Impact of Green Building Technology on Goal Attainment and Efficiency in Construction Industries in North West Nigeria

by

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Abstract

The study was carried out to determine the impact of green building technology on goal attainment and efficiency in the construction industries in North West Nigeria. Three research questions answer The study, while three null hypotheses formulated were testes at 0.05 level of significance. The study adopted descriptive survey design and was carried out in North -West Nigeria. The population for the study were 50, Comprised of 28contractors and 22 engineers. There was no sampling because of manageable size of the population. A 50-item questionnaire was used for data collection. The instrument was validated by three experts Lecturers from department of Industrial Technical Education, University of Nigeria Nsukka, while 0.81 was obtained as reliability coefficient value using Cronbach alpha reliability method. Fifty copies of the questionnaire were administered on the respondent by the researcher and three research assistants. Out of the 50 copies of the questionnaire administered, 48 copies were retrieved indicating 94% rate of return. The data collected were analyzed using mean to answer the three research questions while analysis of variance was employ to test the hypotheses at 0.05 level of significant. The findings on hypotheses revealed that there was no significant difference between the mean responses of the respondents on the goal attainment and efficiency in construction industries for using green building technology. Based on the findings, the study recommended that construction industries in north-west should adopt and utilized green building technology in their construction projects.

Keywords: Green Building Technology, Building Construction, Construction Industries, Goal attainment, Efficiency.

Introduction

Green building technology is becoming increasingly important in Nigeria's construction industries due to its potential to address environmental, economic, and social challenges. Green building technology is a revolutionary approach in the construction industries that focuses on developing eco-friendly and sustainable buildings. According to Razkenari (2022), green building technology is an integrated strategy to construct, maintain, and operate structures in a way that minimizes their environmental impact. Green building technology utilize advanced technologies and materials to reduce energy consumption for heating, lighting, and cooling, often achieving a 15-30% reduction through measures like insulation, natural lighting, and solar panel (Shajal, 2023). Green building technology prioritize occupant health and comfort by improving indoor air quality, acoustics, and access to natural light.

According to Uddin and Elumalai, (2021) Green building technology is use of eco-friendly, locally sourced, and recyclable materials is a crucial aspect of green building technology, reducing the embodied carbon of the construction process. However, the adoption of green building technology practices will significantly transform the construction landscape, which has traditionally relied on conventional methods that often neglect sustainability, and also enhanced the environmental, social, and economic performance of buildings. Therefore, Green Building Technology emphasize on the use of Smart building Technology, Sustainable materials , Waste reduction ,water efficiency by incorporating water-saving fixtures, rainwater harvesting, and grey water recycling systems.

Smart building technology in the construction industries represents a significant evolution in how buildings are designed, constructed, and managed. Smart buildings utilize advanced technologies to enhance efficiency, sustainability, and user comfort through automation and data -driven decision-making. According to Karimi and Nasrolahi (2021)Smart building technology is defined as a structure that integrates automated processes to control various operational systems, including heating, ventilation, air conditioning (HVAC), smart lighting, smart surveillance, security, and safety systems. Smart building Technology is a self-regulate systems based on real-time data, optimizing energy consumption and enhancing occupant comfort. Smart building technology utilize Building Information Modeling (BIM) to create digital representations of physical spaces, facilitating better planning, design, and management (Panteli and Fokaides 2020). Smart building technology are use to reduce energy consumption by optimizing resource usage, which is crucial for sustainability efforts and reducing operational costs. According to Jia (2019), smart building technology is a tool that Continuously monitoring of building systems and enables predictive maintenance, where potential issues can be identified and addressed before they lead to significant problems, such as Siemens digital twin, drones with thermal imaging, and smart thermostats, thus reducing downtime and maintenance costs. Therefore, smart building technology is transforming the construction industry by integrating innovative solutions that promote sustainability, efficiency, and occupant well-being.

Sustainable materials in the construction industries are essential for reducing environmental impact and promoting eco-friendly building practices. According to Soni and Chelliapan (2022) Sustainable materials are Utilizing materials that are sourced locally such as bamboo, reclaimed wood, and recycled glass, metal and plastic to reduces transportation emissions and supports local economies. Thought, Sustainable materials are sourced from renewable or recycled resources, reducing the need for virgin materials. Sustainable materials are Recycled Materials such as recycled steel, glass, and plastics can be repurposed for construction, significantly reducing waste and energy consumption associated with new material production (Sormunen, 2019). However, Sustainable materials are made from hemp fibers, this material is lightweight, insulating, and carbon-negative, making it a sustainable option for building walls. According to Marut etal (2020), sustainable materials are rapidly renewable resource, bamboo is strong, flexible, and biodegradable, making it an excellent alternative to traditional timber. Therefore, Sustainable materials in construction industries continues to rise the industry and expected to witness significant growth in innovative materials and technologies that further reduce environmental impact while meeting the functional needs of modern buildings.

Waste reduction encompasses a variety of methods, including reducing material usage, reusing items, recycling, and designing products with sustainability in mind. According to Yazdani and Lakzian (2023) Waste reduction refers to the strategies and practices aimed at minimizing the amount and impact of waste generated by human activities. Thought, Waste reduction encourages the reuse and recycling of materials, which conserves natural resources and reduces the need for new material extraction. Waste reduction in the construction industries involves minimizing the amount of waste generated during construction project such as excess cement and concrete, surplus steel and metal and unused roofing materials which reduce the environmental impact and promoting sustainability (Bajjou and Chafi2024). However, Waste reduction is essential for conserving resources, saving energy, and mitigating environmental impacts. According to Kabirifar etal (2020), waste reduction involves implementing strategies and practices to reduce the generation of waste during the planning, design, construction, and demolition phases such as brick wood, demolition debris and renovation waste. Therefore, Waste reduction involves designing products and processes to minimize material use and waste generation in the Construction industries.

Construction industries are a vital sector that encompasses the planning, design, construction, maintenance, and operation of physical facilities, including residential, commercial, and infrastructure projects. According to Tekola and Gidey (2019), construction industries play a crucial role in the economic growth of an individual or organization by creating employment opportunities, generating investment, and contributing to the GDP. However implementing lean construction principles and effective project planning and management can lead to significant cost savings and improved project delivery. Ashworth and Perera (2018) stated that, Construction industries involves a wide range of parties including clients, professional advisers, contractors, suppliers, manufacturers, financial institutions, and public authorities, they plays a critical role in economic growth, providing employment opportunities, investment, and supporting government initiatives. Construction industries are essential for providing the physical infrastructure necessary for economic and social development (Iacovidou and Purnell 2016).Therefore, construction industries enhances efficiency and productivity, and also adopt new technologies like Building Information Modeling (BIM), construction management software, and mobile applications. However, construction industries can be in to three categories based on the type of work Building Construction, Infrastructure Construction, and special Trade for goal attainment in the Construction.

Goal attainment in the construction industry involves setting strategic objectives and implementing effective strategies to achieve them. According to Choudhry et al, (2021), goal attainment refers to the achievement of specific objectives and target in the design, construction and operation of sustainable building. It is also a process through which human and other resources are mobilized to achieve collective goals and purposes within a social system. According to Ida et al (2022) goal attainment involves writing down all goals, identifying completed goals, computing the percentage of goals completed, and communicating the results. Though, Goal attainment refers to the achievement of specific, measurable, and desired outcomes in construction project. Goal Attainment is a method used for evaluating outcomes in complex interventions, allowing for flexible and responsive evaluation of Green Building Technology (Zhang, and Ying 2019). Therefore, Goal attainment is a process

of setting and achieving specific objectives within the construction industries, focusing on the development and implementation of innovative technologies, materials, and practices to improve the efficiency, sustainability, and quality of building for positive outcomes in the construction industries.

Efficiency in the construction industry is a critical factor that influences project success, encompassing the effective use of resources to achieve desired outcomes within budget and time constraints. According to Harris and Baldwin (2021) Efficiency in Construction involves optimizing processes to maintain high standards of quality while minimizing costs . Efficiency in construction is defined as the ability to maximize output while minimizing input. Efficiency includes managing time, labor, materials, and equipment effectively to ensure projects are completed on schedule and within budget (Suresh & Sivakumar 2021). Thought, construction industries that operates efficiently can deliver high-quality work consistently, which enhances its reputation and competitiveness in the market. According to Zhang Azhar and Khalfan (2018), efficiency is refers to optimizing resources and workflows to minimize waste, reduce cost and deliver a project on time without compromising quality. It also consist the following factors that influence it which include: Project Planning and Management, Communication, Technology Adoption, Skilled Workforce, Supply Chain Management and Lean Construction Principles. However, efficiency in the construction industries for green building technology has its own benefits which may include: Cost Savings, Timely Project Completion, Quality Assurance, and Sustainability.

Statement of the Problem

Green building technology is becoming increasingly important in Nigeria's construction industry due to its potential to address environmental, economic, and social challenges. The adoption of green building practices will significantly transform the construction landscape in Nigeria, which has traditionally relied on conventional methods that often neglect sustainability. Green building technology in Nigeria's construction industry envisions a transformative approach that integrates sustainability into every aspect of building design, construction, and operation. Green buildings are designed to minimize energy consumption, promote the use of sustainable materials, help to decrease the carbon footprint associated with construction and operation, Cost Savings and Market Demand. Green building practices will create new job opportunities in areas such as renewable energy, sustainable materials production, and energy efficiency. Therefore the implementation of green building technology in Nigeria's construction industries offers significant environmental, economic, and social benefits, paving the way for a more sustainable future.

Despite the important of adoption of Green building Technology has in the construction industries in North-west Nigeria, The adoption of green building technology in Nigeria's construction industry faces several challenges such as High Initial Costs and Limited Financial Incentives. Green building technology often faces challenges of Outdated Building Codes, Lack of Standard Assessment Systems, Limited Awareness and Knowledge, Cultural Resistance, and Inadequate Training. To addressing these challenges it requires a multifaceted approach, including policy reforms, increased awareness and education, and financial incentives to promote the adoption of green building technologies in Nigeria's construction industry.

Therefore, this study sought to determine the impact of green building technology on goal attainment and efficiency in construction industries in North-West Nigeria,

Purpose of the study

The general purpose of this study was to examine the impact of green Building technology on goal attainment and efficiency in construction industries in North West Nigeria. Specifically to examine the impact of:

1. smart building Technology on Goal attainment and efficiency in construction industries.
2. sustainable materials on Goal attainment and efficiency in construction industries
3. waste reduction on Goal attainment and efficiency in construction industries.

Research Questions

The following research questions guided the study:

1. What is the impact of Smart building Technology on Goal attainment and efficiency in construction industries?
2. What is the impact of Sustainable materials on Goal attainment and efficiency in construction industries?
3. What is the impact of Waste reduction on Goal attainment and efficiency in construction industries?

Hypotheses

The following null hypotheses are postulated to guide the study:

1. There is no significant difference in the mean response of building contractors and building engineers on smart building Technology, goal attainment and Efficiency in Construction industries North-West Nigeria
2. There is no significant difference in the mean response of building contractors and building engineers on sustainable materials, goal attainment and Efficiency in Construction industries North-West Nigeria
3. There is no significant difference in the mean response of building contractors and building engineers on west reduction, goal attainment and Efficiency in Construction industries North-West Nigeria

Method

The study adopted descriptive survey design. The study was conducted in North - West Nigeria. The respondents for the study consisted of 50 made up of 28 contractors of construction industries and 22 engineers in North-West Nigeria. There was no sampling since the manageable size of the population. The Instrument used for data collection was well structured questionnaire Titled "impact of green building technology on goal attainment and efficiency (IGGEQ) to ascertain the appropriateness of the instrument, three experts was validated the instrument, from the Department of Industrial Technical Education University of Nigeria, Nsukka Enugu state. In order to ensure the internal consistency of the instrument, the researcher adopted Cronbach Alpha Reliability method. trail-testing of 5 copies in Bauchi state .The reliability coefficient obtained for the two chapters of the questionnaire were 0.79 and 0.69, The overall reliability index for the instrument was 0.74 .

The data collected from the respondents was analyzed using descriptive statistics Research questions were answered using mean and standard deviation. for answering research questions, with a mean response of 3.50 and above was considered as Agree. For testing the null hypotheses, any item with significant or p-value of 0.05 and above is considered significant while any item with significant or p-value of less than 0.05 is considered not significant

Results

Research Question 1

What is the impact of Smart building in construction industries? Technology on Goal attainment and efficiency

Table 1: Mean Responses of the Respondents on Smart building Technology

S/N	Item Statements	Mean	SD	D
1	I find the smart building technology easy to operate during construction tasks.	3.00	1.01	D
2	Interface of smart building technology is user-friendly.	4.04	1.14	A
3	Smart building technology integrates well with existing systems and processes.	4.04	.946	A
4	Smart building technology effectively manages energy consumption	3.10	1.34	D
5	Using smart building technology improves the operational efficiency of construction activities.	1.80	.989	D
6	Smart building technology enhances the utilization of resources on the job site.	2.16	1.26 D	D
7	Smart building technology improves emergency response capabilities during construction	3.92	.965	A
8	I am satisfied with the performance of the smart building technology.	3.78	.910	A
9	I would like to continue using smart building technology in future construction projects.	2.70	1.07	D
10	Using smart building technology positively impacts my productivity on the job.	2.38	1.22	D

Key: X-Men, SD-Standard Deviation, SA-Strongly Agree, A-Agree, U- Undecided, D-Disagree, SD-Strongly Disagree

Data presented in table 1 reveal that mean ratings of the respondents ranging from 1.80 to 4.04. The table shows that items number 2, 3, 7, and 8 were above 3.50 rated as Agreed. While items number 1, 4, 5, 6, 9, and 10 were below 3.50 rated disagree. The result shows that impact of Smart building Technology on Goal attainment and efficiency in construction industries in North-West Nigeria.

Research Question 2

What is the impact of Sustainable materials on Goal attainment and efficiency in construction industries?

Table 2: Mean responses of the respondents on the Sustainable materials

S/N	Item statements	Mean	SD	D
1	I am aware of what constitutes sustainable materials in construction.	2.70	1.07	D
2	I believe that using sustainable materials is important for the construction industry.	2.38	1.22	D
3	Sustainable materials are easy to work with during construction projects.	3.58	1.27	A
4	Sustainable materials integrate well with traditional construction methods.	3.54	1.18	A
5	I have received sufficient training on the use of sustainable materials in construction.	3.46	1.28	D
6	Using sustainable materials significantly reduces the environmental impact of construction projects.	3.36	1.35	D
7	Sustainable materials contribute to the conservation of natural	3.58	1.08	A

	resource			
8	Use of sustainable materials helps minimize waste generated during construction.	3.74	1.06	A
9	Investing in sustainable materials leads to a positive return on investment over time.	3.98	1.09	A
10	Use of sustainable materials enhances the overall quality of the construction projects I work on.	4.24	.846	A

Key: X-Men, SD-Standard Deviation, SA-Strongly Agree, A-Agree, U- Undecided, D-Disagree, SD-Strongly Disagree

Data presented in table 2 reveal that mean ratings of the respondents ranging from 1.80 to 4.04. The table shows that items number 3, 4 7, 8, 9 and 10 were above 3.50 rated as Agreed. While items number 1, 2, 5, and 6, were below 3.50 rated disagree. The result shows that the impact of Sustainable materials on Goal attainment and efficiency in construction industries in North-West Nigeria.

Research Question 3

What is the impact of West reduction on Goal attainment and efficiency in construction Industries?

Table 3: Mean Responses of the Respondents on the West Reduction

S/N	Item statements	Mean	SD	D
1	My construction projects have a comprehensive waste management plan in place.	3.53	1.37	A
2	Designs used in my projects are optimized to minimize waste generation.	3.50	1.30	A
3	Effective scheduling of construction activities reduces unnecessary waste.	2.94	1.31	D
4	Regular monitoring of waste generation is conducted to identify areas for improvement.	2.44	1.29	D
5	I prioritize using materials that are recyclable or made from recycled content.	2.64	1.45	D
6	I consistently order the correct amount of materials to avoid excess waste.	2.72	1.29	D
7	There are initiatives in place to raise awareness among workers about waste reduction strategies.	3.02	1.42	D
8	Employees are actively involved in implementing waste management practices on-site.	2.60	1.37	D
9	Reducing waste has positively impacted the overall costs of my construction projects.	2.66	1.45	D
10	Waste reduction efforts contribute significantly to minimizing the environmental impact of my construction activities.	3.92	1.19	A
11	Builders should Committed to continuing waste reduction practices in future construction projects.	3.78	1.21	A

Key: X-Men, SD-Standard Deviation, SA-Strongly Agree, A-Agree, U- Undecided, D-Disagree, SD-Strongly Disagree

Data presented in table 3 reveal that mean ratings of the respondents ranging from 1.80 to 4.04. The table shows that items number 1, 2, 9 and 11 were above 3.50 rated

as Agreed. While items number 3, 4, 5, 6, 7, 8, and 10 were below 3.50 rated disagree. The result shows that the impact of West reduction on Goal attainment and efficiency in construction Industries in North-West Nigeria.

Discussion of Findings

The results of the analysis of research question one reveal that, the use of Smart building Technology on Goal attainment and efficiency in construction industries Technology helps to develop eco-friendly and sustainable buildings, Smart building technology improves emergency response capabilities during construction. This finding agreed with the submission of Kibert (2016) Considered sustainable construction is green buildings and their proliferation around the world is evidence that the sustainable construction paradigm is being widely accepted as the right solution at the right time. Similarly Shajal (2023) reveal that green buildings prioritize energy efficiency through innovative building envelope design, advanced insulation techniques, and optimized heating, ventilation, and air conditioning (HVAC) systems. Implementation of smart lighting controls, occupancy sensors, and energy management systems significantly optimizes energy usage and minimizes wastage. The findings is in line with Uddin and elumalia (2021) show that considerable amount of building energy savings, and also a significant reduction of embodied energy and carbon footprint by using local construction materials.

This study on research question two identified that impact of Sustainable materials on Goal attainment and efficiency in construction industries such as Investing in sustainable materials leads to a positive return on investment over time, Use of sustainable materials enhances the overall quality and Use of sustainable materials helps minimize waste generated during construction in the construction industries . This is in line with Najjar,(2019) reveal that sustainable building materials can be achieved by optimizing the material selection and assessment of environmental impact via Building Information Modeling and life cycle assessment. Similarly Yu, (2023) described that findings natural resource development has potential to be a significant driver of green economic recovery. Policies to combat energy ineffectiveness should thus check an overworked world-ecology, reduce urban oddities, and encourage ecological learning for a better atmosphere. This is in line with Shah and Wang (2021). described that, Advanced construction techniques, renewable energy resources and recycled materials applications are highly recommended aspects of policy interpretations.

The findings of research question three reveal that, Waste reduction efforts contribute significantly to minimizing the environmental impact of my construction activities and Builders should Committed to continuing waste reduction practices in future construction projects. This findings agreed with the submission of Rose (2018) who affirmed that construction industry uses more resources and produces more waste than any other industrial sector; sustainable development depends on the reduction of both, while providing for a growing global population However, west reduction help guide the judicious adoption of practices to reduce buildings' waste production and greenhouse gas emissions. Similarly Melella. (2021) described that, the overall reduction in the environmental impact of building materials is achieved by establishing sustainable continuity between the end-of-life phase of the building and the production phase of individual building components.

Conclusion

Green building technologies offer numerous benefits, including enhanced energy efficiency, improved occupant health, and reduced environmental impact. These technologies can significantly contribute to

sustainable development goals by minimizing resource consumption and promoting the use of renewable materials. The findings indicate a growing awareness of green building technologies among construction professionals and the general public in North West Nigeria. However, despite this awareness, the actual adoption of green practices remains limited. Factors such as inadequate government support, lack of incentives, and insufficient training opportunities hinder the widespread implementation of green technologies in construction projects.

Recommendations

Based on the findings from this study the following recommendations were made:

1. Establishing clear policies that promote green building practices through incentives and subsidies can encourage wider adoption among developers and contractors
2. Implementing educational programs for construction professionals on the benefits and implementation of green technologies is essential. Such as Workshops, seminars, and hands-on training can improve knowledge dissemination.
3. Increasing public awareness through community engagement initiatives can foster a culture that values sustainability in construction practices.

REFERENCES

Ashworth, S., Bueno de Mesquita, E., & Friedenberg, A. (2018). Learning about voter rationality. *American Journal of Political Science*, *62*(1), 37-54.

Bajjou, M. S., & Chafi, A. (2024). Enhancing environmental sustainability through leanconstruction principles: an industry-based SEM analysis. Engineering, Construction and Architectural Management.

Choudhry, S., Patritti, B. L., Woodman, R., Hakendorf, P., & Huang, L. (2021). Goal Attainment: A Clinically Meaningful Measure of Success of Botulinum Toxin-A Treatment for Lower Limb Spasticity in Ambulatory Patients. *Archives of Rehabilitation Research and Clinical Translation*, *3*(2), 100129–100129. https://doi.org/10.1016/j.arrct.2021.100129

Harris, F., McCaffer, R., Baldwin, A., & Edum-Fotwe, F. (2021). *Modern construction management*. John Wiley & Sons.

Ida, Hauger, S. L., Forslund, M. V., Ingerid Kleffelgård, Brunborg, C., Andelic, N.,

Sveen, U., Søberg, H. L., Solrun Sigurdardottir, Cecilie Røe, & Løvstad, M. (2022). Goal Attainment in an Individually Tailored and Home-Based Intervention in the Chronic Phase after Traumatic Brain Injury. *Journal of Clinical Medicine*, *11*(4), 958–958. https://doi.org/10.3390/jcm11040958

Iacovidou, E., & Purnell, P. (2016). Mining the physical infrastructure: Opportunities, barriers and interventions in promoting structural components reuse. *Science of the Total Environment*, *557*, 791-807.

Jia, M., Komeily, A., Wang, Y., & Srinivasan, R. S. (2019). Adopting Internet of Things for the development of smart buildings: A review of enabling technologies and applications. Automation in Construction, 101, 111-126.

Kabirifar, K., Mojtahedi, M., Wang, C., & Tam, V. W. (2020). Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: A review. Journal of cleaner production, 263, 121265.

Karimi, R., Farahzadi, L., Sepasgozar, S. M., Sargolzaei, S., Sepasgozar, S. M. E., Zareian, M., & Nasrolahi, A. (2021). Smart built environment including smart home, smart building and smart city: definitions and applied technologies. Advances and Technologies in Building Construction and Structural Analysis, 179.

Marut, J. J., ALAEZI, J. O., & OBEKA, I. C. (2020). A review of alternative building materials for sustainable construction towards sustainable development. Journal of Modern Materials, 7(1), 68-78.

Panteli, C., Kylili, A., & Fokaides, P. A. (2020). Building information modelling applications in smart buildings: From design to commissioning and beyond A critical review. Journal of Cleaner Production, 265, 121766.

Razkenari, M., & Kibert, C. J. (2022). A framework for assessing maturity and readiness towards industrialized construction. *Journal of Architectural Engineering*, *28*(2), 04022003.

Soni, A., Das, P. K., Hashmi, A. W., Yusuf, M., Kamyab, H., & Chelliapan, S. (2022). Challenges and opportunities of utilizing municipal solid waste as alternative building materials for sustainable development goals: A review. Sustainable Chemistry and Pharmacy, 27, 100706.

Sormunen, P., & Kärki, T. (2019). Recycled construction and demolition waste as a possible source of materials for composite manufacturing. Journal of building engineering, 24, 100742.

Suresh, d. s. a., & sivakumar, a. (2021). An Empirical Study, Analysis and Investigation about Impact of Schedule Management Plan in Project Management Effectiveness Using Structural Equation Modeling. *Int J Adv Eng Manag*.

Shajal, A. K. (2023). The Impact of Green Buildings on Urban Sustainability and Energy Consumption. *Journal of Sustainable Urban Futures*, *13*(6), 11-21.

Uddin, M. N., Wei, H. H., Chi, H. L., Ni, M., & Elumalai, P. (2021). Building information modeling (BIM) incorporated green building analysis: An application of local construction materials and sustainable practice in the built environment. *Journal of building pathology and rehabilitation*, *6*, 1-25.

Yazdani, S., & Lakzian, E. (2023). Conservation; waste reduction/zero waste. In Pragmatic engineering and lifestyle (pp. 131-152). Emerald Publishing Limited.

Zhang, Y., Wang, H., Gao, W., Wang, F., Zhou, N., Kammen, D. M., & Ying, X. (2019). A survey of the status and challenges of green building development in various countries. *Sustainability*, *11*(19), 5385.

Zhang, X., Azhar, S., Nadeem, A., & Khalfan, M. (2018). Using Building Information Modelling to achieve Lean principles by improving efficiency of work teams. *International Journal of Construction Management*, *18*(4), 293-300.