

Navigating Environmental Stewardship: A Review of Construction Industry Practices in Developed Countries

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ABSTRACT: Due to rapid urbanization, the construction industry has expanded significantly to meet human needs. Controlling environmental impacts in the construction sector has become a major global issue. The implementation of environmental management practices in the construction sector has contributed to protecting the environment through various management methods. This review aims to provide an overview of environmental management practices in the construction industry in developed countries, including a review of the types of environmental management practices and government policies for adopting these practices. The current status of these practices in developed countries is discussed, as well as the barriers and prospects for environmental management practices. Challenges include behavior adoption, lack of material standardization, monitoring difficulties, and inefficient formation of temporary organizations. Cooperation among construction parties presents coordination issues, exacerbating uneven cost distribution and neglect of environmental impacts. Adoption of ISO 14001 Environmental Management Systems faces hurdles such as lack of management involvement, third-party interference, and lack of guidelines. Initiatives like Green Star struggle due to poor enforcement and organizational issues, hindering sustainable development. To accomplish the goal of sustainable development, additional environmental factors have been taken into account and discussed.

KEYWORDS: Urbanization; construction industry; environmental management practices; sustainable development; environmental impacts

1. Introduction

Concerns about sustainable development have gained global awareness, with environmental management practices being highlighted, including in developed countries. Proper methods of environmental management are desired to improve environmental performance across all industries, especially in construction. Construction is considered an environmentally unfriendly activity and has the largest impact on environmental pollution compared to other industries. The significant environmental impacts of construction include the emissions of pollutants from energy consumption, such as air pollution, waste pollution, and water pollution. It has been found that more than 40% of total global energy consumption and global greenhouse gas emissions are produced by the construction industry [1]. For example, 42% of greenhouse

gas such as carbon dioxide emissions has been generated from construction activities in the United States [2]. In China, the environmental pollution has been increased in line due to the contribution of urban development construction since the early 1980s, where the emissions of sulfur dioxide and total air-suspended particulates resulted in more than 200 mg/m³ which have exceeded the international standards of 90 mg/m³ [3]. Not only that, in Europe, the construction industry has generated 46% of construction and demolition waste among the total waste generated every year [4]. The construction and demolition waste is considered as the potential issues in construction activity due to the environmental and economic impacts as well as the social impacts [5]. Besides that, the construction activities have become one of the motivation in term of national economy, where the social impacts and energy consumption are more significant [6]. It has been reported that most of the contractors pay more attention on the ranking of completion time of a project instead of the consideration on the environment [7]. However, with the implementation of sustainable development, the attention on the environmental impacts has been highlighted and there is a rapid growth on the efforts towards environmental management practice in the construction industry. In the context above, the review on the environmental management practices and the policies adopted by the government is discussed as well as the current status, prospect and barriers of the implementation of environmental management practices in developed countries.

2. Environmental Management Practices

Environmental management practices encompass various concepts such as environmental technology, environmental practices, management programs, and control technology. Environmental management practices can be considered a combination of organizational activities aimed at reducing energy consumption and improving waste disposal. This is because activities such as the generation of raw materials, production processes, packaging, and waste disposal are classified as organizational activities related to environmental problems. Environmental management practices can also be defined as the techniques and policies controlled by an organization to address environmental changes and issues in the industrial sector [10]. The categorization of environmental management practices is complex and various as some researchers classify the environmental management practice into several dimensions which include the planning and organization, product design, corporate planning process and business practices [11]. Environmental management practices can also be categorized in term of business practices that include the design for environmental protection, life cycle analysis, management of green supply chain, and Interactional Organization for Standardization (ISO) ISO environmental management requirements [8]. From the view above, the term of environmental management practices involves the cooperation of business firm in promoting the sustainable development and reducing the environmental impacts.

There are several types of methods for environmental management practices in construction sector which include Environmental Management Systems (EMS), life cycle environmental assessment, green supply chain management and waste management. EMS is a set of procedures that approach to increase the operating efficiency of an organization through the environmental practicing of the staffs on the environmental impacts [12]. The procedure of EMS typically includes the environmental policies and regulations, planning, controlling and monitoring of environmental performance improvement and development of management and training programs related to environment [13]. EMS enables the construction firms and business to identify their decision-making on the design of products and services into a more

environmental friendly way [14]. EMS also enhances a win-win situation to keep the growth of economics and maintain the environment.

Life cycle environmental assessment is an assessment technique that accounting and management of environment that includes all the stages of life cycle of a product such as the extraction and consumption of resources use as well as the production and distribution of environmental pollutants release from the construction sectors [15]. Life cycle environmental assessment intends in helping the companies in decision making and evaluates the major environmental impacts during the selection of construction materials through life cycle analysis, life cycle impact assessment as well as life cycle costing [16]. ISO standards have provided a standard methodology framework in conducting and presenting the life cycle environmental assessment studies. The standards have been divided into four parts which are goal and scope, life cycle inventory, life cycle assessment, and life cycle interpretation [17].

The ‘green’ concept has played a vital role in the mission of sustainable development as it is referred to the actions which integrating both environmental and ecological concern. The supply chain is the main key in the management of operating which have potential impacts on the environment. The companies have introduced the environmental concerns into their operation of supply chain management through purchasing, manufacturing processes, material sourcing and selection, and distribution of knowledge [18, 19]. The combination of environmental issues into the supply chain is known as ‘green supply chain management’ environmental practices [20]. With the implementation of green supply chain management, the companies consider the environmental thinking of the end-of-life management of a used product as well as the delivery of the final products [21]. The practice of green supply chain management has been established as a significant principle to improve the eco-sustainability business strategy in worldwide.

3. Government Policy on Environmental Management Practices

The policies and legislation regarding environmental management practices in developed countries vary depending on their organizations. For the environmental management of construction and demolition waste, most developed countries have adopted the widespread waste minimization hierarchy of 3Rs or 4Rs. The hierarchy of 3Rs includes reduce, reuse, and recycle, while the hierarchy of 4Rs includes an additional term: recover. In the European Union, the environmental management of construction and demolition waste is governed by the EU Waste Framework Directive, which aims to achieve at least 70% recycling of non-hazardous construction waste by 2020. The legislation set by the European Union government has been adopted by several member states. For instance, the government legislation in Germany has implemented the management of construction and demolition waste by encouraging waste generators or related representatives to analyze, recycle, and reuse construction and demolition waste [22]. In Spain, the governmental legislation governing the environmental management which include the Second Construction and Demolition Waste Plan and define the commitment of all individual that had involved in construction [23]. In Taiwan, the monitoring of the construction sites has implemented since 2005 and all the construction waste produced must delivered to the treatment facilities [24]. In Hong Kong, the governmental policies are encouraged contractors or related organizations to use the recycled construction materials in the foundation works of a building [22].

4. Current Status on Environmental Management Practices

With the rapid urbanization and the increasing in population, the construction development in developed countries has produced a large amount of construction and demolition waste which might have adverse impacts towards the environment as well as the ecosystem. Thus, the implementation of the environmental management practices has become an importance practice in managing the construction and demolition waste in order to achieve the mission of sustainable development. The management of construction waste such as the recycling rate of 70% of the construction and demolition wastes has become a target in several countries [25]. For example, in Europe, approximately 820 million tons of construction waste has been produced every year. Thus, the government has produce several environmental management frameworks for the construction and demolition waste as shown in Table 1 [4]. The environmental management practices include the waste management strategies, prevention and collection, and waste treatment and material recovery.

Table 1. Environmental management practices for construction waste.

Environmental Management Practices	Description	Relevant Stakeholders
<i>Waste management strategies</i>		
Construction and demolition waste management plans	Development of re-use and waste prevention management as well as regulation of hazardous materials.	Contractors, construction firm and suppliers
Economic appliances	To have high efficiency on the performance of environmental waste management systems through the use of recycling materials.	Construction firm, contractors and waste management companies
Site waste management plans	Develop a standard waste management plan to manage and reduce the amount of waste generated.	Contactors, developers and clients
<i>Prevention and collection</i>		
Life cycle assessment	To minimize the waste generated at every stages of life cycle of the use of construction materials.	Construction firm and waste management organization.
Site waste management and prevention	Monitor the wastes generated and establish the separation and collection of demolition waste.	Contractors, waste management companies, construction firm and suppliers.
<i>Waste treatment and material recovery</i>		
Green supply chain management	Recycle or recovery the used materials to reduce the generation of construction waste.	Waste management organization

From the environmental management practice, the environmental impacts caused by the construction activities have been reduced. For instance, with the implementation of life cycle assessment, the emissions of carbon dioxide and primary consumption of energy have resulted in a net reduction by using the recycled aggregates as the construction materials [4]. Not only that, the dust generation from the recycling plants were found to be decreased to a range of 20 to 25% in the surrounding of the plants [26]. Besides from Europe country, Singapore also implemented the life cycle environmental assessment on their construction sector. The Building and Construction Authority of Singapore has enhanced the construction companies to implement the use of recycled materials which are the recycled aggregates and green concrete in the construction of buildings and resulted in lowering the environmental load by reducing the emissions of air pollutants and construction wastes [27]. Moreover, the environmental management in USA is focused more attention on the implementation of environmental management systems as the government of USA has introduced a regulation of the Deconstruction of Building Law in 2019, which was related to the enforcement and penalties policy [28]. However, this policy has encouraged the construction companies in targeting to a zero emission of construction waste and pollutants and has resulted in a good condition with

an increasing of recycling rate to 70% [29]. Not only that, the environmental management system in the standard of ISO 14000 is promoted in Hong Kong. The number of construction firm that have applied and obtained the ISO 14000 certification was found to be increased. As the environmental management system can provide some benefits to the contractors as well as the community such as the cost saving, improvement in environmental performance, reduce the environment-related sickness, and increase the overall competitiveness of business [3]. Thus, it can be concluded that most of the construction firms or organizations in developed countries have complied with the environmental management practices for construction sector which include Europe, Singapore and USA. The formation of environmental management practices encourages the developed countries in minimizing the potential environmental impacts from construction activities and enhance the target towards the mission of sustainable development with three pillars of environment, economic and society.

5. Challenges on Environmental Management Practices

Environmental management practices offer various advantages both environmentally and economically. However, the levels of innovation and efficiency remain low, and there are several barriers to sustainable construction and environmental practices in the construction sector of developed countries. The main challenge of environmental management practices for construction is the behavior of the construction industry in adopting green construction practices [2]. Reinforcing conservation in green design, production of green materials, and energy conservation is crucial, as the construction of green products carries a high responsibility towards the health and safety of society. This conservation should be maintained in the current practices of the construction industry in order to foster potential innovations regarding sustainable construction products or materials [30] Moreover, the materials used in construction are mostly considered as one-time-used products, and the materials used in each construction projects are different and specific. This has led to the barriers and problems in an individual construction firm due to the limitation of the standardization of a construction product [31]. The monitoring and measuring on the environmental performance of various construction products have become a challenge for construction firms over year to year. Moreover, the formation of temporary organization of construction project can shorten the encouragement in considering the environmental impacts from construction [3].

A construction project involves the cooperation between the related parties such as clients, the main contractor, sub-contractor, production supplier, waste management organization and different principal in engineering. The collaboration between the organization, the client, and the construction firm have the potential in resulting several barriers in the construction sector as each parties have their interests and practices on the environmental management [32]. For example, the individual contractors in USA as they have implemented their independent management practice in waste production and recycling process. This situation considered as the lack of coordination with the organization which resulted in only 5% of recycled concrete were found to be used in the construction of building [33]. Besides that, the uneven distribution of costs and benefits between the contractors, construction firms, and designers can also become one of the issues in enhancing the sustainable construction development. In the case of costs limitation, the construction firms or the contractors reduced the efficiency in planning and monitoring of environmental impacts. Due to the incur of the extra costs for the environmental practices was not fully provided by the clients or the government, the firms lowered the quantity of the construction production in order to have

more benefits on their economic and has neglected the environmental impacts [34]. The environmental management practices often involve the conflict between the management of environment with the cost for construction and contract time of a development [35].

The implementation of ISO 14001 EMS in the organizations provide the awareness on environmental impacts and integrating the prevention of pollutants emission between the construction firms and organizations. However, the challenges in adopting the ISO 14001 EMS were found in the organization of several developed countries. The challenges include the lack of management and clients' involvement, involvement of third parties in the private information, the association of time and costs, and the limitation of expertise in managing the system. Furthermore, the major barriers in the implementation of EMS is the limitation of standard and detailed guidelines related to the environmental management practice, which resulted in an inefficiency production of management system [36]. For example, the Green Building Council of Australia has launched the EMS tool known as Green Star which is a voluntary instrument that use to manage the environment quality, energy, waste, as well as the educational health and safety [37]. However, only less than 0.5% of the construction industry in Australia has complied with the Green Star instrument due to the poor enforcement by the government and lack of upgrading of the environmental management systems. The organizational and procedural issues also affect the efficiency of the environmental management system in term of marketing, where the buy-in and practices behavior of the clients, designers and firms in Australia were far from the expectation of the values of green building [38]. The main challenges on environmental management practices in construction industry can be shown in Figure 1.



Figure 1. The main challenges on environmental management practices in construction industry.

6. Future Trends on Environmental Management Practices

Currently, the environmental management practice for construction sector in several developed countries are doing well such as USA and European Union. The implementation of environmental management practices still can be improved in order to make closer towards the

mission of sustainable development. For example, the life cycle assessment can be integrated into the process of environmental management system in order to have a better solution for the environmental issues. Besides that, the method of mutual coordination among all the operational organizations can be implemented [29]. The environmental problems of a construction development can be engaged between the local government and globally. Moreover, the combination of life cycle environmental assessment with the green supply chain management can be implemented into the environmental performance frameworks for a better environmental management [33]. However, the use of such combination of the environmental management practices might not only has the strengths but also certain weakness. The strength of the combination of the environmental management practices is the financial benefits arisen from these implementation towards the construction industrial as well as the manufacturing sector [38]. The weakness of the combination management practices is that the practices might only focus on certain specific environmental aspect such as construction waste and wastewater pollutant generated from the construction of a building [3]. Thus, the prospect for environmental management practices in construction is still have a wide range of improvement to fully protect the environment as well as achieve the mission of sustainable development.

Besides from the environmental considerations on the emission of construction waste, air and water pollutants, there are several other environmental considerations should be included which are the noise pollution and the impacts of vegetation. During the construction activities, noise pollution was generated which is considered as one of the important barriers in achieving the sustainable development [39]. As noise pollution disturbed the natural environment at the surrounding of a construction activity and has significant negative impacts towards the health of the construction workers as well as the community nearby. Not only that, the noise pollution would not only affect the wildlife on land at the surrounding of the construction site but also the wildlife in the ocean. For example, the construction activity in the ocean have adverse impacts towards the marine animals which are very sensitive to the sound frequency such as whales and dolphins. Furthermore, a development of a construction activity always links to the clearance of land which lead to the impact towards the vegetation. The clearance of a land area caused the formation of soil loosen and might lead to soil erosion and the soil degradation as well as the loss of natural environment which lead to the habitat loss of the wildlife. Thus, several environmental impacts such as noise pollution and impacts towards the vegetation should be considered in the environmental management practice in order to achieve the mission of sustainable development.

7. Conclusion

Most developed countries have implemented and adopted to the environmental management practices. The environmental management practice includes the environmental management system, life cycle environmental assessment, green supply chain management and the construction and demolition waste management. In the construction sector, the common pollutants generated from construction activities is the production of construction and demolition waste pollutants. Thus, the developed countries have taken more consideration on the construction and demolition waste as the production of the construction waste pollutants has the potential in linking towards the air and water pollution. However, there are several challenges in the adaptation of environmental management practice which mainly due to the encouragement and enforcement by the government. As some of the individual construction

firms do not comply with the policies related to the environmental practices. Not only that, financial benefit is also one of the barriers as some of the construction firms or clients focus more on the financial benefits instead of the environmental impacts and thus lowering the efficiency in environmental management practices. In order to protecting and managing the environment, some of the environmental impacts should also be considered in the practices such as the noise pollution and the impacts of vegetation. In the term of sustainable development, the environmental management practices still can be improved to maintain the environment and economic as well as the society.

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Competing Interest

All authors have no competing interest.

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