

Sustainability Risks and Decision Making in the Construction Industry: A Case Study-Based Approach

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Abstract. In recent years, with the concept of sustainability put forward, more and more enterprises have considered it when making strategies and decisions. Sustainability emphasizes striking a balance between the economic, environmental, and social dimensions to ensure that current development does not jeopardize future resources and opportunities. The construction industry is not an exception. However, due to the huge energy consumption and inevitable uncertainty in the construction scenes, the sustainability concept needs to be conducted better in this industry. Current studies focused on the sustainability decision-making model choices; these studies greatly contribute to the theoretical background but could be more focused on the construction scenes and sustainability decision-making chain. This paper first revealed the risks and consequences of sustainability to point out the necessity of this research. Secondly, this paper demonstrated two case studies about sustainability decision-making. Reviewing these cases concluded a sustainability decision-making chain, which may help the construction industry reduce energy consumption and shoulder more social responsibilities.

Keywords: Sustainability decision-making, Construction industry, Sustainability risks, ESG.

1. Introduction

Sustainability is gradually becoming an issue in some companies' strategies and decision-making processes. While some sustainability reports illustrate that more and more enterprises do a good job conducting such a concept, some companies still need help to combine the concept with their industry. This study explores a sustainability decision-making process chain that aims to help construction enterprises obtain a competitive situation in the market while considering the environment and social and governance profits.

Sustainability is defined as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]. From an enterprise perspective, sustainability means a business approach that seeks to create long-term value for stakeholders by embracing the opportunities and managing risks associated with economic, environmental, and social developments [2].

Implementing sustainability management in enterprises differs from traditional project or company management. Sustainability management is a unique concept considering financial profit and environmental protection [3]. It is also complex work to measure the specific effects on the environment and social responsibilities [4]. Due to the complexity, many companies need help transitioning to sustainability. Also, one of the issues the company is concerned about is the green supply chain management. Green supply chain management is an extension of sustainability. It refers to the supply chain management that should satisfy sustainability requirements and the environmental regulations made by the government [5]. The impact of implementing a green supply chain is to cut down energy consumption, such as raw materials or electricity, and contribute to eliminating toxic gas emissions. The construction enterprises are facing severe issues mentioned above. Thus, the essence of investigation towards sustainability strategies implementation is necessary.

This paper aims to conclude a sustainability decision model through two case studies. The ability to take risks is critical for construction companies. Thus, the questions this research aims to tackle are listed as follows:

How do strategy makers obtain the first information, such as data from a construction scene?

How does a construction company transition to a sustainability supply chain, and what are the policy differences between enterprises?

The outcome of the first question aims to collect first-hand data from exact construction scenes. What materials or technologies can be used to identify the risks of sustainability? The outcome of the second question aims to ways of sustainability transition that construction companies conduct. What transitions are more easy to conduct with a low cost of budget? An investigation of multiple construction industry companies is conducted to answer these questions.

2. ESG and Sustainability Risks

In recent years, the sustainability risk in the construction industry has become more and more critical for researchers to study. Due to the complexity of raw materials and the inevitable emission of huge amounts of pollution gas, the construction project faces unique triggers and unexpected risks in sustainability [6]. Based on this background, this paper analyzes sustainability risk in the construction industry. It puts forward a decision-making way to calculate the capacity of sustainable ability in construction management.

2.1. Explanation of ESG and Sustainability Risks

Environment social governance (ESG) has gradually been implemented worldwide in firm plans and decision-making. It is a unique perspective towards non-financial issues that a business company should consider. ESG focuses on the integrity and responsibility of sustainability practice and the circular economy built in the company. More precisely, when a decision and plan are put on the table, it must ensure that these methods or operations are aligned with the environment, society and governance [7]. The construction industry is not an exception. According to the '2021 Global Status Report for Buildings and Construction' [8], the buildings and construction's share of global final energy and energy-related carbon dioxide emissions is 37% of the whole industry, and the whole department's efforts are far from satisfactory. From the perspective of the environment of ESG, the main sustainable risk for construction is the consumption of energy like electricity and the emission of greenhouse gases like carbon dioxide, which would damage the Earth's atmosphere and lead to the melting of glaciers. From another view of society's contribution to the construction industry, to complete the requirements of 'The Paris Agreement,' the whole industry must satisfy the surge needs of energy services and the area of buildings by constructing more architecture. There is a potential risk in this. While achieving the goals, there could be more raw materials and energy use costs, which is just beyond sustainability. The governance risk of the construction industry is another problem during the company's development. To tackle the potential risks of sustainability, the choice a company may make is to shrink the size of the company, which cannot deal with the uncertainty from the supplier and the contractor.

Thus far, we have seen the significant consequence of sustainability risk in the construction industry. A strategy is a series of plans for the company's future the owner wants [9]. In this case, a strategy involves sustainability transition building of a circular economy. Thus, it can be called a sustainability strategy. This paper will demonstrate two leading construction enterprises' sustainability strategies to conclude the decision tools they used and provide an overview of the sustainability strategy of the construction industry.

3. Case Analysis

In this part of the paper, two case studies demonstrate how the construction industry copes with the decision about sustainability.

3.1. The Sustainability Transition of Construction SCM

3.1.1 Sustainability Supply Chain Management (SSCM)

Supply chain management is now well established and implemented in many firms to obtain a competitive position in the world market. Sustainability supply chain management (SSCM) combines supply chain management with sustainability. SSCM is a basic method for the circular economy and reaching sustainability development goals the United Nations put forward in 2015. The growing impact of SSCM has now reached a new stage. In addition to the huge economic income and social responsibility, it shows a positive tendency to protect the environment. Over the last decades, many SSCM theories have emerged [10]. These frameworks are well explain the concept of SSCM. The SSCM aims to minimize environmental impact by minimizing material flows. To build a circular economy, the material can be used repeatedly, truly healthy to nature. As for the construction industry, SSCM means that it can cut the cost of raw materials and put them to use more than once, raising the efficiency of using materials.

3.1.2 Sustainability Transition

The concept of sustainability transition could be explained by a series of actions contributing to sustainability. The examples of it are numerous, using renewable materials or resources are included. To have a better understanding of sustainability transition, an overall and holistic perspective is needed. Sustainability transition research could be dated back to the 1990s in the Netherlands with the Knowledge Network for System Innovations and Transitions. Current studies now shift to theoretical concepts and specific science approaches. To create a sustainable world and complete sustainable development goals put forward by the United Nations, a sustainability transition of the construction industry is strongly needed because of its huge energy consumption, such as electricity or fossil fuels.

3.1.3 Case Study on the SCM of Sustainability Transition in Construction Company

Nowadays, the construction companies' strategy toward sustainability transition can be concluded as follows: Policy of sustainability, organization management, and supply chain management. The performances of these construction companies are listed in Table 1.

Table 1. Performances of the construction industry

	Policy of sustainability	Management of organization	Supply chain management
Company A	Establishment of tools towards to sustainability	Special department of making technology policy	Green contractors and materials reuse
Company B	Zero 2050	Committees of environment, green transport and risk management	Tools of choosing green supplier and implement of recycled resources
Company C	Sustainability and social responsibility	Using the life circle model	Share of environment, social, governance related information, help the transition of supply chain

Table 1 illustrates three companies' decisions to boost the transition to sustainability. The sustainability transition of the supply chain could be divided into three parts: tool, recycled resources and information sharing with upstream and downstream in the supply chain.

3.1.4 Discussion and Case Conclusion

For the construction company, the easiest way to transition towards sustainability is to identify the enterprises from the upstream and downstream of the supply chain where their materials and products flow in and out. However, choosing the contractor or supplier suitable for the sustainability supply

chain takes time and effort. How can the construction industry evaluate the potential ability of sustainability an enterprise obtains? The decision-making and assessment theories are now put to use. Fagerlind explained that sustainability decision-making could be divided into these parts: central decision-making, aggregated decision-making, integrated decision-making, intermediate decision making and local decision-making [11]. This structure demonstrates a vision toward the choice of supplier and contractor and how a company can put the concept of sustainability into everyday life in the enterprise. Another effective choice for a construction company to update its supply chain is to recycle discarded materials. The cost of the whole supply chain could be cut by reusing and selling these discarded materials. It is an essential method to build a circular economy in the construction company. Aluminum-clad products are usually common for the construction industry to keep the concrete from moisture; they will be discarded after the concrete completes the hardening process. An example of recycling aluminum-clad products in China is collecting and heating them. By heating the aluminum, it becomes easy to shape, and the construction company sells these recycled products to the market to gain profits; in other words, they cut down the cost of the supply chain with no harm to the environment.

3.2. Sustainability Decision-Making through Digital Platforms that Supervise the Risks in the Construction Scenes

3.2.1 Digital Platform

The digital platform for the construction industry appeared after the concept of Industry 4.0 came up, which refers to a series of technological innovations and methods. Digital platforms in the construction scene include the functions as follows: security of working members, cost of electricity and water, risk detected camera, prediction and calculation of raw materials. The data collected from the construction scene is essential for sustainable decisions. Implementing digital platforms can play a role in the first step of decision-making data analysis and identifying the risk.

3.2.2 Case Study on the Implement of Digital Platforms in the Construction Scenes

The digital platforms for identifying everyday life in construction scenes are still experimental in China. After conducting an investment in one of the construction scenes in Shan Dong Province of China, the related information is listed in Table 2.

Table 2. The digital platforms of the construction scene

Platforms	Functions
Unsecure behaviors detected platform	To identify the unsecure behaviors of workers. The lack of helmet for example.
Supervision of consume of energy platform	To identify everyday consume of electricity or water
Cameras toward scene	To identify the risks of construction scene
Prediction platform	To predict the consume of energy and potential sustainable risks of the construction

From the information demonstrated in Table 2, the functions of the digital platform show an innovative way to collect first-hand data from the construction scene. Take the Supervision of the consumption of energy platforms as an example. This unique platform collects data from the scanner placed on the water pump, and once the water pump is opened, the computer calculates the water consumption. In such a way, the construction industry manager could have an overall picture of the energy consumed in a project. After analyzing the data, they use decision tools like AHP to evaluate potential sustainability risks and make the right strategy to fight against the risk.

3.2.3 Discussion and Case Conclusion

In this case, the construction company in Shan Dong Province of China uses a series of digital platforms such as noise detectors and scanners to consume energy to detect the potential sustainability risks in the construction scene. After the investigation and interview with the construction project

manager, a sustainable decision-making model based on the digital platform could be concluded. The whole decision chain is demonstrated in Figure 3.

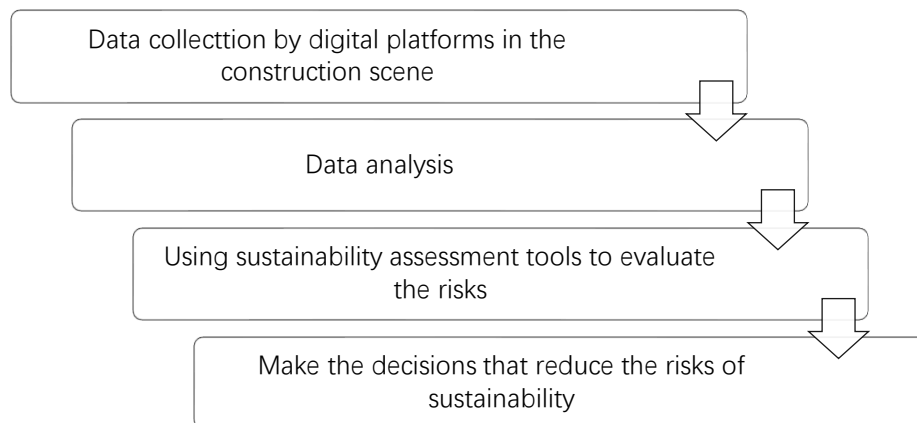


Figure 1. Decision making chain

One of the competitive points of this model is that it can collect first-hand data for a project manager to analyze the current risks in the construction scene so that timeliness can be ensured. However, after consideration and careful interview with the manager, its shortcomings also emerged. This model must run in such hypotheses.

H1: There should be a large database with adequate computing power to store the data collected from scanners and cameras and analyze these data. Once the construction company lacks devices like this, the model's first and second stages cannot be used.

H2: The sustainability risks must be digitalized so the decision-making tools can be used. In other words, the digital platform must detect the sustainability risks' performance. However, some of the sustainability risks may not perform in the construction scene at the first time, but they may have a strong impact on the consequences.

Once the conditions can be satisfied, the model could be used and effectively influence sustainability.

4. Discussion

The consequences of sustainability risks can sometimes cause the company fierce damage to the supply chain or profit. Those consequences act as a trigger to force the construction industry to consider sustainability when making the strategy. To complete such goals, construction companies need help the first time. However, with the concept of Industry 4.0 and new technologies implemented, those enterprises can make the transition and decision more precisely at low cost. These processes can be divided into such parts. First, a sustainable policy is published based on the SDG goals put forward by the United Nations. Secondly, a decision-making chain using data collected from new technologies is established. Implementing decision-making tools and evaluation methods in such a chain makes the decision more scientific and precise. Last, the supply chain transition is one of the easiest ways for construction enterprises to achieve sustainability goals. They choose green suppliers and contractors to build a circular economy. Such research can help the construction industry enlarge the horizon of decision-making methods. By reducing energy consumption and shouldering more social responsibility, the construction industry may find a balance between profit and sustainability.

5. Conclusion

This study aims to add research on sustainability risk identification and decision-making results. Current studies find it hard to put sustainability into construction scenes, and the decision-making chain needs to be completed. This study conducted investigations of construction enterprises and obtained first-hand information.

This study jumps the circle of current theoretical research on sustainability. Instead, the dimension of construction scenes is another approach to the research. In this study, the introduction to the sustainability risks revealed the current situation and the consequences those risks lead to. For construction industries, the process of elimination of carbon is steadily conducted. However, there's still a growing need for construction industries. Thus, the meaning stage of investigation is ensured. Second, the investigation of construction industries is conducted. From two case studies, a series of current strategies are concluded. From the first case, a green supply chain transition is the easiest way for construction companies to conduct a sustainability transition. Implementing recycled materials starts the transition; building a circular economy with upstream suppliers and downstream contractors can boost such transition. In the second case, digital platforms emerge in the construction scenes that can collect data and information. Based on the two cases, a sustainability decision-making chain is concluded. The company could make use of information collected from digital platforms to analyze the risks of sustainability. Then, according to those risks, a transition process of the supply chain is conducted. By using the decision-making tools, a scientific decision is drafted.

To summarize the contribution of this study, it adds more perspectives to the sustainability decision-making field and supports designers in making further strategies for the company. First, this study reveals the consequences and risks of sustainability. Secondly, this study finds four stages of a decision-making process, demonstrating a clear picture of the decision-making process based on digital platforms and tools. Unlike the current studies, this study combines external and internal factors and considers the specific construction companies' performance toward sustainability. These studies may help construction industries deploy more scientific strategies for sustainability.

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