

Article

Identifying and Categorizing Sustainable Supply Chain Practices Based on Triple Bottom Line Dimensions: Evaluation of Practice Implementation in the Cement Industry

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Abstract: Recent research has placed greater emphasis on sustainable supply chain management (SSCM), specifically within the manufacturing sector. SSCM expands upon traditional supply chain management (SCM) by taking environmental and social considerations into account. Given the sustainability challenges facing the cement industry, SSCM has become a crucial topic for companies operating in this sector. Accordingly, the aim of this study is to identify and categorize SSCM practices based on the triple bottom line (TBL) dimensions of sustainability. Additionally, the study assesses the adoption of SSCM practices by Jordanian cement manufacturers according to the developed model. There is a lack of studies focused on creating a tailored and comprehensive SSCM conceptual model to evaluate sustainability practices within cement manufacturing. Therefore, this study attempted to develop a model for SSCM practices by incorporating 23 SSCM factors divided into three dimensions of sustainability: nine factors of environmental SSCM, seven factors of social SSCM, and seven factors of economic SSCM. The study employed a quantitative research approach, using a structured questionnaire to collect data from 41 cement company managers in Jordan and industry specialists. The proposed hypotheses were tested using SPSS software. The research findings revealed that the average level of implementation for all environmental factors was at a medium level within the Jordanian cement industry, the average level of implementation for all social factors was at a high level, and the average level of implementation for all economic factors was at a medium level. Overall, the implementation of SSCM practices was found to be at a moderate level. The study also provided a detailed level of implementation for each SSCM practice for each dimension of sustainability. By identifying and categorizing SSCM practices related to the cement industry, this study addresses a gap in the literature. It also highlights critical sustainability issues for decision-makers and academics, which can aid in the evaluation and improvement of SSCM practices in the cement industry. Future studies should aim to replicate this study with larger sample sizes and probability-sampling techniques to enhance the generalizability of the results.

Keywords: cement industry; CO₂ emissions; developing country; economic practices; environmental practices; social practices; sustainability dimensions; sustainable supply chain management



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1. Introduction

Cement is a vital component of concrete, which is the most frequently used building material worldwide. However, its production significantly contributes to climate change [1,2]. The thermal and chemical combustion processes used to make clinker emit large amounts of carbon dioxide (CO₂), making cement production responsible for more than 4 billion tons of CO₂ emissions per year, accounting for 8% of all global CO₂ emissions [3]. This is a major environmental concern, as the built environment has been recognized as a major contributor to the loss of biodiversity and should play a significant role in a sustainable world in which ecological values are enhanced [4,5]. Environmental concerns,

such as global warming, and social concerns, such as health and safety, have compelled firms to consider environmental and economic concerns in supply chain decisions [6]. Recent research has focused on sustainable supply chain management (SSCM) practices that improve sustainability performance [5,7–10]. According to Cataldo et al. [5], sustainable supply chain management (SSCM) is an extension of traditional supply chain management (SCM) that takes into account environmental and social concerns. Growing environmental concerns, such as global warming, and social concerns, such as human rights and safety, have compelled many businesses to consider factors other than economics when making supply chain decisions [11]. As a result, SSCM has become an approach through which firms improve the sustainable dimension outcomes in their supply chains [2,7,12].

Sustainability is a widely recognized phenomenon, with businesses transforming themselves to be more sustainable through culture change. This enables these businesses to lead sustainability in all three dimensions: economic, environmental, and social [8,13], making SSCM vital for every business. In this case, firms plan to achieve balance among the SSCM processes and to be successful while considering SSCM dimensions. However, the implementation of SSCM is extremely challenging due to the complexity of the SSCM dimensions [14]. Firms of all sizes and industries have faced significant challenges in becoming more accountable to the environment and to society [6,15]. Similarly, striving for sustainability has been recognized as an effective strategy for dealing with some of the contemporary challenges faced by global supply chains [13]. In striving for sustainability, firms' competitiveness and financial performance will be enhanced, which will generate more capital and mitigate potential noise risks [7,16]. Su et al. [17] mentioned that the competitive priorities in SSCM refer to the manufacturing units' objectives. This allows firms to compete, obtain the capabilities determined for the activity, and strengthen the firms' competitive advantage. Moreover, enterprises ensure the satisfaction of all supply chain parties, including shareholders, suppliers, customers, employees, and society [8,18]. Thus, many researchers have argued that sustainability is the future of SCM [6–8].

At present, there is a critical need for the manufacturing industry to preserve the environment without neglecting economic growth and social responsibility, and the cement industry is no exception [2,19,20]. The cement industry is confronted by many challenges, such as decreases in the availability of fossil fuel, a lack of raw materials, a continuously increasing need for cement, increasing environmental anxiety, and the weakness of the world economy [1]. On the other hand, the cement industry is recognized as the largest contributor to CO₂ emissions among all industries worldwide. This industry consumes significant amounts of non-renewable energy and raw materials, resulting in high levels of CO₂ production [21]. To mitigate the negative impact of its operations on the environment, the cement industry must adopt sustainable production practices, such as reducing energy consumption, reusing and recycling materials, and engaging in remanufacturing [21,22]. These measures can help to minimize CO₂ emissions and promote a more sustainable future for the industry.

Therefore, sustainability in manufacturing, particularly in the cement industry, has received significant attention in recent years [2,5,6,8–10,13,20,23]. Cement manufacturing has been recognized as an intensive consumer of natural raw materials, fossil fuels, and energy, as well as a major source of multiple pollutants. In addition, cement producers are under massive pressure to reduce the environmental impacts of their products and operations; thus, the implementation of sustainability in the cement industry is critical [23,24]. Furthermore, cement is an essential commodity for economic growth, but its operations necessitate large amounts of energy and the use of natural raw materials and fossil fuels. This forces cement manufacturers to emit high levels of pollution while also facing challenges in implementing sustainable processes and manufacturing their products [2,9,23]. Recently, in Jordan, the industrial company Lafarge had to shut down the Alfuhais cement factory due to environmental violations, such as CO₂ emissions and dust discharge causing air pollution. The company was also required to pay JOD 45 million in financial compensation to residents of the neighborhood after losing a lawsuit in the Jordanian court, which was

submitted by the residents. Consequently, accumulating losses forced Lafarge Jordan to lay off 200 employees in order to continue their operations in Jordan [25]. Thus, evaluating the sustainability of manufacturing in this industry has become a necessity.

As the cement industry faces numerous social and environmental challenges, there is a growing need to examine its sustainability practices. However, there is a dearth of studies examining sustainable supply chain management (SSCM) practices in this sector [1,2,22,23], particularly in developing countries such as Jordan. Furthermore, there is a lack of comprehensive models that measure SSCM practices specifically designed for the cement industry. Therefore, this study aims to address this gap by developing a model for SSCM practices categorized by the TBL dimensions and evaluating their implementation among cement manufacturers in Jordan. The paper comprises several sections. First, a literature review was conducted, drawing from relevant studies that aligned with the objectives of this study. Next, the paper presents the hypothesis and conceptual model. The methodology is then comprehensively explained. The study's findings are subsequently presented, followed by a discussion of the conclusions drawn and the limitations of the study.

2. Literature Review

The triple bottom line (TBL) is sustainability framework that includes bottom-line categories for social, environmental, and financial issues. Several companies have begun to understand the link between environmental health, social well-being, and an organization's financial success and resilience as a result of TBL theory and practice [13].

2.1. Environmental Concerns

By addressing the environmental factor, environmental concerns have been incorporated into supply chain procedures and processes, such as product design, vendor selection, operations, and transportation, as well as the end-of-life management of used products [7,11]. The environment dimension is made up of a number of elements, some of which are discussed in depth, including alternative fuel, governmental rules and regulations, emission reduction, life cycle assessment, environmental certifications, noise and waste reduction, non-Portland cement, and recycling.

Fore et al. [26] explained that using alternative fuels to provide the high temperatures needed to facilitate calcination in the kiln would be ecologically friendly for the environment and would limit the exploitation of fossil fuel natural resources, such as coal. Moreover, waste from other industries, such as rubber production, timber saw milling, or even municipal trash, is regarded as a good alternative fuel; hence, this could result in an effective by-product synergy. Furthermore, decreasing the fossil fuel dependency by using an alternative fuel will result in decreasing CO₂ emissions and production costs [21,27]. Increasing the use of alternative fuels instead of primary fuels in order to maintain the environment and control emissions is considered to be a pivotal action [14].

The government should be involved in the production of cement to ensure that the rules are followed during production to reduce environmental damage [6,28]. The government should similarly push cement producers to include corporate social responsibility and sustainable practices into their policies [28]. Sadly, emerging nations, including Jordan and the United Arab Emirates, have lagged behind in implementing clean production in their cement-manufacturing businesses. However, the USA and the UK have passed several environmental legislations, and there have been tremendous advancements in environmental quality theory and practice [26]. In reality, Pakistan must make substantial efforts in creating binding rules, regulations, and policies to forbid the creation of harmful types of pollution that could impair the environment, the economy, and the health of living things [28]. Additionally, the Chinese government is considering requiring Chinese cement firms to comply with environmental laws pertaining to the adoption of sustainable supply chain methods [29]. As a result, government regulations and legislation are critical for manufacturing companies to adopt green practices that lead to sustainability [6,30].

One of the most useful materials in the world for the construction sector is cement. Cement manufacturing releases a number of pollutants, including SO₂, NO_x, CO₂, HF, and HCL, which have serious local and worldwide environmental consequences [26]. Therefore, lowering raw material and energy consumption is linked to limiting waste production. It can also boost productivity, which would benefit businesses financially [26,27].

According to Shrivastava et al. [21], a life cycle assessment (LCA) is an essential tool for understanding overall energy consumption, identifying opportunities for energy savings, and educating decision-makers about policies and energy-efficient investments [31]. It also aids in understanding the contained energy, environmental effects, and potential energy savings of manufactured products. Moreover, the ISO has created LCA standards including ISO 14040:2006, ISO 14044:2006, and ISO/TR 14048:2002 [21]. From the same perspective, Jayal et al. [32] stated that “LCA attempts to quantify the overall environmental and economic impact in terms of material and energy consumption and carbon footprint over the entire life cycle of a product, from material extraction to eventual disposal at the end of life”. As per Barve et al. [33], every stage of a product’s life cycle, from resource extraction through manufacturing to the disposal or recycling of the final product, has the possibility of having an effect on the ecosystem within its supply chain. In a similar vein, various environmental management practices have been adopted by various industries, including ISO 14001 certification and cleaner production throughout the entire supply chain, in an effort to reduce energy emissions and various hazardous wastes, chemical wastes, and solid wastes.

Various types of environmental management systems (EMSs) have been adopted by international and local businesses to manage the environmental impact of commercial, industrial, and service operations [34]. This is confirmed by more small and large businesses becoming aware of the benefits of EMSs for their operations in the long term, resulting in the use of EMSs to improve environmental performance, enhance compliance with environmental rules and regulations, and increase plant operational efficiency [34]. This is evident for one of the EMS standards, ISO 14001, which has been used globally [13,34,35]. Furthermore, ISO 14001-certified cement plants outperformed non-certified cement plants in both operational environmental practices [13,34,35].

Noise is thought to contribute significantly to environmental pollution and has a negative impact on society’s quality of life [27,36]. As per Vladimir and Madalina [37], after water pollution and exhaust emissions pollution, noise pollution was considered the most dangerous cause for environmental pollution. Moreover, noise has a detrimental effect on human function, leading to socioeconomic issues, psychiatric diseases, and job discontent. Therefore, regulations have been established regarding the limitation of noise exposure for industrial workers: noise levels equivalent to or less than 85 dBA are considered safe for workers. The cement industry must therefore concentrate on types of environmental pollution such as noise, which is primarily relevant as a hazardous working condition in factories [36,37].

Considerations for sustainable manufacturing operations include minimizing waste during production and utilizing inputs such as air and water at their lowest possible levels [19,38,39]. In addition, the increase in waste production and environmental contamination is mostly a result of industrialization and urbanization. Chemical discharge from industrial sources could be harmful to human health. In addition, improper waste disposal will lead to water and land contamination, aggravating the issue of industrial discharge into rivers and other waterways, which also degrades the local natural environment. In addition, society can implement waste management programs in a variety of methods, depending on the physical and chemical characteristics of the discharge [21]. Lakhani [40] argued that this makes the issue of a negative consequence vital while pursuing a zero-waste aim, including waste avoidance and limitation through clean production, as cost might be a deterrent to adopting greener methods.

One of the key processes increasing the risk of global warming is the production of Portland cement, which emits significant amounts of carbon dioxide. Therefore, cement

producers must provide an ecologically friendly alternative cement with strong mechanical qualities, such as a non-Portland cement or an alkali-activated slag cement, which is thought to be a more affordable and environmentally friendly cement [41]. According to Shehab et al. [42], the most commonly used cement in daily concrete production is Portland cement, and the Portland-cement-manufacturing processes require large amounts of energy, resulting in high levels of CO₂ emissions. Shehab et al. [42] stated that slag cement is an alternative product that can assist cement manufacturers in reducing the amount of Portland cement they use. As a result, it can replace a significant amount of Portland cement.

Recycling is one of the most effective waste-reduction strategies; however, it cannot be successful without the involvement and cooperation of all stakeholders. In addition to providing numerous benefits to society, recycling activities create new jobs, raise wages, and increase tax revenues for countries [43]. Similarly, industries that are highly productive and can efficiently use raw material resources benefit society, are economically competitive, contribute to national development, and protect the environment [43]. According to new research, recycling waste from cement manufacturing is, to a limited extent, highly desirable for reducing cement producers' negative environmental impact and converting wastes into sustainable products [44].

2.2. Social Concerns

Social sustainability is the advancement of the moral and ethical principles that are pertinent to a company's operations [45]. Social sustainability enables organizations to conduct their operations and economic activities in an ethical manner [46]. According to Carter et al. [47], social sustainability also promotes equality of opportunity and protects the needs of the community and labor force. Additionally, according to Jum'a et al. [13], social sustainability frequently includes societal pursuits, including quality of life, community development, social support, labor rights, social equity, and corporate social responsibility (CSR). Furthermore, with respect to social performance, organizations must be sustainable and should provide a healthy environment for employees, offering social obligations, local community involvement, and a variety of education and training courses, as well as employee engagement in organizational development [48]. Consequently, social sustainability can be enhanced by implementing social factors that can improve a firm's social reputation and corporate image [13,49].

The social dimension consists of several factors. Some of these important social factors will be explored, such as workforce training, local community involvement, employee satisfaction, health and safety, sustainable product design, corporate governance, the Ministry of Labor, and job creation.

Programs for employee learning and development are a smart way to reduce work difficulties [50]. A competent workforce will be easier to recruit and maintain the introduction of improved information distribution within the business, increased workforce diversity, equitable employment opportunities for all, job security, comparable remuneration, and the career development of the employees [50,51]. The importance of human capital in training people, highlighting the value of CSR, and determining the best way to apply it makes it a criterion of organizational success. In this regard, firms must be aware that effective CSR implementation increases employees' sense of belonging in their organizations and in society by demonstrating respect for various cultural developments and sensitivity to ideas, values, and beliefs [2,18].

The active participation of key stakeholders, such as local communities and lobbying groups, is critical to resolving environmental issues [21]. Furthermore, increased collaboration among industries and stakeholders may encourage the development of environmental and social practices that will lead to pollution reduction and community support [21]. In the same vein, the UN Global Compact emphasized the importance of stakeholder engagement, community involvement, public participation, and conservation efforts as essential components of a sustainable strategy [52].

Due to their importance in gauging an organization's overall development, occupational health and safety are key components of social responsibility. Legislation and national law are the primary means through which health and safety regulations are enforced, and these laws directly affect the workers' effectiveness and productivity [21]. For example, a research study by the European Agency for Health and Safety at Work revealed that increased occupational health and safety results in increased productivity and lower employment costs [21].

One of the key strategies for achieving sustainability has been thought to be sustainable product design [53]. A company must frequently cope with certain challenging technical trade-offs between conventional and environmental features that call for new design concepts and engineering requirements in order to improve the environmental performance of a product through product design [53,54]. Likewise, both the public and business sectors around the world have paid significant attention to contemporary sustainable product design [54,55]. According to the most recent Green Brand Survey conducted in 2010, which included 9000 respondents from a variety of nations, including Australia, Brazil, China, France, Germany, India, the United States, and the United Kingdom, more than 60% of respondents reported that they preferred to patronize environmentally conscious businesses [54]. Offering good value was still viewed as a key factor in making purchasing decisions by 72% of respondents, but environmental consciousness was also viewed as a significant factor by 50% of respondents [54].

A company's management, board, shareholders, and other stakeholders are said to be involved in a complex of interactions known as corporate governance [56]. The company's stakeholders, which include its owners, creditors, management, employees, customers, and the general public, can formulate and address issues as they arise through the use of corporate governance. Additionally, it is believed that the establishment of sound corporate governance is essential for the development of a competitive market [56,57]. In reality, good capital markets are stabilized and strengthened by good corporate governance standards, and investors are protected [57]. Moreover, corporate governance enables businesses to achieve their goals, attract investment, and protect shareholder rights in addition to assisting businesses in improving performance [56].

Labor law is responsible for improving jobs and job providers and offers an opportunity to improve the skills of the laborers. It also aids in making decisions in labor injustice cases and governs laborers' rights in the labor market. Furthermore, in developing countries, the labor law is regulated in terms of worker protection from the different problems faced by laborers, such as an imbalance of power between employers and employees, the payment of wages, and sex discrimination [58]. Moreover, Koberg et al. [59] indicated that to be socially responsible, organizations must take into consideration local labor laws and adopt social standards such as the ISO 26000 [59].

The social sector is linked to the other sub-systems of manufacturing profit. In fact, when production costs decrease, the manufacturer's income increases, and the willingness to invest in expansions in the cement sector increases; therefore, job opportunities also increase. In addition to the government regulation needed to support emission reduction policies that can play a positive role in creating environmental sustainability, there is a need to create more job vacancies [60]. From the same perspective, the government must encourage cement manufacturers to invest in cement substitution, which would aid in the reduction of environmental pollution and create more jobs [60].

2.3. Economic Concerns

The economic dimension focuses on a firm's ability to effectively use both tangible and intangible assets, as well as profit and financial gain [61]. Additionally, the economic dimension is seen as a long-term objective, one which aims to ensure a company's continued existence by meeting the needs of its stakeholders and enabling it to generate a cash flow that ensures enough liquidity to safeguard the company's future development [62]. Economic sustainability aims to address conventional economic goals while taking into

account their societal and environmental consequences [47,55]. Moreover, metrics including sales, earnings, ROIs, cash flows, taxes paid, personal income, jobs generated, and the cost of underemployment can be used to determine an organization's commitment to economic sustainability [63]. In a similar vein, a company's ability to operate well in terms of both the environment and society depends on its ability to survive in the long run [64].

In developing countries, consumer awareness regarding the fairness of employee working conditions has forced companies to acknowledge their responsibility in providing employees with good working conditions [64]. The economic dimension consists of several factors, some of which are important economic factors that will be explored, such as risk management, improving employee skills, sustainable energy, innovation, branding, tax regulation, and transportation.

A supply chain risk is any potential threat facing any part of the supply chain, beginning with the supply of raw materials, information, operations, and processes and ending with the delivery of the end product to the consumer [1,65,66].

In their discussion of supply chain risks, Rostamzadeh et al. [67] distinguished between internal and external risks. Internal risks are disruptions to a firm's operations and its established policies. External risks are logistical challenges, supplier issues, and risks resulting from governmental actions. Each unfavorable activity poses a danger to the SCM since organizational sustainability, social responsibility, and environmental sustainability are interrelated [67]. Companies are advised to act quickly in response to both internal and external threats in order to maintain company activity, productivity, and profitability [65,68]. The supply chain must also be flexible in its reactivity, efficiency, and dependability should any disruptions or unforeseen circumstances arise [66,67]. In addition, managers of supply chains must take responsibility for decisions involving asset recovery, relationship management, sustainable sourcing and the creation of local content in order to avoid sustainability-related risks and cut costs [67]. In most cases, seriously misleading information can result from conducting a risk analysis without considering impreciseness and uncertainty; therefore, a valid risk management analysis should be considered [66,69].

Top management can encourage their employees by providing financial support, encouraging a positive attitude, and empowering their employees in rethinking the traditional manufacturing operations or processes with consideration for sustainable practices [55]. Comparatively, a company sharing values with its employees reaps valuable financial and non-financial benefits that increase employee productivity and loyalty to achieve the firm's objectives with the lowest possible risk [70]. Wolf [71] emphasized that better sustainability practices can be achieved by adopting advanced skills and experience, such as product life cycle and product design. Wolf [71] also added that organizations' investments in employee skills, qualifications, and training will develop the workforce's capabilities in using sustainable techniques and tools. Such investments will generate sustainable knowledge and skills that will, in turn, enable the firm to acquire a sustainable competitive advantage [72].

As a result, a company's ability to integrate its employees into structural changes that will improve its sustainability, economic benefits, and performance will have an impact on the firm's sustainability performance [71,72]. Strong staff motivation and loyalty, which lead to employee commitment and increased labor productivity, are other significant advantages of adopting environmental management systems, according to Wolf [71].

The availability of energy has a significant impact on the expansion of human civilization, including the economy, living standards, and population; these characteristics are connected to modifications in our capacity to obtain and transform energy for beneficial purposes [6,21,27]. In fact, energy is crucial to achieving all SDGs, including those related to industrialization, water supply, health, and education, as well as battling climate change. As a result, energy plays a vital role in sustainable development. Sustainable energy typically produces and uses energy that can meet society's present and future needs for the least amount of money and with the least negative effects on the environment, the economy, and society [13,21,27,30].

In contrast to Pitak et al. [27], Mirzakhani et al. [73] mentioned that the cement industry consumes a massive amount of energy during the production processes due to the operation of the pyro-process unit. Indeed, the cost of sustainable technologies such as wind and solar energy has largely declined as a result of increased production volumes, unit sizes, and economies of scale. This has led to a reduction in manufacturing costs due to lower energy consumption, which is important for a circular economy because it reduces the demand for resources, materials, and production parts that rely on fossil fuel-based energy, thereby lowering the carbon footprint [21,27].

Green design, green manufacturing processes, and green packaging are indicators of advanced applications and innovations in which the advancement of ICT leads to improved operations, safety, and traceability [29,74]. An innovation culture, as opposed to a bureaucratic culture, usually motivates individuals to reflect, advance knowledge and communication, and adopt novel ideas [74]. In particular, innovation is a major source of technological advancement and economic expansion, with radical innovation resulting in major shifts in product lines and processes or the development of entirely new goods and incremental innovation resulting in continuous improvements in the manufacturing process. Overall, both radical and incremental innovations improve quality and help a company maintain its leadership position in its industry [30,70,74].

When companies combine sustainability and branding, they appeal to customers who are concerned about the environment, providing the company with a competitive advantage. As a consequence, stakeholders' perceptions of product evaluations and customer satisfaction will improve, and talented employees will be attracted [75,76]. Furthermore, sustainability initiatives, which may include social or environmental practices, can have an impact on the corporate brand by creating sustainability associations, which are typically related to values such as responsibility, social and environmental stewardship, and morality, and become part of their brand image [75]. According to Suryakumar and Ramesh [77]), cement has evolved into more than a grey powder sold in paper or plastic bags: it has evolved into a brand as a result of the decisions made by consumers and decision-makers when purchasing cement. Cement branding is critical to creating appropriate product appeal: a good image of cement is strongly related to being first-class, and quality is related to power.

Jordanian policymakers are interested in establishing a link between the tax system and economic expansion. Therefore, Jordan's economy has grown more slowly than it did in previous years, and policymakers are still unsure of the influence of taxation on economic growth in Jordan [78]. Bani-Khalid et al. [78] underline that attaining economic growth largely depends on the type and structure of tax financing. Moreover, Bani-Khalid et al. [78] concluded that paying attention to the taxation system is necessary for ensuring sustained economic growth and that various taxes, including income and personal taxes, have a detrimental impact on Jordanian economic growth.

The supply chain largely depends on logistics. In addition to logistics, cost plays a crucial role as an economic factor in supply chain efficiency. Transportation and logistics are two factors that enable a world-class supply chain for the company [79,80]. Additionally, transportation costs represent an essential element of the supply chain in which logistics costs include transportation, warehousing, administration, and inventory holding [81]. In the cement industry, the improvement of transportation is a significant approach to energy consumption in the cement industry [80,82]. In fact, as cement is a bulky product, the logistics costs for the cement company are crucial: a 25% higher cost of beverage goods, sold as a result of optimizing transportation costs, would be critical for the cement company [83].

The SSCM were identified and categorized based on TBL dimensions as shown in Table 1.

Therefore, this study attempted to develop a model for SSCM practices by incorporating 23 SSCM factors divided into three dimensions of sustainability, including nine factors of environmental SSCM, seven factors of social SSCM, and seven factors of economic SSCM.

2.4. The Relationship between SSCM Practices Based on TBL and SDGs

The study covers several sustainable development goals (SDGs) that are connected to the three TBL dimensions.

Regarding the environmental dimension, SDG12, “Ensure sustainable consumption and production patterns”, suggests that to achieve the social and economic objectives of the global community, a significant amount of chemical use is required, and this use can be achieved with a high level of safety when best practices are followed [84–86]. Two of the main issues identified, especially in developing nations, are a lack of resources for assessing chemicals for which data are available and a lack of adequate scientific information for risk assessment [86]. Moreover, in addition to eradicating poverty and managing natural resources to promote economic and social development, sustainable consumption and production has been chosen as one of the three overarching goals of and prerequisites for sustainable development [86]. Therefore, this study focuses on changing unsustainable consumption and production patterns that should be a priority for the private sector and all main groups. Furthermore, SDG15, “Protect, restore and promote sustainable use of terrestrial ecosystems”, suggests that a substantial reduction in the loss of biodiversity at the global, regional, and national levels is critical in order to help end poverty and globally benefit all life [84,85,87]. Thus, this study attempts to encourage cement manufacturers to adopt more recycling activities, quality certificates related to the environment, emission reduction initiatives, the production of environmentally friendly products, noise control, and waste reduction.

Regarding the social dimension, SDG3, “Ensure healthy lives and promote well-being for all at all ages”, suggests it is critical to ensure universal access to national health care and lower the number of illnesses and fatalities caused by pollution and hazardous chemicals [84,85,88]. It has been recognized that the objectives of sustainable development can only be met in the absence of a high prevalence of crippling diseases and while achieving health improvements for the entire population, recalling that human beings have a right to a healthy and productive existence in harmony with nature [84,85,88]. Thus, this study attempts to encourage and ensure that cement manufacturers are providing health and safety programs for their employees, activities for the local community, workforce training programs, and are alignment with laws and regulations from the Ministry of Labor.

Regarding the economic dimension, SDG8, “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”, suggests that the new 2030 agenda for sustainable development includes essential components related to social protection and dialogue through employment and decent work [84,85,89]. Additionally, many of the other goals’ targets can be found in important parts of decent work. This can be achieved by aiding in the expansion of employment possibilities, generating income [84,85,89]. The foundations of long-term economic development, the eradication of poverty, and the creation of jobs are a better infrastructure and sound economic policies tailored to the needs of the people [89]. Thus, this study attempts to ensure that cement manufacturers provide a risk management framework for critical decisions, improve the employees’ skills, use efficient energy and transportation modes for their operations, improve business and products, and have reasonable taxes imposed upon them by the government.

2.5. SSCM Practices and Development of Hypotheses

The developed framework presents the following SSCM practices in the cement industry in Jordan. The practices are classified based on the three pillars of sustainability, as shown in Table 1.

Based on Table 1, the following hypotheses have been formulated:

Hypothesis 1 (H1). *The mean of the overall implementation of environmental SSCM factors is significant at the $\alpha < 0.05$ level.*

Hypothesis 2 (H2). *The mean of the overall implementation of social SSCM factors is significant at the $\alpha < 0.05$ level.*

Hypothesis 3 (H3). *The mean of the overall implementation of economic SSCM factors is significant at the $\alpha < 0.05$ level.*

Hypothesis 4 (H4). *The mean of the overall implementation of SSCM dimensions is significant at the $\alpha < 0.05$ level.*

3. Materials and Methods

3.1. Sampling and Data Collection

Participants in this study were Jordanian industry experts or managers holding various positions in Jordanian cement manufacturing companies. The sample respondents provided primary data via a structured questionnaire, and the samples were chosen using a purposive sampling strategy. Using a non-probability sampling strategy known as “purposive sampling”, we aimed to find participants in the population who were the most likely to have cement industry experience and were willing to share their experiences in the study. We chose the respondents who best matched our study by selecting a sample of a relatively small number of respondents [90]. Table 1 lists the scale items used in this study, which were adapted from previous studies. Using a 5-point Likert scale, the respondents were asked to indicate how much they agreed or disagreed with statements about the three types of SSCM practices. The final sample included 41 cement company managers in Jordan as well as industry specialists who were qualified and willing to evaluate SSCM practices in the industry.

3.2. Sample Profile

This section of the study provides the percentages and frequencies of the study respondents based on their demographic characteristics.

According to Table 2, the majority of respondents (90.2%) were male, and 51.2% had 5–10 years of experience. The majority of respondents had a Bachelor’s degree, and the majority (82.9%) were top-level managers.

Table 2. Demographic profile of respondents.

Question	Options	Frequency	Percentage %
Gender	Male	37	90.2%
	Female	4	9.8%
Age	18–24 years old	1	2.4%
	25–39 years old	25	61.0%
	40–60 years old	12	29.3%
	>60	3	7.3%
	<5 years	4	9.8%
Years of experience	5–10 years	21	51.2%
	>10	16	39.0%
	Bachelor’s	28	68.3%
Education level	Master’s/PhD	13	31.7%

Table 2. *Cont.*

Question	Options	Frequency	Percentage %
Managerial position	First-line managers	3	7.3%
	Middle-level managers	4	9.7%
	Top-level managers	34	82.9%

4. Results

4.1. Descriptive Analysis

The descriptive statistics included the mean, standard deviation, and implementation level. Furthermore, the level of implementation was based on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Cumulative values were classified into three categories: low (1–2.33), moderate (2.34–3.67), and high (3.68–5). The evaluation of the SSCM practices was based on three levels: low, medium, and high. The equation for calculating the length of the interval for the levels is: interval length for level = (maximum value of the scale – minimum value of the scale)/(Number of levels). These three intervals were used by many studies in the literature, such as the study by Mutamimah et al. [91].

4.1.1. Environmental Dimension

The mean, standard deviation, level of implementation, and rank according to the mean score of each SSCM practices related to the environmental dimension of sustainability are shown in Table 3.

Table 3. Descriptive statistics for environmental SSCM practices.

Factors	Mean	Standard Deviation	Level of Implementation	Rank
The company has recycling activities for its products	2.39	1.36	Medium	8
The company plans for the life-cycle assessment	2.63	1.41	Medium	7
Government rules and regulations support the environmental practices of the company	2.24	1.34	Low	9
The company has quality certificate/s related to the environment	3.10	1.41	Medium	6
The company has emission reduction initiatives (CO ₂ , NO _x , dust, etc.)	3.88	1.47	High	2
The company uses alternative fuel in its production such as biomass fuel, or natural gas	3.56	1.48	Medium	4
The percentage of non-Portland cement production is high	3.46	1.36	Medium	5
The company has waste reduction practices in use in the factory	3.85	1.15	High	3
The company controls the level of noise in all operations	4.22	1.13	High	1
Overall implementation of environmental sustainability indicators	3.26	0.86	Medium	

Table 3 indicates that the overall implementation of environmental practices was at a medium level, with a mean of 3.26. More specifically, the lowest applied practice in Jordan's cement factories was "Government rules and regulations support the company's environmental practices" with a mean of 2.24, indicating that its implementation was low. The highest applied practice was "The company controls the level of noise in all operations" which had an average of 4.22, indicating that it was widely used.

4.1.2. Social Dimension

Table 4 shows the mean, standard deviation, level of implementation, and rank according to the mean score of each SSCM practice related the social dimension of sustainability.

Table 4. Descriptive statistics for social SSCM practices.

Factors	Mean	Standard Deviation	Level of Implementation	Rank
The company has a program of health and safety for its employees	4.37	1.28	High	2
The company has support activities for the local community	4.15	1.28	High	3
The company has significant job creation and employee satisfaction	4.02	1.25	High	5
The company has sustainable product designs	2.90	1.39	Medium	7
The company has workforce training programs	4.07	1.17	High	4
The company has a clear corporate governance structure	3.32	1.21	Medium	6
The company is committed to laws and regulations by the Ministry of Labor	4.41	1.22	High	1
Overall implementation of social sustainability indicators	3.89	0.98	High	

Table 4 shows that the overall implementation of social practices was at a high level, with an overall mean of 3.89. The highest applied practices were “The company is committed to Ministry of Labor laws and regulations”, with an average of 4.41, followed by “The company has a health and safety program for its employees”, with an average of 4.37. The table also revealed that the factor with the lowest level of implementation was “The company has sustainable product designs”, with an average of 2.90.

4.1.3. Economic Dimension

Table 5 shows the mean, standard deviation, level of implementation, and rank according to the mean score of each SSCM practice related the economic dimension of sustainability.

Table 5. Descriptive statistics for economic SSCM practices.

Factors	Mean	Standard Deviation	Level of Implementation	Rank
The company has a risk management framework for critical decisions	3.98	1.17	High	1
The company is improving the employees’ skills	3.56	1.29	Medium	4
The company uses sustainable energy to reduce energy consumption costs	3.46	1.19	Medium	5
The company has a business innovation center	3.29	1.25	Medium	6
The company uses the most efficient transportation mode for inbound/outbound logistics	3.68	1.08	High	2
Tax regulation imposed by the government is reasonable	2.00	1.40	Low	7
The company has branding	3.63	1.46	Medium	3
Overall implementation of the economic sustainability indicators	3.37	0.91	Medium	

Table 5 demonstrates that the overall implementation of economic practices was at a high level, with an overall mean of 3.37. According to Table 5, the most widely used economic practice was “The company has a risk management framework for critical decisions”, which had a high level of implementation, with an average of 3.98. The practice with the lowest level of implementation was “Tax rate imposed by the government is reasonable”, with an average of 2.00.

4.1.4. Overall Implementation of the Sustainability Dimensions

Table 6 shows the mean, standard deviation, level of implementation, and rank according to the mean score of the SSCM practices related to each dimension of sustainability.

Table 6. Descriptive statistics for SSCM practices by sustainability dimensions.

Factor	Mean	Standard Deviation	Level of Implementation	Rank
Overall implementation of environmental sustainability indicators	3.26	0.86	Medium	3
Overall implementation of social sustainability indicators	3.89	0.90	High	1
Overall implementation of economic sustainability indicators	3.37	0.90	Medium	2
Overall implementation of sustainability indicators	3.51	0.79	Medium	

Table 6 shows the averages of the overall implementation SSCM practices, with the social dimension having the highest average (3.89), the economic dimension having the second highest average (3.37), and the environmental dimension having the lowest average (3.26). Furthermore, the table shows that the mean of the overall sustainability indicators was 3.51, indicating that the overall implementation of sustainability factors in Jordanian cement factories was moderate.

4.2. Hypotheses Testing Results

The study tested the hypotheses using a *t*-tests analysis in which a test value was considered significant at mean = 3 [92].

Table 7 shows that the statistical significance (*p*-value) of the *t*-test is less than 0.05 for all SSCM dimensions [92]. As a result, the means of the SSCM practices are statistically significant. Thus, we accept all the study's hypotheses.

Table 7. Hypotheses testing results.

	SSCM Dimensions	Test	Mean	<i>t</i> -Value	<i>p</i> -Value	Result
H1	Environmental	<i>t</i> -test	3.26	1.929	0.061	Accepted
H2	Social	<i>t</i> -test	3.89	5.823	0.000	Accepted
H3	Economic	<i>t</i> -test	3.37	2.634	0.012	Accepted
H4	Overall	<i>t</i> -test	3.51	4.057	0.002	Accepted

5. Discussion and Conclusions

This study attempted to develop a model for SSCM practices employing 23 SSCM factors divided into three dimensions of sustainability, namely, 9 factors of environmental SSCM, 7 factors of social SSCM, and 7 factors of economic SSCM. The model, in combination with its classification of SSCM according to the TBL dimensions, aids in the explanation and expansion of knowledge regarding the adoption of SSCM in the cement industry. On the other hand, practice is built upon the combination of theory and research. Theory aids in bridging the gap between the conceptual and the practical, leading to actions and directions that can be used by cement manufacturers.

The study revealed that the overall implementation of environmental sustainability indicators was at a medium level. The findings revealed that the level of implementation for the factor of government rules and regulations in Jordan was low. Zeb et al. [28] concluded that government rules and regulations are important in the cement industry manufacturing processes, where they should be applied to ensure manufacturing regulations are followed to minimize environmental pollution. Moving on to the medium implementation of environmental SSCM, we can see that life cycle assessment (LCA) practice was implemented at a medium level in Jordan. Shrivastava et al. [21] considered LCA a critical tool for reducing total energy consumption and identifying energy-saving opportunities. Additionally, ISO industries should have established LCA standards through the ISO environment. The recycling factor had a medium implementation. Cho (2019) [43] concluded that recycling is one of the most effective strategies for reducing the negative impact of waste on the environment, and it cannot be successful without the involvement and cooperation of

stakeholders. The result for non-Portland cement showed a medium implementation. Abdel-Gawwad et al. [41] concluded that non-Portland cement is one of the main factors concerning the cement industry's contribution to the global warming potential as cement manufacturing produces high levels of carbon emissions. Cement manufacturers must also develop an eco-friendly alternative cement. International and local firms have embraced a variety of environmental management systems to control the environmental impact of their commercial, industrial, and service operations [34]. This is supported by the fact that more small and large enterprises are becoming aware of the advantages of EMSs for their long-term operations, leading to the use of EMSs to enhance environmental compliance, improve environmental performance, and boost plant operational efficiency [34]. This is particularly true with the ISO 14001, one of the EMS standards that has gained widespread adoption [13,34,35,93]. Additionally, cement factories with ISO 14001 certification outperformed cement plants without certification in terms of both operational and environmental practices [13,34,35]. Additionally, the alternative fuel factor had a medium level of implementation. Cankaya et al. [14] concluded that increasing the use of alternative fuels rather than polluting fuels such as coal helps to preserve the environment and reduce emissions. Finally, it is believed that noise severely degrades the quality of life in society and contributes to environmental damage [27,36]. Noise exposure is a hazard for industrial workers, for whom 85 dBA or less is considered a safe limit. As a result, the cement sector must focus on environmental pollution, particularly noise, which is a dangerous working environment in factories [36,37].

The study revealed that the overall implementation of social sustainability indicators was at a high level. Reducing job challenges through employee learning and development programs is a wise approach [50]. The value of human capital in developing employees, highlighting the importance of CSR, and figuring out the best approach to implement it makes it a success factor for firms. Firms must be aware that by exhibiting respect for various cultural trends and sensitivity to ideas, values, and beliefs, good CSR implementation promotes employees' sense of belonging within their enterprises and in society [18,51]. Moreover, the resolution of environmental challenges depends on the active involvement of important stakeholders, including local communities and lobbying organizations [21]. Additionally, enhanced cooperation between sectors and stakeholders may promote the formation of social and environmental norms that result in pollution reduction and community support [21]. Occupational health and safety are essential elements of social responsibility due to their significance in assessing an organization's overall progress. Legislation and national law serve as the main tools for enforcing health and safety rules, and these laws have a direct impact on the productivity and effectiveness of the workforce [21]. Sustainable product design is one of the main tactics for achieving sustainability, according to some experts [53]. In order to increase the environmental performance of a product through product design, a corporation must frequently cope with certain difficult technical trade-offs between conventional and environmental aspects that necessitate new design concepts and engineering requirements [53,54]. Likewise, current sustainable product design has received considerable attention from both the public and private sectors worldwide [54,55]. Furthermore, it is thought that the establishment of good corporate governance is necessary for the growth of a competitive market [56,57]. In reality, sound corporate governance practices help to stabilize and improve capital markets while safeguarding investors [58]. Additionally, labor law governs workers' rights in the labor market, improves jobs and job providers, and provides an opportunity for workers to develop their talents. It also renders judgments in cases of labor injustice. Moreover, Koberg et al. [59] pointed out that in order for organizations to be socially responsible, they are required to implement social standards such as the ISO 26000 and to consider local labor regulations. The government must also persuade cement producers to invest in cement substitutes in order to reduce environmental pollution and increase employment [60].

This study revealed that the overall implementation of economic sustainability indicators was at a medium level. To preserve business activity, productivity, and profitability,

companies are encouraged to respond swiftly to both internal and external dangers [68]. A genuine risk management analysis should be taken into consideration because, in the majority of circumstances, performing a risk analysis without taking imprecision and uncertainty into account can lead to seriously misleading information [66,69]. Wolf [71] stressed that applying advanced knowledge and expertise, such as product lifecycle and product design, can lead to better sustainability practices. By using sustainable methods and resources, firms will increase the workforce's capabilities through investing in employee skills, credentials, and training. Such investments will provide long-lasting knowledge and abilities which allow the company to gain a long-lasting competitive advantage [72]. As a result, a company's capacity to include its personnel in structural modifications that enhance its performance, economic advantages, and sustainability will have an effect on the firm's sustainability performance [71,72]. Furthermore, sustainable energy usually generates and consumes energy that can satisfy society's present and future demands for the least amount of money and with the least detrimental consequences for the environment, the economy, and society [13,21,27,30]. In contrast to Pitak et al. [27], Mirzakhani et al. [73] noted that the operation of the pyro-process unit causes the cement industry to expend a significant amount of energy during the production operations. Indeed, as a result of greater production volumes, larger unit sizes, and economies of scale, the cost of sustainable technologies such as wind and solar energy has significantly decreased [21,27]. The growth of ICT results in improved operations, safety, and traceability, as evidenced by green design, green manufacturing processes and green packaging [29,74]. As a result, innovations enhance quality and assist a business in maintaining a top spot in its sector [30,70,74]. Moreover, cement firms mix sustainability and branding to attract clients who are environmentally conscious, giving the business a competitive advantage [75,76]. Moreover, logistics costs, which include transportation, warehousing, management, and keeping an inventory, are a crucial component of the supply chain [81]. One of the most important means of reducing energy usage in the cement business is to enhance transportation [80,82]. Finally, the tax regulations factor demonstrated a low implementation level, which was consistent with the conclusions of Bani-Khalid et al. [78] that different types of taxes, such as income and personal, have a negative impact on Jordanian economic growth and that paying attention to the taxation system is important for providing sustained economic growth.

As Jordan took initiatives to join international environmental agreements in order to gain knowledge on incorporating sustainability dimensions in various industrial domains, the cement industry has faced numerous challenges in recent years as a result of economic recession, rising energy costs, and a decline in cement exports. Similarly, cement manufacturers are confronted with critical issues such as overcapacity in cement production. As a result, SSCM practices are challenging for this industry. The study developed a model for assessing and empirically testing the SSCM factors that influence the cement industry. Jordan's cement industry is vital to the Jordanian industrial economy. As a result, the aim of this research was to identify and categorize sustainable supply chain practices based on triple bottom line dimensions and evaluate the implementation of practices in the cement industry. The SSCM factors were included in the comprehensive framework after reviewing the relevant SSCM literature, and 23 SSCM factors, divided into three dimensions of sustainability, namely the environment, social, and economic dimensions, were included.

According to the study results, the average level of implementation for all environmental factors in the Jordanian cement industry was 3.26 out of 5, indicating a medium level of SSCM implementation, whereas the average level of implementation for all social factors was 3.89 out of 5, indicating a high level of related SSCM implementation. In the Jordanian cement industry, the average level of implementation for all economic factors was 3.37 out of 5, which is considered a medium level of implementation. Figure 1 summarizes the evaluation of the cement industry's implementation of SSCM practices in Jordan.

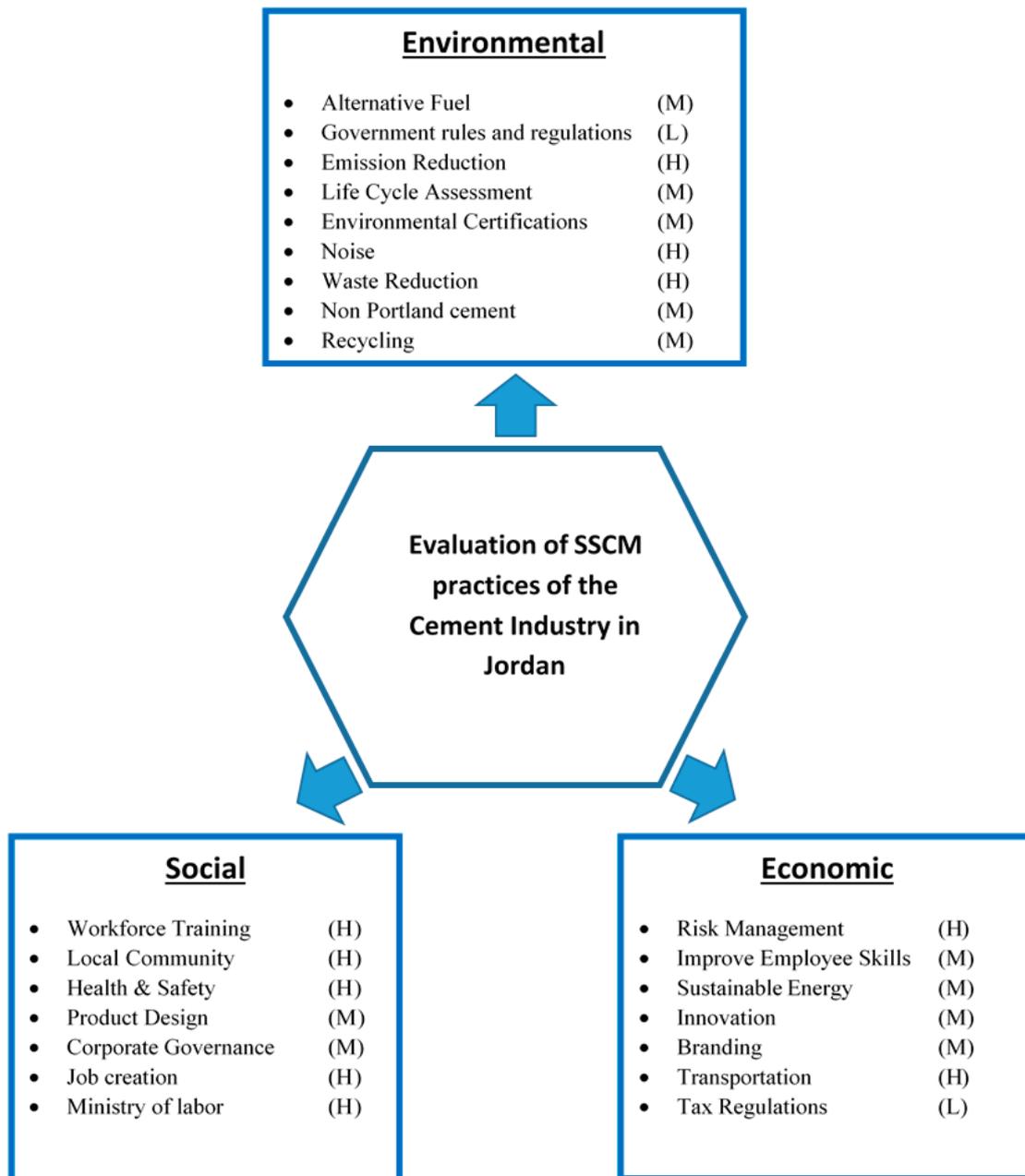


Figure 1. Summary of the status of SSCM practice implementation in Jordan’s cement industry (Level of Implementation. H: High, M: Medium, L: Low).

5.1. Theoretical and Practical Contribution

This study adds to the SSCM literature by developing a comprehensive framework for evaluating SSCM practices related to the three dimensions of sustainability. This comprehensive framework identified SSCM practices to be used for identifying and evaluating industry-specific sustainability factors.

Furthermore, this framework assists managers and decision-makers in identifying practices that will improve sustainability performance, such as increasing non-Portland cement products, improving life cycle assessments, increasing energy savings, increasing branding, improving process sustainability, and developing recycling practices in their factories. This study’s comprehensive framework can be used as a reference by Jordan’s policymakers, government officials, and cement manufacturers to implement a new strategy that incorporates sustainability into their future strategic development. The study

discovered that the current taxation system has a negative impact on the development of the cement industry's sustainable supply chain, emphasizing cement manufacturers' requests to reform the taxation system in order to reduce the obstacles and barriers that the industry faces. This framework also raises awareness of SSCM practices and encourages cement manufacturers to adopt global sustainability standards in their performance. As a result, this framework will help top managers in the cement industry become aware of any new sustainability rules and regulations, which will assist them in improving sustainability performance. Furthermore, middle management, supervisors, team leaders, and on-the-floor operators in the cement industry should receive sustainability-related training to support the implementation of SSCM.

Based on the findings of this study, recommendations for SSCM practices in the cement industry within the Jordanian context are as follows: because the average implementation of the tax regulations factor was low, Jordanian cement manufacturers and the government should work together more to implement a progressive taxation program to reduce the tax burdens faced by cement companies. The implementation of the innovation center practice was moderate, indicating that more efforts are required in the Jordanian cement industry to achieve more powerful innovation, not only in the areas of resource conservation, energy and environmental management, and waste utilization but also in developing cements with lower Portland materials and making newer cement product types, such as slag cement and blended cement. Furthermore, the average implementation of branding practice was at a medium level, indicating that Jordanian cement producers should put more effort into branding projects by improving their brand reputation among consumers and providing high-quality products at reasonable prices. Similarly, cement companies must develop niche products for the market by offering new cement solutions to consumers. The Jordanian government should encourage cement companies to design and develop green products because the average implementation of product design practice was assessed as medium. Furthermore, the average level of recycling practice was medium, indicating that the Jordanian government, in collaboration with the Ministries of Municipalities and Environment, must develop a comprehensive plan for recycling waste in a way that achieves environmental, economic, and social benefits. Furthermore, the average implementation of environmental certification practices was at a medium level, implying that the Jordanian government should encourage the cement industry to obtain relevant environmental certification, such as the ISO-14001. Moreover, the average implementation of non-Portland cement production was at a medium level, indicating that Jordanian cement producers should initiate expansion plans to produce a substitute cement for various implementations such as tile plaster, grouting, and construction solutions. The average use of alternative fuel was medium, indicating that the Jordanian government should encourage cement manufacturing companies to use natural gas to replace the use of fossil fuel in their manufacturing processes. Furthermore, the average implementation of governmental rules and regulations that support the environment factor was low, indicating that Jordanian regulatory bodies and authorities should be especially concerned with establishing policies and rules related to environmental regulation that are effective and convenient for the cement industries. Finally, the average implementation of sustainable energy to reduce energy consumption costs practice was medium, indicating that the Jordanian cement industry must use renewable energy resources to improve efficiency and energy savings during manufacturing processes, thereby sustaining energy for longer and lowering operational costs.

5.2. Limitations and Direction for Future Research

The framework was developed with a primary focus on Jordanian cement manufacturing, and no consideration was given to other types of manufacturing. To generalize results, it is also recommended to use a larger sample size and probability-sampling techniques. Future research can validate the framework in other countries. Furthermore, the framework can be tested and validated in other types of manufacturing sectors and geographical

contexts. Finally, it is worthwhile to compare SSCM practices in developing and developed countries to see if there are any noticeable differences in sustainability practices.

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References

1. Benhelal, E.; Shamsaei, E.; Rashid, M.I. Challenges against CO₂ abatement strategies in cement industry: A review. *J. Environ. Sci.* **2020**, *104*, 84–101. [[CrossRef](#)] [[PubMed](#)]
2. Khan, M.N.; Sinha, A.K. Development of a sustainable supply chain network for the cement manufacturing industry using real-coded genetic algorithm. *Soft Comput.* **2022**, *26*, 12235–12255. [[CrossRef](#)]
3. Lehne, J.; Preston, F. Making Concrete Change: Innovation in Low-Carbon Cement and Concrete. Policy Commons. 22 March 2018. Available online: <https://policycommons.net/artifacts/1423241/making-concrete-change/2037504/> (accessed on 1 October 2022).
4. Opoku, A. Biodiversity and the built environment: Implications for the Sustainable Development Goals (SDGs). *Resour. Conserv. Recycl.* **2019**, *141*, 1–7. [[CrossRef](#)]
5. Cataldo, I.; Banaitis, A.; Samadhiya, A.; Banaitienè, N.; Kumar, A.; Luthra, S. Sustainable supply chain management in construction: An exploratory review for future research. *J. Civ. Eng. Manag.* **2022**, *28*, 536–553. [[CrossRef](#)]
6. Jum'a, L.; Ikram, M.; Alkalha, Z.; Alaraj, M. Factors affecting managers' intention to adopt green supply chain management practices: Evidence from manufacturing firms in Jordan. *Environ. Sci. Pollut. Res.* **2022**, *29*, 5605–5621. [[CrossRef](#)]
7. Jum'a, L.; Zimon, D.; Ikram, M. A Relationship Between Supply Chain Practices, Environmental Sustainability and Financial Performance: Evidence from Manufacturing Companies in Jordan. *Sustainability* **2021**, *13*, 2152. [[CrossRef](#)]
8. Shabbir, M.S.; Kassim, N.M. Supply chain management drivers and sustainability of green initiatives in manufacturing enterprises: A case in Pakistan. *Int. J. Entrep.* **2018**, *22*, 1–19.
9. Kosanoglu, F.; Kus, H.T. Sustainable supply chain management in construction industry: A Turkish case. *Clean Technol. Environ. Policy* **2021**, *23*, 2589–2613. [[CrossRef](#)]
10. Adegoke, I.; Mingbao, C.; Abredu, P.; Ndafira, G.C.; Amoateng, P.A.; Owusu-Gyan, L. Impact of Sustainable Supply Chain Management Practices on Organizational Performance in Ghana. *Manag. Sci. Bus. Decis.* **2021**, *1*, 23–38. [[CrossRef](#)]
11. Varsei, M. Sustainable supply chain management: A brief literature review. *J. Dev. Areas* **2016**, *50*, 411–419. [[CrossRef](#)]
12. Ahi, P.; Searcy, C. A comparative literature analysis of definitions for green and sustainable supply chain management. *J. Clean. Prod.* **2013**, *52*, 329–341. [[CrossRef](#)]
13. Jum'a, L.; Zimon, D.; Ikram, M.; Madzík, P. Towards a sustainability paradigm; the nexus between lean green practices, sustainability-oriented innovation and Triple Bottom Line. *Int. J. Prod. Econ.* **2021**, *245*, 108393. [[CrossRef](#)]
14. Cankaya, S.; Sezen, B. Effects of green supply chain management practices on sustainability performance. *J. Manuf. Technol. Manag.* **2019**, *30*, 98–121. [[CrossRef](#)]
15. Ashby, A.; Leat, M.; Hudson-Smith, M. Making connections: A review of supply chain management and sustainability literature. *Supply Chain Manag. Int. J.* **2012**, *17*, 497–516. [[CrossRef](#)]
16. Godfrey, P.C.; Merrill, C.B.; Hansen, J.M. The relationship between corporate social responsibility and share-holder value: An empirical test of the risk management hypothesis. *Strateg. Manag. J.* **2009**, *30*, 425–445. [[CrossRef](#)]
17. Su, C.M.; Horng, D.J.; Tseng, M.L.; Chiu, A.S.; Wu, K.J.; Chen, H.P. Improving sustainable supply chain management using a novel hierarchical grey-DEMATEL approach. *J. Clean. Prod.* **2016**, *134*, 469–481. [[CrossRef](#)]
18. Jum'a, L. The effect of value-added activities of key suppliers on the performance of manufacturing firms. *Pol. J. Manag. Stud.* **2020**, *22*, 231–246. [[CrossRef](#)]
19. Abdul-Rashid, S.H.; Ghazilla, R.A.R.; Thurasamy, R. The impact of sustainable manufacturing practices on sustainability performance: Empirical evidence from Malaysia. *Int. J. Oper. Prod. Manag.* **2017**, *37*, 182–204. [[CrossRef](#)]
20. Mardani, A.; Kannan, D.; Hooker, R.E.; Ozkul, S.; Alrasheedi, M.; Tirkolaei, E.B. Evaluation of green and sustainable supply chain management using structural equation modelling: A systematic review of the state of the art literature and recommendations for future research. *J. Clean. Prod.* **2020**, *249*, 119383. [[CrossRef](#)]

21. Shrivastava, S.; Shrivastava, R.L. A systematic literature review on green manufacturing concepts in cement industries. *Int. J. Qual. Reliab. Manag.* **2017**, *34*, 68–90. [CrossRef]
22. Naqi, A.; Jang, J.G. Recent Progress in Green Cement Technology Utilizing Low-Carbon Emission Fuels and Raw Materials: A Review. *Sustainability* **2019**, *11*, 537. [CrossRef]
23. Rukuni, T.F.; Maziriri, E.T.; Booysen, K.; Zondo, M.P. Examining factors influencing green supply chain management implementation in the cement manufacturing industry in South Africa. *J. Contemp. Manag.* **2022**, *19*, 157–185. [CrossRef]
24. Amrina, E.; Ramadhani, C.; Vilsa, A.L. A Fuzzy Multi Criteria Approach for Sustainable Manufacturing Evaluation in Cement Industry. *Procedia CIRP* **2016**, *40*, 619–624. [CrossRef]
25. Almamlaka News Channel. Lafarge Company Reducing the Number of Employees to Sustain Its Operation. Almamlaka. 2019. Available online: <https://www.almamlakatv.com/news/28607> (accessed on 1 October 2022).
26. Fore, S.; Mbohwa, C. Greening manufacturing practices in a continuous process industry. *J. Eng. Des. Technol.* **2015**, *13*, 94–122. [CrossRef]
27. Pitak, I.; Denafas, G.; Baltušnikas, A.; Praspaliauskas, M.; Lukošiušė, S. Proposal for Implementation of Extraction Mechanism of Raw Materials during Landfill Mining and Its Application in Alternative Fuel Production. *Sustainability* **2023**, *15*, 4538. [CrossRef]
28. Zeb, K.; Ali, Y.; Khan, M.W. Factors influencing environment and human health by cement industry: Pakistan a case in point. *Manag. Environ. Qual. Int. J.* **2018**, *30*, 751–767. [CrossRef]
29. Aboelmaged, M. The drivers of sustainable manufacturing practices in Egyptian SMEs and their impact on competitive capabilities: A PLS-SEM model. *J. Clean. Prod.* **2018**, *175*, 207–221. [CrossRef]
30. Tu, H.; Dai, W.; Fang, Y.; Xiao, X. Environmental Regulation, Technological Innovation and Industrial Environmental Efficiency: An Empirical Study Based on Chinese Cement Industry. *Sustainability* **2022**, *14*, 11326. [CrossRef]
31. Meshram, R.B.; Kumar, S. Comparative life cycle assessment (LCA) of geopolymer cement manufacturing with Portland cement in Indian context. *Int. J. Environ. Sci. Technol.* **2021**, *19*, 4791–4802. [CrossRef]
32. Jayal, A.D.; Badurdeen, F.; Dillon, O.W., Jr.; Jawahir, I.S. Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels. *CIRP J. Manuf. Sci. Technol.* **2010**, *2*, 144–152. [CrossRef]
33. Barve, A.; Muduli, K. Modelling the challenges of green supply chain management practices in Indian mining industries. *J. Manuf. Technol. Manag.* **2013**, *24*, 1102–1122. [CrossRef]
34. Wong, J.J.; Abdullah, M.O.; Baini, R.; Tan, Y.H. Performance monitoring: A study on ISO 14001 certified power plant in Malaysia. *J. Clean. Prod.* **2017**, *147*, 165–174. [CrossRef]
35. Singh, M.; Brueckner, M.; Padhy, P.K. Environmental management system ISO 14001: Effective waste minimisation in small and medium enterprises in India. *J. Clean. Prod.* **2015**, *102*, 285–301. [CrossRef]
36. Hadzi-Nikolova, M.; Mirakovski, D.; Doneva, N.; Bakreska Kormushoska, N.; Kepeski, A. Environmental Noise Reduction Measures in Cement Industry: Usje Cement Plant Case Study. *J. Environ. Prot. Ecol.* **2018**, *19*, 173–185.
37. Vladimir, M.; Madalina, C. Optimizing urban landscapes in regard to noise pollution. *Procedia Manuf.* **2019**, *32*, 161–166. [CrossRef]
38. Singh, R.K.; Modgil, S.; Tiwari, A.A. Identification and evaluation of determinants of sustainable manufacturing: A case of Indian cement manufacturing. *Meas. Bus. Excell.* **2019**, *23*, 24–40. [CrossRef]
39. Yusuf, Y.Y.; Gunasekaran, A.; Musa, A.; El-Berishy, N.M.; Abubakar, T.; Ambursa, H.M. The UK oil and gas supply chains: An empirical analysis of adoption of sustainable measures and performance outcomes. *Int. J. Prod. Econ.* **2012**, *146*, 501–514. [CrossRef]
40. Lakhani, M. The need for Clean Production and Product Re-design. *J. Clean. Prod.* **2007**, *15*, 1391–1394. [CrossRef]
41. Abdel-Gawwad, H.A.; Hekal, E.E.; El-Didamony, H.; Hashem, F.S.; Mohammed, A.H. A new method to create one-part non-Portland cement powder. *J. Therm. Anal. Calorim.* **2018**, *134*, 1447–1456. [CrossRef]
42. Shehab, H.K.; Eisa, A.S.; Wahba, A.M. Mechanical properties of fly ash based geopolymer concrete with full and partial cement replacement. *Constr. Build. Mater.* **2016**, *126*, 560–565. [CrossRef]
43. Cho, M. Campus sustainability an integrated model of college students' recycling behavior on campus. *Int. J. Sustain. High. Educ.* **2019**, *20*, 1042–1060. [CrossRef]
44. El-Attar, M.M.; Sadek, D.M.; Salah, A.M. Recycling of high volumes of cement kiln dust in bricks industry. *J. Clean. Prod.* **2017**, *143*, 506–515. [CrossRef]
45. Carter, C.R.; Jennings, M.M. The role of purchasing in corporate social responsibility: A structural equation analysis. *J. Bus. Logist.* **2004**, *25*, 145–186. [CrossRef]
46. Zhu, Q.; Sarkis, J.; Lai, K.-H. Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *J. Purch. Supply Manag.* **2013**, *19*, 106–117. [CrossRef]
47. Carter, C.R.; Rogers, D.S. A Framework of Sustainable Supply Chain Management: Moving Toward New Theory. *Int. J. Phys. Distrib. Logist. Manag.* **2008**, *38*, 360–387. [CrossRef]
48. Kazancoglu, Y.; Kazancoglu, I.; Sagnak, M. Fuzzy DEMATEL-based green supply chain management performance. *Ind. Manag. Data Syst.* **2018**, *118*, 412–431. [CrossRef]
49. Fombrun, C.J. The leadership challenge: Building resilient corporate reputations. In *Handbook on Responsible Leadership and Governance in Global Business*; Elgar: Cheltenham, UK, 2005; Volume 54, p. 68.

50. Branca, T.A.; Fornai, B.; Colla, V.; Pistelli, M.I.; Faraci, E.L.; Cirilli, F.; Schröder, A.J. Skills Demand in Energy Intensive Industries Targeting Industrial Symbiosis and Energy Efficiency. *Sustainability* **2022**, *14*, 15615. [[CrossRef](#)]
51. Khan, M.; Majid, A.; Yasir, M.; Arshad, M. Corporate social responsibility and corporate reputation: A case of cement industry in Pakistan. *Interdiscip. J. Contemp. Res. Bus.* **2013**, *5*, 843–857.
52. Millar, E.; Searcy, C. The presence of citizen science in sustainability reporting. *Sustain. Account. Manag. Policy J.* **2020**, *11*, 31–64. [[CrossRef](#)]
53. Rahman, M.M.; Rahman, M.S.; Chowdhury, S.R.; Elhaj, A.; Razzak, S.A.; Abu Shoaib, S.; Islam, M.K.; Islam, M.M.; Rushd, S.; Rahman, S.M. Greenhouse Gas Emissions in the Industrial Processes and Product Use Sector of Saudi Arabia—An Emerging Challenge. *Sustainability* **2022**, *14*, 7388. [[CrossRef](#)]
54. Chen, C.; Zhu, J.; Yu, J.-Y.; Noori, H. A new methodology for evaluating sustainable product design performance with two-stage network data envelopment analysis. *Eur. J. Oper. Res.* **2012**, *221*, 348–359. [[CrossRef](#)]
55. Jum'a, L.; Ikram, M.; Alkalha, Z.; Alaraj, M. Do Companies Adopt Big Data as Determinants of Sustainability: Evidence from Manufacturing Companies in Jordan. *Glob. J. Flex. Syst. Manag.* **2022**, *23*, 479–494. [[CrossRef](#)]
56. Kazi, A.G.; Arain, M.A.; Sahetiya, P.D. Corporate governance and firm performance nexus: A case of cement industry of Pakistan. *Int. J. Entrep. Res.* **2018**, *1*, 1–6. [[CrossRef](#)]
57. Shahid, M.N.; Siddiqui, M.A.; Qureshi, M.H.; Ahmad, F. Corporate governance and its impact on firm's performance: Evidence from cement industry of Pakistan. *J. Appl. Environ. Biol. Sci.* **2018**, *8*, 35–41.
58. Rajah, M. 'From Third World to First': A Case Study of Labor Laws in a Changing Singapore. *Labor Law J.* **2019**, *70*, 42–63.
59. Koberg, E.; Longoni, A. A systematic review of sustainable supply chain management in global supply chains. *J. Clean. Prod.* **2018**, *207*, 1084–1098. [[CrossRef](#)]
60. Jokar, Z.; Mokhtar, A. Policy making in the cement industry for CO₂ mitigation on the pathway of sustainable development—A system dynamics approach. *J. Clean. Prod.* **2018**, *201*, 142–155. [[CrossRef](#)]
61. Carroll, A.; Buchholtz, A. *Business and Society: Ethics, Sustainability, and Stakeholder Management*; Cengage Learning: Boston, MA, USA, 2014.
62. Longoni, A.; Golini, R.; Cagliano, R. The role of New Forms of Work Organization in developing sustainability strategies in operations. *Int. J. Prod. Econ.* **2014**, *147*, 147–160. [[CrossRef](#)]
63. Savitz, A. *The Triple Bottom Line: How Today's Best-Run Companies Are Achieving Economic, Social and Environmental Success—And How You Can Too*; John Wiley & Sons: Hoboken, NJ, USA, 2013.
64. Ashley, P.A.; Crowther, D. (Eds.) *Territories of Social Responsibility*; Gower Publishing: Farnham, UK, 2012.
65. Alkalha, Z.; Al-Zu'bi, Z.B.M.; Jum'a, L. Investigating the impact of servitization architecture and development on supply Chain design. *Supply Chain Forum Int. J.* **2022**, *23*, 68–80. [[CrossRef](#)]
66. Jum'a, L. The role of blockchain-enabled supply chain applications in improving supply chain performance: The case of Jordanian manufacturing sector. *Manag. Res. Rev.* **2023**; ahead of print. [[CrossRef](#)]
67. Rostamzadeh, R.; Ghorabae, M.K.; Govindan, K.; Esmaeili, A.; Nobar, H.B.K. Evaluation of sustainable supply chain risk management using an integrated fuzzy TOPSIS-CRITIC approach. *J. Clean. Prod.* **2018**, *175*, 651–669. [[CrossRef](#)]
68. Baghizadeh, K.; Ebadi, N.; Zimon, D.; Jum'a, L. Using Four Metaheuristic Algorithms to Reduce Supplier Disruption Risk in a Mathematical Inventory Model for Supplying Spare Parts. *Mathematics* **2022**, *11*, 42. [[CrossRef](#)]
69. Waters, D. *Supply Chain Risk Management: Vulnerability and Resilience in Logistics*; Kogan Page Publishers: London, UK, 2011.
70. Kantabutra, S.; Avery, G.C. Sustainable leadership at Siam Cement Group. *J. Bus. Strategy* **2011**, *32*, 32–41. [[CrossRef](#)]
71. Wolf, J. Improving the sustainable development of firms: The role of employees. *Bus. Strategy Environ.* **2013**, *22*, 92–108. [[CrossRef](#)]
72. Potnuru, R.K.G.; Sahoo, C.K.; Parle, K.C. HRD practices, employee competencies and organizational effectiveness: Role of organizational learning culture. *J. Asia Bus. Stud.* **2021**, *15*, 401–419. [[CrossRef](#)]
73. Mirzakhani, M.A.; Tahouni, N.; Panjeshahi, M.H. Energy benchmarking of cement industry, based on Process Integration concepts. *Energy* **2017**, *130*, 382–391. [[CrossRef](#)]
74. Juma, L.; Kilani, S. Adoption enablers of big data analytics in supply chain management practices: The moderating role of innovation culture. *Uncertain Supply Chain Manag.* **2022**, *10*, 711–720. [[CrossRef](#)]
75. Kumar, V.; Christodouloupoulou, A. Sustainability and branding: An integrated perspective. *Ind. Mark. Manag.* **2014**, *43*, 6–15. [[CrossRef](#)]
76. Sheth, J.N.; Sinha, M. B2B branding in emerging markets: A sustainability perspective. *Ind. Mark. Manag.* **2015**, *51*, 79–88. [[CrossRef](#)]
77. Suryakumar, D.M.; Ramesh, T. Buyers' approach towards different brands of cement in Salem District—An Analytical study. *Int. J. Sci. Res. Comput. Sci. Appl. Manag. Stud.* **2019**, *8*, 453–459.
78. Bani-Khalid, T.; Alshira'h, A.F.; Alshirah, M.H. Determinants of tax compliance intention among Jordanian SMEs: A focus on the theory of planned behavior. *Economies* **2022**, *10*, 30. [[CrossRef](#)]
79. Baghizadeh, K.; Zimon, D.; Jum'a, L. Modeling and optimization sustainable forest supply chain considering discount in transportation system and supplier selection under uncertainty. *Forests* **2021**, *12*, 964. [[CrossRef](#)]
80. Campos, P.; Pimentel, C.; Lopes, J. Determinant factors for the strategic management of the supply chain of the Angolan cement industry. *J. Ind. Eng. Manag.* **2022**, *15*, 566–586. [[CrossRef](#)]

81. Adnan, T.M.; Das, A. Developing an Optimization Model for Reducing the Transportation Costs of River Vessels (Case Study: Lafarge Surma Cement Ltd.). *Int. J. Mech. Eng. Autom* **2017**, *4*, 120–129.
82. Andruschak, S.V.; Besedin, P.V.; Doroganov, E.A. Modeling the transportation and batching of slurry into a cement kiln. *IOP Conf. Ser. Mater. Sci. Eng.* **2019**, *560*, 012139. [CrossRef]
83. Khandelwal, A.; Bhaskaran, S. Sustainability in Road transportation—Case Study of a Beverage & a Cement Company. *J. Gujarat Res. Soc.* **2019**, *21*, 57–68.
84. Dalampira, E.S.; Nastis, S.A. Back to the future: Simplifying Sustainable Development Goals based on three pillars of sustainability. *Int. J. Sustain. Agric. Manag. Inform.* **2020**, *6*, 226–240. [CrossRef]
85. Taghvaei, V.M.; Nodehi, M.; Saber, R.M.; Mohebi, M. Sustainable development goals and transportation modes: Analyzing sustainability pillars of environment, health, and economy. *World Dev. Sustain.* **2022**, *1*, 100018. [CrossRef]
86. United Nations. Goal 12 | Department of Economic and Social Affairs. 2023. Available online: <https://sdgs.un.org/goals/goal12> (accessed on 3 April 2023).
87. United Nations. Goal 15 | Department of Economic and Social Affairs. 2023. Available online: <https://sdgs.un.org/goals/goal15> (accessed on 3 April 2023).
88. United Nations. Goal 3 | Department of Economic and Social Affairs. 2023. Available online: <https://sdgs.un.org/goals/goal3> (accessed on 3 April 2023).
89. United Nations. Goal 8 | Department of Economic and Social Affairs. 2023. Available online: <https://sdgs.un.org/goals/goal8> (accessed on 3 April 2023).
90. Sekaran, U.; Bougie, R. *Research Methods for Business: A Skill-Building Approach*; John Wiley & Sons: Chichester, UK, 2016.
91. Mutamimah, M.; Tholib, M.; Robiyanto, R. Corporate governance, credit risk, and financial literacy for small medium enterprise in indonesia. *Bus. Theory Pract.* **2021**, *22*, 406–413. [CrossRef]
92. Hair, J.F.; Anderson, R.E.; Tatham, R.L.; Black, W.C. *Multivariate Data Analysis*; Prentice-Hall, Inc.: Upper Saddle River, NJ, USA, 2001.
93. Nguyen, Q.A.; Hens, L. Environmental performance of the cement industry in Vietnam: The influence of ISO 14001 certification. *J. Clean. Prod.* **2015**, *96*, 362–378. [CrossRef]

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