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Stakeholder Opinions of Implementing Environmental Management Systems in the Construction Sector of the U.S.

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Abstract: Environmental concerns over the effects of construction sector activities necessitate meaningful measures to be taken. Despite worldwide increases in the uptake of environmental management systems (EMS), implementation of EMS across the construction sector of the U.S. remains slow. To date, stakeholder opinions about the uptake of EMS in the construction sector of the U.S. remain unexplored. The purpose of this study is to investigate the views of U.S. stakeholders towards the benefits and barriers of implementing EMS, and how these compare internationally. Underpinned by a positivism philosophy, an online questionnaire survey was used to collect the views of construction professionals (n = 50). Weighted average analysis scores reveal that the benefits of EMS are seen to improve the public perception and credibility of an organization/company and reduce waste levels and are a tool to improve the environmental standards of the U.S.'s construction sector; in contrast, the barriers of EMS are an absence of sub-contractor cooperation and resistance to change in existing company structure and policy, plus the requirement for additional employee training. The potential impact of this work demonstrates not only the role that the U.S. construction sector can play in advancing environmental and sustainability matters using EMS but also the obstacles that need to be addressed to enable their success. Understanding these benefits and barriers at an organizational level could enable them to devise more effective business strategies/policies, where evidence-based practices could be used to support EMS implementation.

Keywords: environmental sustainability; environmental impact; EMAS; ISO 14001

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1. Introduction

The growing global population brings about an increased requirement for construction not only for new homes but also for the infrastructure needed to accommodate the increased population. Concomitantly, this causes both direct and indirect impacts on the environment. The increased construction requirement places demand on the natural environment both in terms of resources and land to accommodate this requirement. The construction sector is one of the largest users of energy, non-renewable resources and water [1]. It uses a variety of materials that have potential to contaminate water supplies, land and the atmosphere [2]. Further, it must not be forgotten that there are substantial amounts of both waste and pollution resulting from construction and demolition projects [1,2].

It is not, however, just the direct effects of construction that are causing concern but also the indirect effects, because the occupation and use of buildings after construction have environmental impacts too. Carbon dioxide emissions from the operation of buildings and the construction sector are estimated to contribute 36% of the total global amount; within this, 10% is classed as embodied carbon from construction [3]. Thus, the impacts from the construction sector are significant.

The construction sector has many unique characteristics and complex challenges to consider. These include safety, a contractual workforce and the necessity to balance

time, cost, quality and efficiency [2]. Therefore, a multifaceted approach is required to enable this sector to become environmentally sustainable [2]. The integration of sustainable development concepts to reduce the environmental impact of construction has prompted a host of sustainable building practices and management tools [4], such as Leadership in Energy and Environmental Design (LEED) or the Building Research Establishment Environmental Assessment Method (BREEAM).

Environmental management systems (EMS), such as EMAS and ISO 14001, are widely used across many industries and sectors to aid organizations in minimizing their environmental impact, enabling companies to manage their operations and improving their environmental policies, objectives and plans [5,6]. An EMS also enables organizations to ensure their continuing compliance with legislation by identifying, managing, monitoring and regularly reviewing the environmental aspects of their operations [7].

Studies have shown EMS uptake worldwide is substantial, and it has been consistently increasing across the Asian and European construction sectors [8–10]. In contrast, the uptake of EMS by the construction sector of the U.S. has been slow. Furthermore, unlike other nations (such as China, Australia, Italy and the UK) where investigations have been conducted to understand the reasoning for and against the uptake of EMS, there is an absence of reporting about this issue for the U.S. construction sector and, therefore, a research gap exists. As a consequence, the aim of this study is to investigate the views of U.S. construction professionals towards the benefits and barriers for implementing EMS in the U.S. and to reveal how these compare with the views of construction stakeholders from other nations.

1.1. Background

Historically, in the U.S., there was notable activity and interest in environmental protection, resulting in the creation of the National Environmental Policy Act in 1969 [11]. This legislation encouraged businesses to protect the environment. Later, there was growing recognition of the benefits of reducing environmental impacts not only to comply with regulatory pressures and costs associated with those regulations but also as a response to stakeholder concerns [12,13]. In response to this, there was increasing adoption of environmental management tools, such as ways to reduce pollutants during the design phase of construction and environmental auditing programs [12]. Similarities were noted in the various environmental management practices, and companies began integrating these into management systems [12,13]. These early EMS were independently designed in house, which meant comparisons between companies was challenging not only within sectors but internationally too [14]. To ensure reductions in cost and removal of trade barriers, there was a need for a standardized approach [14]. The need for better environmental management and creation of a standardized approach was also supported at the 1992 Earth Summit in Rio de Janeiro, where professional bodies, governments and international organizations highlighted the issues and put forward guidelines [12,15].

Nowadays, the two most used systems employed globally throughout a multitude of sectors are the Eco-Management and Audit Scheme (EMAS), which is a European standard, and ISO 14001, which is an international standard [16]. The latter, ISO 14001, is the commonly used EMS adopted across industries and sectors of the U.S.

1.2. Benefits of the Implementation of EMS in the Construction Sector

There are a variety of reasons that may encourage an organization to adopt an EMS. The main benefit for many is improved corporate image [17], with companies believing that an EMS can strengthen their image, thereby increasing their competitiveness [18]. The use of an EMS could provide a competitive advantage in the 'green' market [19]. Previous studies note that growing awareness of the environmental impacts and improved environmental performance of construction are the major benefits, with enhanced corporate image also being noted [20–23].

Previous studies note that contractors were not only looking to improve their image but also to reduce costs via waste reduction within their EMS [24]. This supports past observations [18] that while corporate image was the major advantage within the company surveyed, to improve that image, specific actions were taken to not only promote safe working environments but to comply with government regulations to implement clean product practices and also to reduce waste. The implementation of ISO 14001 helps to reduce costs through actions such as waste reduction, which will also improve employee safety and reduce insurance premiums [25].

1.3. Barriers to the Implementation of EMS in the Construction Sector

Consideration cannot be given just to the benefits of ISO 14001. It must be noted that there will also be barriers to adoption. The most reported barrier is that of the costs linked to EMS implementation, especially in the short term [24]. This is further supported by several studies that observed that an increase in management and operation costs are significant obstacles to EMS implementation [22,25–27]. Other studies have noted obstacles such as a lack of trained staff and systems expertise, inadequate knowledge of the benefits of EMS in construction and an absence of government pressure [24,27,28]. However, some researchers [17,29] argue that increased management support could resolve these issues in conjunction with the certification benefits. One vital point to remember, however, is that ISO 14001 does not guarantee an improved environmental performance [23].

1.4. Worldwide Implementation of EMS in the Construction Sector

Studies in a global context have been conducted in various countries to assess regional differences in relation to the benefits and barriers to EMS implementation within the construction sector (Table 1). Surveys within Asian operations established major barriers including increased management costs, absence of trained staff and expertise, lack of sub-contractor cooperation and insufficient client support [9,25,30]. The local business culture of focusing on short-term results is a common factor contributing to these obstacles [9]. The significant benefits noted include contributions to environmental protection and improved environmental corporate image [9,31]. It has also been noted that there has been a recent increase in certification within Asia [10]. When this is compared to similar studies within the African construction sector, the benefits and barriers cited were only marginally different. In these studies, technological advancement, infrastructure and management culture were more likely to influence the reasons for engaging with an EMS [22,32,33]. Furthermore, cost and environmental protection were reported to be key [22]. Additional examples of regional differences include improvements in waste management, a lack of technical, government and legislative support of organizations and a lack of awareness of EMS [22,32,33]. Globally cited benefits are found in Table 1.

Table 1. Recognized benefits of implementing EMS in the construction sector.

Benefits	References
Improved corporate image	[5,8,9,17,20–24,27,33–42]
Reduced costs	[5,8,9,17,18,20–22,24,25,33,35,37–39,42–44]
Increased competitiveness	[5,9,24,25,27,33,39,40,42,43]
Contributed to the environmental standards within the construction sector	[42,45]
Reduced levels of waste and waste production	[5,6,18,21,24–26,35,38,40,42–44,46–50]
Improved environmental performance	[5,8,19–24,30,35,37,38,42,47,49–51]
Increased energy savings	[9,25,26,35,38,44,46,47,50]
Reduced environmental impacts	[5,8,9,18,19,21–24,37–39,42,43,47,49]
Improved project quality and value	[18,20,24,27,34,43]
Improved health, safety and welfare of staff	[5,22,24,25,27,33,35,39,40,42,43,49]
Reduced environmental complaints from clients	[22,37,47]
Improved relationships with stakeholders	[5,8,17,20,21,34,37,52]
Improved work environment with increased training and development opportunities	[5,9,17,24,27,29,30,37,39,42,44,49]
Reduced environmental regulation and policy burden	[8,24,27,33,38,40,41,43,47,48,52]

In Europe, the focus is firmly on the contribution to environmental protection [42]. Surveys, however, from the perspectives of construction companies in Germany, the UK, Finland and Portugal found that the main benefits included a reduction of environmental-related sickness and reduction of waste production along with the levels of existing waste [27,35,39,40]. The barriers noted in Europe are the requirements to undertake training, a lack of senior management commitment and an increase in EMS documentation [26,27,29,37,38,40,48,53]. Globally cited barriers are found in Table 2.

Table 2. Recognized barriers of implementing EMS in the construction sector.

Barriers	References
Cost benefit	[6,8,24,42,43,45]
High implementation costs	[6,24–26,32,37,40,43,45,46,54,55]
Challenge in identifying environmental issues	[17,24,28,38,51,53,54]
Uncertainty regarding the benefits	[8,17,23,25,27,28,32,33,41,43,49,53,54]
Additional documentation	[5,8,9,17,21,22,25–28,32,37,38,40,42]
Low employee support	[8,9,17,22–26,29,32,33,35,40,42,50,56]
Lack of client support	[9,22,24,25,42,43,54]
Lack of sub-contractor cooperation	[6,9,22,23,25,32,33,35,42,55]
Lack of internal technical support	[9,17,23,27,29,32,41,56]
Employee training requirements	[5,9,17,22–25,27–30,32,33,43,48,53]
Human resource availability	[6,24,28,30,40]
Change in practices of company structure and policy	[9,22,32,33]
Lack of legal enforcement	[22,24,25,33,48,54,55]
Lack of concern for the environment	[8,26–28,41,53,55]
Lack of senior management commitment	[9,17,23,28,29,33,37,41,48,53,56]
Increasing management and operation costs	[6,9,17,22,25,27,33,43]

1.5. Prevalence of EMS in the Construction Sector of the U.S.

While there appears to be interest in the use of EMS within the U.S. [8], particularly in organizations at a federal level, such as the U.S. Environmental Protection Agency and the U.S. Department of Energy, the uptake in the construction sector appears to be slow. In the U.S. manufacturing sector, there seems to be more engagement, possibly due to past environmental concerns [5]. However, industrial and manufacturing companies find cost, uncertainty of benefits and additional training to be the main barriers to EMS implementation [28]. The main benefits noted are a reduction of solid waste as a result of improved awareness and increased monitoring, measuring and reporting [47]. Due to some of the similarities between manufacturing and construction, these could also be seen as being relevant to the construction sector. Further, in a case study of the firm 'Beers Skanska' [5], it has been noted that their EMS provided benefits of cost savings, improved environmental performance and competitive advantage. The same study also suggested that these benefits outweighed the barriers of auditing and consistent implementation at operating sites and the challenges of monitoring environmental performance [5]. To date, there is a scarcity of studies that have focused on EMS in the U.S. Therefore, it is still unclear why there is a general lack of EMS uptake within the U.S. construction sector.

2. Research Design and Methodology

This study takes a positivist approach to gain an objective understanding [57] on the assumption that knowledge is best understood through both objective observation and reason [58]. Given the adopted philosophy, a quantitative cross-sectional online questionnaire survey was designed to collect a large amount of data in a controlled setting with minimal influence by the researcher. The choice of this strategy was borne out of the need to capture both the benefits and the barriers of implementing EMS in construction organizations, in line with previous studies [9,22,42].

2.1. Data Collection

The questionnaire design of exploring the opinions of construction professionals towards the benefits and barriers of implementing EMS in the construction sector of the U.S. was adapted from similar studies [9,22,43]. A pilot survey (n = 8) was conducted to validate the draft questions [59] that helped improve the wording, layout and design. The final questionnaire comprised four sections: personal profile, company profile, benefits to EMS implementation and barriers to EMS implementation. Participants were requested to answer each question before progressing to the next. The personal profile (Q1–6) included participants' demographic information, including job title, education level, state, membership of any professional body(s) and years of experience both within construction and environmental sustainability. The company profile (Q7–10) gathered data on the companies' demographics, such as the company size, the project locations and whether that company had an EMS in place. The questions regarding benefits of EMS implementation (Q11–24) focused on perceived advantages to EMS implementation, including 14 statements relating to previously identified benefits. The questions regarding barriers to EMS implementation (Q25–40) examined perceived disadvantages to implementation and consisted of 16 statements relating to previously identified barriers. The last two sections both used a five-point Likert scale. The participants were also invited to provide qualitative comments. The questionnaire survey was then shared with participants via the online Qualtrics XM platform.

A purposive sampling strategy was employed. Before answering questions, all participants were asked to confirm they were over the age of 18 years and currently employed in the construction sector with a minimum of three years of experience and have been involved in environmental- and/or sustainability-related construction projects. All invitations were sent out to publicly available email addresses accessed through website searches of U.S. construction professional bodies, whose geographical coverage spread over the four main regions of the continental U.S. (i.e., west, midwest, northeast and south).

2.2. Data Analysis

All primary data collected were entered into Microsoft Excel (2019 version) for statistical analysis. Demographical information was analyzed by means of frequency analysis to provide a snapshot of the participant characteristics. As with many other construction [9,22,42] and built environment [60–62] studies that have scrutinized questionnaire data, a weighted average method was used to analyze the data.

The following weighted average formula was used to calculate the average score for each factor (Equation (1)), where WASi denotes the weighted average score for each factor i, αj denotes the numerical value for each ranking level in which 1 is allocated to the lowest rank and 5 is allocated to the highest rank, nij denotes the number of participants for factor i with ranking level αj and N denotes the total number of participants for the question.

$$\mathrm{WASi} = \frac{\sum_{j=1}^{5} (\alpha \mathrm{j}\ \mathrm{nij})}{\mathrm{N}} \quad (1)$$

An additional formulation was used to address the weakness of the weight average score, which did not account for the degree of variation between the responses. Hence, a coefficient of variation was added to each of the weighted average scores to compute the Benefit/Barrier Index Value (BIV) (Equation (2)), which determined the final rankings, where BIVi denotes the Benefit/Barrier Index Value for each factor i and δi denotes the standard deviation for each factor i.

$$\mathrm{BIVi} = \mathrm{WASi} + \frac{\mathrm{WASi}}{\delta \mathrm{i}} \quad (2)$$

Prior to commencing the data collection, ethical approval was sought. Once gained, approval meant all participants were informed in an information cover page that their

consent to be involvement in the study was entirely voluntary. Further, since the data collected would be anonymous, at the end of the questionnaire, all participants were invited to create their own unique identification code that they could later quote in an email if they decided to withdraw their data responses within a two-week window from the date of their involvement. This procedure is compliant with the expectations of university research ethics regulations in the UK.

3. Results

This section is separated under three main headings: (i) Participants and their Companies; (ii) Benefits to Implementing an EMS; and (iii) Barriers to Implementing an EMS.

3.1. Participants and Their Companies

Following the screening of returned questionnaires and scrutiny for missing data, the data collection exercise yielded 47 fully completed surveys. Given the size of the U.S. construction sector, this may be considered a somewhat modest number of participants to proceed. However, the precedent of similar studies can be used to determine an acceptable sample size [63]. A similar EMS study in the Nigerian construction sector received 40 completed responses [22], while a similar EMS study investigating the UK construction sector received 49 completed responses [42]. As these are comparable to the sample size of this study, 47 responses are considered adequate.

The demographics of the participants were assessed in relation to education, years of experience, membership of a professional body, job level and years of experience in environmental/sustainability projects. This enabled support for the findings' relevance [64]. Almost all participants were university educated, with almost one-third of participants (30%) holding postgraduate qualifications. In terms of job level, 57% reported to have management-level positions, with the remainder being associate or mid to senior level positions. Importantly, all participants confirmed they were over the age of 18 years and currently employed in the construction sector with a minimum of three years of experience (including 30% with >10 years) and have been involved in environmental- and/or sustainability-related construction projects.

Information was collected about the organizations where the participants are employed. Almost two-thirds of participants' companies reported to have a current and operational EMS in place. The workplaces of most of the participants were small- and medium-sized businesses (SMBs) as defined by the U.S. Census Bureau as having under 500 employees [65]. Large businesses employed only 21% of participants compared to the 79% of those whom SMBs employed. The U.S. Census Bureau notes that most of the U.S. construction sector is made up of SMBs, therefore, the survey data align to this demographic [66].

In respect of the type of work undertaken by the participants' companies, 34% and 15% of participants identified their company as only involved in constructing buildings or only as specialized trade contractors, respectively. Twenty-one percent of participants identified their company as working in 'other' areas of construction. The participants listed various areas, including, but not limited to, construction management, consulting, engineering and surveying. The remaining category of 'other' was used by the remainder of the participants. One identified that their company builds healthcare facilities and another specified that their company was a specialty trade contractor working in flooring. The remaining 30% of participants identified their company as performing multiple types of construction work, such as heavy and civil engineering, environmental services, wetland delineation and construction of buildings.

3.2. Benefits to Implementing an Environmental Management System

The questionnaire listed fourteen factors considered to be advantages to organizations in the construction sector (Table 3). Analysis of the questionnaire responses (Table 4) has been used to rank the beneficial factors of implementing an EMS (Table 5; Figure 1).

Table 3. List of beneficial factors used in the questionnaire.

Code	Beneficial Factors
BENa	Reduces environmental impacts (air pollution, land and water)
BENb	Improves environmental performance of a company
BENc	Increases energy savings
BENd	Reduces environmental complaints from clients
BENe	Contributes to the environmental standards of the construction industry
BENf	Reduces waste levels
BENg	Reduces costs
BENh	Increases a company's competitiveness
BENi	Improves finished project quality and value
BENj	Improves corporate image and credibility
BENk	Improves relationships with stakeholders, clients and regulators
BENl	Improves worker's health, safety and welfare
BENm	Relieves environmental regulation and policy burden
BENn	Improves employee work environment by providing training and development opportunities

Table 4. Questionnaire responses and calculation of parameter values for the benefit factors.

Factor	SA	SWA	N	SWD	SD	Total	ASS	ASS Rank	BIV	BIV Rank
BENa	18	19	6	3	1	47	4.06	4	8.23	6
BENb	17	21	7	1	1	47	4.11	3	8.77	4
BENc	12	21	12	1	1	47	3.89	7	8.31	5
BENd	10	18	16	2	1	47	3.72	10	7.79	9
BENe	18	19	9	1	0	47	4.15	2	9.35	1
BENf	17	16	13	1	0	47	4.04	5	8.80	3
BENg	10	11	15	7	4	47	3.34	13	6.11	14
BENh	10	17	14	4	2	47	3.62	11	7.09	12
BENi	11	19	15	1	1	47	3.81	9	8.08	7
BENj	20	18	7	2	0	47	4.19	1	9.17	2
BENk	14	17	10	6	0	47	3.83	8	7.67	10
BENl	20	11	14	1	1	47	4.02	6	8.04	8
BENm	7	16	14	6	4	47	3.34	13	6.28	13
BENn	9	16	17	4	1	47	3.60	12	7.34	11

Table 5. List of beneficial factors in ranked order.

Rank	Code	Beneficial Factors
1	BENe	Contributes to the environmental standards of the construction industry
2	BENj	Improves corporate image and credibility
3	BENf	Reduces waste levels
4	BENb	Improves environmental performance of a company
5	BENc	Increases energy savings
6	BENa	Reduces environmental impacts (air, land and water pollution)
7	BENi	Improves finished project quality and value
8	BENl	Improves worker's health, safety and welfare
9	BENd	Reduces environmental complaints from clients
10	BENk	Improves relationships with stakeholders, clients and regulators
11	BENn	Improves employee work environment by providing training and development opportunities
12	BENh	Increases a company's competitiveness
13	BENm	Relieves environmental regulation and policy burden
14	BENg	Reduces costs

Table 4 provides details of the responses to the benefits section of the questionnaire survey. It also provides the results of the calculations for Equations (1) and (2) to determine the ASS, BIV and, therefore, the highest and lowest ranking of factors.

Participants were asked to rank each of the benefits using a Likert scale: 'Strongly Agree' (SA), 'Somewhat Agree' (SWA), 'Neither Agree nor Disagree' (N), 'Somewhat Disagree'

(SWD) or 'Strongly Disagree' (SD). In the survey, the vast majority (79%) of participants noted either 'Strongly Agree' or 'Somewhat Agree' with BENa (Reduces environmental impacts (air pollution, land and water)) and BENe (Contributes to the environmental standards of the construction industry). More, however (81%), chose to 'Strongly Agree' or 'Somewhat Agree' with BENb (Improves environmental performance of a company) and BENj (Improves corporate image and credibility). Fewer disagreed with the presented beneficial factors. BENg (Reduces costs) had the most considerable amount, followed by BENm (Relieves environmental regulation and policy burden), with 23% and 21% of participants indicating they 'Somewhat Disagree' or 'Strongly Disagree', respectively.

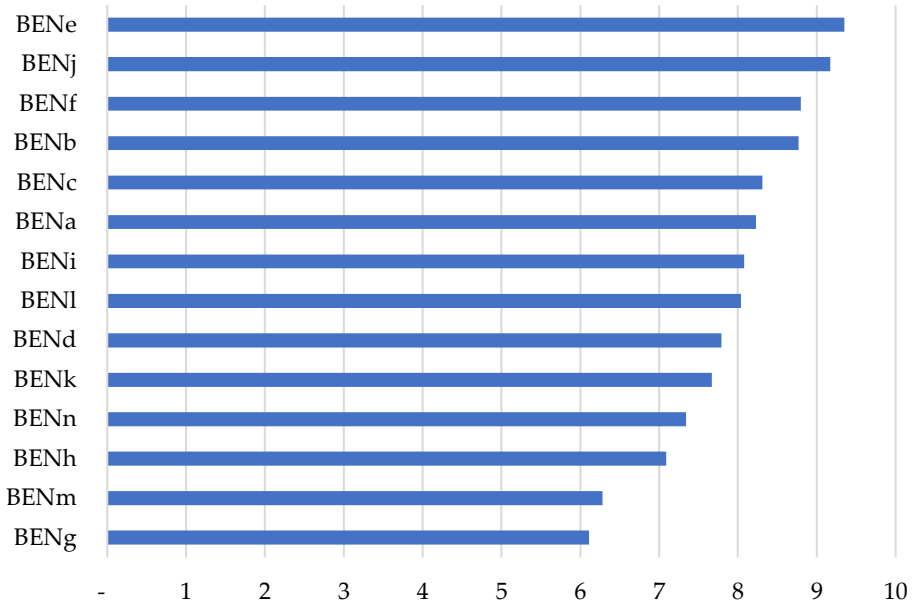

Figure 1. BIV ranking profile of the beneficial factors (BEN).

The ranking profile was established based on the BIV data, as shown in Table 5. Based on the results, participants considered BENe (Contributes to the environmental standards of the construction industry), BENj (Improves corporate image and credibility) and BENf (Reduces waste levels) as the top three benefits of EMS implementation. The lowest ranking benefit factors were found to be BENh (Increases a company's competitiveness), BENm (Relieves environmental regulation and policy burden) and BENg (Reduces costs). Figure 1 provides a visual representation of the ranking.

3.3. Barriers to Implementing an Environmental Management System

The questionnaire listed sixteen barriers to organizations in the construction industry (Table 6). Analysis of the questionnaire responses (Table 7) has been used to rank the barrier factors of implementing an EMS (Table 8; Figure 2).

Participants again were asked to rank each of the barriers using a Likert scale: 'Strongly Agree' (SA), 'Somewhat Agree' (SWA), 'Neither Agree nor Disagree' (N), 'Somewhat Disagree' (SWD) or 'Strongly Disagree' (SD). Table 7 provides details of the responses along with the ASS value and the BIV value for the barriers section of the questionnaire survey. Responses to BARh (Lack of sub-contractor cooperation), BARl (Changes in existing practices of company structure and policy), BARn (Weak environmental culture or lack of concern about environmental issues) and BARo (Lack of top management commitment) had the highest ratio of participants (77% for each) who either chose 'Strongly Agree' or 'Somewhat Agree'. More participants chose to select 'Neither Agree nor Disagree' for barrier factors than for the beneficial factors; it was noted that 45% selected this option for BARa (The costs savings do not balance the cost of implementing EMS strategies) and 40% selected it for BARg (Lack of client support) and BARk (Availability of human resources).

Table 6. List of barrier factors.

Code	Barrier Factors
BARa	The costs savings do not balance the cost of implementing EMS strategies
BARb	The implementation costs of EMS are high
BARc	Difficulty identifying environmental issues
BARd	Uncertainty regarding the benefits of EMS
BARe	Additional documentation
BARf	Low employee support
BARg	Lack of client support
BARh	Lack of sub-contractor cooperation
BARi	Lack of internal technical support
BARj	The requirement for additional employee training on new policies
BARk	Availability of human resources
BARl	Changes in existing practices of company structure and policy
BARm	Lack of legal enforcement
BARn	Weak environmental culture or lack of concern about environmental issues
BARo	Lack of top management commitment
BARp	Increases management and operation costs

Table 7. Questionnaire responses and calculation of parameter values for the barrier factors.

Factor	SA	SWA	N	SWD	SD	Total	ASS	ASS Rank	BIV	BIV Rank
BARa	8	7	21	7	4	47	3.17	15	5.96	16
BARb	10	14	16	6	1	47	3.55	12	7.01	11
BARc	3	15	17	9	3	47	3.13	16	6.25	15
BARd	13	22	7	4	1	47	3.94	2	7.98	4
BARe	13	18	13	1	2	47	3.83	3	7.67	7
BARf	10	15	18	4	0	47	3.66	9	7.70	6
BARg	6	17	19	4	1	47	3.49	13	7.38	8
BARh	17	19	10	1	0	47	4.11	1	9.21	1
BARi	9	15	18	4	1	47	3.57	10	7.29	9
BARj	7	22	14	4	0	47	3.68	7	8.13	3
BARk	8	12	19	7	1	47	3.40	14	6.80	13
BARl	7	24	14	2	0	47	3.77	5	8.79	2
BARm	10	17	12	5	3	47	3.55	11	6.71	14
BARn	12	18	9	6	2	47	3.68	8	6.99	12
BARo	14	16	10	6	1	47	3.77	6	7.27	10
BARp	11	22	8	6	0	47	3.81	4	7.87	5

Table 8. List of barrier factors in ranked order.

Rank	Code	Barrier Factor
1	BARh	Lack of sub-contractor cooperation
2	BARl	Changes in existing practices of company structure and policy
3	BARj	The requirement for additional employee training on new policies
4	BARd	Uncertainty regarding the benefits of EMS
5	BARp	Increases management and operation costs
6	BARf	Low employee support
7	BARe	Additional documentation
8	BARg	Lack of client support
9	BARi	Lack of internal technical support
10	BARo	Lack of top management commitment
11	BARb	The implementation costs of EMS are high
12	BARn	Weak environmental culture or lack of concern about environmental issues
13	BARk	Availability of human resources
14	BARm	Lack of legal enforcement
15	BARc	Difficulty identifying environmental issues
16	BARa	The costs savings do not balance the cost of implementing EMS strategies

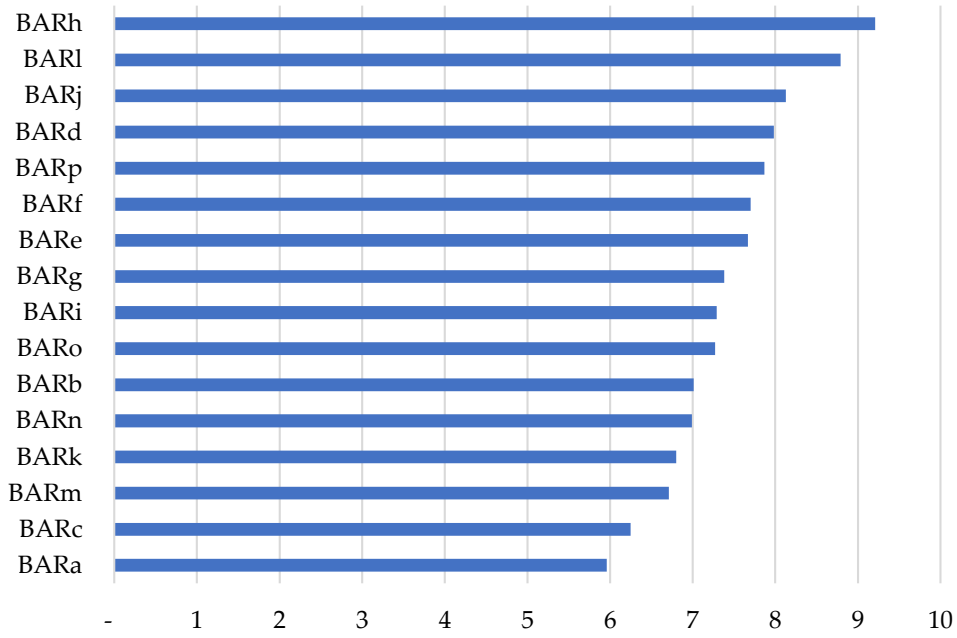

Figure 2. Ranking profile of the barrier factors (BAR).

The ranking profile was based on the BIV data to provide the final ranking (Table 7). Based on the results (Table 8; Figure 2), the top three ranked barriers to EMS implementation according to participants are BARh (Lack of sub-contractor cooperation), BARl (Changes in existing practices of company structure and policy) and BARj (The requirement for additional employee training on new policies). Meanwhile, the lowest ranking barriers to implementation of an EMS were found to be BARm (Lack of legal enforcement), BARc (Difficulty identifying environmental issues) and BARa (Costs savings do not balance the cost of implementing EMS strategies).

4. Discussion

4.1. Perceived Benefits of EMS Implementation in the Construction Sector of the U.S.

This study suggests the main benefit of EMS implementation is its contribution to the environmental standards of the construction sector. This is in line with previous studies [42] that have highlighted this factor among those considered significant in understanding the perceived benefits of contractors in the UK regarding EMS implementation. It was suggested that contractors see a rising of standards as making a positive contribution to the environment [42]. Considering that participants ranked environmental improvements as the third, fourth, fifth and sixth most significant benefits, it can be implied that there is a rise in environmental awareness among U.S. construction professionals. This is further supported by recent studies and professional reports that have shown a steady rise in environmental awareness throughout not only the U.S. construction sector but also the general U.S. population [67,68].

Recent studies have noted that environmental codes and standards are among the main influencing factors for U.S. designers and builders to use 'green' building practices [68]. Although mandatory city, state and voluntary building-specific 'green' codes and standards have been developed in the U.S., there are still many other local, state and federal building codes and standards that remain outdated [69]. These codes and standards are unable to provide mitigation against the effects of climate change and contribute to an inconsistency in standards across the U.S. construction sector [69]. The rise in environmental consciousness, which is being witnessed in the U.S. construction sector, could allow for EMS to be used to promote improved environmental performance of the construction sector by redefining the operational environmental management practices despite the variation in mandatory and voluntary building standards and codes [12,17].

This study also revealed that corporate image and credibility were perceived to be improved by EMS implementation. This is in line with previous studies, such as the findings of a study on Malaysian manufacturing firms [17]. However, this was not found to be the case in an Italian study [70], where they reported that EMS has no significant effect on corporate image performance, which may be due to the location of the companies and variety of industries beyond construction. Conversely, it has been reported that highly visible environmental practices, such as EMS, significantly contribute to a better corporate environmental image and reputation of businesses in the U.S. [71]. This improved image and reputation could be a result of demonstrating commitment to environmental management through increasing stakeholder confidence in reducing environmental impact by incorporating EMS into company policy and strategy [20,71].

The results in this paper suggest that participants see the implementation of EMS as a decision to enhance their company's external recognition to provide marketing benefits when targeting clients with an environmental focus. Using an EMS to improve business performance could raise issues in relation to only having an EMS for appearance while hiding poor environmental performance. It has, however, been noted that even if environmental standards are being used to increase economic value and wealth, it does not mean that they are not concurrently improving their environmental impact [72,73].

In the current study, the reduction of waste levels was ranked third out of the list of benefits. This ranking may be due to the large amount of construction and demolition waste generated in the U.S. and the level of regulations for waste management, which play a primary role in regulating construction and demolition waste management [74,75]. A U.S. case study of 'Beers Skanska' [5] further validates these findings by highlighting a high waste diversion rate from landfills as a result of an EMS. The outcome of the findings of this and previous studies [35,40] suggest the ability of an EMS to increase financial savings while reducing environmental impact. These reduced costs can further enhance corporate image, increase competitiveness and highlight a potential relationship between this benefit and an improved corporate image [24].

It is interesting, considering the interrelationship that exists between the reduction of costs and waste levels among other financial benefits, that the participants did not consider reducing costs as more beneficial. This factor was considered the least relevant benefit of EMS implementation. This result contrasts with previous studies in the U.S., the UK and Germany, where it was reported that improved environmental performance from well-designed EMS implementation generates cost savings and increases direct and indirect financial benefits due to savings associated with reduced waste, landfill tax and energy consumption [35,44,76].

Comments from the participants noted that clients viewed the costs of implementing site-specific EMS as excess spending where expenses could be reduced. The same participants considered EMS implementation to increase management and operational costs, which ranked as the fifth barrier. This finding is consistent with a Hong Kong study [9] noting that contractors often have a greater concern for increased short-term implementation costs, such as investment of time and resources, rather than the long-term benefits. Further, owners of U.S. construction companies were found to prefer upfront savings rather than long-term ones and are unwilling to invest in sustainable construction practices that require extra time and training [4]. It should be recognized that the findings of this study may be connected to participants' thoughts on 'uncertainty regarding the benefits of EMS' as a barrier to EMS implementation. This barrier implies a lack of awareness and education of long-term benefits for owners, contractors and clients. When this is considered in conjunction with the business culture of immediate savings, the rationale for the participants' responses may be understandable.

The relief of environmental regulation and policy burden was ranked as the next-to-last benefit. Interestingly, one respondent commented that instead of relieving environmental regulation and policy burden, 'self-reporting on EMS efforts invites regulatory agencies to look closer and implementation increases policy work'. However, a case study examining

the utilization of EMS on a project in New York takes an opposing perspective on this [52]. It suggested that the risk of non-compliance increases as building regulations and codes increase in complexity by involving multiple regulatory agencies, permits and trades [52]. This suggests that the increased complexity in an already complex sector emphasizes the need for EMS in construction [52]. It has also been reported that the motivation to develop ISO 14001 was a result of the increase in the number of environmental laws and regulations worldwide, driving companies to implement EMS to ease problems of compliance with laws and regulations [24]. Here, the results suggest that a more passive approach may be taken towards compliance with environmental building regulations, codes and EMS to avoid attention. This also suggests that until more stringent regulations and policies are implemented, an active approach will be avoided.

Similar to previous studies [9], one of the least significant benefits was found to be the increased competitiveness due to EMS implementation. However, it has been suggested [18,19] that an environmentally friendly image can increase competitiveness in the 'green' building market. The construction sector is highly competitive, but EMS implementation may not increase competitiveness unless the target is the 'green' building market.

The belief that an EMS does not reduce costs but is more likely to increase them may also contribute to participants ranking this benefit factor as they did. Increased overhead cost may lead to higher prices and, consequently, a loss of competitiveness [77]. A company may choose to rely on more straightforward environmentally sustainable construction practices, as mentioned in the comments of one respondent.

4.2. Perceived Barriers of EMS Implementation in the Construction Sector of the U.S.

The most significant obstacle to EMS implementation was found to be a 'lack of sub-contractor cooperation'. This is in line with previous studies [9]. To establish effective EMS implementation, previous studies have recognized that sub-contractors must improve their commitment to the contractors' EMS [8,35]. It is, however, the responsibility of the contractor to communicate and provide training to raise awareness [8,35].

The perceived significance of the barrier, 'the requirement for additional employee training on new policies', implies that U.S. construction professionals may not see communicating environmental issues and providing training for EMS as worthwhile for their own employees let alone their sub-contractors. Effective communication of environmental issues has been reported to be an effective strategy for implementing EMS among sub-contractors, but overcoming this barrier is further complicated by the reluctance of participants to invest in short-term costs such as time and resources for training and education [4,5,22].

The need to implement changes to existing practices within the organization to then implement EMS demonstrated resistance. This perceived resistance to change indicates that participants may view this type of change as more of an imposition than an opportunity. Despite different local circumstances for the construction sector, similar challenges were reported in Egypt [33] and Nigeria [22,32]. Resistance to change suggests that there is an absence of continuous improvement culture regarding the traditional construction approaches built up over decades that continue to have consequences for the environment [32,78,79]. Resistance to organizational changes could also indicate the level of education and understanding of construction stakeholders on the importance of environmental impact and EMS uptake, increasing the necessary commitment of time and personnel towards these types of changes [32]. It is also required that an EMS contains an employee training plan, among other aspects, to respond and increase environmental awareness [5]. This links to the barrier rated as third in the ranking of this study, which was the requirement for additional employee training on new policies. Although training has also been found to be one of the most relevant factors to ensure EMS effectiveness, it has previously been identified in the U.S. as one of the elements of ISO 14001 that requires the most significant effort [28,40]. The resistance seen towards training could potentially signify the level of value placed on EMS and the management approaches needed to promote a continuous improvement towards organizational changes within the U.S. construction sector.

The response that notes cost reductions as the least significant benefit is further validated by the reported perception that 'cost savings do not balance the cost of implementing EMS strategies'. This is in line with previous studies that highlight the idea that U.S. construction professionals may be more likely to believe that EMS implementation generates additional internal costs, resulting in a lower likelihood to invest time and resources [9]. However, this conflicts with more recent studies [42] suggesting that this barrier is more significant to contractors in the UK, inferring that investments do not compensate for any actual costs or add monetary value to the organization. The main difference seen here is that EMS implementation was found to occasionally produce cost reduction benefits such as cost savings from the segregation of waste, waste minimization and efficient procurement. Therefore, if participants do not believe long-term cost savings occur, they will not justify the implementation costs.

Difficulty identifying environmental issues was considered the second-to-last most significant barrier to EMS implementation. Identifying environmental aspects is essential to the development of EMS and was reported to be the element that requires the most effort when implementing an EMS in the U.S. [28]. This study, however, suggests that progress has been made in stakeholder ability to identify environmental aspects and impacts of construction. This aligns with recent studies that have focused on the Italian construction sector, where it was found that this factor was not relevant to the success of EMS implementation [29]. Interviews suggested that environmental impacts were easier to identify, and it was revealed that they were fewer than in other industries [29]. More insight would be required from stakeholders in the U.S. to ascertain if there is a similar reason for the low ranking of this barrier factor. The rise, however, of environmental awareness within the U.S. may also contribute to better identification of environmental issues [67,68]. Although, it can be argued that the most significant barriers, 'lack of subcontractor cooperation', 'changes in existing practices of company structure and policy' and 'the requirement for additional employee training on new policies', suggest that stakeholder understanding or awareness of the impacts of environmental issues remains questionable.

Participants in this study perceived a lack of legal enforcement to be among the least significant barriers to EMS implementation. The opinions on the benefit of relieving 'environmental regulation and policy burden' imply that a company-specific EMS may not be considered necessary if there is no adequate legal pressure. This also suggests that nothing more than the bare minimum is required to avoid added legal implications. It has been previously highlighted that an absence of legal enforcement is also one of the least significant barriers in Hong Kong [9]. In this study, interviews with contractors suggested that legislation was a motivating factor behind environmental management practices [9]. However, the lack of government enforcement and support limited the effectiveness of environmental regulations, which could restrict the desire to implement an EMS [9]. Since a report on the environmental value and impact of permits and codes in the U.S. points out that environmental legal requirements for buildings are often not enforced well enough, a similar assumption that EMS is not needed to comply with environmental legislation can be made of the U.S. construction sector [69].

5. Conclusions and Recommendations

The significance of the various benefits and barriers towards implementing EMS in the U.S. construction sector has revealed multiple opportunities for improved implementation. In this study, the perceived key benefits by U.S. construction stakeholders include the following: 'contributes to the environmental standards of the construction industry', 'improves corporate image and credibility' and 'reduces waste levels.' These statements demonstrate that U.S. construction professionals perceive EMS as a structured approach required to drive the improvement of both voluntary and non-voluntary standards for more environmentally conscious construction. Additionally, it demonstrates that there is an awareness of the sizeable amounts of waste the sector produces and the need for effective waste reduction methods. EMS implementation is also viewed as improving

public perception. Therefore, while construction professionals view EMS implementation as improving the sector and society, they are equally concerned about improving their business.

EMS implementation has visible benefits to construction stakeholders, but it is clear that U.S. construction professionals also recognized existing obstacles. This study showed that a 'lack of sub-contractor cooperation' and resistance to 'changes in existing company structure and policy', along with 'the requirement for additional employee training' are some of the main barriers to EMS implementation in the U.S. These perceived barriers reveal that the core challenge in relation to EMS implementation among U.S. construction professionals is the level of importance given to effective communication of environmental issues. Without a foundation of knowledge, the U.S. construction sector is unlikely to overcome the barriers to EMS implementation reported in this study.

The U.S. construction sector has a significant responsibility to minimize adverse effects on the environment due to construction projects. The progress of this sector in addressing the environmental impacts of its operation and the need for sustainability could be improved, as there is a growing concern in society of the environmental pressure that exists. EMS will be vital in assisting this journey for the construction sector as society moves towards a more environmentally sustainable world. This study demonstrates not only the role that the U.S. construction sector can have in advancing sustainable development using EMS but also what obstacles need to be addressed to enable success.

The findings from this study have implications for various stakeholders in the U.S., including, but not limited to, clients, contractors and consultants. Understanding the perceived benefits and barriers of EMS implementation at the organizational level could enable organizations to devise more effective business strategies and policies enabling evidence-based practices to promote EMS implementation. Given the views surrounding the benefits and barriers to EMS implementation, the evidence from this study also suggests that training, awareness and understanding are the keys to positive change and overcoming any barriers. This is critical at all levels of an organization, as successful implementation of EMS requires the support of knowledgeable managers equipped with effective change management, teamwork and communication skills to champion the cause. Thus, it is essential that organizations, professional bodies and higher education carefully plan well-informed training for managers and employees. Training could mitigate perceived barriers by increasing the level of understanding for management and employees, therefore increasing the likelihood of improved sub-contractor cooperation.

Despite widespread promotion of the opportunity to engage with this study through appropriate professional channels, a possible limitation or issue of the study could be the recruitment of participants. Whilst the sample size accords with the precedent of previous national EMS studies, there may be an underlying reason why many construction professionals in the U.S. chose not to participate (e.g., not meeting the specific criteria for the study's selection process, having a lack of personal insight and/or knowledge of EMS or having a disconnect to engage with environmental agendas [80]). This may also resonate with other issues identified and discussed in previous EMS studies [73].

Based on the evidence revealed in this study, the following recommendations for stakeholders are proposed:

- implement training programs for managers to aid in setting out the value of training for employees and sub-contractors;
- incorporate environmental management education as a part of organizational management programs and construction-related courses at undergraduate and postgraduate levels within colleges/universities;
- offer short training courses provided by construction professional bodies and trade unions; and
- offer in-house training for employees and toolbox talks for sub-contractors.

The study has also highlighted where there are opportunities to expand EMS implementation research, which include the following proposals:

- The uptake of EMS across 'global south' nations remains limited compared to 'global north' nations. Therefore, we propose for similar studies, using the same approach used here, to be conducted for many nations across Asia, Africa and South America.
- Many studies, similar to this, have adopted a weight average method for analyzing the data collected. Therefore, we propose that future studies may wish to employ an alternative method using the analytic hierarchy process (AHP), particularly as this will allow participants to indicate their consensus opinion on the collective responses.
- Quantitative data collection techniques have dominated many EMS studies. Therefore, we propose that more qualitative studies are conducted. For instance, this should include studies that utilize a phenomenological methodology so the 'lived experiences' of implementing and using EMS are explored through the hands-on experience of those experts managing the systems.

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