. They are astounded by the range of 0.90 to 1.00. The results of Bartlett's test of sphericity are as follows:

Chi-square statistic approximately equals 190, with degrees of freedom = 190 and significance level = .000.

Table 1. KMO (Kaiser-Meyer-Olkin) and Bartlett's Test for Sampling Adequacy measure: 0.839.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.839
Bartlett's Test of Sphericity	Approx. Chi-Square	3252.968
	df	190
	Sig.	.000

This validates the authenticity of assertions made just for sampling reasons. Researchers used Bartlett's Test of Sphericity to determine the significance of the correlation matrices. The Kaiser-Meyer-Olkin measure indicates that a value of 0.839 denotes the adequacy of the sample. Bartlett's sphericity test yields a p-value of 0.00. A favourable result from Bartlett's sphericity test indicates that the correlation matrix is not an identity matrix.

INDEPENDENT VARIABLE

Construction Technology: Construction technology refers to the cutting-edge equipment and techniques that are used by the industry to make projects more environmentally friendly, safer, and more efficient overall, as well as to save money. When people talk about "construction technology," the researcher are referring to these. It is not the intention of these apps and technologies to replace trained construction personnel; rather, the researcher will simplify the areas of the job that require the greatest amount of labour and are the most hazardous. Modern construction workers rely on a broad variety of hardware and software tools that are included inside their "toolbox" in order to carry out duties such as planning, designing, building, and managing construction projects. These items are included in their "toolbox." Construction technology has not only made building operations more efficient by supplying tools, equipment, and software programs, but it has also streamlined the processes that take place before construction starts. This is because construction technology has made it possible to provide these things. Construction managers and their teams have the ability to get off to a strong start with each phase of a project if the researcher make use of technology that facilitate bid management, document organisation, and communication. Applications for project management that are compatible with mobile devices, intelligent tools and equipment, digital blueprints, autonomous machinery, and 3D printing technology, which enables the prefabrication of building materials that are both affordable and of high quality, are some of the most revolutionary developments in the construction industry. These technologies have the potential to revolutionise the construction industry (He et al., 2021).

FACTOR

Building Information Modeling: The process of creating and maintaining digital models of a building's or other physical asset's or facilities physical and functional features is known as building information modelling. Tools, methods, technologies, and contracts are all necessary for building information modelling. In order to aid in decision-making pertaining to a constructed asset, building information models may be retrieved, distributed, or networked. These files often include proprietary data and are in proprietary formats. Building information modelling software is used by many entities for the following purposes: planning, designing, constructing, operating, and maintaining buildings and other physical infrastructures, including but not limited to: water, sewage, electricity, gas, communication utilities, roads, trains, bridges, ports, and tunnels (Kato & Wang, 2022).

DEPENDENT VARIABLE

High Rise Building in Hong Kong: By 2025, 567 of Hong Kong's more than 9,000 high-rise projects will be more than 150 meters (492 feet) tall, with over 4,000 of them being skyscrapers, according to the Council on Tall projects and Urban Habitat. The 108-story International Commerce Centre, standing at 484 meters (1,588 ft), is both Hong Kong's tallest building and the thirteenth tallest in the world. Hong Kong continues to hold the title of tallest urban agglomeration on Earth, with a total built-up height of over 333.8 km (207 miles) from its numerous buildings. Furthermore, with more people living on the fifteenth level or above, and more buildings measuring 100 m (328 ft) and 150 m (492 ft) in height, Hong Kong is the only metropolis in the world to rival this. The city's dense population is reflected in this. Although most of Hong Kong's buildings are situated on Kowloon and the northern shore of Hong Kong Island, there are a few new satellite towns in the New Territories, such as Tsuen Wan and Sha Tin. The investigator may come upon more skyscrapers in the areas around the MTR stations and along the southern coast of Hong Kong Island (Kwok et al., 2024).

Relationship between Building Information Modeling and High Rise Building in Hong Kong: Building Information Modelling, more often referred to as BIM, is a digital process that encompasses the creation of full three-dimensional models of a building as well as the continuing maintenance of these models. These models include information that contains both graphical and non-graphical facts about the building over its entire history. This information is contained in what is included in these models. This encompasses all of these processes, which include designing, constructing, utilising, and maintaining the structure. The whole of these procedures is included in this article. Building information modelling is an extremely important component in the construction of high-rise structures in Hong Kong. This is due to the fact that it has the capacity to enhance project management, reduce the number of errors that occur, speed up the construction process, and supply stakeholders with assistance in making decisions that are better informed. With regard to the construction industry in Hong Kong, there are a number of challenges that must be overcome. The fact that there is a limited amount of land that is available, the fact that there are stringent limitations, and the fact that the development is fairly thick are all examples of these hurdles. The construction of high-rise

buildings necessitates the use of a wide range of design skills, the construction of intricate structures, and the completion of the project under stringent time constraints. In spite of the fact that high-rise structures are the most typical solution to the issue of limited space, this is the situation that has arisen. Building Information Modelling provides architects, engineers, contractors, and other stakeholders with a unified digital platform that enables them to collaborate in real time, identify design flaws at an earlier stage, and practise construction sequences before work begins on-site. This is one of the ways that. Building information modelling offers solutions to these concerns. Additionally, because of this platform, the researcher are able to rehearse building sequences before the actual work starts on-site. As far as the construction of high-rise buildings in Hong Kong is concerned, Building Information Modelling has already shown that it is of immense use. Some examples of the advantages that have emerged from its implementation include the formation of more accurate quantity estimates, the decrease of the amount of rework that was caused by design discrepancies, and the contribution to the inclusion of sustainability measures. All of these benefits have been a direct consequence of the deployment of the system. When Building Information Modelling was integrated with intelligent construction technologies such as augmented reality and the Internet of Things, the result was an improvement in quality control as well as safer working conditions. Utilising these technologies allowed for the successful completion of this task. Building Information Modelling may be useful in a variety of contexts, including the management of facilities, the planning of maintenance, and the optimisation of energy use during the working phase. Each of these characteristics is very important with regard to the performance of high-rise buildings throughout the course of their expected lifespan. On the other hand, the application of Building Information Modelling in Hong Kong's high-rise buildings carries with it a number of new challenges in addition to those that have previously been highlighted. Some of the factors that contribute to the challenges include, for example, the high cost of software and training, the fact that traditional construction businesses do not want to change their technology, and the need for all project teams to adhere to the same regulations. All of these factors add to the problems. The challenges are caused by a number of variables, some of which are only mentioned here. It is abundantly evident that Hong Kong's corporate leaders and government officials have a strong commitment to digital transformation, despite the challenges that the researcher are now encountering. This is the case despite the fact that the researcher are currently confronting problems. This is being accomplished via the implementation of training programmes and activities within the public sector that are geared towards improving the usage of Building Information Modelling. In conclusion, Building Information Modelling and high-rise constructions in Hong Kong are both activities that are of important and strategic character. Both of these endeavours are very important. Building Information Modelling has the ability to make it easier to create high-rise buildings that are not only more accurate but also more efficient and less destructive to the environment. Furthermore, these buildings might be more environmentally friendly. It is an instrument that is essential for the ongoing efforts that the city is making to modernise its construction industry

and improve the quality of the built environment. This is because of the reasons stated above (Lam et al., 2023).

This theory, developed from the preceding debate, investigates the relationship between building information modeling and high rise building in Hong Kong.

"H_{01}: There is no significant Relationship between Building Information Modeling and High Rise Building in Hong Kong."

"H_1: There is a significant Relationship between Building Information Modeling and High Rise Building in Hong Kong."

Table 2. H1 ANOVA Test.

ANOVA					
Sum					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	39588.620	469	4659.539	794.329	.000
Within Groups	492.770	545	5.866		
Total	40081.390	1014			

This study has significant results. The F value of 794.329 is almost statistically significant, since the p-value of 0.000 is less than the 0.05 alpha threshold. Hence, the researcher accept *"H_1: There is a significant Relationship between Building Information Modeling and High Rise Building in Hong Kong."*

DISCUSSION

The results of this study indicate that the skyscraper sector in Hong Kong has been significantly impacted by modular integrated construction. This is the conclusion that can be drawn from the researcher's findings. That this is the case is shown by the findings that were obtained from the inquiry. When it comes to meeting the requirements of cities, which include a large number of people living in a relatively small area, a scarcity of land that is ideal for development, and an urgent need for housing, conventional construction techniques are typically slow, inefficient, and disturb the environment. These are all factors that contribute to the challenges that cities face. This is a list of all the variables that contribute to the difficulties that cities are confronted with. The following is a list of all the many factors that contribute to the challenges that cities are now facing. Modular integrated construction is an appropriate option for the construction of massive structures in densely crowded cities. This is due to the fact that it decreases the amount of time that projects require to complete, it improves quality control, and it makes the site safer. This is due to the fact that it decreases the amount of time that is required to complete their tasks. The utility of modular integrated construction has already been proved in Hong Kong via projects such as InnoCell, which was able to achieve its environmental objectives and complete the project many months ahead of schedule. The researcher is able to speed up the

construction process, decrease the number of workers who are necessary, and significantly improve the safety of the working environment when the researcher employ modular building technologies.

CONCLUSION

A lot of people are worried about how dangerous, labour-intensive, and ecologically destructive the building industry in Hong Kong is. Conventional building methods are still used for the majority of buildings. These methods are labour-intensive and entail cast-in-situ concrete, wood formworks and wet trades. When contrasted with conventional construction methods, the case studies proved that prefabrication provided substantial benefits. To achieve this higher standard, the precast parts were mass-produced in a factory environment subjected to stringent quality control measures. Due to the fact that the components were made off-site using prefabrication technology, there was no longer any requirement for personnel to be at heights on-site during the manufacturing and fabrication of building components with specific shapes and curves. There were significant environmental benefits to using prefabricated components on-site. Consequently, the atmosphere improved in terms of cleanliness and safety. Prefabrication adds very little to the cost of a construction compared to the conventional approach. This additional cost would be more than covered by the time savings achieved during construction. Site quality and environmental benefits are substantially improved. Considerations like as early decision-making, scheduling, logistics, and site access/storage of prefabricated components in densely populated urban areas were significant when considering the use of prefabrication. A major criticism levelled against prefabrication was the perceived need of making snap decisions. Building projects in Hong Kong may see more prefabrication due to improved incentives and the aim of an environmentally aware construction industry.

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