Applied Science and Innovative Research
ISSN 2474-4972 (Print) ISSN 2474-4980 (Online)
Vol. 8, No. 4, 2024
www.scholink.org/ojs/index.php/asir

Original Paper

Application of BIM Technology in Construction Engineering

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Received: October 20, 2024 Accepted: November 15, 2024 Online Published: November 21, 2024

doi:10.22158/asir.v8n4p138 URL: http://doi.org/10.22158/asir.v8n4p138

Abstract

Building Information Modeling (BIM) technology has become a transformative tool in construction engineering, enabling enhanced efficiency, collaboration, and project management. This paper explores the application of BIM in various aspects of construction, including design optimization, scheduling, cost estimation, and facility management. The use of BIM allows for better visualization, clash detection, and data integration, significantly reducing errors and improving decision-making. Despite its numerous benefits, challenges such as high implementation costs, skill gaps, and resistance to change hinder its widespread adoption. By addressing these issues and leveraging emerging technologies like artificial intelligence and IoT, BIM is set to play a critical role in advancing sustainable and smart construction practices.

Keywords

BIM, construction engineering, efficiency, collaboration, sustainable construction

1. Introduction

1.1 Background of Study

The construction industry, a cornerstone of global economic development, faces mounting pressures to deliver projects that are more efficient, cost-effective, and environmentally sustainable. Increasingly complex designs, tighter deadlines, and a growing demand for resource conservation necessitate innovative approaches to project management. Building Information Modeling (BIM), a digital technology that integrates multidisciplinary data into a single coherent model, has emerged as a game-changer. By offering enhanced visualization, coordination, and data-driven decision-making, BIM addresses many of the traditional challenges in construction engineering.

1.2 Current Status and Trends

BIM has gained significant traction worldwide, with its adoption driven by the need to improve construction processes and outcomes. Developed countries, such as the United States, the United Kingdom, and Singapore, have made BIM usage mandatory for public projects, setting benchmarks for

its application. In practice, BIM is widely used in architectural design, structural analysis, construction scheduling (4D BIM), cost estimation (5D BIM), and post-construction facility management. Additionally, its ability to detect clashes between systems has substantially reduced errors and delays. Despite its advantages, BIM implementation remains uneven across regions and sectors. Developing countries face barriers such as high costs, limited technical expertise, and resistance to change, hindering widespread adoption.

The evolution of BIM technology is closely tied to advancements in related fields. Combining BIM with artificial intelligence (AI), Internet of Things (IoT), and augmented reality (AR) enhances its analytical capabilities and supports smart construction initiatives. For example, AI can improve design optimization, while IoT enables real-time monitoring of construction sites. Cloud technology allows for seamless sharing of BIM models, enabling better collaboration across geographically dispersed teams. BIM is increasingly being used to design energy-efficient buildings and optimize resource usage, aligning with global sustainability goals. Governments and industry organizations are establishing BIM standards and guidelines to encourage its adoption and integration across projects.

1.3 Summary

The continuous development of BIM technology and its integration with other digital innovations will transform construction engineering. While challenges remain, the potential for BIM to improve efficiency, reduce costs, and enhance sustainability makes it a critical component of modern construction practices. By understanding its current state and future trends, stakeholders can better leverage BIM to address the demands of a rapidly evolving industry.

2. Literature Review

2.1 Obesity

Webster's Dictionary defines obesity as a state of excess accumulation and storage of fat in the body. Obesity is a chronic metabolic disorder characterized by an increase in the number and/or volume of adipocytes. The global prevalence of obesity has nearly doubled since 1980 and is now an epidemic that threatens public health. In 2008, more than 1.4 billion adults worldwide were overweight, of which approximately 200 million men and 300 million women were obese (World Health Organization, 2016). Overweight and obesity are the fifth leading risk factor for death worldwide (World Health Organization, 2016). Overweight and obesity are becoming more common in low- and middle-income countries, a problem once thought to be a problem in high-income countries.

The initial stage in the clinical evaluation of obesity and overweight is a measurement of the patient's height and weight. In 1908, Symonds reported the results of a large prospective study of weight and mortality in New Jersey, arguing that weight was partly related to height and age (Azizi, Azadbakht, & Mirmiran, 2005). Subsequently, obesity was defined as being related to ideal body weight. Later, the journal Diet and Health questioned the use of an ideal body mass index and suggested that a healthy or good weight range was associated with lower mortality. Afterwards, the body mass index (BMI)

replaced the assessment of obesity, which is the weight (kg) divided by the height (meters) squared. The index was first used in 1842, when the Belgian mathematician Quetelet (1842) discovered that in people who he thought had a normal frame, the weight was proportional to the square of the height. In the 1970s, several epidemiological studies used BMI to demonstrate the link between obesity and mortality, cardiovascular disease, diabetes, and many other obesity-related diseases. With the help of experts from around the world, the World Health Organization (WHO) defined obesity as BMI>30 in 1997. This definition also describes other degrees of obesity, such as overweight and obesity grades I and II.

Obesity can be broadly classified into two categories: overweight and obesity. The measurement methods of obesity can be divided into two categories: simple measurement method and precise measurement method. Simple measurement methods include calculating body mass index and measuring the thickness of skinfolds, etc.; precise measurement methods include computed tomography and magnetic resonance imaging techniques. Although the precise measurement method has the advantages of high measurement accuracy, it is too expensive and difficult to operate. The body mass index has the advantages of low cost, easy operation, and can more concisely and intuitively reflect the obesity degree of an individual or group. It has become one of the most popular weight measurement methods in the world.

The understanding of the relationship between obesity and health has not been recognized by the medical community for a long time. It wasn't until 1985 that a committee of experts from the National Institutes of Health agreed that there was already substantial evidence that obesity had adverse effects on health and longevity, and defined it as the body's storage of excess energy in the form of fat. In 1997, the WHO also clearly declared obesity as a disease, and obesity is closely related to health.

The global prevalence of obesity has nearly tripled since 1975, and it is defined as the fifth leading cause of death globally. As of 2016, there were more than 1.9 billion overweight people in the world, of which 650 million were obese. The overweight population accounts for about 39% of the world's population, and the obese population accounts for about 13% of the world's population (11% of obese men and 15% of obese women). Since 2015, China has become the "world's first fat person" and is the country with the largest number of obese people in the world. There are about 43.2 million obese men and 46.4 million obese women, accounting for 16.3% and 12.4% of the world's total. The number of severely obese men and women ranks second in the world, after the United States. In the past three decades, the obesity population in my country has increased by 10% every 10 years, which is an alarming growth rate. In recent years, with the improvement of people's living standards, the diet structure has undergone great changes. High sugar and high nutrients have become the main components of food for people, especially young children, resulting in excess nutrition and a large increase in obesity. At present, the number of obese people in China has exceeded 70 million. The detection rate of simple obesity in preschool age (0-7 years old) has remained high for a long time, with an average of 2.0% in the country and 17.5% in the highest area. Up to 20% of primary school students

(11-13 years old) are obese, and 33% of the elderly are on the rise.

Obesity not only affects people's physical beauty and restricts behaviour, but also poses a great threat to human health. Obesity in adults can lead to chronic diseases such as coronary heart disease, heart disease, diabetes, etc., which are only common in middle-aged and old age, to an earlier age of onset. Obesity is known to be a precipitating factor for heart disease, and the hemodynamic changes that accompany obesity are the cause of various cardiac dysfunctions. With weight gain, blood volume and cardiac output also increase, which can easily lead to elevated blood pressure, overburden the heart, enlarge the heart, and ultimately lead to heart failure. In addition, obesity is also prone to cause liver and gallbladder lesions, which have adverse effects on lung function. At the same time, obesity can also cause a series of psychological problems and cognitive impairment, such as low self-esteem, depression, executive function decline, memory decline, etc., which further affects its social function. According to statistics, 60% of obese people can only live to the age of 60 or less, only 10% of them can live to the age of 80, and 30% of those who are not obese can live to the age of 80 years or older, which is the most common cause of obesity 3 times. The treatment of obesity requires a lot of money. For example, in the next 25 years in the United States, the cost of treating overweight middle-aged women will reach 16 billion US dollars, and it will be used for type II diabetes, coronary heart disease, coronary heart disease, diabetes, coronary heart disease, etc. The annual direct costs of hypertension and gallstones are estimated at $22.62 billion, compared with $5.89 billion for those with a BMI of 23-24.9. European and American countries have conservatively estimated the economic loss of obesity, which is about 3%-8% of total health care expenditure. As a result, various interventions are being implemented around the world to reduce obesity rates, but because the main factors affecting obesity in different age groups are different, interventions are not effective for everyone. Therefore, understanding the main influencing factors of adult obesity can be more targeted to implement intervention programs for adult obesity.

2.2 Epidemiological Characteristics of Adult Obesity in China

Due to the different survey time, sampling method, age group of respondents, and obesity evaluation criteria, there are some differences in the reports on the specific values of overweight and obesity rates in Chinese adults, but the general rule is that both overweight and obesity rates increase with age.

Wang Wenjuan et al. used the 1997 China Diabetes Epidemiological Survey data and adopted "international standards" to assess the prevalence of overweight among 42,751 community residents aged 20-74 who lived for 5 years or more in 11 provinces (cities) in China (Bruch, 1943). The results of the analysis of the prevalence characteristics of obesity and obesity show that the total overweight prevalence rate of 11 provinces (cities) is 21.51%, and the obesity prevalence rate is 2.92%. After the national population standardization in 1990, the overweight and obesity prevalence rates were 18.28% and 2.48%, respectively. Standardized by the world population in 1992, the prevalence rates of overweight and obesity were 18.61% and 2.49%, respectively. Overall, the prevalence rates of overweight and obesity in women (21.71% and 3.73%) were significantly higher than those in men

(21.25% and 2.11%), but the growth rate of men is higher than that of women, and urban men (25.26%) are higher than women (24.20%). The prevalence of obesity increases with age, showing that the north is high and the south is low, women are high and men are low, the urban is higher than the rural, the elderly the popular characteristics of people above young people.

The Chinese Population Trend Forecast of Cardiovascular Diseases and the 21st Century Prevention Strategies Research Collaborative Group used "international standards" to quantitatively estimate the overweight and obesity rates of 15389 middle-aged people aged 35-59 in 15 populations from 1981 to 1998 (Blauw, Aziz, Tannemaat, Blauw, de Craen, Pijl, & Rensen, 2017). It is found that there are great differences in the overweight and obesity rates of the population in different regions. In Beijing and other overweight areas, the overweight rate of middle-aged people has exceeded 50%; compared with the late 1980s and early 1990s, both overweight and obesity rates rose sharply in the late 1990s. The general trend is that the north is higher than the south, large and medium cities are higher than inland rural areas, and women are higher than men.

2.3 Research Status of the Influencing Factors of Obesity Level

The early studies of overweight and obesity, which were initially studied in the medical and public health fields, focused on the causes of overweight or obesity from an individual perspective. It has since been recognized that in addition to individual genetic predispositions, environmental changes are also a major factor in the development of overweight and obesity. As a result, experts and scholars from different fields such as sociology, psychology, behaviour, geography and urbanism have begun to focus on the underlying and environmental mechanisms of the problem of overweight and obesity, which has now developed into a multi-disciplinary and multi-disciplinary cross-section of research. In the context of rapid global economic development and urbanization, people's lifestyles have also adapted and changed, from the physical labour of the agricultural and industrial era to the mental labour of the information age, and the change in sedentary work and lifestyles and dietary structure has led to changes in the health status of the population, including the occurrence of overweight and obesity. It has been suggested that the current dramatic increase in the overweight and obese population is not due to individual genetic mutations, but rather to environmental changes in the availability and cost of food, the physical environment and social factors (Barreto, Passos, & Lima-Costa, 2003).

Many studies have proposed systematic analytical frameworks to elucidate the determinants of overweight and obesity in the population. These frameworks mainly involve genetic susceptibility, behavioural patterns, environmental regulators, environmental drivers, and system drivers (Cuong, Dibley, Bowe, Hanh, & Loan, 2007). In the field of biomedicine, a lot of research has been done on the genetic and biological attributes of overweight and obesity in individuals. Obesity has an intergenerational genetic effect, and parental obesity increases the probability of children being obese by 20% to 40% (Caballero, 2005).

Diet and behaviour changes induce overweight and obesity. Overweight and obesity occur when a person receives more energy than he or she expends (Chen, 1996). Alterations in human diet are linked

to different patterns of energy intake. From the early collection of human food to today's industrial supply, the energy density of food is gradually increasing. High-sugar, high-fat, deep-processed, and high-volume foods account for a high proportion of modern people's dietary structure. At the same time, changes in eating habits have also led to people get multi-energy (Consultation, 2000). While energy expenditure is mainly related to physical activity, Bruch (1943) found that long-term sedentary life and low levels of physical activity are key factors in the occurrence of obesity based on empirical research on children's physical development. Overweight and obesity are caused by an imbalance between energy intake and expenditure.

Researchers in the field of sociology believe that obesity is not a purely physiological problem, but is also affected by social environment and social structural factors (Fock & Khoo, 2013). Many scholars have focused on the impact of people's socioeconomic status on individual health. Some scholars believe that socioeconomic status is a decisive factor affecting individual health status (GBD 2015 Obesity Collaborators, 2017). There are significant differences in overweight and obesity among groups of different socioeconomic status. However, differences in overweight and obesity among different socioeconomic statuses show different patterns in developed and developing countries. Most empirical studies have shown that there is a negative correlation between socioeconomic status and overweight and obesity in developed countries. On the contrary, most research results show that the relationship between socioeconomic status and overweight and obesity in developing countries is positively correlated, that is, groups with higher socioeconomic status are more prone to overweight and obesity. While there are more detailed empirical studies on developed countries, there is a lack of systematic examination of the relationship between overweight obesity and socio-economic status in developing countries.

At the same time, some scholars have found that obesity may be related to seasonal affective disorder, which is reflected in decreased seasonal daylight hours and increased food intake (Gildner, Liebert, Kowal, Chatterji, & Snodgrass, 2014). Changes in the global climate will also lead to changes in the prevalence of obesity, and related researchers believe that rising global temperatures will lead to the prevalence of global glucose intolerance and various metabolic disorders that are conducive to the occurrence of obesity. The social and cultural environment involves cultural aesthetics, social economy, neighbourhood food environment, etc. Some adults in developing China aspire to be overweight as a symbol of wealth and health, whereas those in developed countries value slimness as a reflection of a balanced diet and active lifestyle (Hosseinpanah, Rambod, & Azizi, 2007). The social environment covers community norms and values related to diet and activity, as well as social support for behaviours such as social networking and recreational walking, with specific influencing factors including the availability of healthy foods, the number of retail food stores, public leisure facilities, etc. The socioeconomic environment is the internal driving factor for the occurrence of overweight and obesity in the population. The changes brought about by the economic transformation will lead to the obesity-prone environment, including the urbanization of the population, the automation of technology,

and the change of eating habits (Jebb, Prentice, Goldberg, Murgatroyd, Black, & Coward, 1996). Lee used traditional OLS and geographically weighted regression to study the associations between population obesity and society, economy, and the environment in 3109 U.S. counties and found that obesity prevalence was influenced by the U.S. natural and recreational built environments (Jackson, Eagle, Leidal, Gurm, Smolarski, Goldberg, C., ... & Eagle, 2009).

2.4 Summary

In summary, in the field of research related to factors influencing obesity levels in China, most scholars have studied the factors influencing obesity levels in young children and adolescents, while most studies on factors influencing obesity levels in adults have been theoretical in nature. Therefore, this study will explore the relationship between these independent variables and body mass index through a machine learning approach, using body mass index as the dependent variable and dietary habits, lifestyle and physical activity as the independent variables, as well as analysing the main influencing factors of obesity levels in adults, so as to provide some effective references for weight reduction in obese individuals.

3. Discussion

3.1 Personal Conditions

As can be seen from Table 4.10, the estimated regression coefficient for males is -4.294, indicating that males have a significant negative effect relationship on obesity level and that males are 0.01 times more likely than females to have at least one grade lower in obesity after adjusting for gender variable. Therefore, females are more likely to be obese than males, indicating that hypothesis H1a is valid. Females are more likely to be obese than males and this may be related to the role of females in the family and society, their psychology and their lives (Shebl et al, 2015). Higher levels of obesity in females compared to males may be caused by lower levels of physical activity in females than in males and by females gaining weight at the end of pregnancy but not returning to their pre-pregnancy weight status (Hosseinpanah et al, 2007). Studies have also suggested that gender differences in food intake, such as females choosing to consume more sugary foods, may also be one of the reasons (Azizi et al, 2005).

Although marital status and place of residence passed the correlation test, they were not significantly associated with obesity level, so hypothesis H1c and hypothesis H1e did not hold. There is little research in China on the effect of marital status on obesity levels, but in foreign studies, marital status is closely related to obesity, with people in marital status having higher obesity rates than those not in marital status. The reason for this may be that people who are married are less strict about their appearance and relax their body image management, which leads to obesity. Similar to the conclusion obtained in Figure 4.4, the BMI of married people is relatively high. The results of the current study were not significant, probably because females have become stricter about their body image management nowadays due to the low level of marital happiness. Today's society has long entered the

fast-paced era, and the same is true for marriage. Many young people like to marry in a flash, not only do they have no emotional foundation, but they also have little understanding of each other, which naturally makes divorce much more likely. Moreover, many females are financially independent and have higher and higher requirements for their image, so even if they are married, women are very strict about body management. One of the main reasons for the lack of significant effect of place of residence on obesity levels is that people's standard of living has now improved. Both in urban and rural areas, people have high expectations of their quality of life, so the difference in place of residence has little effect on obesity level.

3.2 Dietary Habits

The variables that had a significant effect on obesity level in this section were frequency of eating high-calorie food, water consumption, eating speed and whether there was a habit of eating late-night supper, meaning that hypothesis H2 was considered to pass the test.

Although the frequency of eating other foods between meals passed the correlation test, there was no significant relationship with the obesity level, so the hypothesis H2d did not hold. The result obtained in Figure 4.10 is that the BMI of people who never eat other food between meals is higher than that of the remaining three frequencies. The reason for this may be that most Chinese adults often do not eat on time because of work, and a long-term irregular diet can seriously affect the digestive function of the intestines, which can become very problematic in cases of excessive hunger, overeating, etc. The two independent variables, frequency of eating vegetables and the number of main meals per day, were excluded before the logistic regression was created, so hypothesis H2b and hypothesis H2c did not hold, which is not quite in line with the results of previously available studies. The lack of correlation between these two variables and obesity levels may be related to too many study variables, unbalanced data or small sample sizes.

There were no variables in this section that had a significant effect with obesity level, which means that hypothesis H3 was rejected. The results in Figure 4.14 show that those who exercised every day had a higher BMI, which is probably related to their dietary habits. The aim of exercise is to achieve a more toned body and to reduce BMI requires a combination of diet and exercise. The relationship between hours of technology equipment use and BMI is obtained from Figure 4.15. The lowest BMI was found for those with excessive hours of technology equipment use, which is grossly inconsistent with previous research findings, the reason for which may be due to data imbalance. Those who chose a mode of travel that required a certain amount of exercise had a relatively low BMI, which is consistent with the results of previous studies. However, there was no significance between this variable and obesity level and it is likely that this result was due to the inadequate sample size of this study.

The three independent variables of whether to monitor calories, alcohol and sleep quality were removed before the logistic regression model was built, so Hypothesis H4b, Hypothesis H4c and Hypothesis H4e were not valid. It is clear from Figure 4.18 that whether or not calorie intake was monitored did not have a significant effect on BMI, so the variable was not significantly associated

with obesity level. The sample size of the data collected with an 'always' drinking frequency was too small, resulting in an imbalance in the data and the final findings being inconsistent with previous studies. In Figure 4.21 though it is shown that the better the quality of sleep, the lower the obesity level. However, the quality of sleep is influenced by many factors, including gender, which is associated with sleep quality and obesity, and gender may be an effect modifier in the relationship between sleep quality and obesity (Gildner et al., 2014).

As shown in Table 5.1 for the hypothesis results, all hypotheses were accepted except for the main hypothesis H3 which was rejected. Among them, nine branching hypotheses were accepted, namely H1a, H1b, H1d, H2a, H2e, H2f, H2g, H4a and H4d. Age, gender, family history of obesity, frequency of eating high-calorie foods, water consumption, eating speed, whether or not to eat late-night supper, whether or not to smoke and whether or not to stay up late regularly were all significantly associated with obesity level, which is consistent with previous findings in Chapter 2. Other factors showed insignificant results in this study, which may be due to the unbalanced data and biased results due to external factors in the collection of data in this study, resulting in some findings of this study being different from previous studies. Studies have found that the greatest impact on obesity level is in the area of dietary habits. Over-eating, which causes the intake of calories to exceed consumption, is an important cause of simple obesity. In addition, unreasonable meal arrangements and fast eating speed, these factors it can also lead to obesity.

4. Conclusion

4.1 Summary of Findings and Implications

This study investigated the relationship between personal conditions, dietary habits, physical activity and living habits and obesity level in a study of Chinese adults. The data used in the study was collected from 581 respondents through a questionnaire, which was then checked for validity at a later stage by eliminating questionnaires with missing options and those with serious problems such as defying logic and selecting all the same options, resulting in 559 valid questionnaires.

This study investigated the relationship between personal conditions, dietary habits, physical activity and living habits and obesity level in a study of Chinese adults. The data used in the study was collected from 581 respondents through a questionnaire, which was then checked for validity at a later stage by eliminating questionnaires with missing options and those with serious problems such as defying logic and selecting all the same options, resulting in 559 valid questionnaires. The effects of personal conditions, dietary habits, physical exercise and living habits on obesity level was examined through descriptive analysis and the construction of ordered multi-class logistic regression model, and nine main factors influencing obesity level in Chinese adults were identified. Based on the results of this study, a number of recommendations can be made for obese people.

At the individual level, healthy dietary and lifestyle habits are useful in maintaining normal obesity levels, with people being advised to limit their intake of high-calorie meals and obtain adequate sleep.

Furthermore, establishing an awareness of exercise and living a healthy lifestyle will not only avoid other chronic diseases, but will also regulate the build up of harmful fat. Although there has been a significant shift in lifestyle and work styles, this study contends that people can still be proactive in improving their sedentary work and recreational lifestyle by being more active during work breaks, such as using less motorised travel when out and about, participating in more sports during leisure time, and reducing the amount of time spent watching videos.

At the social level, the relevant government departments should strengthen publicity and education to popularise the knowledge of obesity, and let more people understand the harm of obesity itself to the human body, and obesity will bring corresponding chronic diseases. In addition, Internet technology can be used to produce obesity knowledge videos and obesity knowledge competitions, so that people can better understand the hazards of obesity; secondly, encourage people to eat a reasonable diet, actively engage in physical exercise and develop good living habits.

4.2 Research Contribution

This study analyses the factors that influence the level of obesity in Chinese adults through four aspects, using data from questionnaires, descriptive analysis and ordered multi-class logistic regression to build a model, and finally proposes some recommendations based on the results of the study. In this study, the effect of each variable on the level of obesity was analysed using ordered multi-class logistic regression. The results showed that age, gender, family history of obesity, frequency of eating high-calorie food, water consumption, eating speed, whether to eat late-night supper, whether to smoke and stay up late had significant effects on obesity level. Specifically, females are more likely to be obese than males; the older the age, the higher the obesity level; people with a family history of obesity are more likely to be obese; people who regularly eat high-calorie foods are more likely to be obese; daily water consumption is inversely related to obesity level; the faster you eat, the higher the obesity level; people who like to eat late-night supper are more likely to be obese; people who smoke are more likely to be obese; people who stay up late often are more likely to be obese. These factors can help obese people to better understand the causes of their obesity, so that they can better reduce their obesity level.

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