



INTERNATIONAL JOURNAL OF MANAGEMENT STUDIES

<https://e-journal.uum.edu.my/index.php/ijms>

How to cite this article:

Khoo, T. J., Ha, C. Y., Mohd Shafiei, M. W., & Ismail, R. (2024). Analyzing green site management practices in Malaysia: Trends and Insights. *International Journal of Management Studies*, 32(1), 41-60
<https://doi.org/10.32890/ijms2025.32.1.3>

ANALYZING GREEN SITE MANAGEMENT PRACTICES IN MALAYSIA: TRENDS AND INSIGHTS

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Received: 17/3/2022

Revised: 16/8/2024

Accepted: 18/8/2024

Published: 8/1/2025

ABSTRACT

This research explores the current green site management practices (GSMPs) commonly practiced by contractors. While the construction industry has contributed significantly to Malaysia's development, it has also raised various environmental concerns. GSMPs are gaining attention as a solution to these issues. Nevertheless, their implementation faces various challenges, such as financial concerns and a lack of knowledge. A qualitative approach was adopted to focus on contractors' experiences with green practices. Five contractors were randomly selected from the construction sites in Malaysia using the convenience sampling method. These respondents, all at the management level, were well-positioned to provide insights. Data collection continued until no new issues emerged from the interviews. The findings revealed that GSMPs are becoming a current trend within the industry. Contractors are beginning to integrate green practices in their construction activities, focusing on construction site waste management, workforce management, best regulatory practices, site establishment and administration, and site facilities. However, there is a notable lack of awareness and knowledge about these green practices among contractors. The study offers practical implications for the future of GSMPs, highlighting the need for increased understanding and adoption. By elaborating on available practices and their implications, this study aims to encourage broader implementation of GSMPs in construction sites.

Keywords: Construction industry, sustainable, green site management practices, environmentally friendly, Malaysia

INTRODUCTION

Malaysia is experiencing a surge in construction projects aimed at fostering development and progress. However, this growth has also led to environmental damage (Chevallier & Goutte, 2017). Construction activities contribute to pollution and waste, often due to inadequate treatment and management of these byproducts (Onubi et al., 2020c; Yusof et al., 2020). Additionally, construction processes can lead to contamination of water and air, especially when dust and untreated wastewater are not properly managed (Huisingh et al., 2015). Despite efforts by recent graduates to mitigate these environmental impacts, their influence on the construction industry remains limited. This limited impact may be due to a lack of awareness among senior management, highlighting the need for more extensive training (Liao et al., 2021). Furthermore, small and medium-sized enterprises (SMEs) often lack the financial capability to implement green practices effectively and require support from authorities (Tan et al., 2015). To encourage the adoption of green site management practices (GSMPs), it is crucial to recognize and reward firms that actively implement these practices. Awards and incentives can enhance a firm's reputation and promote social performance (Jing, Ismail, et al., 2019). However, rewards alone are insufficient; penalties should also be imposed on stakeholders responsible for environmental damage to ensure comprehensive enforcement of green practices.

GSMPs are crucial for mitigating adverse environmental impacts caused by construction activities while simultaneously enhancing various aspects of corporate performance, including economic, social, and operational performance (Yusof et al., 2020). Implementing green development practices on construction sites should be a priority (Jing, Radzi, et al., 2019). However, not all construction stakeholders are concerned about their environmental responsibilities. Therefore, government intervention through regulatory enforcement is essential to ensure the adoption of green practices and to foster commitment from all stakeholders (Martín-de Castro et al., 2016). In Malaysia, significant strides have been made to advance GSMPs. The government has introduced several initiatives, including the Green Building Index (GBI), Energy Efficiency (EE) standards, and the Building Sector Energy Efficiency Program (BSEEP) in recent years. Additionally, a partnership between the government and the Construction Industry Development Board (CIDB) has been established to explore more effective approaches for achieving green development within the construction industry. Various training programs and seminars have been organized to educate construction stakeholders about sustainable development, leading to increased awareness and adoption of green practices among construction professionals (Chang et al., 2018). This research aims to identify the current GSMPs commonly employed by contractors on construction sites.

LITERATURE REVIEW

The construction sector has played a major role in national development, but it has also led to considerable environmental damage (Owusu-Manu et al., 2023). To address these environmental issues, experts recommend that construction stakeholders adopt green development practices (Chevallier & Goutte, 2017). Green development is defined as development that meets current needs without compromising the ability of future generations to meet their own needs (Onubi et al., 2019). Implementing GSMPs can significantly reduce environmental problems (Chang et al., 2018; CIDB, 2007). However, the adoption of GSMPs is often challenging due to a lack of clear guidelines. Construction site management practices vary widely, with construction site management teams frequently relying solely on their own experience to guide their approach. Although different GSMPs

may be implemented across sites, this research aims to identify the variations in green practices currently adopted and assess their sustainability. One notable approach to GSMPs is the 3Rs concept, which focuses on reducing, reusing, and recycling (Lamprey et al., 2021). These practices can significantly enhance the environmental performance of construction projects (Yusof et al., 2017). Enhanced implementation of GSMPs can lead to better environmental, economic, and social performance for companies (Chang et al., 2018). Furthermore, the level of GSMPs implementation can serve as a benchmark for a firm's corporate social responsibility (Department of Environment, 2010), thereby boosting the firm's reputation (Building and Construction Authority, 2010) while sustaining its environmental performance (Yusof et al., 2017) and economic performance (Karimi et al., 2018).

Government Efforts in Promoting Green Site Management Practices

Construction Industry Development Board

CIDB has implemented several initiatives to promote the adoption of GSMPs across construction sites in Malaysia. CIDB's efforts encompass not only the introduction of green practices and policies but also the consideration of construction materials (Rahim et al., 2023) and the experiences and qualifications of site management teams (CIDB, 2007). The initiatives promoted by CIDB include:

i. Green Contractor Accreditation

The Green Contractor Accreditation program has been introduced to facilitate public access to information about contractors who meet green construction standards. This program enables interested parties to identify and select qualified contractors for green construction projects.

ii. Green Labeling

Green labeling plays a crucial role in identifying the specifications of construction materials. It is essential for construction materials delivered to construction sites to be green-labeled. This practice not only facilitates the work of the site management team and accelerates construction progress but also helps buildings achieve recognition as green buildings by the Green Building Index (GBI). Buildings aiming for high GBI scores must adhere to rigorous green practices, which are evaluated during the certification process (Roh et al., 2018). Furthermore, the Green Performance Assessment System (Green PASS) evaluation system assesses the environmental impact and operational performance of construction projects. This evaluation focuses on carbon emission reduction, aligning with the objectives of the Low Carbon Cities Framework and Assessment System (LCCF & AS) policies (Kementerian Tenaga Teknologi Hijau dan Air, 2012). The Green PASS recognition encourages peer reviews of construction and operational management practices, promoting greater awareness and adoption of GSMPs by highlighting the importance of reducing carbon emissions and addressing environmental impacts in construction activities (Construction Industry Development Board, 2013; SEDA, 2013).

iii. Construction Industry Standard

The Construction Industry Standard (CIS) was developed by CIDB to complement the Green PASS. Based on the principles of the green assessment system for construction projects, the CIS serves as a performance-oriented rating tool to assess the energy efficiency of buildings (APEC,

2019). Additionally, the CIS supports the GBI evaluation by providing an industry-led tool that focuses on green building design performance (SEDA, 2013).

iv. One Stop Learning Centre

The One Stop Learning Centre was established to provide training on GSMPs. Besides training the relevant parties, the center evaluates the knowledge levels of individuals in the construction industry. This dual function helps enhance expertise and ensures that stakeholders are well-informed about GSMPs.

Research and Development on Green Site Management Practices

Government agencies, including CIDB, have actively supported GSMPs by providing funding for research and development in green practices. The Construction Research Institute of Malaysia (CREAM) has also participated in these efforts. Their research focuses on the following areas:

Waste Management

Research in this area focuses on waste minimization and explores the potential for recycling construction materials. This includes both recyclable and non-recyclable materials used on construction sites.

Bill of Qualities

The preparation of the Bill of Quantities (BQ) is mandatory during the tendering stage of construction projects. It is crucial to integrate sustainable practices early in this process. For example, Environmental Protection Works (EPW) should be included to increase the likelihood of adopting GSMPs on the construction site. Furthermore, the Public Works Department (PWD) has incorporated EPW requirements into its tender documentation to encourage the private sector to prioritize these considerations.

Environmental Assessment

Environmental assessments are essential during the pre-construction phase, including both the design and tendering stages. The Environmental Impact Assessment (EIA) and the Environmental Management Plan (EMP) should be included in the tender documentation. Conducting these assessments early allows for effective mitigation of the construction project's environmental impact.

Sustainable Development

Green and sustainable development practices are becoming prevalent in the construction industry due to growing public awareness of the negative environmental impact of construction activities. This shift can be facilitated by adopting various standards and programs, such as the International Environmental Management Standards and the International Organization for Standardization (ISO) standards, like ISO 14001. These standards promote green and sustainable practices within the construction industry.

Industrialized Building System

Implementing the Industrialized Building System (IBS) can significantly improve environmental performance by reducing the raw materials used and minimizing construction waste. By reducing waste, IBS enhances waste management practices, thus driving construction projects toward more sustainable outcomes.

Common Green Site Management Practices

Traditional construction methods involve various elements that can be adapted into GSMPs. These elements can be categorized into three main areas: materials, manpower, and machinery. For effective implementation of these green practices, it is crucial for contractors to have a strong understanding of their applications (Onubi et al., 2020c). Besides that, contractors' willingness to adopt green practices is vital, despite the potential high initial costs and risks that might affect their financial performance. Addressing these concerns with appropriate expertise can help resolve issues and boost contractors' confidence in adopting green practices.

While construction sites may implement a range of GSMPs, this study identifies five key practices that are widely considered effective: Construction Site Waste Management, Workforce Management, Best Regulatory Practices, Construction Site Establishment and Administration, and Site Facilities. These practices in construction sites have been drawn from various sources, including Chang and Kumar (2021), Tawfik Alqadami et al. (2020), Onubi et al. (2020b), and Onubi et al. (2019). This study will further explore these five GSMPs in detail.

Construction Site Waste Management

Construction waste is produced from various activities within a construction project, including remodeling, alteration, repair, and demolition. Construction waste can be categorized into scheduled waste and non-scheduled waste. Additionally, waste can come from the packaging of construction materials such as wood pallets and plastic (Huang et al., 2017). Since construction sites produce a significant volume of waste daily, an effective construction waste management plan is crucial. Such a plan should include strategies for diverting reusable construction waste to other construction sites or repurposing it in landfills (Construction Industry Development Board, 2013; Onubi et al., 2019).

i. Scheduled Waste

Scheduled waste refers to construction waste that requires ongoing management due to its hazardous nature. This type of waste, which includes materials like polymers and paint, can cause risk to human health and the environment if not handled properly (Huang et al., 2017). To manage scheduled waste properly, it is essential to communicate information about the associated hazards through clear labels. The site management team should appoint licensed contractors to manage the transportation, removal, and disposal of scheduled waste at designated facilities.

ii. Non-scheduled Waste

Non-schedule waste primarily consists of residual waste, including rubbish from construction workers, biomass from workers' accommodation, and other non-hazardous materials (Huang et al.,

2017). Thus, the site management team should utilize the principles of reduce, reuse, and recycle to handle non-scheduled waste effectively (Ajayi et al., 2016). Proper management involves understanding and categorizing different types of non-scheduled waste and designating temporary storage areas before final disposal. This approach helps to protect the environment and streamlines waste handling.

iii. General Waste

Construction activities, especially demolition, renovation, and refurbishment, frequently produce waste (Huang et al., 2017). Demolition, particularly, is a common aspect of construction due to errors or updates needed during the project. Proper planning is essential for managing general waste from demolition to address all aspects of the project effectively. Although some factors are unpredictable, minor adjustments to waste management of general waste can help mitigate negative impacts on triple project constraints—cost, scope, and time (Construction Industry Development Board, 2013). A detailed demolition plan provides guidelines for segregating and maximizing the reuse and recycling of general waste from demolition activities (Bhardwaj, 2016). Moreover, such a plan can hasten the demolition process (Zarei et al., 2018). Implementing a pre-demolition audit, sequential demolition approach, and a site waste management plan is crucial for effective recovery and management of general waste (Ajayi et al., 2016; Construction Industry Development Board, 2013).

iv. Arrangement of the Used Materials

There are a lot of used materials in construction projects such as plywood, steel reinforcement bars, and concrete waste. Reusing and recycling these materials can improve economic performance. If these materials are to be resold as scrap, it is important to inform the relevant parties promptly to facilitate proper planning for logistics and storage (Ajayi et al., 2016). A list of reusable, recyclable, and re-marketable materials should be provided to contractors during the tendering stage, enabling them to plan costs effectively for the project (Construction Industry Development Board, 2013). Defining the ownership of these scrap materials clearly in the contract documents can prevent future disputes. According to the Shooshtarian et al. (2020), the ownership of scrap materials typically belongs to the contractors.

Workforce Management

Effective workforce management is crucial for ensuring the health, welfare, and overall working conditions of construction workers. To safeguard workers with insurance, it is mandatory for all site personnel to own a valid CIDB green card. This card, issued by CIDB, verifies that workers are qualified to enter construction sites, have the necessary knowledge, and are protected by insurance. Furthermore, regular induction and training are essential to raise workers' awareness of GSMPs, as well as health and safety issues. Providing basic amenities such as clean water supply, sanitary facilities, and canteens is also necessary to ensure a satisfactory living environment for construction workers.

Given the high-risk nature of most construction activities, the provision of Personal Protective Equipment (PPE) is mandatory for construction workers. Additionally, first aid facilities must be made available to provide immediate assistance in case of injury. Moreover, morning exercise during toolbox meetings can help maintain workers' health. Furthermore, recognizing and rewarding outstanding performance can also motivate workers to perform efficiently.

With large numbers of construction workers on site, implementing disciplinary procedures is crucial. Assigning specific job responsibilities to supervisors can help manage site cleanliness and personal safety while maintaining green performance standards (Department of Environment, 2010). Accommodation blocks for construction workers can be divided into smaller sections for easier management and improved efficiency in supervising green performance (Construction Industry Development Board, 2013).

Best Regulatory Practices

To ensure excellent green performance in construction sites, adopting the best regulatory practices is crucial. Chang et al. (2018) supports the implementation of these practices, also known as GSMPs, as they help maintain a high-quality environment around construction sites. Furthermore, GSMPs serve as government tools for creating better regulations, thereby assisting the construction site management team to achieve public policy objectives. Looking ahead, GSMPs are expected to become the standard due to their role in promoting transparency, information accessibility, and social benefits while reducing resource consumption (OECD, 2011). Continuous efforts to develop Best Regulatory Practices are crucial for enhancing regulatory efficiency. Once established, these practices can also help reduce unnecessary government costs related to frequent site inspections, which can impede economic growth. In short, Best Regulatory Practices include the presence of an internal agency or mechanism to coordinate regulatory work, conducting impact assessments of both new and existing regulations, and engaging in public consultations for creating and modifying regulations.

Practitioners recognize the value of implementing GSMPs for achieving green performance (CIDB, 2007). To support this, regulatory coherence should be promoted through coordination mechanisms at supranational, national, and subnational levels. This involves addressing regulatory issues, enhancing regulatory coherence, and avoiding duplication (Windapo & Goulding, 2015). For GSMPs to remain effective, strict enforcement by the government is necessary to protect the public interest and the benefits for practitioners (Saeed et al., 2018). Besides government oversight, periodic expert assessments of GSMPs are crucial (Rivera-Torres et al., 2015). These assessments should encompass economic, social, and environmental dimensions, with environmental regulations reviewed at least every five years to enhance effectiveness and efficiency (Cai et al., 2023).

Construction Site Establishment and Administration

Proper establishment of construction sites is crucial as they serve as the hub for all construction activities. Once a contractor receives permission to begin a project, they should start work promptly according to the scope of the contract. Given the tight schedule typical of construction projects, starting work immediately helps prevent delays and enables the stakeholders to have higher profits within a shorter construction period. Therefore, careful establishment and administration of construction sites are essential for enhancing contractor productivity while reducing construction costs (Ennin, 2012). A construction site that implements GSMPs will be well-organized, which not only shows a good image but also reduces resource consumption and construction waste (Construction Industry Development Board, 2013). An organized site minimizes the time spent searching for construction equipment and materials, leading to significantly improved overall performance. Effective site establishment and administration are crucial for maintaining construction progress and quality (Zhang et al., 2024).

The site layout must be carefully planned to optimize space utilization, minimize issues, and ensure convenience throughout the construction period. Key considerations include the orientation of buildings such as construction workers' accommodation, site offices, storage areas, and mechanical service yards. Facilities and utilities, including electricity, water supply, telephone, and internet connections, should be thoughtfully integrated into the site layout. Proper planning is crucial to avoid future problems with the installation of conduit pipes and cables for these utilities (Construction Industry Development Board, 2013). In addition, construction activities can impact the surrounding area with noise, dust, vibration, and pollution (Onubi et al., 2020a). Such impacts can lead to complaints and compensation claims from nearby residents, increasing construction costs. To mitigate these issues, builders should maintain open communication channels with neighboring communities (Construction Industry Development Board, 2013).

i. Green and Gracious Builder Scheme

Green and Gracious Builder Scheme (GGBS), as recommended by the Building and Construction Authority (2015), can guide site establishment and administration. This code consists of five categories: amiable, environment, cleanliness, good neighbor, and responsibility.

Amiable. Although GSMPs are relatively new to staff, it is important for everyone to be open to learning and adopting environmentally beneficial practices. Thus, staff members should be friendly, receptive to advice, and willing to share knowledge about green practices. Each task should be approached with a positive attitude that considers the needs of employers, consultants, and contractors.

Environment. The construction industry often contributes to environmental contamination. Therefore, site management practices should emphasize minimizing these negative effects. For example, construction activities can cause vibrations that impact nearby building structures. Implementing GSMPs, such as the 3Rs concept (Reduce, Reuse, Recycle) for construction materials, office supplies, and other resources, can help mitigate negative environmental impacts. Additionally, employing energy-efficient appliances and machinery can lower energy consumption. Effective scheduling and management of worker activities can further reduce unnecessary fuel and electricity use, positively impacting the environment.

Cleanliness. Maintaining the cleanliness of the construction site is vital to prevent accidents and avoid time lost searching for construction materials and equipment. Proper management of construction materials and waste is essential. Stacking of construction materials and waste haphazardly can lead to a messy site, therefore, designating specific areas for these items helps keep the construction site organized. Furthermore, areas such as offices, canteens, and toilets should be regularly cleaned. To address hygiene concerns, rubbish must be disposed of regularly, and recyclable and reusable construction waste should be properly managed to prevent accumulation and spillage around the construction site.

Good Neighbor. Establishing a two-way communication channel between the construction site management team with neighboring communities is important for resolving issues. This communication should begin at the start of the construction project and continue until its completion to foster mutual understanding. Keeping neighbors informed about the project helps ensure that construction activities do not cause undue inconvenience, reducing the likelihood of complaints from neighbors or fines from

the authorities. Moreover, regular updates through this communication channel allow neighbors to make appropriate adjustments to their daily routines as needed.

Responsibility. GSMPs are a collective responsibility involving all parties on the site. Therefore, it is essential that all parties understand their roles and responsibilities related to green practices and compliance with codes and regulations. To ensure this understanding, regular training and seminars should be organized, and attendance should be mandatory for site staff. These educational opportunities will provide staff with the necessary knowledge and enhance their sense of responsibility regarding GSMPs.

Site Facilities

i. Ablution Facilities

Toilets are essential on construction sites due to the large number of workers who work in confined areas. With so many workers, the number of toilets provided must be adequate to meet the demand. These facilities must be regularly maintained, and clean water should always be available (Construction Industry Development Board, 2013). Additionally, grey water from toilets cannot be discharged directly to nearby rivers or drainage systems, as this can cause significant environmental harm. Instead, grey water should be treated properly. Installing septic tanks is crucial to prevent wastewater from being directly released into natural water sources (Kontogianni & Moussiopoulos, 2017).

ii. Construction Equipment and Machinery Areas

A well-organized construction site should include a designated area for storing construction equipment and parking vehicles. Equipment and machinery such as graders, bulldozers, excavators, and trucks should be stored and parked properly. Having a designated area for this purpose simplifies the work of locating necessary equipment and helps security guards monitor heavy machinery more effectively. The designated area should be large enough to facilitate maintenance work, as heavy machinery requires regular maintenance service to ensure optimal performance. Proper maintenance is essential for maximizing diesel efficiency while minimizing exhaust emissions (Yusof et al., 2017). Regular maintenance according to scheduled intervals, is necessary to keep all equipment in optimal condition throughout the construction project (Construction Industry Development Board, 2013).

iii. Work Areas

Work areas on a construction site should be clearly designated for different types of work, such as steel installation, bending, crafting, and assembling or disassembling construction materials. These activities generate construction waste that must be managed properly; requiring special attention and monitoring (Construction Industry Development Board, 2013; Huang et al., 2017). Additionally, the layout of these work areas is important. Proper orientation can enhance work efficiency, especially for tasks that rely on access and tower crane hoisting, such as bar bending and concrete casting. With many different areas for construction activities, maintaining an organized environment for construction materials and machinery is essential. This helps the site management team to save time and avoid delays, particularly by eliminating the need for

workers to spend time searching or relocating necessary materials, thus keeping the construction process on track (Construction Industry Development Board, 2013; Zarei et al., 2018).

iv. Meetings

Effective communication is vital for the successful implementation of GSMPs (Onubi et al., 2019). Meetings provide a platform for all parties to share their views and address construction-related issues. They facilitate quick decision-making and problem-solving through collective brainstorming, allowing for more efficient resolution of challenges (Construction Industry Development Board, 2013). Additionally, meetings clarify roles and responsibilities, ensuring that all construction stakeholders understand their duties and can perform their tasks effectively.

v. Store

Proper handling and management of machinery and equipment make the store an important component of GSMPs. Effective store management helps prevent unnecessary purchases by keeping track of materials and equipment already on site. Accurate store records are essential for avoiding unnecessary expenditures and meeting the needs of all parties involved (Papargyropoulou et al., 2011). Efficient store management saves time by reducing the effort needed to find construction materials in an organized environment. It also prevents the purchase of duplicate construction tools and materials, contributing to cost savings. Furthermore, maintaining detailed records of stored materials and tools facilitates the site management team locating them in the future, as these records serve as a reference, enabling unused materials to be sold, minimizing wastage (Construction Industry Development Board, 2013). Proper storage of materials is an essential aspect of GSMPs, extending their lifespan and preventing damage (Bhardwaj, 2016; Land Transport Authority, 2009). For example, materials like cement can degrade over time and eventually become unusable if not stored correctly. Therefore, careful management and protection are necessary to extend their durability (Barbhuiya et al., 2024). These materials should be used in the order they are received, and their expiration dates must always be verified before use (Pagare & Sonawane, 2022).

The Importance of Green Site Management Practices

While GSMPs can be complex, effective planning and resource allocation can make their implementation more manageable (Onubi et al., 2020c). Effective planning and resource allocation help optimize GSMPs, minimizing resource wastage and improving utilization (Bhardwaj, 2016; Construction Industry Development Board, 2013). Without proper planning, green practices may fail, leading to dissatisfaction among construction workers and increased construction costs. Poor implementation of GSMPs can negatively impact the cash flow of the project, causing delays in the overall construction progress (Construction Industry Development Board, 2013). Therefore, to ensure successful GSMPs implementation, it is crucial to focus on improving planning and resource management. This improves efficiency and productivity, thereby helping to avoid penalties from authorities, boost staff motivation, and ensure client satisfaction.

Activity List

Effective sequencing of construction activities is crucial as it determines the time required for each task, including the use of materials and labor (Zarei et al., 2018). This approach simplifies tracking and planning by estimating the resources needed for each activity, thereby preventing resource overuse and reducing wastage. Consequently, proper sequencing conserves resources and contributes to more efficient construction activities (Construction Industry Development Board, 2013). The order of construction activities significantly impacts the project's time, cost, and quality. Therefore, an experienced team with a thorough understanding of various construction activities should plan and organize the construction activities to identify the most effective approaches (Construction Industry Development Board, 2013).

Managing Resources

Resources in construction projects include raw materials, equipment and machinery, and labor. Efficient consumption of these resources by the site management team is crucial as it directly impacts the cost of a construction project (Qian et al., 2015). Every resource-related decision must be determined carefully, as it will impact the outcomes of the construction project (Onubi et al., 2020a). Proper utilization of allocated resources is also important as it is considered green to the environment (Rivera-Torres et al., 2015). Site supervisors play a key role in ensuring that resources are utilized efficiently to maximize productivity (Onubi et al., 2020a). Efficient use of resources minimizes environmental impacts by conserving energy and raw materials needed for construction (Bhardwaj, 2016; Construction Industry Development Board, 2013). Planning tools help accurately assess the materials required for specific construction activities. This approach helps the purchasing department to order only the necessary materials in the right quantities, reducing excessive orders and preventing waste as materials degrade over time (Bhardwaj, 2016). In addition, these tools assist in estimating delivery times for ordered construction materials, minimizing storage space used, and reducing the risk of loss due to shrinkage, spoilage, or theft (Construction Industry Development Board, 2013).

Maintenance of Equipment and Machinery

Planning tools are also used to schedule work duties for equipment and machinery. Proper storage of equipment and machinery is crucial to prevent damage or theft, thus avoiding extra costs for rental and repairs (Construction Industry Development Board, 2013). Regular maintenance of equipment is important to ensure construction activities run smoothly and to prevent delays caused by equipment breakdowns. Heavy machinery typically requires a set servicing and maintenance schedule to prevent breakdowns, although unexpected issues may still occur. Regular service and maintenance not only extend the lifespan of machinery but also contribute to cost and time savings. Investing time in maintenance and proper handling and storage can significantly reduce overall costs (Land Transport Authority, 2009; Zarei et al., 2018).

Work Methods

Work methods, also known as procurement methods, play an important role in the successful implementation of GSMPs (Onubi et al., 2019). Selecting appropriate work methods is essential to achieve the best outcomes, although this can be challenging due to the unique specifications of each

construction project. Factors such as the type of soil and topography can vary from one site to another (Daud et al., 2019).

This variation requires tailored methods for each construction project. Before selecting the most suitable work methods, every aspect of the construction site should be closely monitored, as these factors influence the project's workflow. Once all elements have been evaluated, the site management team should meet to discuss and determine the best approach (EL Mounla et al., 2023). Careful planning of important tasks can reduce resource consumption and selecting appropriate work methods can help save time and enhance the quality of work (Zarei et al., 2018). Furthermore, as the construction industry is more labor-intensive than capital-intensive, some lighter tasks should be carried out by laborers instead of machinery. In certain cases, human labor can be more efficient and cost-effective compared to heavy machinery. Five common GSMPs have been discussed in this study, and Figure 1 shows the relationship between these green practices and their contributions to GSMPs in construction sites.

Figure 1

Common Green Site Management Practices in Construction Sites



METHODOLOGY

This research aims to identify the most common GSMPs among contractors at Malaysian construction sites. To achieve this, a qualitative phenomenological approach was employed, using observations and interviews. A research phenomenon can emerge from any real-world problem, issue, or topic selected for investigation (Van de Ven, 2016). Since this research aimed to explore the most prevalent GSMPs employed by contractors, an exploratory research method was chosen. Contractors play a critical role in managing construction projects and addressing site issues, drawing on their skills and expertise. Therefore, this study involves interviewing site supervisors, construction managers, and project managers to gather in-depth insights into the GSMPs most frequently implemented. These individuals

were selected as respondents due to their direct influence on implementing green practices. The interviews provided perspectives on the most common GSMPs observed in their construction sites. Given the large population size, convenience sampling was used. This non-probability sampling method involves collecting data from accessible and willing participants, which is practical for exploratory research. Five respondents with extensive experience managing construction projects across various locations in Malaysia participated in the study.

A list of contractors was obtained from CIDB, and several were randomly selected using Microsoft Excel 365 to ensure a diverse data range from various construction sites. To ensure data accuracy and representativeness, respondents were randomly chosen to eliminate bias. They were selected from various regions, project sizes, scales, and experience levels, aligning with Onubi et al. (2019), who emphasized that GSMPs should be applicable across all construction activities, not just large-scale projects. Permission was obtained from the contractors' headquarters to interview the chosen respondents. Due to COVID-19 restrictions, interviews were conducted online, focusing on the most implemented GSMPs in their construction sites. Data collection continued until the saturation point was reached, meaning no new insights emerged. Thematic analysis was then used to examine the data and identify common themes related to GSMPs based on the interview transcripts.

RESULTS

Demographic Profiles of the Respondents

Table 1 summarizes the demographic backgrounds of the respondents, highlighting their diverse positions and locations within the construction industry. They possess a wide range of experiences, most of which hold significant roles within their organizations. All respondents are part of the site management team, and the majority have more than five years of experience managing construction sites. This extensive experience validates the quality of their opinions as they are directly involved in daily site management tasks. The feedback from the respondents indicates that GSMPs are implemented on every construction site, although the level of implementation varies. The variation is due to the differences in the level of understanding of the green concept. The respondents noted that the successful implementation of GSMPs requires a detailed and comprehensive design plan. Such a plan incorporates all necessary green practices required for the construction project to be prepared for all staff involved in site management tasks to ensure effective execution.

Table 1

Respondents' Background

Respondent	Location	Position	Years of experience
A	Pulau Pinang	Project Manager	10-15 years
B	Pulau Pinang	Construction Manager	10-15 years
C	Kuala Lumpur	Senior Site Supervisor	5-9 years
D	Kuala Lumpur	Senior Site Supervisor	5-9 years
E	Johor Bharu	Site Supervisor	1-4 years

Green Site Management Practices

Table 2 shows a summary of the GSMPs implemented by the respondents, which includes construction site waste management, workforce management, best regulatory practices, site establishment and administration, and site facilities. These practices will be discussed further in this study. The results reveal that construction site waste management, and best regulatory practices have been fully implemented by all respondents. On the other hand, site establishment and administration and site facilities have been implemented by 80% of the respondents. Workforce Management has been implemented by only 60% of respondents. From the results, the implemented GSMPs can be categorized into two main themes: human management and materials management. Human management includes workforce management and best regulatory practices, while materials management encompasses construction site waste management, site establishment and administration, and site facilities.

Table 2

Green Site Management Practices Implemented by Contractors

Respondents	Construction Site Waste Management	Workforce Management	Best Regulatory Practices	Site Establishment and Administration	Site Facilities
A	/	/	/	/	/
B	/	/	/	/	/
C	/	/	/	/	/
D	/	/	/	/	/
E	/	/	/	/	/

Human Management

Effective workforce management is important in construction sites due to the large number of construction workers and various parties involved. It is essential to record the total number of workers, along with their backgrounds and expertise, for efficient workforce management. Respondents A, B, and C emphasized the importance of training, noting that *“To ensure all parties understand their roles, training should involve briefings and demonstrations of the correct approach to implementing GSMPs.”* In contrast, Respondents D and E, who manage smaller teams, did not implement workforce management practices as rigorously. Best regulatory practices emphasizes maintaining the quality of the environment surrounding construction sites. These practices are part of government efforts to generate better regulations and achieve public policy objectives. Basically, all respondents agreed that best regulatory practices are an ongoing effort in construction sites. Internal agencies such as audit teams, safety teams, and site management teams are responsible for assessing and coordinating activities to ensure compliance with government requirements. Since adherence to best regulatory practices is mandated by the authorities, all respondents implement the practices. Respondents A and C highlighted the necessity of internal oversight, stating, *“If we do not set up internal agencies to monitor our work, we could be in trouble when government inspectors visit our construction site.”*

Materials Management

Construction site waste management relies heavily on the site management team to develop an effective construction waste management plan. This plan should address both scheduled and non-scheduled

waste. Scheduled waste refers to waste generated regularly by construction activities such as metal scrap, while non-scheduled waste refers to general rubbish and biomass produced by construction workers. All respondents reported effective waste management practices in their construction sites. Proper management is crucial, as waste accumulation from construction activities and workers can lead to hygiene issues. All respondents expressed the importance of waste management in construction sites, with Respondents D and E noting that, *“Although our construction site might not be large, the amount of waste produced daily is still substantial.”*

In addition, site establishment and administration involves organizing the construction site and the placement of equipment and materials. Careful planning of the site layout, including the positioning of accommodation, site offices, storage areas, and temporary access routes, is essential for convenience throughout the construction period. Basically, all respondents have implemented site establishment and administration practices except Respondent E, who, due to a smaller workforce, has not prioritized this practice. Respondents A and B, however, are particular about this aspect, stating that, *“A well-organized construction site will help us to utilize most of the limited space and reduce potential problems during the construction period. Therefore, everyone must know their roles and responsibilities to ensure their tasks can be completed efficiently.”*

Lastly, site facilities encompass several aspects, including ablution facilities, working platforms, and storage areas. Providing and maintaining these facilities is crucial to ensure orderliness of the construction site. Respondents B and D emphasized the benefits of having well-maintained facilities, stating, *“The facilities provided in the construction site help us to work more efficiently, saving time and solving problems such as looking for nearby toilets or looking for equipment needed for construction tasks.”*

Overall, the results showed that most of the respondents are actively implementing GSMPs. The adoption of GSMPs could likely be due to normative pressure from top management and coercive pressure from the government. The most frequently implemented practices include construction site waste management, workforce management, best regulatory practices, construction site establishment and administration, and site facilities. On the other hand, practices such as vibration level management and noise level management are less commonly implemented, despite their importance, as noted by Onubi et al. (2020a). Moreover, based on the opinions collected from the respondents, not all common GSMPs are adopted due to inadequate enforcement of government regulations and a lack of self-awareness among the top management. This highlights the need for increased attention to environmental protection while ensuring that development processes remain unaffected.

DISCUSSIONS AND IMPLICATIONS

Based on the collected responses, the primary focus of GSMPs has been mainly on construction site waste management, workforce management, best regulatory practices, construction site establishment and administration, and site facilities. These areas have always been discussed due to their impact on the surrounding environment. Several reasons explain why contractors prioritize these aspects over others. One major factor is cost control. Contractors often continue with conventional practices from previous projects or adopt new practices primarily based on their cost implications to maximize profit. However, this issue can be mitigated through stricter enforcement of government regulations (Martín-de Castro et al., 2016).

Government regulation is a key factor in compelling contractors to adopt GSMPs (Martín-de Castro et al., 2016). Most construction sites implement these practices due to regulatory mandates. Failure to meet government standards can result in fines or work suspension. Certain practices, such as using steel formwork, spun piles, and crushed concrete, not only enhance work performance but also offer practical benefits. Respondent A noted that *“Steel formwork reduces the time spent crafting plywood formworks to match building shapes, as it is pre-manufactured to design specifications,”* which aligns with Nandhinipriya et al. (2016). Additionally, Respondents B and C noted that green practices improve performance. They explained that *“Crushed stones and concrete from spun piles can replace crusher run and aggregate, saving time and cost by utilizing existing resources instead of transporting aggregate to the construction site,”* as mentioned by Onubi et al. (2020a).

Some reasons that drive contractors to adopt green practices are often related to the knowledge possessed by top management. Implementing GSMPs requires a substantial amount of knowledge (Qian et al., 2015). Respondents indicated that *“Contractors must hire professionals to implement these practices, which directly increases consultation costs and reduces project profitability. Additionally, contractors need to provide training for site management staff, which is time-consuming and adds a financial burden to the project.”* This concern is echoed by Onubi et al. (2020b), who noted that *“There may be no additional funds allocated for training if it is not compulsory. Each member of staff has specific duties, leaving little room for additional tasks. Without enforcement requirements, only essential tasks will be completed,”* said Respondent A.

Contractors play a crucial role in implementing green practices. However, their commitment to these practices is often influenced by government regulations. All respondents indicated that financial benefit is the primary consideration. As Respondents C, D, and E noted, *“The financial aspect is the main consideration.”* Respondents A and B added, *“Implementing GSMPs can mitigate negative environmental impacts and offer financial benefits, but not all practices are beneficial. Contractors adopt these practices primarily to comply with government regulations.”* For instance, green practices include constructing washing bays in construction sites’ exits to clean lorry tires and prevent mud from spreading onto roads, building retention ponds to manage stormwater runoff, and preventing flooding and downstream erosion while enhancing water quality (Kumari et al., 2014). These green practices are implemented to prevent fines from authorities, making them economically beneficial for contractors.

CONCLUSION, LIMITATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

In conclusion, this study highlights current site management practices, which reveals an encouraging trend among contractors in adopting GSMPs. Interviews with experienced staff, including site supervisors, construction managers, and project managers, indicate that GSMPs are being increasingly implemented. This study categorized these practices into two main themes: human management and materials management. Human management includes workforce management and best regulatory practices, while materials management encompasses construction site waste management, site establishment and administration, and site facilities. Given the construction site management team’s growing awareness and adoption of GSMPs, it is important to continue these efforts. Government agencies and higher learning institutions have played significant roles in raising awareness about the importance of sustainable development, making GSMPs a prevailing trend. The mainstream adoption of GSMPs is expected to be supported by technological advancements and industry knowledge levels. To encourage a higher adoption rate of GSMPs, authorities can conduct seminars, campaigns, and regulations. While this study provides valuable insights, it is limited by the small sample size of only

five respondents. Future studies should aim to include a broader range of key stakeholders in the construction industry to obtain more comprehensive data on GSMPs.

ACKNOWLEDGEMENT

This research did not receive any specific grant from any funding agency in the public, commercial, or not-for-profit organizations.

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