sustainability

MDPI

Article

Evaluating Decision Making in Sustainable Project Selection Between Literature and Practice

Rakan Alyamani [1,2,*], Suzanna Long [2] and Mohammad Nurunnabi [3]

1 Department of Engineering Management, Prince Sultan University, P.O. Box 66833, Riyadh 11586, Saudi Arabia
2 Department of Engineering Management & Systems Engineering, Missouri University of Science and Technology, Rolla, MO 65409, USA; longsuz@mst.edu
3 Department of Accounting, Prince Sultan University, P.O. Box 66833, Riyadh 11586, Saudi Arabia; mnurunnabi@psu.edu.sa
* Correspondence: ralyamani@psu.edu.sa

Abstract: A robust project selection process is critical for the selection of sustainable projects that meet the needs of an organization or community. There are multiple factors or criteria that can be considered in the selection of the appropriate sustainable project, but it can be challenging to find sufficient depth of expert opinion to perform a strong evaluation of these criteria. Several researchers have turned to the sustainable project literature as a source of expert opinion to evaluate the criteria used in sustainable project selection and rank them based on importance using different multi-criteria decision-making (MCDM) methodologies. However, using the literature as a source of expert opinion poses a different set of challenges and may not accurately represent the actual opinions of sustainable project subject matter experts (SMEs) and practitioners. In this study, the fuzzy analytic hierarchy process (FAHP) methodology is used to determine the importance of project cost, project maturity, skill and experience, uncertainty, and technology information transfer as selection criteria using collected opinions from academic sustainable project experts and practitioners. The results are then compared with previous research that used the literature to rank these five criteria based on importance when selecting between multiple sustainable project alternatives. The results show that project cost is still considered the major driver of decision making in sustainable project selection by both the literature and practice. However, unlike the literature-as-experts approach, SMEs prioritize skill and experience and technology information transfer over project maturity and uncertainty. Project managers and decision makers can use these findings to best prioritize the types of challenges that may occur depending on inputs for the FAHP analysis.

Keywords: sustainable projects; project selection; fuzzy AHP; multi-criteria decision making

check for updates

Citation: Alyamani, R.; Long, S.; Nurunnabi, M. Evaluating Decision Making in Sustainable Project Selection Between Literature and Practice. *Sustainability* **2021**, *13*, 8216. https://doi.org/10.3390/su13158216

Academic Editor: Andrea Pérez

Received: 22 June 2021
Accepted: 19 July 2021
Published: 22 July 2021

1. Introduction

This study focuses on comparing how the decision-making process that occurs during the selection between multiple sustainable project alternatives is approached in both the literature and practice. More specifically, this study aims to use the fuzzy analytic hierarchy process (FAHP) to rank project cost, project maturity, skill and experience, uncertainty, and technology information transfer based on importance as sustainable project selection criteria based on the collected opinions of subject matter experts (SMEs) and practitioners. The results from this study are then evaluated against the results presented by Alyamani and Long [1] who used existing project management and sustainable development FAHP literature as an alternative source of expert opinion to rank these criteria in the context of sustainable projects. Doing so will provide an opportunity to compare how these five key selection criteria are prioritized in both the literature and practice, as well as identify any variation in opinion between the two perspectives regarding how these selection criteria are prioritized in sustainable project selection.

Organizations today focus on incorporating sustainability in doing business by protecting the environment and human health while still maintaining good economic performance [2]. This has contributed to the concept of sustainable development. The literature presents a number of definitions for the term sustainability or, more specifically, sustainable development. However, the most commonly agreed upon definition is the one presented by the UN World Commission on Environment and Development which states that sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [3,4]. Accordingly, in this research area, sustainable projects mainly refer to projects that adopt sustainable or renewable energy technologies and practices in an effort to contribute to sustainable development.

An extremely useful approach to the sustainable project selection process is the use of an established list of key project selection criteria to identify the project that can best meet the needs of an organization or community. Ranking these selection criteria based on importance can help project managers and decision makers differentiate between the multiple project alternatives and focus on important areas that may require additional attention. Several researchers have utilized the FAHP as a multi-criteria decision-making (MCDM) methodology to rank multiple selection criteria in the context of sustainable projects while using the sustainable project literature as a source of expert opinion. For example, Hatefi and Tamošaitienė [5] used a combination of literature and experts' opinions to identify and rank sustainability development criteria used in the assessment of construction projects. Pérez et al. [6] utilized the literature to rank the environmental performance criteria for maritime transportation system projects. Finally, the most relevant literature for the purpose of this study is presented by Alyamani and Long [1] who implemented the FAHP to rank project cost, novelty, uncertainty, skill and experience, and technology information transfer based on importance as five key sustainable project selection criteria by utilizing the literature as expert opinion.

Even though the literature may be considered a reliable, inexpensive, and readily available source of expert opinion, it is still subject to the interpretations and judgments of the authors. This, in turn, can add an additional level of uncertainty that may not be included in the FAHP analysis [1]. Additionally, the conclusions that are drawn using the literature may not necessarily reflect what is being observed in practice. In addition, there seems to be a lack of research that explores the variation of opinion regarding the relative importance of key sustainable project selection criteria between the literature and practice, especially variation in opinion that is related to project cost, project maturity, skill and experience, uncertainty, and technology information transfer. Accordingly, this research aims to help fill this gap by identifying the differences in opinion regarding the relative importance of five key sustainable project selection criteria between the literature and practice. This could be done by answering the following research question:

- How does the ranking of project cost, project maturity, uncertainty, skill and experience, and technology information transfer differ as key sustainable project selection criteria between the literature and practice?

Answering this question is a crucial initial step towards understanding and consequently minimizing these differences in opinion between the two perspectives. Doing so would provide project managers and decision makers with a more standardized, consistent, and reliable sustainable project selection tool.

The remainder of this study is organized as follows: Section 2 is a literature review section that positions this article within the literature using the FAHP in sustainable project selection and outlines the gaps being addressed through this research. Section 3 presents a description and the implementation of the fuzzy AHP methodology used in this research and the obtained results. Section 4 provides a discussion of the results from this study and a comparison of the criteria ranking between the literature and practice. Finally, Section 5 presents the conclusions drawn from this study, limitations, and opportunities for future work.

2. Literature Review

Project selection is one of the most important steps in the sustainable project development process. The inadequate selection of the appropriate project can have devastating effects on the success of the project and, thus, the ability to achieve the desired project performance and goals [7]. As a result, researchers have used multiple MCDM techniques in an effort to improve the project selection process by evaluating the different project alternatives based on established selection criteria through a structured and reliable process [8].

Some of the most commonly used MCDM methods to rank different sustainable project alternatives are the technique for order preference by similarity to the ideal solution (TOPSIS) and the Vlse Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) [9]. However, these methods suffer from ambiguities and uncertainties in presenting clear information [10]. In addition, these methods also require that the criteria weights are determined before they are implemented and, thus, are commonly reserved for ranking the alternatives instead of the selection criteria after the criteria weights are determined using the analytic hierarchy process (AHP) [11,12] or FAHP [6,13].

The AHP is one of the most commonly used and reliable MCDM methods in sustainable project selection. It is used to determine the relative importance of a set of competing selection criteria in MCDM problems [8]. It provides decision makers with the opportunity to transform qualitative judgments into a quantitative comparison between the selection criteria. However, the AHP fails to effectively address the ambiguity and uncertainty that is usually associated with the project selection process [14]. The source of this uncertainty is usually unquantifiable information or the subjective opinions of the experts and decision makers which make the project selection process at risk of being inaccurate [6]. To overcome this issue, fuzzy logic was combined with the AHP, resulting in the creation of the fuzzy analytic hierarchy process (FAHP) to account for such uncertainty and ambiguity associated with expert judgments through the use of fuzzy numbers instead of crisp numbers [15].

The fuzzy AHP has been used in the selection between multiple types of projects. For example, Bilgen and Şen [16] used the FAHP to select between multiple Six Sigma projects and Six Sigma methodologies to reduce energy costs in the automotive supplier industry. Huang et al. [17] also used FAHP to evaluate different government-sponsored R&D projects in Taiwan. Nguyen and Tran [18] presented a framework for the application of the FAHP in construction projects. They covered the use of the FAHP in the selection between project sites, contractors, construction means and methods, construction risk, and finally the construction projects as a whole.

The fuzzy AHP has also been used in the sustainable development field. More specifically, in the selection between multiple sustainable projects based on different sets of established criteria. Wang et al. [13] used the FAHP in the selection between multiple bioenergy technology projects to rank different selection criteria like GHG mitigation, energy efficiency, technological maturity, policy adaptability, and job creation. Figueiredo et al. [15] also used the fuzzy AHP to select between different construction projects based on the sustainability of the materials used in these projects by ranking a list of five selection criteria based on importance in the selection process. Dang et al. [19] utilized the FAHP to determine the most important factors impacting sustainability in prefabrication construction projects in China. Dimić et al. [20] developed a sustainable project selection tool using the fuzzy AHP by developing a ranking for key sustainable selection criteria in Serbia. The selection criteria they used included time, costs, project sustainability monitoring, and users' health impact. There are also multiple other examples that exist of the utilization of the FAHP in sustainable project selection [21–24].

As mentioned in the previous section, the FAHP is used to translate collected expert opinions about the relative importance of the selection criteria into measurable weights that can be used to compare the importance of the chosen criteria. To collect expert opinions, some researchers have relied on opinions collected from SMEs and practitioners through interviews or surveys [13,15,25]. Other researchers used a combination of the literature and expert opinions to develop a ranking for the different sustainable project selection criteria [5,19], while others only relied on the literature as the source of expert opinion when implementing the FAHP to rank the selection criteria [1,6].

However, there seems to be a lack of research that studies the difference between how the chosen selection criteria are prioritized in the literature and practice, especially for the criteria chosen in this research. As a result, this research aims to explore the differences in opinion between the literature and practice regarding the relative importance of project cost, project maturity, skill and experience, uncertainty, and technology information transfer in sustainable project selection. Identifying the differences in opinion regarding these selection criteria, and others in the future, is considered an important initial step towards minimizing these differences and creating a more standardized, consistent, and reliable sustainable project selection tool. Accordingly, the contributions made by this research are as follows:

- Explore how project cost, project maturity, skill and experience, uncertainty, and technology information transfer are prioritized as sustainable project selection criteria in both the literature and practice as two different sources of expert opinion.
- Identify important differences in opinion between the two perspectives regarding the relative importance of these criteria in sustainable project selection.
- Identify possible reasons from the literature for why such differences exist between the literature and practice.

3. Methodology

Alyamani and Long [1] applied the FAHP methodology to rank project cost, novelty, skill and experience, uncertainty, and technology information transfer based on importance as selection criteria in sustainable project selection using the literature as a source of expert opinion. This study extends their work by applying the same FAHP methodology to rank the criteria by instead using collected opinions from sustainability and sustainable development experts and practitioners on the importance of these selection criteria when selecting between multiple sustainable project proposals. The results from this study are then compared to the results from their work. This is done to identify the differences in how these key sustainable project selection criteria are ranked based on importance between the literature and practice. Accordingly, the steps used to conduct the FAHP analysis in this study are as shown in Alyamani and Long [1] and Pérez et al. [6].

The project selection process is considered a complex process, partly due to the many interrelated variables that are considered in the selection process, the difficulty in providing exact decisions, and the uncertainties in the subjective judgments and opinions of the decision makers who are making the selection between the project alternatives [26–28]. In addition, many decisions are usually made by multiple decision makers and, thus, require incorporating opinions from multiple sources or experts [29]. This, in turn, makes the project selection process highly susceptible to the opinions of the decision makers, leading to a large variety of different opinions and, thus, disagreements on the importance of the project selection criteria used in making the selection [6,30]. To overcome this issue, the fuzzy AHP has been developed to account for these uncertainties and inconsistency in subjective judgments [31]. The FAHP applies fuzzy set theory to convert vague and uncertain linguistic variables used by experts and decision makers into specific decision intervals that are more convenient to deal with [32]. Consequently, a single linguistic variable will instead be translated into a fuzzy number which consists of a range of numbers representing that variable [33]. It is generally considered more convenient to apply triangular fuzzy numbers (TFNs) in the FAHP due to their computational simplicity and ease in representing information related to the fuzzy variables. Accordingly, TFNs are expressed as three numbers (l, m, u) where l represents the lowest possible value, m represents the most likely value, and u represents the upper or highest value. A mathematical representation of a fuzzy number M with $\mu_M(x)$ as its membership function is shown in Equation (1), as presented by Alyamani and Long [1].

$$\mu_M(x) = \begin{cases} 0 & x < l; \\ \frac{x-l}{m-l} & l \leq x \leq m; \\ \frac{u-x}{u-m} & m \leq x \leq u; \\ 0 & x > u. \end{cases} \tag{1}$$

As such, the geometric representation of the fuzzy number M according to Equation (1) is shown in Figure 1, as presented by Pérez et al. [6] and Ballı and Korukoğlu [34].

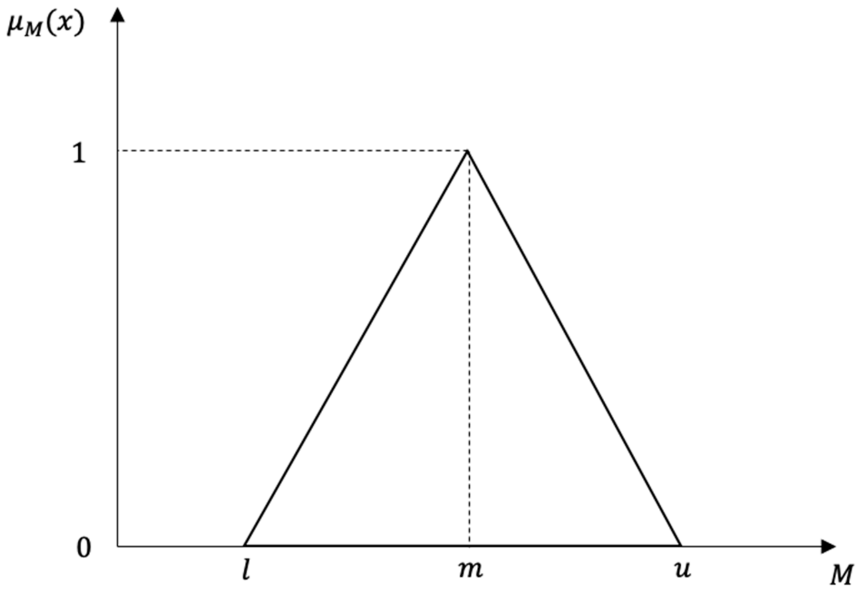


Figure 1. Geometric representation of TFN M.

3.1. Sustainable Project Selection Criteria

The criteria chosen for this study extend the work of Alyamani and Long [1] in an effort to compare how the five key sustainable project selection criteria are prioritized in both the literature and practice as two different sources of expert opinion, and identify key differences that exist between the two perspectives. They used the literature as a source of expert opinion to rank project cost, novelty, skill and experience, uncertainty, and technology information transfer, while this study collects opinions from sustainable project experts and practitioners to rank these five criteria as they are described by Alyamani and Long [1] and Alyamani et al. [35]. Accordingly, the criteria used in this study are described as follows:

- **Project Cost**: this criterion refers to the combined cost of the project through its overall life cycle. This includes the project's investment cost, operating and maintenance (O&M) cost, taxes and fees, labor, and any other subsequent annual costs associated with the project. Cost is considered one of the main drivers of sustainability and sustainable development. It is a fact of today's business world that cost, among other economic factors, has to be taken into account when evaluating the current and future worth of any investment [36]. The reason for that is the current difficulty for sustainable energy sources to compete with conventional energy sources when it comes to cost in spite of the continuous decrease in sustainable energy costs in recent years [37].
- **Project Maturity**: this criterion, referred to as "novelty" by Alyamani and Long [1], describes the maturity and originality of the sustainable practices and technologies used in the sustainable project. An original and novel project that utilizes original and novel sustainable technologies and practices would pose a different level and type of

challenge and would require a different set of resources as opposed to a more mature project [35]. In addition, project maturity is considered an indicator of how widespread and standardized the sustainable practices and technologies used in the project are, and whether or not there is still space for improvement for these sustainable practices and technologies [13].

- **Uncertainty**: this criterion describes the level of uncertainty surrounding each of the different sustainable project alternatives. Uncertainty, as defined in the literature, describes negative events for which both the probability of occurrence and consequence cannot be quantified [38]. There are many potential sources of uncertainty associated with sustainable projects, whether it is economic, technological, environmental, social, political, or any other source of uncertainty. Regardless of the source, the different uncertainties surrounding the project should be identified and appropriately addressed and mitigated to minimize their potential impact on the sustainable project [35].
- **Skill and Experience**: this criterion refers to the required level of skill and experience for the project team members to be able to effectively and efficiently undertake the different project tasks, as well as provide the required operating support and maintenance requirements to ensure project success [39]. Essentially, this criterion refers to matching the human resource capabilities and know-how with the sustainable project requirements [40].
- **Technology Information Transfer**: this criterion refers to the amount of technical information regarding the sustainable technology that needs to be shared between the party supplying the sustainable technology and the project team integrating the sustainable technology into the project. This information sharing or interaction between the supplier and recipient of the sustainable technology can vary from a basic purchase transaction with routine and standard information sharing all the way to a more collaborative or mutual development process that involves an intense and comprehensive information exchange to successfully integrate the sustainable technology into the project [35,41].

An outline of these criteria and their notation as applied in the FAHP methodology in this study is shown in Table 1.

Table 1. Project selection criteria and notation.

Notation	Selection Criteria
C1	Project Cost
C2	Project Maturity
C3	Uncertainty
C4	Skill and Experience
C5	Technology Information Transfer

The next step after defining these criteria is building the typical FAHP decision model representing the three different levels of decision making in project selection, as shown in Figure 2. Figure 2 is adapted and modified from Alyamani and Long [1]. More specifically, project maturity was added as a criterion, unnecessary criteria notations were removed, and hierarchy level terminology was slightly modified to be more specific. The first level represents the overall goal of evaluating the different sustainable project alternatives. The second level represents the five key sustainable project criteria chosen in this study that are ranked based on importance and used to evaluate the project alternatives. The third and final level of the decision tree outlines the different sustainable project alternatives that are evaluated and selected by using these criteria.

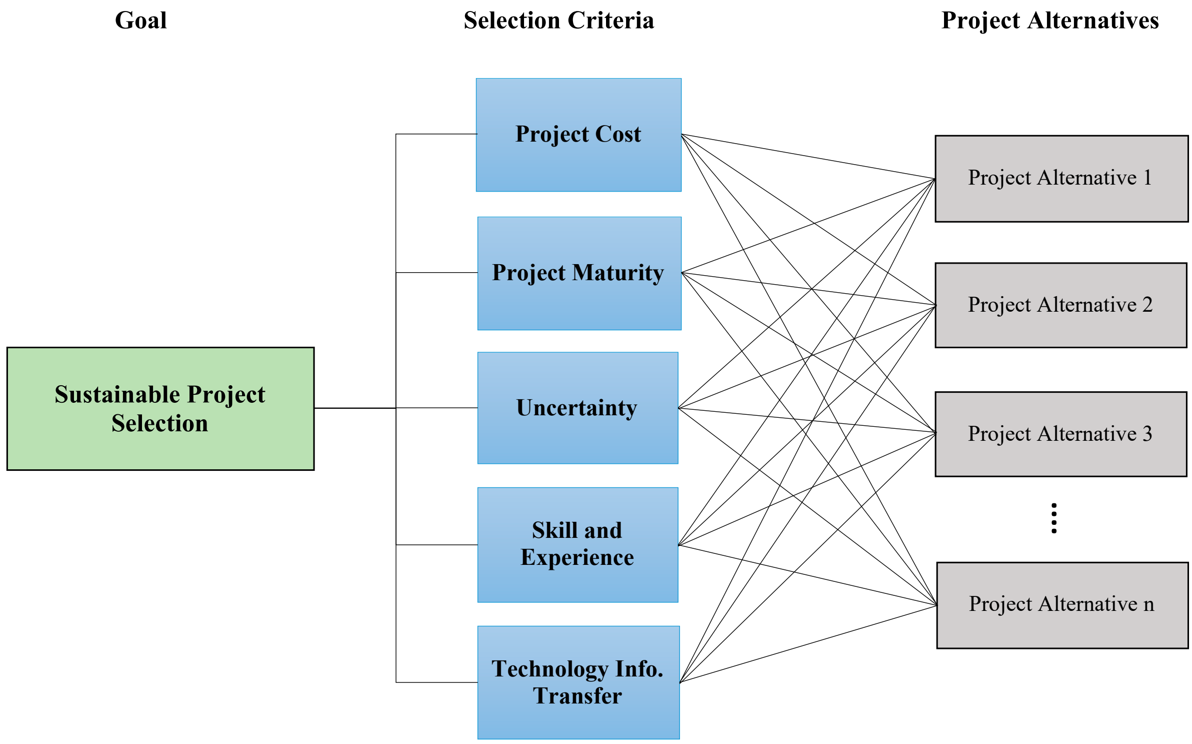


Figure 2. Sustainable project selection decision hierarchy. Adapted and modifiedfrom Alyamani and Long [1].

3.2. Calculating Criteria Weights Using FAHP

The next step after defining the sustainable project selection criteria, as previously outlined, is the collection of sustainability and sustainable development expert opinions on the relative importance of these criteria with respect to sustainable project selection. To do that, a survey tool was developed to gather subjective judgments from experts in academia and the industry. In this survey, an explanation of this study was presented to the experts detailing the purpose and objectives. The experts were also provided with a description of all five criteria as presented in this study in an effort to maintain a level of consistency between the different experts regarding criteria definitions. The experts were then asked to make a pairwise comparison between the different criteria with respect to the overall goal of evaluating sustainable project alternatives. They were asked to select one of the five linguistic variables shown in Table 2 based on their opinions when comparing one criterion versus another by filling out the pairwise comparison table shown in Table 3. The rating scale shown in Table 2 is adapted from Alyamani and Long [1].

Table 2. Linguistic scale and corresponding triangular fuzzy numbers (TFNs).

Linguistic Variables	Triangular Fuzzy Number (TFN)	TFN Reciprocal
Equal Importance (E)	(1, 1, 1)	(1, 1, 1)
Weak Importance (W)	(1, 3, 5)	(1/5, 1/3, 1)
Fair Importance (F)	(3, 5, 7)	(1/7, 1/5, 1/3)
Strong Importance (S)	(5, 7. 9)	(1/9, 1/7, 1/5)
Absolute Importance (A)	(7, 9, 11)	(1/11, 1/9, 1/7)

Source: adapted from Alyamani and Long [1].

Table 3. Pairwise comparison table.

A	Absolutely	Strongly	Fairly	Weakly	Equal	Weakly	Fairly	Strongly	Absolutely	B
Project Cost	A □	S □	F □	W □	E □	W □	F □	S □	A □	Project Maturity
Project Cost	A □	S □	F □	W □	E □	W □	F □	S □	A □	Uncertainty
Project Cost	A □	S □	F □	W □	E □	W □	F □	S □	A □	Skill and Experience
Project Cost	A □	S □	F □	W □	E □	W □	F □	S □	A □	Technology Info. Transfer
Project Maturity	A □	S □	F □	W □	E □	W □	F □	S □	A □	Uncertainty
Project Maturity	A □	S □	F □	W □	E □	W □	F □	S □	A □	Skill and Experience
Project Maturity	A □	S □	F □	W □	E □	W □	F □	S □	A □	Technology Info. Transfer
Uncertainty	A □	S □	F □	W □	E □	W □	F □	S □	A □	Skill and Experience
Uncertainty	A □	S □	F □	W □	E □	W □	F □	S □	A □	Technology Info. Transfer
Skill and Experience	A □	S □	F □	W □	E □	W □	F □	S □	A □	Technology Info. Transfer

The survey was originally sent to 25 sustainability and sustainable development experts, including academic researchers, practitioners, or both, to gather their opinions with regard to the relative importance of the five chosen criteria in sustainable project selection. The chosen experts had at least five years of experience working in the sustainable development industry as project managers, project engineers, or project consultants. A total of 12 experts responded to the survey with two out of the 12 responses being deemed unusable due to major errors in taking the survey, making them invalid. Ultimately, a total of 10 expert responses were included in this study. Out of the 10 experts whose opinions were included in this study, three served as academic researchers while seven served as both researchers and practitioners. Four of these experts worked in Saudi Arabia, three in Mexico, two in Italy, and one in Spain. The linguistic pairwise comparison from each of the 10 experts was then gathered to develop a combined pairwise comparison matrix consisting of all verbal expert ratings. The verbal ratings in that matrix were then converted into the triangular fuzzy numbers and TFN reciprocals following the scale shown in Table 2. Doing so led to the creation of the combined TFN pairwise comparison matrix shown in Table 4.

Table 4. Combined TFN pairwise comparison matrix.

Criteria	Expert	C1	C2	C3	C4	C5
C1	E1	(1, 1, 1)	(5, 7. 9)	(7, 9, 11)	(3, 5, 7)	(3, 5, 7)
	E2	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(3, 5, 7)	(1, 1, 1)
	E3	(1, 1, 1)	(5, 7. 9)	(5, 7. 9)	(5, 7. 9)	(5, 7. 9)
	E4	(1, 1, 1)	(3, 5, 7)	(1/5, 1/3, 1)	(1, 1, 1)	(1, 1, 1)
	E5	(1, 1, 1)	(5, 7. 9)	(5, 7. 9)	(7, 9, 11)	(7, 9, 11)
	E6	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/5, 1/3, 1)	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)
	E7	(1, 1, 1)	(3, 5, 7)	(5, 7. 9)	(3, 5, 7)	(3, 5, 7)
	E8	(1, 1, 1)	(7, 9, 11)	(5, 7. 9)	(1, 3, 5)	(3, 5, 7)
	E9	(1, 1, 1)	(5, 7. 9)	(5, 7. 9)	(3, 5, 7)	(3, 5, 7)
	E10	(1, 1, 1)	(7, 9, 11)	(1, 1, 1)	(5, 7. 9)	(5, 7. 9)

Table 4. *Cont.*

Criteria	Expert	C1	C2	C3	C4	C5
C2	E1	(1/9, 1/7, 1/5)	(1, 1, 1)	(1, 3, 5)	(1/7, 1/5, 1/3)	(1/5, 1/3, 1)
	E2	(1/9, 1/7, 1/5)	(1, 1, 1)	(1, 1, 1)	(1/7, 1/5, 1/3)	(1/9, 1/7, 1/5)
	E3	(1/9, 1/7, 1/5)	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(1, 1, 1)
	E4	(1/7, 1/5, 1/3)	(1, 1, 1)	(1/5, 1/3, 1)	(1/7, 1/5, 1/3)	(1, 3, 5)
	E5	(1/9, 1/7, 1/5)	(1, 1, 1)	(3, 5, 7)	(5, 7. 9)	(5, 7. 9)
	E6	(5, 7. 9)	(1, 1, 1)	(3, 5, 7)	(1/5, 1/3, 1)	(1, 3, 5)
	E7	(1/7, 1/5, 1/3)	(1, 1, 1)	(3, 5, 7)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)
	E8	(1/11, 1/9, 1/7)	(1, 1, 1)	(1/5, 1/3, 1)	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)
	E9	(1/9, 1/7, 1/5)	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(1, 1, 1)
	E10	(1/11, 1/9, 1/7)	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)
C3	E1	(1/11, 1/9, 1/7)	(1/5, 1/3, 1)	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)
	E2	(1, 1, 1)	(1, 1, 1)	(1, 1, 1)	(5, 7. 9)	(3, 5, 7)
	E3	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)
	E4	(1, 3, 5)	(1, 3, 5)	(1, 1, 1)	(1/5, 1/3, 1)	(3, 5, 7)
	E5	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)	(1, 1, 1)	(5, 7. 9)	(5, 7. 9)
	E6	(1, 3, 5)	(1/7, 1/5, 1/3)	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/5, 1/3, 1)
	E7	(1/9, 1/7, 1/5)	(1/7, 1/5, 1/3)	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)
	E8	(1/9, 1/7, 1/5)	(1, 3, 5)	(1, 1, 1)	(1/7, 1/5, 1/3)	(1/5, 1/3, 1)
	E9	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)	(1, 1, 1)	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)
	E10	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(5, 7. 9)	(7, 9, 11)
C4	E1	(1/7, 1/5, 1/3)	(3, 5, 7)	(5, 7. 9)	(1, 1, 1)	(1, 3, 5)
	E2	(1/7, 1/5, 1/3)	(3, 5, 7)	(1/9, 1/7, 1/5)	(1, 1, 1)	(3, 5, 7)
	E3	(1/9, 1/7, 1/5)	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(3, 5, 7)
	E4	(1, 1, 1)	(3, 5, 7)	(1, 3, 5)	(1, 1, 1)	(1, 1, 1)
	E5	(1/11, 1/9, 1/7)	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)	(1, 1, 1)	(1, 3, 5)
	E6	(5, 7. 9)	(1, 3, 5)	(5, 7. 9)	(1, 1, 1)	(3, 5, 7)
	E7	(1/7, 1/5, 1/3)	(3, 5, 7)	(5, 7. 9)	(1, 1, 1)	(1, 1, 1)
	E8	(1/5, 1/3, 1)	(5, 7. 9)	(3, 5, 7)	(1, 1, 1)	(3, 5, 7)
	E9	(1/7, 1/5, 1/3)	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(1, 1, 1)
	E10	(1/9, 1/7, 1/5)	(5, 7. 9)	(1/9, 1/7, 1/5)	(1, 1, 1)	(5, 7. 9)
C5	E1	(1/7, 1/5, 1/3)	(1, 3, 5)	(3, 5, 7)	(1/5, 1/3, 1)	(1, 1, 1)
	E2	(1, 1, 1)	(5, 7. 9)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)	(1, 1, 1)
	E3	(1/9, 1/7, 1/5)	(1, 1, 1)	(3, 5, 7)	(1/7, 1/5, 1/3)	(1, 1, 1)
	E4	(1, 1, 1)	(1/5, 1/3, 1)	(1/7, 1/5, 1/3)	(1, 1, 1)	(1, 1, 1)
	E5	(1/11, 1/9, 1/7)	(1/9, 1/7, 1/5)	(1/9, 1/7, 1/5)	(1/5, 1/3, 1)	(1, 1, 1)
	E6	(3, 5, 7)	(1/5, 1/3, 1)	(1, 3, 5)	(1/7, 1/5, 1/3)	(1, 1, 1)
	E7	(1/7, 1/5, 1/3)	(3, 5, 7)	(5, 7. 9)	(1, 1, 1)	(1, 1, 1)
	E8	(1/7, 1/5, 1/3)	(3, 5, 7)	(1, 3, 5)	(1/7, 1/5, 1/3)	(1, 1, 1)
	E9	(1/7, 1/5, 1/3)	(1, 1, 1)	(5, 7. 9)	(1, 1, 1)	(1, 1, 1)
	E10	(1/9, 1/7, 1/5)	(3, 5, 7)	(1/11, 1/9, 1/7)	(1/9, 1/7, 1/5)	(1, 1, 1)

In order to calculate the criteria weights, the fuzzy pairwise comparisons from each of the 10 experts were first combined for each of the five criteria in this study. This was done using the geometric mean method introduced by Buckley [42]. This resulted in the geometric mean of the combined TFN pairwise comparison matrix shown in Table 5. This matrix basically shows the pairwise comparison of all five criteria that combines the opinions of all 10 experts used in this study, as shown in Table 4.

Table 5. Geometric mean of combined TFN pairwise comparison matrix.

Criteria	C1	C2	C3	C4	C5
C1	(1, 1, 1)	(3.3, 4.663, 6.089)	(1.969, 2.646, 3.813)	(2.088, 3.215, 4.296)	(2.141, 2.979, 3.849)
C2	(0.164, 0.214, 0.303)	(1, 1, 1)	(1.116, 1.764, 2.782)	(0.296, 0.387, 0.582)	(0.448, 0.689, 1.052)
C3	(0.262, 0.378, 0.508)	(0.359, 0.567, 0.896)	(1, 1, 1)	(0.379, 0.517, 0.775)	(0.563, 0.823, 1.359)
C4	(0.233, 0.311, 0.479)	(1.719, 2.581, 3.380)	(1.291, 1.935, 2.641)	(1, 1, 1)	(1.823, 2.881, 3.743)
C5	(0.260, 0.336, 0.467)	(0.950, 1.452, 2.233)	(0.736, 1.215, 1.778)	(0.267, 0.347, 0.549)	(1, 1, 1)

Using the fuzzy geometric mean pairwise comparisons shown in Table 5, the fuzzy weights of the importance of the five criteria can be calculated using Chang's [43] extent analysis methodology as shown in Equations (2)–(5). In this methodology, the fuzzy criteria weights are referred to as the fuzzy synthetic extent. Let $G = \{g_1, g_2, g_3, \ldots, g_i\}$ be a goal set. Then, the extent analysis for each goal g_i is calculated for each criterion, respectively. Therefore, the m extent value for each criterion is calculated as $M_{g_i}^1, M_{g_i}^2, M_{g_i}^3, \ldots, M_{g_i}^m$ where g_i $(i = 1, 2, 3, \ldots, n)$ is the goal set, and $M_{g_i}^m$ $(j = 1, 2, 3, \ldots, m)$ are the TFNs [1,6]. Accordingly, the fuzzy synthetic extent (S_i) for each criterion i is defined as illustrated in Equation (2).

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1} \quad (2)$$

Therefore, as to calculate $\sum_{j=1}^{m} M_{g_i}^j$ from Equation (2), a fuzzy addition operation to the m extent [44] is employed on the matrix in Table 5 as shown in Equation (3) in which l represents the lowest possible value, m represents the most likely value, and u represents the upper or highest value as explained earlier is this section.

$$\sum_{j=1}^{m} M_{g_i}^j = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \quad (3)$$

Next, to calculate the $\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j$ portion of Equation (2), another fuzzy addition operation is performed for $M_{g_i}^m$ $(j = 1, 2, 3, \ldots, m)$ as shown in Equation (4).

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right) \quad (4)$$

Finally, the inverse of the vector from Equation (4) is taken to calculate $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1}$ as shown in Equation (5).

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \quad (5)$$

By using the outlined Equations (2–5), as explained above, on the geometric means of the combined pairwise comparison matrix shown in Table 5, the fuzzy synthetic extent value (S_i) or the fuzzy relative importance weights for each of the five criteria are calculated, leading to the fuzzy synthetic extent values shown in Table 6.

Table 6. Fuzzy relative weights of importance for sustainable project selection criteria.

Criteria	S_i—Low	S_i—Med	S_i—Upper
C1	0.225	0.416	0.751
C2	0.065	0.116	0.225
C3	0.055	0.094	0.179
C4	0.130	0.250	0.443
C5	0.069	0.125	0.238

Finally, calculating the relative wight of importance of each of the five criteria is done by defuzzifying the fuzzy relative weights of importance shown in Table 6. This is done by employing the defuzzification method shown in Equation (6), as presented by Sun [44] and Alyamani and Long [1]. This defuzzification method results in obtaining the best non-fuzzy priority (BNP) or crisp weights of importance of the criteria shown in Table 7. These BNP values are then used to rank the importance of the five sustainable project selection criteria where the criterion with the highest weight is considered the most important while the criterion with the lowest weight is considered the least important.

$$BNP_{S_i} = \frac{[(u_{s_i} - l_{s_i}) + (m_{s_i} - l_{s_i})]}{3} + l_{s_i} \quad where\ i = 1, 2, \ldots, 5 \tag{6}$$

Table 7. Sustainable project selection criteria crisp weights or importance.

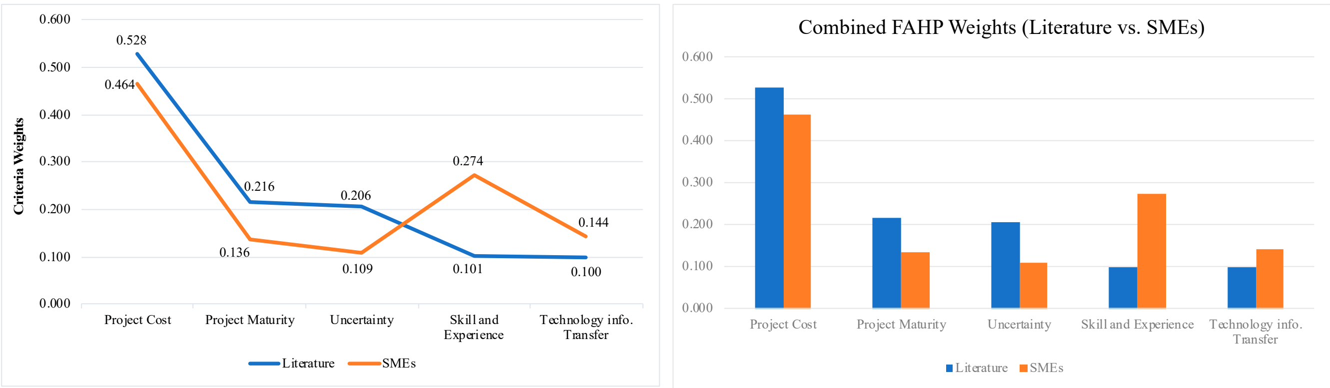
Notation	Selection Criteria	BNP	Ranking
C1	Project Cost	0.464	1
C2	Project Maturity	0.136	4
C3	Uncertainty	0.109	5
C4	Skill and Experience	0.274	2
C5	Technology Info. Transfer	0.144	3

4. Discussion and Comparison of Results

In this study, a fuzzy multi-criteria decision-making methodology or, more specifically, the FAHP, is implemented to rank the importance of five key sustainable project criteria in sustainable project selection. This is done in an attempt to help project managers and decision makers in the sustainable project selection process. The results from this study that are determined based on the opinions of sustainable project experts and practitioners are then compared with a previous research by Alyamani and Long [1] who utilized the literature to rank the importance of these five criteria in the sustainable project selection process. This is done in an effort to compare the two different perspectives stemming from the literature and practice on the importance these five criteria in sustainable project selection.

The results from this study as shown in Table 7 indicate that the most important selection criterion out of the five criteria considered in this study when evaluating different sustainable project alternatives is project cost, with a BNP of 0.464. As explained earlier, this criterion describes the overall project cost throughout the project's life, including the initial investment cost and any other costs associated with the development of the sustainable project. The second most important selection criterion when evaluating sustainable project alternatives according to the results from this study is the required project team skill and experience, with a BNP of 0.274. This criterion is concerned with matching the human resource capabilities with the requirements of the selected sustainable project. The third most important selection criterion when evaluating sustainable project alternatives according to experts is the amount of technology information transfer between the supplier of the sustainable technology and the project team utilizing that technology in the project, with a BNP of 0.144. The fourth most important criterion in sustainable project selection out of the five identified in this study is project maturity, or "novelty" as identified by Alyamani and Long [1], with a BNP of 0.136. Again, this criterion describes the maturity, or novelty, of the sustainable practices and technologies implemented in the sustainable project. Finally, the least important criterion out of the five chosen in this study is project uncertainty, with a BNP of 0.109. This criterion describes the level of uncertainty surrounding the sustainable project that can stem from different sources, whether it is economic, technological, environmental, social, political, or any other source of uncertainty that can potentially impact the sustainable project.

The results presented by Alyamani and Long [1], who utilized the literature in ranking these five criteria based on importance, show that the most important selection criterion to consider when evaluating sustainable project alternatives is project cost, with a BNP of 0.528. The second and third most important criteria were project maturity and project uncertainty, with BNPs of 0.216 and 0.206, respectively. The least important criteria out of the five according to their results were the required level of project team skill and experience and the amount of technology information transfer between the party supplying the sustainable technology and the project team, with BNPs of 0.101 and 0.100, respectively. A graphical representation of the results utilizing the literature from Alyamani and Long [1] and the results utilizing sustainable project subject matter experts (SMEs) from this study is shown in Figure 3a,b.



(a) (b)

Figure 3. Graphical comparison of criterion weights (literature vs. SMEs). (**a**) Linear representation of criterion weights; (**b**) combined FAHP weights.

Looking at the results shown in Figure 3a,b and comparing the weights of each criterion, it is clear that both the literature and SMEs prioritized project cost as the most important criterion when evaluating multiple sustainable project alternatives, with BNPs of 0.528 and 0.464, respectively. This is consistent with what has been discussed in the literature and what was previously discussed in this study in which project cost in considered one of the main drivers in development of sustainable projects [37]. It is actually believed that one of the biggest concerns associated with sustainable projects is the high cost that is usually associated with sustainable development which makes it more difficult for these projects to compete with conventional energy sources [45]. Accordingly, the development of low-cost sustainable technologies and practices can help lead to a significant boost in sustainable development.

However, the two perspectives differ in opinion when it comes to the relative importance of the four remaining criteria. On one hand, SMEs view skill and experience and technology information transfer as being more important sustainable project selection criteria than project maturity and uncertainty, with skill and experience considered the second most important criterion after project cost, as shown in Figure 3a,b. This view is consistent with part of the sustainable project selection literature that emphasizes the importance of matching the human resource capabilities with project requirements and the availability of sustainable technology information as major factors in successful sustainable development [9,39,40,45]. On the other hand, the literature view puts more emphasis on project maturity and uncertainty as selection criteria as opposed to skill and experience and technology information transfer, with project maturity being just slightly more important than uncertainty. In this perspective, skill and experience and technology information transfer are seen as almost equal in importance. The literature views project maturity and uncertainty as major factors in sustainable project selection that can hinder or accelerate sustainable technology adaption [46]. Nonetheless, it is worth noting that the criteria with the lowest weights of importance, in both perspectives, do not have no importance in sustainable project selection. The results simply indicate that criteria with the highest weights should be assigned a higher priority when selecting between different sustainable projects.

One possible reason to why the collective judgment of SMEs in this study prioritized skill and experience and technology information transfer is that lacking the required skilled workforce and technology information in the country or region in which these projects exist can pose a bigger concern for practitioners than the maturity of the sustainable project and level of uncertainty associated with it. This is supported by several researchers who argue the importance of having a skilled workforce and adequate information regarding the implemented technology. For example, Luthra et al. [45] described the lack of skilled and experienced workforce in addition to the lack of technology information flow and communication as some of the biggest barriers to sustainable development and adoption in a given country or region. Solangi et al. [9] also emphasize the importance of having the required human resource skill and experience and adequate technical information sharing in the region or county in which these sustainable energy projects exist. Alyamani et al. [35] also argue the importance of possessing the required level of skill and experience and adequate technology information sharing to be able to deal with different sustainable projects with varying levels of novelty and uncertainty. What can essentially be concluded from these arguments is that the availability of the required skilled workforce and adequate information regarding the implemented sustainable technology provide the project team with the ability to deal with different sustainable projects with varying levels of uncertainty and maturity.

The results from this research clearly show that there is a difference in how four out of the five chosen key sustainable project selection criteria are prioritized between literature and practice. For academic researchers, the literature lacks research that explores these differences and identifies potential reasons to why such differences exist. Accordingly, this research presents the crucial first step in identifying these differences between the literature and practice regarding the five key sustainable project selection criteria. Identifying the differences in importance for these key criteria, and others in the future, is key to the creation of a more standardized, consistent, and reliable sustainable project selection tool. As for industry practitioners, this presents a potential issue to decision makers as to which of the four differing criteria is more important when evaluating multiple sustainable project alternatives. More specifically, the inconsistencies in the priority of most of the chosen key selection criteria as shown in this research make it more difficult for decision makers to make reliable decisions when selecting between different sustainable project alternatives, mainly identifying which of these criteria should be prioritized when evaluating different sustainable project alternatives. Accordingly, the development of a standardized sustainable project selection tool, as mentioned previously, will provide project managers and decision makers with a consistent and reliable process to compare multiple sustainable project alternatives for selection.

5. Conclusions

The ability to select and implement the appropriate sustainable projects is a crucial factor in sustainable development to ensure the needs of an organization or community are met. Part of the selection process involves considering different key sustainable project criteria that are used to select the best possible project out of the different sustainable project alternatives. Ranking these selection criteria based on importance in sustainable project selection can help decision makers differentiate between the different project alternatives and focus on important areas that may require additional attention. This study uses the fuzzy analytic hierarchy process (FAHP) as an MCDM approach to rank project cost, project maturity, uncertainty, skill and experience, and technology information transfer selection criteria based on importance by collecting opinions from subject matter experts (SMEs), consisting of academic sustainable project experts and practitioners. The results are then compared with previous research ranking these five criteria by utilizing the literature as the source of expert opinion in an effort to explore any variation in opinion between the SMEs and the literature. These results will help identify any variation in opinion regarding the importance of these key selection criteria between the literature and practice.

The results from this study show that the most important criterion when evaluating between multiple sustainable project alternatives out of the five considered based on SME opinion is project cost, with a BNP of 0.464. The second and third most important criteria based on the results are skill and experience and technology information transfer, with BNPs of 0.274 and 0.144, respectively. The two least important criteria in this study are project maturity and uncertainty, with BNPs of 0.136 and 0.109, respectively. By comparing these results with the previous research utilizing the literature, it is shown that both the literature and SMEs agree that project cost is the most important criterion in sustainable project selection. However, the two perspectives differ regarding the importance of the remaining four criteria. SEMs put more emphasis on matching the human resource capabilities with the requirements of the selected sustainable project, then adequate technical information sharing and communication over the maturity of the sustainable project and the level of uncertainty associated with it when selecting between project alternatives (Figure 3a,b). On the other hand, the literature prioritizes project maturity and project uncertainty over having the required skill and experience and technology information transfer in sustainable project selection, with project maturity being slightly more important than project uncertainty. A possible reason for such variation in opinion between the two perspectives is that lacking the required skilled and experienced human resources and the adequate technology information in a given country or region can present a larger concern to practitioners than dealing with an uncertain and novel sustainable project.

One main limitation of this study is the small number of SME opinions considered, with a total of only 10 responses utilized to generate the results. Accordingly, the results shown in this study are limited to the opinions and preferences of the participating experts only. Obtaining a larger sample size of expert opinions can be used in future research to generate more accurate results when ranking these sustainable project selection criteria based on SME opinions. In addition, the research could be expanded to include additional key selection criteria and sub-criteria to create a more detailed selection tool that can help project managers and decision makers in the sustainable project selection process. A more extensive review of the literature can also be done for a more accurate and detailed comparison between the literature and SME perspectives regarding the priorities of the chosen selection criteria in sustainable project selection. Such an extensive analysis of both perspectives can lead to more accurately identifying possible reasons to why such variations in opinion exist between the two perspectives through detailed statistical analysis, and how these variations can be minimized to produce a more standardized ranking of the sustainable project selection criteria. In the future, this statistical analysis can also explore ways to use sensitivity analysis methods, such as the Monte Carlo method, on the qualitative input data to test the robustness of the developed criteria ranking.

Author Contributions: Conceptualization, R.A., S.L. and M.N; Data curation, R.A. and M.N; Formal analysis, R.A.; Investigation, R.A.; Methodology, R.A.; Project administration, S.L.; Resources, S.L. and M.N; Software, R.A.; Supervision, S.L.; Validation, R.A.; Writing—original draft, R.A.; Writing—review and editing, S.L. and M.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research is partially funded by the Engineering Management Department at Prince Sultan University (PSU) and the Engineering Management & Systems Engineering Department at Missouri University of Science & Technology.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors gratefully acknowledge the support provided by the Engineering Management Department at Prince Sultan University (PSU) and the Engineering Management & Systems Engineering Department at Missouri University of Science & Technology.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Alyamani, R.; Long, S. The Application of Fuzzy Analytic Hierarchy Process in Sustainable Project Selection. *Sustainability* **2020**, *12*, 8314. [CrossRef]
2. El Amrani, S.; Hossain, N.U.I.; Karam, S.; Jaradat, R.; Nur, F.; Hamilton, M.A.; Ma, J. Modelling and assessing sustainability of a supply chain network leveraging multi Echelon Bayesian Network. *J. Clean. Prod.* **2021**, *302*, 126855. [CrossRef]
3. Doli, A.; Bamwesigye, D.; Hlaváčková, P.; Fialová, J.; Kupec, P.; Asamoah, O. Forest Park Visitors Opinions and Willingness to Pay for Sustainable Development of the Germia Forest and Recreational Park. *Sustainability* **2021**, *13*, 3160. [CrossRef]
4. World Commission on Environment and Development. *Our Common Future*; Oxford University Press: Oxford, UK; New York, NY, USA, 1987.
5. Hatefi, S.M.; Tamošaitienė, J. Construction projects assessment based on the sustainable development criteria by an integrated fuzzy AHP and improved GRA model. *Sustainability* **2018**, *10*, 991. [CrossRef]
6. Pérez Lespier, L.; Long, S.; Shoberg, T.; Corns, S. A model for the evaluation of environmental impact indicators for a sustainable maritime transportation systems. *Front. Eng. Manag.* **2019**, *6*, 368–383. [CrossRef]
7. Hsieh, T.-Y.; Lu, S.-T.; Tzeng, G.-H. Fuzzy MCDM approach for planning and design tenders selection in public office buildings. *Int. J. Proj. Manag.* **2004**, *22*, 573–584. [CrossRef]
8. Amiri, M.P. Project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods. *Expert Syst. Appl.* **2010**, *37*, 6218–6224. [CrossRef]
9. Solangi, Y.A.; Tan, Q.; Mirjat, N.H.; Das Valasai, G.; Khan, M.W.A.; Ikram, M. An Integrated Delphi-AHP and Fuzzy TOPSIS Approach toward Ranking and Selection of Renewable Energy Resources in Pakistan. *Process* **2019**, *7*, 118. [CrossRef]
10. Solangi, Y.A.; Tan, Q.; Khan, M.W.A.; Mirjat, N.H.; Ahmed, I. The Selection of Wind Power Project Location in the Southeastern Corridor of Pakistan: A Factor Analysis, AHP, and Fuzzy-TOPSIS Application. *Energies* **2018**, *11*, 1940. [CrossRef]
11. Büyüközkan, G.; Karabulut, Y. Energy project performance evaluation with sustainability perspective. *Energy* **2017**, *119*, 549–560. [CrossRef]
12. Karatas, M.; Sulukan, E.; Karacan, I. Assessment of Turkey's energy management performance via a hybrid multi-criteria decision-making methodology. *Energy* **2018**, *153*, 890–912. [CrossRef]
13. Wang, B.; Song, J.; Ren, J.; Li, K.; Duan, H. Selecting sustainable energy conversion technologies for agricultural residues: A fuzzy AHP-VIKOR based prioritization from life cycle perspective. *Resour. Conserv. Recy.* **2019**, *142*, 78–87. [CrossRef]
14. Ligus, M. Evaluation of economic, social and environmental effects of low-emission energy technologies development in Poland: A multi-criteria analysis with application of a fuzzy analytic hierarchy process (FAHP). *Energies* **2017**, *10*, 1550. [CrossRef]
15. Figueiredo, K.; Pierott, R.; Hammad, A.W.; Haddad, A. Sustainable material choice for construction projects: A Life Cycle Sustainability Assessment framework based on BIM and Fuzzy-AHP. *Build. Environ.* **2021**, *196*, 107805. [CrossRef]
16. Bilgen, B.; Şen, M. Project selection through fuzzy analytic hierarchy process and a case study on Six Sigma implementation in an automotive industry. *Prod. Plan. Control* **2012**, *23*, 2–25. [CrossRef]
17. Huang, C.-C.; Chu, P.-Y.; Chiang, Y.-H. A fuzzy AHP application in government-sponsored R&D project selection. *Omega* **2008**, *36*, 1038–1052.
18. Nguyen, L.D.; Tran, D.Q. FAHP-Based Decision Making Framework for Construction Projects. In *Fuzzy Analytic Hierarchy Process*; Emrouznejad, A., Ho, W., Eds.; CRC Press: Boca Raton, FL, USA, 2017; pp. 327–346.
19. Dang, P.; Niu, Z.; Gao, S.; Hou, L.; Zhang, G. Critical Factors Influencing the Sustainable Construction Capability in Prefabrication of Chinese Construction Enterprises. *Sustainability* **2020**, *12*, 8996. [CrossRef]

20. Dimić, V.; Milošević, M.; Milošević, D.; Stević, D. Adjustable model of renewable energy projects for sustainable development: A case study of the Nišava district in Serbia. *Sustainability* **2018**, *10*, 775. [CrossRef]
21. Azarnivand, A.; Hashemi-Madani, F.S.; Banihabib, M.E. Extended fuzzy analytic hierarchy process approach in water and environmental management (case study: Lake Urmia Basin, Iran). *Environ. Earth Sci.* **2015**, *73*, 13–26. [CrossRef]
22. Durairaj, S.; Sathiya Sekar, K.; Ilangkumaran, M.; RamManohar, M.; Thyalan, B.; Yuvaraj, E.; Ramesh, S. Multi-Criteria Decision Model for Biodiesel Selection in an Electrical Power Generator Based on Fahp-Gra-Topsis. *IJRET* **2014**, *3*, 226–233.
23. Sabaghi, M.; Mascle, C.; Baptiste, P.; Rostamzadeh, R. Sustainability assessment using fuzzy-inference technique (SAFT): A methodology toward green products. *Expert Syst. Appl.* **2016**, *56*, 69–79. [CrossRef]
24. Seddiki, M.; Bennadji, A. Multi-criteria evaluation of renewable energy alternatives for electricity generation in a residential building. *Renew. Sustain. Energy Rev.* **2019**, *110*, 101–117. [CrossRef]
25. Li, L.; Fan, F.; Ma, L.; Tang, Z. Energy utilization evaluation of carbon performance in public projects by FAHP and cloud model. *Sustainability* **2016**, *8*, 630. [CrossRef]
26. Tsai, H.-C.; Lee, A.-S.; Lee, H.-N.; Chen, C.-N.; Liu, Y.-C. An Application of the Fuzzy Delphi Method and Fuzzy AHP on the Discussion of Training Indicators for the Regional Competition, Taiwan National Skills Competition, in the Trade of Joinery. *Sustainability* **2020**, *12*, 4290. [CrossRef]
27. Mostafaeipour, A.; Sadeghi Sedeh, A.; Chowdhury, S.; Techato, K. Ranking Potential Renewable Energy Systems to Power On-Farm Fertilizer Production. *Sustainability* **2020**, *12*, 7850. [CrossRef]
28. Lin, C.-N. A Fuzzy Analytic Hierarchy Process-Based Analysis of the Dynamic Sustainable Management Index in Leisure Agriculture. *Sustainability* **2020**, *12*, 5395. [CrossRef]
29. Kerr, C.S.; Hossain, N.U.I.; Jaradat, R.M. Application of Method for Non-Linear Scaling of Multi-Criteria Decision Making Attribute Values. In Proceedings of the 2020 IEEE International Systems Conference (SysCon), Montreal, QC, Canada, 24 August–20 September 2020.
30. Enea, M.; Piazza, T. Project selection by constrained fuzzy AHP. *Fuzzy Optim. Decis. Mak.* **2004**, *3*, 39–62. [CrossRef]
31. Kubler, S.; Robert, J.; Derigent, W.; Voisin, A.; Le Traon, Y. A state-of-the-art survey & testbed of fuzzy AHP (FAHP) applications. *Expert Syst. Appl.* **2016**, *65*, 398–422.
32. Fu, H.-H.; Chen, Y.-Y.; Wang, G.-J. Using a Fuzzy Analytic Hierarchy Process to Formulate an Effectual Tea Assessment System. *Sustainability* **2020**, *12*, 6131. [CrossRef]
33. Shukla, R.K.; Garg, D.; Agarwal, A. An integrated approach of Fuzzy AHP and Fuzzy TOPSIS in modeling supply chain coordination. *Prod. Manuf. Res.* **2014**, *2*, 415–437. [CrossRef]
34. Ballı, S.; Korukoğlu, S. Operating system selection using fuzzy AHP and TOPSIS methods. *Math. Comput. Appl.* **2009**, *14*, 119–130. [CrossRef]
35. Alyamani, R.; Long, S.; Nurunnabi, M. Exploring the Relationship between Sustainable Projects and Institutional Isomorphisms: A Project Typology. *Sustainability* **2020**, *12*, 3668. [CrossRef]
36. Hossain, N.U.I.; El Amrani, S.; Jaradat, R.; Marufuzzaman, M.; Buchanan, R.; Rinaudo, C.; Hamilton, M. Modeling and assessing interdependencies between critical infrastructures using Bayesian network: A case study of inland waterway port and surrounding supply chain network. *Reliab. Eng. Syst. Saf.* **2020**, *198*, 106898. [CrossRef]
37. Malik, A.; Al Badi, M.; Al Kahali, A.; Al Nabhani, Y.; Al Bahri, A.; Al Barhi, H. Evaluation of renewable energy projects using multi-criteria approach. In Proceedings of the IEEE Global Humanitarian Technology Conference (GHTC 2014), San Jose, CA, USA, 10–13 October 2014.
38. Toma, S.-V.; Chiriţă, M.; Şarpe, D. Risk and uncertainty. *Procedia Econ. Financ.* **2012**, *3*, 975–980. [CrossRef]
39. Kahraman, C.; Kaya, İ.; Cebi, S. A comparative analysis for multiattribute selection among renewable energy alternatives using fuzzy axiomatic design and fuzzy analytic hierarchy process. *Energy* **2009**, *34*, 1603–1616. [CrossRef]
40. Amer, M.; Daim, T.U. Selection of renewable energy technologies for a developing county: A case of Pakistan. *Energy Sustain. Dev.* **2011**, *15*, 420–435. [CrossRef]
41. Stock, G.N.; Tatikonda, M.V. A typology of project-level technology transfer processes. *J. Oper. Manag.* **2000**, *18*, 719–737. [CrossRef]
42. Buckley, J.J. Fuzzy hierarchical analysis. *Fuzzy Sets Syst.* **1985**, *17*, 233–247. [CrossRef]
43. Chang, D. Extent analysis and synthetic decision, optimization techniques and applications. *Optimization Tech. Appl.* **1992**, *1*, 352–355.
44. Sun, C.-C. A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods. *Expert Syst. Appl.* **2010**, *37*, 7745–7754. [CrossRef]
45. Luthra, S.; Kumar, S.; Garg, D.; Haleem, A. Barriers to renewable/sustainable energy technologies adoption: Indian perspective. *Renew. Sustain. Energy Rev.* **2015**, *41*, 762–776. [CrossRef]
46. Chen, H.H.; Kang, H.-Y.; Lee, A.H. Strategic selection of suitable projects for hybrid solar-wind power generation systems. *Renew. Sustain. Energy Rev.* **2010**, *14*, 413–421. [CrossRef]