Multi-criteria decision-making (MCDM) techniques for ranking the drivers and executive solutions of social and environmental accounting

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Abstract

Purpose- Social and environmental accounting (SEA) is a method that may strengthen imagination and new ideas and methods for sustainability leadership. Governments and companies should consider the drivers and executive solutions of SEA comprehensively. The present study aims to identify the SEA drivers and their executive solutions.

Design/methodology/approach- The literature review is used to identify the drivers and executive solutions of SEA. Then, Using the opinions of 21 experts and the techniques of the *Analytical Hierarchy Process* (AHP), the *Technique for Order of Performance by Similarity to Ideal Solution* (TOPSIS) in the fuzzy environment, weights and prioritization of these drivers and executive solutions are obtained.

Findings- The research showed that the most critical drivers of SEA include "sustainable economic development, increasing stock value, management environmental commitment, and corporate social responsibility (CSR)," respectively. Also, "presenting SEA standards (SEA mandatory)" and "obtaining environmental certifications" are the most critical SEA executive solutions that can help strengthen SEA drivers, especially those mentioned above.

Originality/value- This study is the first in the literature to use a combination of multi-criteria decision-making (MCDM) techniques (AHP-TOPSIS) to rank drivers and select the most suitable SEA executive solutions. The proposed method presents an advanced approach for handling uncertainty to rank drivers and executive solutions of SEA, which can help achieve sustainable development.

Keywords: *Social and Environmental Accounting (SEA), Sustainability, Multi-Criteria Decision-Making (MCDM), Fuzzy Set Theory*

1. Introduction

Since 1990, the rapid growth of the global economy and the subsequent surge in trade volume have led to a staggering increase in pollution and the exploitation of natural resources (Jin et al., 2023; Rahimi et al., 2022). This has devastated the environment, exacerbating global

warming and triggering unpredictable climate changes (Agyemang et al., 2024; Devi & Gupta, 2019). These adverse effects pose a significant barrier to sustainable economic development (Lehman, 2017; Pratibha et al., 2019). Because society and the environment have assumed essential roles as pillars of sustainable development (Bergmann, 2009; Rahimi et al., 2022). Therefore, sustainability has emerged as a crucial challenge in recent decades, highlighting the interconnectedness of society and the environment. Today, even the question of sustainability is raised for banks, which are not just purely financial institutions, but also key players in promoting sustainability. Banks must comply with social and environmental principles and pay attention to sustainability. Despite the positive initiatives taken worldwide in recent years (Lehman & Morton, 2017), the harsh reality is that inequalities persist, causing injustice in society and the environment and exacerbating damages (Askari Shahamabad et al., 2023; Deegan, 2017). In this regard, (Ammar et al., 2023) showed that banks do not act based on justice. They are also more interested in economic sustainability and are not involved in environmental and social issues (Hossain et al., 2024).

When it shifts its focus from the economic value to the beauty and intrinsic value of society and the environment, accounting can be a powerful tool in addressing the current crises. The ongoing global effort to develop an international SEA framework is a collective endeavor crucial in defining accounting to pay attention to sustainability accountability (Lomas & Giampietro, 2017). The SEA compels governments and organizations to act in the public interest, measuring and reporting their activities' social and environmental costs (Ferry & Lehman, 2018). Ultimately, SEA emphasizes the integrated role of organizations in social and environmental issues to expand corporate responsibility and foster a sustainable society (Lehman & Morton, 2017).

While attention to SEA and studies in this field is currently less in developing countries than in developed countries, there is significant potential for growth and improvement. Developing countries and others not presently prioritizing SEA must take constructive steps to build it. The development and improvement of any issue requires understanding and analyzing that issue as well as identifying its drivers and executive solutions. In recent years, many researchers have analyzed the SEA drivers and their executive solutions, and each of these studies has provided a limited number of drivers and executive solutions. The gap in existing research knowledge has shown that although the SEA drivers and their executive solutions have been discussed on a case-by-case basis, their comprehensive study deserves more attention from researchers. As a result, The purpose of this study is to fill this gap by comprehensively identifying SEA drivers and executive solutions by reviewing the literature and ranking them by combining expert opinions using a hybrid approach including the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) and Fuzzy Technique for Order Performance by Similarity to Ideal Solution (Fuzzy TOPSIS) which are implemented in multi-criteria decision making (MCDM) techniques with fuzzy sets. The fuzzy AHP method calculates the drivers' weight, and the fuzzy TOPSIS method ranks SEA executive solutions (according to the weights obtained using the fuzzy AHP method). This problem can be solved by using any of these two methods.

Therefore, this study's originality is that it is the first time in the literature that a study uses the comprehensive identification of SEA drivers and implementation solutions and the combined use of AHP-TOPSIS to rank and select the most suitable ones. This is not just an approach, but an advanced, sophisticated method to face multiple factors and manage uncertainty that can help achieve sustainable development, an essential step in addressing social and environmental challenges.

The following section provides an overview of the SEA literature, its drivers, and executive solutions. Section 3 presents the proposed framework for combining MCDM techniques in this study with the research method. Section 4 summarizes the study's results on prioritizing the SEA drivers and executive solutions. Section 5 presents theoretical concepts and discusses

them, and section 6 concludes the topics of this study, highlighting the practical implications of the conclusions for future research and policy-making.

2- Literature Review

This research, underpinned by two grand theories, Institutional theory and New institutional sociology (NIS) theory, advocates for the approach of SEA. That describes the framework of the study and its potential to spark innovation in the field of accounting and sustainability. By applying these theories to the context of SEA, we aim to provide insights that can inform the development of more effective strategies for adopting and implementing these practices in modern firms. This, in turn, contributes to the broader goal of sustainable business practices, a mission we all share.

(DiMaggio & Powell, 1983) The three critical elements of institutional factors, coercive, normative, and mimetic influences, are influential and instrumental in firms' adoption firms'owth of modern sustainability practices (Khan et al., 2014). The coercive influence, driven by stakeholders such as regulatory authorities, parent firms, and customers, plays a pivotal role. The normative effect is equally significant, led by social institutions like academics, social activist groups, institutional financiers, media, and NGOs. Mimetic influence, where firms emulate the best practices of a leading competitor, regardless of their sector, is also a key factor. Past studies (Khodamipour et al., 2022; Khodamipour et al., 2024; Rahimi et al., 2022; Sayyadi Tooranloo & Askari Shahamabad, 2020; Shamsadini et al., 2023; Shamsadini et al., 2022) have shown that as the external reliance on these influencing entities increases, firms are more likely to adopt specific practices to meet stakeholders' underscoring the profound impact of this research.

NIS theory highlights a significant challenge: Organizations need more sustainability information and hesitate to apply SEA. This reluctance stems from the understanding that managerial and organizational behavior change usually does not happen with rational decisions but through external influences (Bose et al., 2018). NIS theory provides clear analytical insight into examining the impact of these external factors, emphasizing the urgent need for sustainable corporate activities (Jan et al., 2021) that cannot be overlooked.

Developing specific environmental strategies, such as carbon footprint reduction or waste management, and implementing environmental control systems, like pollution monitoring or energy efficiency measures, is the primary need of any organization (Askari Shahamabad et al., 2023; Jin et al., 2023; Latan et al., 2018). These issues can lead organizations to use social and environmental management approaches such as SEA (Shamsadini et al., 2023; Tooranloo et al., 2017). As a critical player, accounting plays a vital role in reassuring organizations about their ability to manage the environmental impacts associated with their activities, which led to the development of environmental management accounting in the 1990s (Qian & Burritt, 2009). This issue is closely tied to the accountability of organizations.

SEA is the process of preparing and compiling information to inform stakeholders (inside and outside the organization) about the organization's impact on the communities and environments in which it operates (Deegan, 2017; Khodamipour et al., 2024). Collecting social and environmental cost information and using this information to calculate the cost of goods and services helps make prices more realistic and make better decisions for managers, leading to innovation (Ferreira et al., 2010). Although the SEA has grown over the past 25 years and a great deal of research has been done on it, the evidence shows that its quality and level of acceptance have remained relatively low.

SEA drivers or their executive solutions are both factors in implementing the SEA, and each can be considered alone to help develop this tool. However, simultaneously examining these and determining the most critical SEA executive solutions, given the drivers' weight, will reinforce the SEA drivers. This will ultimately lead to a double benefit. This means that the

results of this study, in addition to providing the best solutions for implementing SEA, also reinforce the most critical SEA drivers.

2-1. SEA drivers

The first part of the literature in this research is to review the SEA drivers. In this part, 22 drivers of SEA have been identified through a literature review and the invaluable expert opinion. These experts, with their profound knowledge and experience, classified these drivers into five categories based on their features, which are analyzed in the following categories and subcategories:

2-1-1. Organizational drivers: including evaluating the performance of managers (Arulrajah et al., 2015), shareholder concern (Latan et al., 2018), organization size (Cadez & Guilding, 2008), product quality monitoring (Latan et al., 2018), and environmentally friendly product production (Lončar et al., 2019) are all powerful SEA drivers. Management's environmental commitment, in particular, is a driver that brings about positive change, leading to the evaluation and improvement of environmental management practices and the adoption of environmental management accounting. Its role in accepting the SEA execution in the organization is a beacon of hope.

2-1-2. Accounting drivers: Accounting drivers include reducing the organization's costs; there is evidence that environmental costs are 20% of the organization's total operating costs. As a result, one of the potential benefits of using the SEA is cost reduction (Hansen & Mowen, 2005). More accurate assessment of a product life cycle (Dong & Hauschild, 2017; Ferreira et al., 2010), identification and allocation of environmental costs of a product or service to the same process (Dong & Hauschild, 2017; Kluczek & Olszewski, 2017), and providing sustainability reports to meet the crucial needs of external stakeholders (Lehman & Kuruppu, 2017; Lončar et al., 2019) are also drivers that have a significant impact on the SEA execution. The accounting task is to prepare social and environmental reports of organizations that increase their social accountability. Criticisms of the accounting discipline in recent years over its lack of international standards for SEA and ethical issues have also been important motivators for the discipline to pay attention to the SEA. These pressures necessitate broader SEA attention and training, which include maintaining independence and avoiding corruption (Ferry & Lehman, 2018).

2-1-3. Environmental drivers: It is important to reiterate that the environmental drivers, including preserving the environment for future generations (Lončar et al., 2019; Patterson et al., 2017), reducing waste (Latifah & Soewarno, 2023; Sayyadi Tooranloo & Askari Shahamabad, 2020), and reducing emissions of pollutants and greenhouse gases (Agyemang et al., 2024; Dong & Hauschild, 2017; Latan et al., 2018), are not isolated actions. They are interconnected and ultimately lead to improved environmental performance (Latan et al., 2018; Tooranloo et al., 2017), reinforcing the importance of our work.

2-1-4. Social drivers: The media and the widespread access to cyberspace play a pivotal role in shaping public opinion about the harms of organizations. This increased awareness creates a pressing need for companies to respond to external stakeholders, thereby reducing the pressure. The impact of this societal pressure on SEA execution (Fallan & Fallan, 2019; Lehman & Kuruppu, 2017) is significant, compelling companies to prioritize their social responsibility. The publication of social and environmental reports (sustainability reports) further amplifies corporate social responsibility (CSR) (Lončar et al., 2019; Mohd Zain et al., 2024; Pizzi et al., 2023; Shamsadini et al., 2022); a concept that has occupied managers, marketing experts, and researchers for more than 60 years (Hanic & Smolo, 2023). It also contributes to the reduction of social inequalities (Deegan, 2017; Ferry & Lehman, 2018) and, ultimately, leads to increased reputation and improves the image of the company (Ferreira et

al., 2010; Latan et al., 2018; Shamsadini et al., 2022), underlining the urgency of companies' response to societal issues.

2-1-5. Financial drivers: The ultimate goal of these financial drivers is to contribute to sustainable economic development. They include helping to increase financial productivity (Agyemang et al., 2024; Porter & Van Der Linde, 1995), improving competitiveness (Latan et al., 2018; Lee, 2012), increasing stock value (Latan et al., 2018; Sayyadi Tooranloo & Askari Shahamabad, 2020), and ultimately sustainable economic development that can affect the SEA adoption and execution (Latifah & Soewarno, 2023; Mohd Zain et al., 2024; Sayyadi Tooranloo & Askari Shahamabad, 2020).

2-2. SEA executive solutions to reinforce drivers

The second part of the literature in this research is to review the SEA executive solutions to reinforce drivers. In this part, 6 SEA executive solutions were identified by reviewing the literature and confirmed by experts' opinions. These solutions, proven to be effective in implementing SEA and reinforcing one or more drivers, hold significant promise. Which are explained below:

2-2-1. Obtaining environmental certificates: SEA is a pivotal aspect of corporate social and environmental justice, a testament to an organization's dedication to society and the environment (Du et al., 2011). Therefore, it is incumbent upon organizations to acquire certificates such as ISO 14001 to uphold justice and manage societal and environmental issues. The ISO 14001 standard is not just a requirement, but a necessity to strike a balance between the environment, society, and the economy, meeting the immediate needs of humanity without compromising the needs of future generations. This underscores the importance of companies being mandated to possess a variety of environmental certifications as one of the most effective ways to implement the SEA (Lončar et al., 2019; Tooranloo et al., 2017).

2-2-2. Raising community awareness: The collective effort in raising public awareness of the importance and effectiveness of SEA is crucial. Universities, in particular, play a significant role in this process, fostering a shared responsibility for understanding ethical and environmental issues. This encourages organizations to execute SEA more effectively, leading to improved social and environmental performance (Ferry & Lehman, 2018; Pratibha et al., 2019).

2-2-3. Industry requirements for the SEA execution: Different industries, depending on their companies' pollution level, can force them to execute the SEA to pay attention to the social and environmental damage they have caused. This strategy, along with the mandatory SEA, plays a crucial role in preventing polluting companies from suffering a negative view of society. It helps them maintain their competitive advantage with other industry companies. Therefore, SEA is suggested to be used more for companies operating in environmentally sensitive industries that incur high environmental costs (Kibwage et al., 2019). For example, (Darnall et al., 2009) state that the American Chemical Industry Associations oblige their member companies to participate in environmental programs.

2-2-4. Presenting SEA standard (SEA mandatory): So far, more than 60 countries and regions in the world have established environmental information disclosure systems, and now the disclosure of environmental information in Europe, the United States, and Japan has led to the formation of a complete system containing legal guarantees and special enforcement mechanisms. As a result, since the SEA may not always be truthful and corrupt in some cases, there is a need for legal requirements for the SEA execution. Also, different interpretations of organizations in how to submit sustainability reports and how to execute the SEA increases the importance of the issue of consistency principle, and the need for the same standard for the SEA execution is obvious (Berkman et al., 2024; Dong & Hauschild, 2017; Ferry & Lehman, 2018; Kosajan et al., 2018; Li et al., 2012; Pizzi et al., 2023).

2-2-5. Environmental tax: The influence of environmental taxes on SEA execution is significant. Companies, when faced with the obligation to pay environmental taxes for their damages, are left with no choice but to conduct SEA to assess their environmental costs. This process is akin to the preparation of financial statements for income tax purposes. Consequently, environmental policies, including taxation, play a pivotal role in driving SEA execution (Khodamipour et al., 2022; Sayyadi Tooranloo & Askari Shahamabad, 2020).

2-2-6. Environmental audit: Environmental auditing is used to determine compliance with regulatory requirements and environmental standards. As a result, auditing can be used to comply with the company's processes and operations (e.g., the SEA execution) with environmental regulations. This tool has a great impact on reducing greenhouse gas emissions. It also increases the need for an independent auditor because of the potential for corruption in environmental reporting, which may occur due to conflicts of interest between the organization and external stakeholders, as well as the lack of independence of accountants in reporting and the SEA execution (Ferry & Lehman, 2018; Ruban & Rydén, 2019; Sayyadi Tooranloo & Askari Shahamabad, 2020).

Figure 1 summarizes the SEA drivers and executive solutions.

Section 1			Section 2	
Categories	**Sub-categories (Drivers)**	**Code**	**Executive solutions**	**Code**
Organizational Drivers (OD)	Evaluating the performance of managers	OD_1	Obtaining environmental certificates	ES1
	Shareholder concern	OD_2		
	Organization size	OD_3		
	Product quality monitoring	OD_4		
	Environmentally friendly product production	OD_5		
	Management environmental commitment	OD_6	Raising community awareness	ES2
Accounting Drivers (AD)	Reduction in costs	AD_1		
	Product life cycle assessment	AD_2		
	Allocation of environmental costs to the same process	AD_3		
	Provide sustainability reports	AD_4	Industry requirements for the SEA execution	ES3
	Criticisms of accounting	AD_5		
Environmental Drivers (ED)	Preserving the environment for future generations	ED_1	Presenting SEA standards (SEA mandatory)	ES4
	Reducing waste	ED_2		
	Reducing emissions of pollutants and greenhouse gases	ED_3		
	Improved environmental performance	ED_4		
Social Drivers (SD)	Existence of media and access of society to cyberspace	SD_1	Environmental tax	ES5
	Corporate Social Responsibility (CSR)	SD_2		
	Reducing social inequalities	SD_3		
Financial Drivers (FD)	Increase financial productivity	FD_1	Environmental audit	ES6
	Improving competitiveness	FD_2		
	Increasing stock value	FD_3		
	Sustainable economic development	FD_4		

Fig. 1. Drivers and executive solutions of social and environmental accounting (SEA).

2.3. Literature on hybrid fuzzy MCDM

Numerous real-world strategic decisions and issues require considering various conflicting criteria and alternatives. Multi-criteria decision-making is making the best decision from other options concerning specific criteria. MCDM approaches generally consider quantitative and qualitative factors, enabling decision-makers to use those criteria to influence the selection. Given that multiple criteria with uncertain alternatives are involved, fuzzy-based methods, such as AHP, TOPSIS, VIKOR, and ELECTRE, are mainly employed in decision-making literature (Zadeh, 1965).

The issue of evaluating the multiple criteria for ranking SEA drivers and its executive solutions has become a challenging task, having vague information. From this perspective, this paper proposes hybrid multi-criteria decision-making methods using the most common methods, such as AHP and TOPSIS. These methods can tackle more complex, uncertain information for ranking SEA drivers and executive solutions in real-world situations. Each approach has its limitations and disadvantages, which policymakers should consider (Topcu & Ulengin, 2004). Numerous MCDM methods may present different alternative rankings. Thus, a single technique may no longer yield the best solution for real-world problems. A hybrid model may critically amplify the effect and reliability of solutions acquired through single models (Khodamipour et al., 2022). T To overcome these problems, this paper uses the fuzzy sets theory (Zadeh, 1965) to characterize uncertainty, imprecision, and vagueness more flexibly.

3. Methodology

This section examines the methods used in this study in detail. It describes the fuzzy set theory, the fuzzy AHP method, and the fuzzy TOPSIS method.

3-1. Fuzzy set theory

In several real-world scenarios, crisp numbered data are often insufficient to model the complexity of human thinking, judgment, and preferences due to their vagueness, imprecision, and subjective nature. In such cases, fuzzy set theory is introduced instead of the crisp set theory to model the uncertainty of human judgments (Zadeh, 1996); the process is called fuzzy multi-criteria decision-making (FMCDM) (Singh & Benyoucef, 2011). A fuzzy set comprises a group of elements, each with its degree of membership. However, the Likert scale cannot handle the ambiguity or vagueness of decision-making as it assigns a single value to each linguistic term. (Zadeh, 1996) introduced the fuzzy set theory in MCDM to resolve the uncertainty and vagueness of human cognition and judgment by providing mathematical strengths to work out such uncertainties of human thinking and reasoning.

Furthermore, a fuzzy number is a generalization of the real number. Given two positive triangular fuzzy numbers $\tilde{T}_1 = (t_1^l,\ t_1^m, t_1^r)$ and $\tilde{T}_2 = (t_2^l,\ t_2^m, t_2^r)$, where $t^l \le t^m \le t^r$. The parameters t^l, t^m, and t^r indicate the smallest possible value, the middle possible value, and the largest possible value, respectively that describe a fuzzy event (as Fig. 2). Fig. 3 also shows the intersection between two fuzzy numbers. The basic arithmetic rules for triangular fuzzy number are described (Khodamipour et al., 2022):

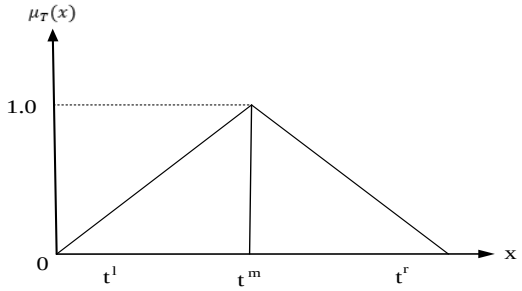

Fig. 2. The membership functions of TFN.

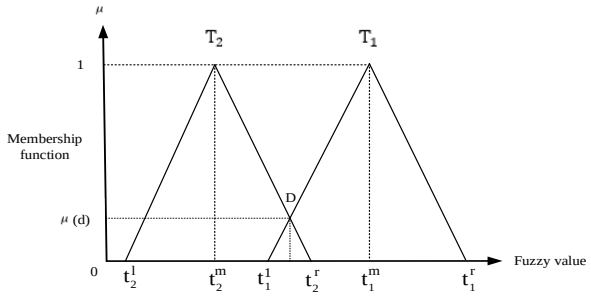

Fig. 3. The intersection between two fuzzy numbers.

3-2. Fuzzy AHP

AHP helps decision-makers set priorities and make the best decision by capturing vague information with the help of expert consultation (Saaty, 2000). AHP is the most popular technique for prioritization purposes, and it is applied to many fields. This method was developed by Saaty (Saaty, 1987) in the 1980s. One of the advantages of using AHP is its ease of use. Pairwise comparisons allow users to weigh criteria and compare alternatives with relative ease. It is also a popular technique for the subjective judgment of qualitative data (Girubha & Vinodh, 2012). The application of Satty's AHP has some limitations that the Fuzzy AHP methodology extends Satty's AHP by combining it with fuzzy set theory to solve hierarchical fuzzy problems. The fuzzy AHP method offers several benefits, such as capturing uncertain, imprecise judgments of experts by handling linguistic variables (Patil & Kant, 2014).

The procedural steps of fuzzy AHP are given in Figure 4. The experts use the linguistic terms in Table 1 to evaluate the relative importance of SEA drivers. Triangular fuzzy numbers (TFN) are preferred for the pairwise comparison scale of Fuzzy AHP.

Definition:

A fuzzy number T on R to be TFN if its membership function $\mu_T(x): R \rightarrow [0.1]$ is equal to following Eq. (1).

$$\mu_T(x) = \begin{cases} \dfrac{(x - t^l)}{(t^m - t^l)} \\ \dfrac{(t^r - x)}{(t^r - t^m)} \\ 0 \end{cases} \quad \begin{matrix} t^l \le x \le t^m \\ t^m \le x \le t^r \\ otherwise \end{matrix} \tag{1}$$

From Eq. (1), $t^l \le t^m \le t^r$, which t^l and t^r mean the lower and upper value of fuzzy number T, and t^m is the modal value (as Fig. 2). TFN can be denoted by $T = (t^l . t^m . t^r)$.

all the $T_{gi}^{j} (j = 1.2.3.4.5. \ldots . m)$ are triangular fuzzy numbers given in Table 1.

$$T_{gi}^{1}, T_{gi}^{2}, T_{gi}^{3}, \cdots, T_{gi}^{m} \qquad i = 1,2,3,4,5, \ldots, n \tag{2}$$

Step 1: The fuzzy judgment matrix $\tilde{A}(a_{ij})$ can be expressed mathematically as in Eq. (3)

$$\widetilde{A} = \begin{Bmatrix} 1 & \tilde{a}_{12} & \tilde{a}_{13} & \cdots & \tilde{a}_{1(n-1)} & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \tilde{a}_{23} & \cdots & \tilde{a}_{2(n-1)} & \tilde{a}_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \tilde{a}_{(n-1)1} & \tilde{a}_{(n-1)2} & \tilde{a}_{(n-1)3} & \cdots & 1 & \tilde{a}_{(n-1)n} \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \tilde{a}_{n3} & \cdots & \tilde{a}_{n(n-1)} & 1 \end{Bmatrix} \tag{3}$$

The judgment matrix $\tilde{A}$ is an $n \times n$ fuzzy matrix containing fuzzy numbers $\tilde{A}_{ij}$

$$\widetilde{A_{ij}} = \begin{cases} 1, & i = j \\ 1,3,5,7,9 \; or \ldots 1^{-1}, 3^{-1}, 5^{-1}, 7^{-1}, 9^{-1} & i \ne j \end{cases} \tag{4}$$

Step 2: The values of fuzzy synthetic extent with respect to i-th criterion is defined as:

$$S_i = \sum_{j=1}^{m} T_{gi}^{j} \times \left[\sum_{i=1}^{n} \sum_{j=1}^{m} T_{gi}^{j} \right] \tag{5}$$

Step 3: The degree of possibility of $T_2 = ({t^l}_2 . {t^m}_2 . {t^r}_2) \ge T_1 = ({t^l}_1 . {t^m}_1 . {t^r}_1)$ can be defined as:
where μd is the highest intersection between two fuzzy (see Fig. 3).

$$V(T_2 \ge T_1) = hgt(T_2 \cap T_1) = \mu(d)$$

$$= \begin{cases} 1 & if \; {t^m}_2 \ge {t^m}_1 \\ 0 & if \;\; {t^l}_2 \ge {t^r}_2 \\ \dfrac{{t^l}_1 - {t^r}_2}{({t^m}_2 - {t^r}_2)({t^m}_1 - {t^l}_1)} & otherwise \end{cases} \tag{6}$$

The degree of possibility for convex fuzzy numbers to be greater than k convex fuzzy numbers $T_i (i = 1.2.3. \ldots . k)$ can be defined as:

By assuming that $d'(A_i) = minV\ (S_i \ge S_k)$
For $k = 1.2.3.4.5. \ldots . n (k \ne i)$, Then the weight vector is given by

$$V(T \ge T_1, \cdots, T_k) = V[(T \ge T_1), \ldots, (T \ge T_k)] = min\, V(T \ge T_1), \qquad i = 1,2,3, \ldots, k \tag{7}$$

$$W' = \left(d'(A_1), d'(A_2), \ldots, d'(A_n)\right)^T$$

where $A_i (i = 1.2.3.4.5. \ldots . n)$ are n elements. (8)

Step 4: Via normalization, the normalized weight vectors are given by

$$W = \left(d(A_1), d(A_2), \ldots, d(A_n)\right)^T$$

where W is a non-fuzzy number. (9)

Fig. 4. Fuzzy AHP steps.

Table 1. Linguistic variables and fuzzy number for calculating the weight of categories and sub-categories.

Linguistic variables	Fuzzy number	Triangular fuzzy numbers
Extreme importance	$\tilde{9}$	(8, 9, 10)
Very strong to Extreme importance	$\tilde{8}$	(7, 8, 9)
Very strong importance	$\tilde{7}$	(6, 7, 8)
Strong to very strong importance	$\tilde{6}$	(5, 6, 7)
Strong importance	$\tilde{5}$	(4, 5, 6)
Moderate to strong importance	$\tilde{4}$	(3, 4, 5)
Moderate importance	$\tilde{3}$	(2, 3, 4)
Equal to moderate importance	$\tilde{2}$	(1, 2, 3)
Equal importance	$\tilde{1}$	(1, 1, 1)

3-3. Fuzzy TOPSIS

The TOPSIS method, a seminal work by (Hwang & Yoon, 1981), is a classic MCDM method used for ranking problems. It determines the best alternatives and ranks them through a series of mathematical computations, based on the idea that the selected alternative has the shortest distance from the positive ideal solution (PIS) and the farthest from the negative ideal solution (NIS) (Prakash & Barua, 2015). Recognizing the extensive use of fuzzy set theory in handling uncertainty and vagueness in MCDM problems, the TOPSIS method has been extended under the fuzzy environment. This extension, known as the fuzzy TOPSIS approach, uses linguistic value rather than crisp value, effectively managing the uncertainty in the judgments and evaluations of the decision-makers (Prakash & Barua, 2015).

Based on the definition above, Figure 5 presents the procedural steps of fuzzy TOPSIS. The triangular fuzzy numbers related to this method are given in Table 2.

Step 1: Form a committee of decision makers, and then identify the evaluation criteria and alternatives.	Decision makers: $D = \{D_1. D_2. \dots . D_k\}$ Alternative: $A = \{A_1. A_2. \dots . A_m\}$ Criteria: $C = \{C_1. C_2. \dots . C_n\}$	$\tilde{D}^k = \begin{matrix} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{matrix} C_1 & C_2 & \cdots & C_n \\ \end{matrix} \begin{pmatrix} \tilde{x}^k{}_{11} & \tilde{x}^k{}_{12} & \cdots & \tilde{x}^k{}_{1n} \\ \tilde{x}^k{}_{21} & \tilde{x}^k{}_{22} & \cdots & \tilde{x}^k{}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{x}^k{}_{m1} & \tilde{x}^k{}_{m2} & \cdots & \tilde{x}^k{}_{mn} \end{pmatrix}$ (10)
Step 2: Form a decision matrix and evaluate the ranking of each criterion according to their importance	$\tilde{x}_{ij} = \frac{1}{K}\left[\tilde{x}^1{}_{ij}(+)\tilde{x}^2{}_{ij}(+)\dots(+)\tilde{x}^k{}_{ij}\right]$ $\tilde{w}_j = \frac{1}{K}\left[\tilde{w}^1{}_j(+)\tilde{w}^2{}_j(+)\dots(+)\tilde{w}^k{}_j\right]$	$\tilde{D} = \begin{pmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{pmatrix}$ (11)
Step 3: Normalize the decision matrix	$\tilde{R} = [\tilde{r}_{ij}]_{m\times n}$	$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+}\right)$ and $c_j^+ = max\, c_{ij} (benefit\ criteria)$ (12) $\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right)$ and $a_j^- = min\, a_{ij} (cost\ criteria)$ (13)
Step 4: Construct the weighted normalized fuzzy decision matrix.	$\tilde{V} = [\tilde{v}_{ij}]_{mxn},\ i = 1,2,3,\dots,m \quad and \quad j = 1,2,3,\dots,n \quad \tilde{v}_{ij} = \tilde{r}_{ij} \times w_{ij}$	(14)
Step 5: Calculate the fuzzy positive ideal solution (FPIS, A^+) and fuzzy negative ideal solution (FNIS, A^-).	$A^+ = \{\tilde{v}_1^+, \tilde{v}_2^+, \cdots, v_n^+\}$, where $\tilde{v}_j^+ = \{max(\tilde{v}_{ij})\ if\ j \in J;\ min\ (\tilde{v}_{ij})\ \ if\ j \in J'\}$, $j = 1,2,3,4,5,\dots,n$	(15)
	$A^- = \{\tilde{v}_1^-, \tilde{v}_2^-, \cdots, v_n^-\}$, where $\tilde{v}_j^- = \{min(\tilde{v}_{ij})\ if\ j \in J; max(\tilde{v}_{ij})\ \ if\ j \in J'\}$, $j = 1,2,3,4,5,\dots,n$	(16)
Step 6: Calculate the distance of each alternative from FPIS and FNIS.	$d_i^+ = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, v_j^+\right)$, i=1,2,...,m	(17)
	$d_i^- = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, v_j^-\right)$, i=1,2,...,m	(18)
Step 7: Calculate the closeness coefficient of each alternative.	$CC_i = \frac{d_i^-}{d_i^- + d_i^+}, \quad i = 1,2,\cdots,m\ \&\ C_i \in (0,1)$	(19)
Step 8: Rank the alternatives based on the closeness coefficient of each alternative's to the ideal solution.		

Fig. 5. Fuzzy TOPSIS steps.

Table 2. Linguistic scale and fuzzy number for ranking the SEA executive solutions.

Linguistic scale	Very High	High	Medium High	Medium	Medium Low	Low	Very Low
Fuzzy number	$\tilde{7}$	$\tilde{6}$	$\tilde{5}$	$\tilde{4}$	$\tilde{3}$	$\tilde{2}$	$\tilde{1}$
Triangular fuzzy numbers	(9, 10, 10)	(7, 9, 10)	(5, 7, 9)	(3, 5, 7)	(1, 3, 5)	(0, 1, 3)	(0, 0, 1)

4. Application of proposed hybrid fuzzy AHP-TOPSIS framework

The fuzzy AHP-TOPSIS combination for ranking SEA drivers and its executive solutions has three phases, as shown in Figure 6.

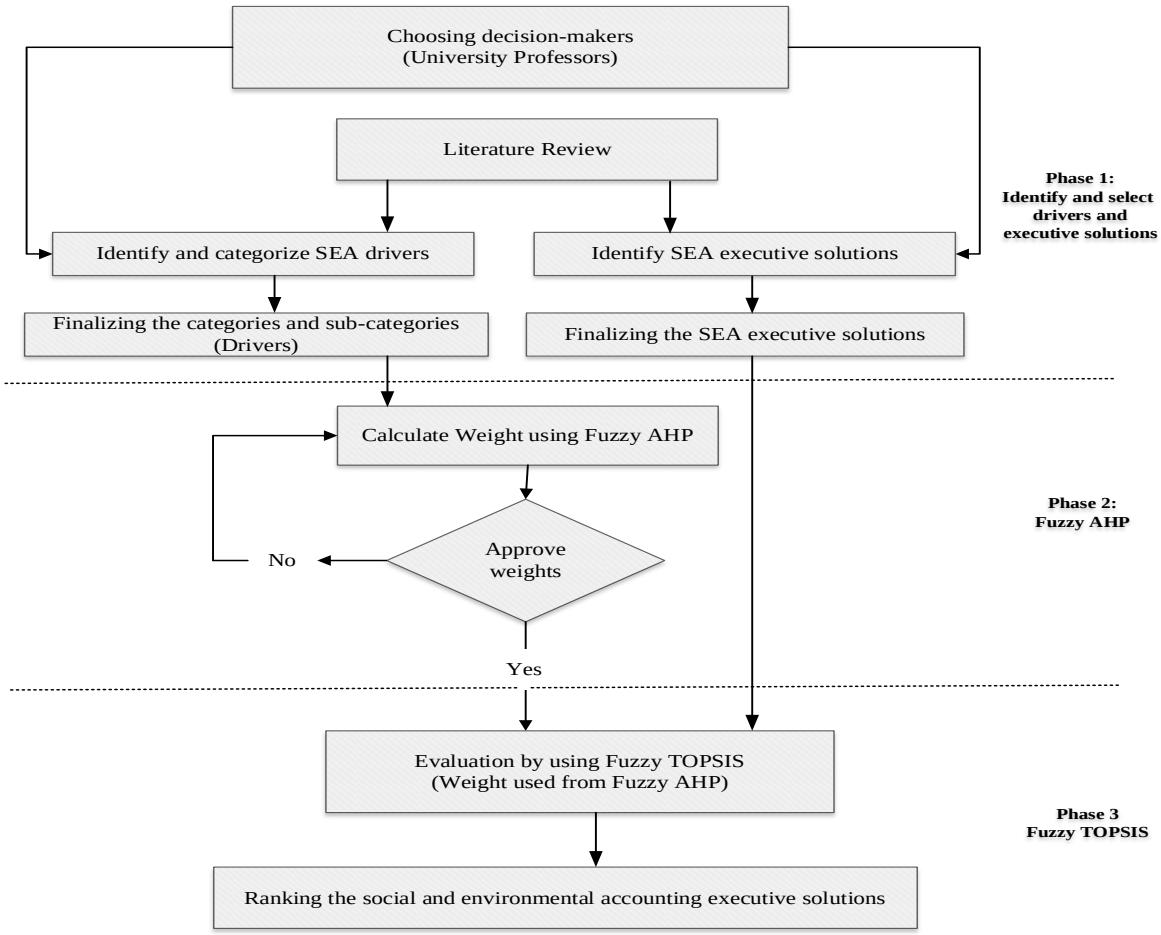

Fig. 6. Hierarchical structure for the ranking the social and environmental accounting executive solutions.

Phase 1: Identify the SEA drivers and executive solutions. In the first stage, a committee of experts consisting of 6 accounting professors with valuable information on the SEA and sustainability issues will be formed to identify and evaluate SEA drivers and executive solutions. Then, by reviewing the research literature and opinions of these experts, the drivers and executive solutions are finalized. This study identified 22 drivers and six solutions through a literature review and discussion with the committee of experts, shown in Figure 1.

Phase 2: Calculation of drivers' weights using fuzzy AHP method.

Phase 3: Determining the final priority of SEA executive solutions using the fuzzy TOPSIS method.

5. The proposed hybrid method computations

5-1. Experts and hierarchical structure of the fuzzy AHP-TOPSIS methods

The experts of this study were 21 specialists, including 10 professors of the accounting department (2 full professors, 4 associate professors, and 4 assistant professors), 6 CEOs, and 5 accountants. The selection criteria for these specialists were more than 15 years of work experience and familiarity with SEA, SCR, and sustainability issues. The data of the fuzzy AHP and fuzzy TOPSIS methods were collected and analyzed by sending a questionnaire.

The decision-making hierarchy for this research has four levels. The overall goal of the decision-making process is to "rank the drivers and executive solutions of SEA" at the first level of the hierarchy. Categories are shown in the second level, sub-categories (SEA drivers) in the third level, and SEA executive solutions in the fourth level of the hierarchy (Figure 7).

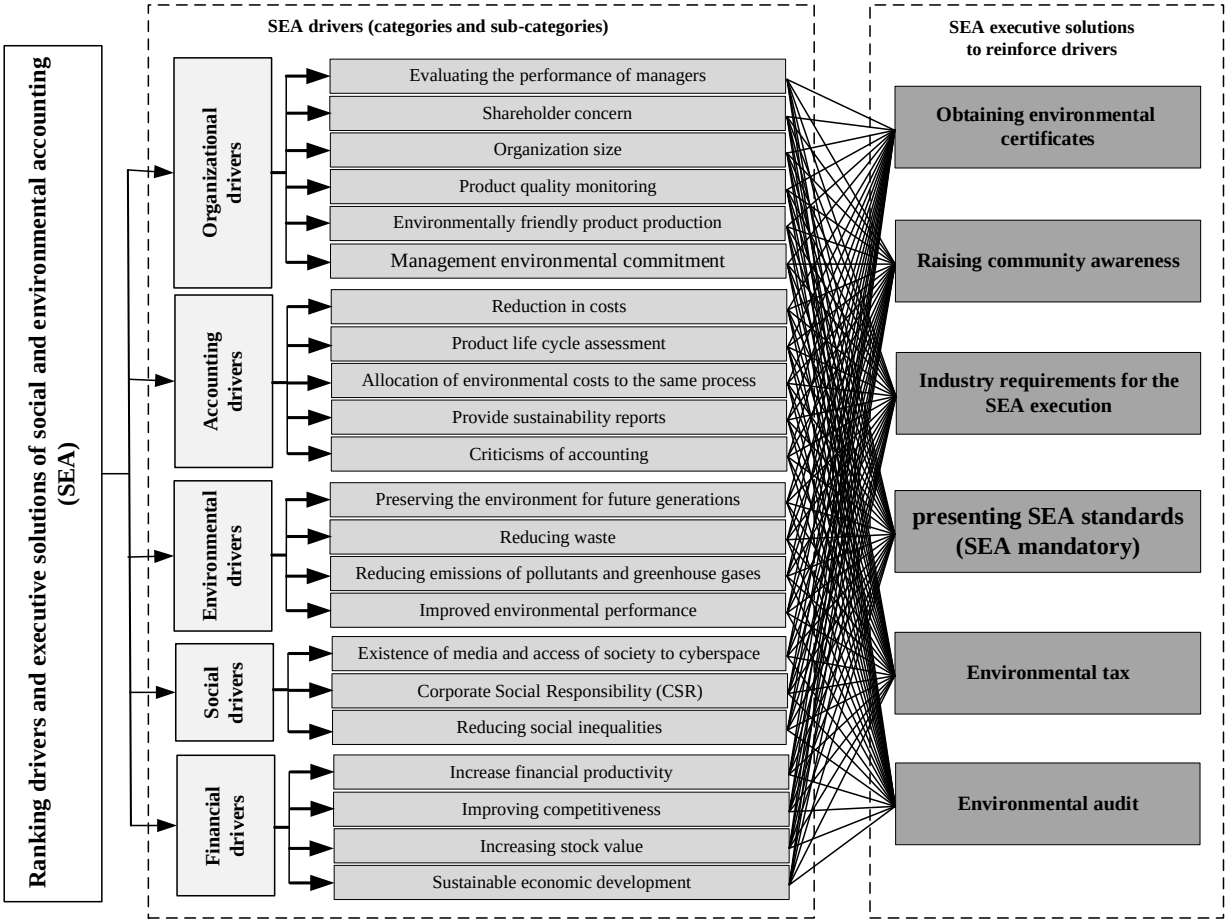

Fig. 7. Proposed research methodology for ranking drivers and executive solutions of social and environmental accounting (SEA)

5-2. Phase 2: Calculating the weight of SEA drivers using fuzzy AHP

Experts evaluated the main categories and sub-categories (SEA drivers) using the relevant questionnaires and the fuzzy triangular numbers in Table 1. Incompatibility rates were calculated for all questionnaires, and inconsistencies were addressed. The following is an integrated fuzzy decision matrix for the categories and sub-categories (drivers), along with the calculated weights in Tables 3-8. The final results of the pairwise comparison of categories and sub-categories, the culmination of our evaluation, are shown in Figure 8, underscoring the importance of our findings.

Table 3. Calculated fuzzy aggregated decision matrix of categories.

Coed	OD	AD	ED	SD	FD	Weight	Rank
OD	(1, 1, 1)	(0.43, 0.64, 1.00)	(0.91, 1.35, 1.90)	(1.15, 1.60, 2.28)	(0.85, 1.17, 1.57)	0.224	3
AD	(1.00, 1.57, 2.32)	(1, 1, 1)	(0.74, 0.96, 1.24)	(1.00, 1.57, 2.32)	(0.91, 1.22, 1.51)	0.243	1
ED	(0.53, 0.74, 1.10)	(0.81, 1.04, 1.35)	(1, 1, 1)	(0.77, 1.10, 1.51)	(0.46, 0.66, 0.96)	0.172	4
SD	(0.44, 0.62, 0.87)	(0.43, 0.64, 1.00)	(0.66, 0.91, 1.29)	(1, 1, 1)	(0.45, 0.61, 0.94)	0.136	5
FD	(0.64, 0.85, 1.17)	(0.66, 0.82, 1.10)	(1.04, 1.51, 2.19)	(1.06, 1.64, 2.23)	(1, 1, 1)	0.226	2

Table 4. Calculated fuzzy aggregated decision matrix of sub-categories (OD).

Code	OD_1	OD_2	…	…	OD_5	OD_6	Weight	Rank
OD_1	(1, 1, 1)	(0.63, 0.81, 1.03)	…	…	(0.41, 0.52, 0.66)	(0.37, 0.47, 0.62)	0.036	6
OD_2	(0.97, 1.24, 1.60)	(1, 1, 1)	…	…	(0.46, 0.69, 1.00)	(0.38, 0.52, 0.77)	0.081	5
OD_3	…	…	…	…	…	…	0.228	2

OD_4	…	…	…	…	…	…	0.112	4
OD_5	(1.51, 1.92, 2.43)	(1.00 1.45, 2.17)	…	…	(1, 1, 1)	(0.34, 0.50, 0.74)	0.214	3
OD_6	(1.60, 2.12, 2.68)	(1.29, 1.92, 2.64)	…	…	(1.35, 1.98, 2.92)	(1, 1, 1)	0.329	1

Table 5. Calculated fuzzy aggregated decision matrix of sub-categories (AD).

Code	AD_1	AD_2	AD_3	AD_4	AD_5	Weight	Rank
AD_1	(1, 1, 1)	(0.65, 0.91, 1.31)	(0.46, 0.67, 1.08)	(0.63, 0.87, 1.24)	(0.87, 1.27, 1.72)	0.183	4
AD_2	(0.76, 1.10, 1.53)	(1, 1, 1)	(0.82, 1.10, 1.43)	(0.50, 0.71, 0.98)	(0.75, 1.17, 1.79)	0.198	3
AD_3	(0.93, 1.49, 2.17)	(0.70, 0.91, 1.22)	(1, 1, 1)	(1.17, 1.74, 2.49)	(0.79, 1.22, 1.72)	0.243	1
AD_4	(0.81, 1.15, 1.58)	(1.02, 1.40, 1.99)	(0.40, 0.58, 0.85)	(1, 1, 1)	(0.82, 1.22, 1.79)	0.209	2
AD_5	(0.58, 0.79, 1.15)	(0.56, 0.85, 1.33)	(0.58, 0.82, 1.29)	(0.56, 0.82, 1.22)	(1, 1, 1)	0.167	5

Table 6. Calculated fuzzy aggregated decision matrix of sub-categories (ED).

Code	ED_1	ED_2	ED_3	ED_4	Weight	Rank
ED_1	(1, 1, 1)	(0.59, 0.85, 1.17)	(0.50, 0.71, 0.98)	(1.00, 1.57, 2.32)	0.246	2
ED_2	(0.85, 1.17, 1.69)	(1, 1, 1)	(0.38, 0.52, 0.77)	(0.57, 0.91, 1.51)	0.212	3
ED_3	(1.02, 1.40, 1.99)	(1.29, 1.92, 2.64)	(1, 1, 1)	(0.83, 1.37, 2.03)	0.334	1
ED_4	(0.43, 0.64, 1.00)	(0.66, 1.10, 1.77)	(0.49, 0.73, 1.21)	(1, 1, 1)	0.208	4

Table 7. Calculated fuzzy aggregated decision matrix of sub-categories (SD).

Code	SD_1	SD_2	SD_3	Weight	Rank
SD_1	(1, 1, 1)	(0.50, 0.64, 0.85)	(0.96, 1.35, 1.79)	0.317	2
SD_2	(1.17, 1.57, 1.98)	(1, 1, 1)	(0.96, 1.27, 1.68)	0.466	1
SD_3	(0.56, 0.74, 1.04)	(0.60, 0.79, 1.04)	(1, 1, 1)	0.218	3

Table 8. Calculated fuzzy aggregated decision matrix of sub-categories (FD).

Code	FD_1	FD_2	FD_3	FD_4	Weight	Rank
FD_1	(1, 1, 1)	(1.22, 1.67, 2.19)	(0.36, 0.49, 0.70)	(0.27, 0.38, 0.55)	0.145	3
FD_2	(0.46, 0.60, 0.82)	(1, 1, 1)	(0.33, 0.45, 0.66)	(0.34, 0.45, 0.61)	0.008	4
FD_3	(1.43, 2.03, 2.75)	(1.51, 2.25, 3.04)	(1, 1, 1)	(0.54, 0.79, 1.15)	0.390	2
FD_4	(1.81, 2.64, 3.65)	(1.64, 2.23, 2.94)	(0.87, 1.27, 1.85)	(1, 1, 1)	0.457	1

Categories	Weight	Sub-categories	Local Weight (LW)	Local rank	Global Weight (GW)	Global rank
Organizational Drivers	0.224	Evaluating the performance of managers	0.036	6	0.008	21
		Shareholder concern	0.081	5	0.018	20
		Organization size	0.228	2	0.051	7
		Product quality monitoring	0.112	4	0.025	19
		Environmentally friendly product production	0.214	3	0.048	10
		Management environmental commitment	0.329	1	0.074	3
Accounting Drivers	0.243	Reduction in costs	0.183	4	0.045	11
		Product life cycle assessment	0.198	3	0.048	9
		Allocation of environmental costs to the same process	0.243	1	0.059	5
		Provide sustainability reports	0.209	2	0.051	8
		Criticisms of accounting	0.167	5	0.041	14
Environmental Drivers	0.172	Preserving the environment for future generations	0.246	2	0.042	13
		Reducing waste	0.212	3	0.037	15
		Reducing emissions of pollutants and greenhouse gases	0.334	1	0.057	6
		Improved environmental performance	0.208	4	0.036	16
Social Drivers	0.136	Existence of media and access of society to cyberspace	0.317	2	0.043	12
		Corporate Social Responsibility (CSR)	0.466	1	0.063	4
		Reducing social inequalities	0.218	3	0.030	18
Financial Drivers	0.226	Increase financial productivity	0.145	3	0.033	17
		Improving competitiveness	0.008	4	0.002	22
		Increasing stock value	0.390	2	0.088	2
		Sustainable economic development	0.457	1	0.103	1

Fig. 8. Final ranking of SEA drivers and executive solutions.

5-3. Phase 3: Ranking the SEA executive solutions by using fuzzy TOPSIS

SEA executive solutions, the focus of our study, were evaluated based on their effectiveness and importance on SEA drivers, an essential aspect of our research. Experts assessed the SEA executive solutions using linguistic variables and triangular fuzzy numbers, as shown in Table 2. Then, Eq. (11) is used to calculate the aggregate fuzzy decision matrix of SEA executive solutions, and the results are given in Table 9 due to the benefit or cost criteria by following Eqs. (12) and (13), this study considered all SEA drivers as benefit criteria. Hence, Eq. (12) was used to normalize the fuzzy decision matrix of executive solutions, as shown in Table 10. To calculate the weight of executive solutions' fuzzy normalized decision matrix, weights of SEA drivers obtained from the fuzzy AHP method in Phase 2 (see Figure 8) were used to calculate Eq. (14) as given in Table 11. As this study considered drivers criteria as benefit criteria, it defined the fuzzy positive ideal solution (FPIS) as A+ (1,1,1) and fuzzy negative ideal solution (FNIS) as A− (0,0,0), then the distance from FPIS and FNIS was calculated by using Eq. (17,18) and the closeness coefficient can be obtained with Eq. (19) which is shown in Table 12. Therefore, the values were used in the final ranking of SEA executive solutions, underscoring the importance of the SEA drivers in our research.

Table 9. Calculated fuzzy aggregated decision matrix of SEA executive solutions.

Code	OD_1	OD_2	OD_3	…	FD_2	FD_3	FD_4
ES_1	(3, 7, 10)	(5, 8.67, 10)	(0, 4.33, 9)	…	(5, 9, 10)	(7, 9.33, 10)	(7, 9.67, 10)
ES_2	(5, 9, 10)	(0, 3, 7)	(0, 1.33, 5)	…	(7, 9.33, 10)	(7, 9.67, 10)	(7, 9.33, 10)
ES_3	(1, 6.33, 10)	(1, 6.33, 10)	(0, 2.67, 7)	…	(1, 4.33, 7)	(3, 7, 10)	(7, 9.33, 10)
ES_4	(1, 5.67, 10)	(1, 7.67, 10)	(5, 8.67, 10)	…	(9, 10, 10)	(7, 9.67, 10)	(5, 8.67, 10)
ES_5	(1, 3.67, 7)	(7, 9.33, 10)	(7, 9.33, 10)	…	(1, 5, 9)	(5, 8.67, 10)	(7, 9.67, 10)
ES_6	(7, 9.97, 10)	(7, 9.33, 10)	(3, 7, 10)	…	(1, 5, 9)	(3, 7, 10)	(5, 8.33, 10)

Table 10. Normalized fuzzy decision matrix of SEA executive solutions.

Code	OD_1	OD_2	OD_3	…	FD_2	FD_3	FD_4

ES1	(0.30, 0.70, 0.89)	(0.50, 0.87, 1.00)	(0.00, 0.43, 0.90)	…	(0.50, 0.90, 1.00)	(0.70, 0.93, 1.00)	(0.70, 0.97, 1.00)
ES2	(0.50, 0.90, 1.00)	(0.00, 0.30, 0.70)	(0.00, 0.13, 0.50)	…	(0.70, 0.93, 1.00)	(0.70, 0.97, 1.00)	(0.70, 0.93, 1.00)
ES3	(0.10, 0.63, 1.00)	(0.10, 0.63, 1.00)	(0.00, 0.27, 0.70)	…	(0.10, 0.43, 0.70)	(0.30, 0.70, 1.00)	(0.70, 0.93, 1.00)
ES4	(0.10, 0.57, 1.00)	(0.10, 0.77, 1.00)	(0.50, 0.87, 1.00)	…	(0.90, 1.00, 1.00)	(0.70, 0.97, 1.00)	(0.50, 0.87, 1.00)
ES5	(0.10, 0.37, 0.70)	(0.70, 0.93, 1.00)	(0.70, 0.93, 1.00)	…	(0.10, 0.50, 0.90)	(0.50, 0.87, 1.00)	(0.70, 0.97, 1.00)
ES6	(0.70, 0.97, 1.00)	(0.70, 0.93, 1.00)	(0.30, 0.70, 1.00)	…	(0.10, 0.50, 0.90)	(0.30, 0.70, 1.00)	(0.50, 0.83, 1.00)

Table 11. Weighted normalized fuzzy decision matrix of SEA executive solutions.

Code	OD1	OD2	OD3	…	FD3	FD4
ES1	(0.002, 0.006, 0.008)	(0.009, 0.016, 0.018)	(0.000, 0.022, 0.046)	…	(0.062, 0.082, 0.088)	(0.072, 0.100, 0.103)
ES2	(0.004, 0.007, 0.008)	(0.000, 0.005, 0.013)	(0.000, 0.007, 0.026)	…	(0.062, 0.085, 0.088)	(0.072, 0.096, 0.103)
ES3	(0.001, 0.005, 0.008)	(0.002, 0.011, 0.018)	(0.000, 0.014, 0.036)	…	(0.026, 0.062, 0.088)	(0.072, 0.096, 0.103)
ES4	(0.001, 0.005, 0.008)	(0.002, 0.014, 0.018)	(0.026, 0.044, 0.051)	…	(0.062, 0.085, 0.088)	(0.052, 0.089, 0.103)
ES5	(0.001, 0.003, 0.006)	(0.013, 0.017, 0.018)	(0.036, 0.048, 0.051)	…	(0.044, 0.076, 0.088)	(0.072, 0.100, 0.103)
ES6	(0.006, 0.008, 0.008)	(0.013, 0.017, 0.018)	(0.015, 0.036, 0.051)	…	(0.026, 0.062, 0.088)	(0.052, 0.086, 0.103)

Table 12. Closeness coefficient and final ranking of social and environmental accounting executive solutions.

Code	SEA executive solutions	D^+	D^-	CC_i	Rank
ES1	Obtaining environmental certificates	0.1391	0.2486	0.641	2
ES2	Raising community awareness	0.1858	0.2173	0.539	6
ES3	Industry requirements for the SEA execution	0.1518	0.2452	0.618	5
ES4	Presenting SEA standards (SEA mandatory)	0.1340	0.2508	0.652	1
ES5	Environmental tax	0.1464	0.2431	0.624	4
ES6	Environmental audit	0.1435	0.2490	0.634	3

6. Discussion

Identifying the SEA drivers is very useful and can help decision-makers how to advance this tool. However, just identifying these drivers may not lead to the SEA execution. As a result, it is essential to identify and review solutions that reinforce key drivers and can also help implement the SEA. In this study, the SEA drivers and SEA executive solutions to reinforce drivers were identified by reviewing the literature and opinions of experts. To evaluate their importance, these drivers and executive solutions were ranked using the combined approach of the AHP-TOPSIS in a fuzzy environment. A total of 22 drivers and 6 executive solutions have been identified by reviewing the literature and expert opinion.

The weight of the drivers was calculated using the fuzzy AHP method. Then, using drivers' weight, the SEA executive solutions were ranked using the fuzzy TOPSIS method. The maximum weight is used to consider the most important categories, which are accounting drivers, financial drivers, organizational drivers, environmental drivers, and social drivers, respectively, and are shown in Table 3. Accounting drivers weighing 0.243 are the most critical categories in the SEA execution. Results show that the drivers of 'management environmental commitment' (weight 0.329), 'organization size', and 'production of environmentally friendly product' have more weight among organizational drivers (Table 4). In accounting drivers, the allocation of environmental costs to the same process with a weight of 0.243 is the most crucial. The following priorities are providing sustainability reports and evaluating the product life cycle ties (Table 5). Reducing the emission of pollutants and greenhouse gases (weighing 0.334), preserving the environment for future generations, and reducing waste are among the most critical environmental drivers (Table 6). In social drivers, corporate social responsibility, with a weight of 0.466, has a higher weight than other drivers. The following priorities are the existence of the media, the access of society to cyberspace, and the reduction of social inequalities (Table 7). In financial drivers, sustainable economic development, with a weight

of 0.457, is the most important among other drivers. Increasing stock value and increased financial productivity are other important drivers of this category (Table 8).

The prioritized 5 categories and 22 sub-categories of SEA drivers (Figure 8) show that experts consider sustainable economic development the most essential SEA driver; it has a local weight of 0.457 and a global weight of 0.103 among all SEA drivers. Research (Agyemang et al., 2024; Latifah & Soewarno, 2023) confirms the great importance of sustainable economic development, which shows that this driver has a high weight in the SEA. The results of the research model (Sayyadi Tooranloo & Askari Shahamabad, 2020) show that SEA leads to sustainability and sustainable economic development, which is the ultimate goal of the SEA implementation model. Therefore, it is a strong driver for SEA. The next important drivers are increasing stock value, management environmental commitment, corporate social responsibility (CSR), allocating environmental costs to the same process, and reducing pollution and greenhouse gas emissions. According to the results of this research and comparison with the results of other researches, it can be clearly stated that the management environmental commitment (Latan et al., 2018) and corporate social responsibility in the implementation of SEA (Lončar et al., 2019; Moudud-Ul-Huq, 2022; Pizzi et al., 2023) helps a lot to improve the image and increase the value of the company's stock (Agyemang et al., 2024; Latan et al., 2018; Sayyadi Tooranloo & Askari Shahamabad, 2020), which are all important SEA drivers at this research. The findings of (Jan et al., 2023) show that sustainability practices such as SEA have a significant positive effect on ROA and ROE, ultimately leading to an increase in stock value. In addition to social and financial drivers, the SEA can also make the prices of goods and services more realistic (Dong & Hauschild, 2017; Ferreira et al., 2010; Kluczek & Olszewski, 2017), as well as reduce pollution and greenhouse gas emissions (Dong & Hauschild, 2017; Ferreira et al., 2010; Latan et al., 2018; Lee, 2012), in which case it has a double benefit.

To help execute SEA, in addition to paying attention to drivers, valuable and efficient solutions must be provided that reinforce drivers to speed up SEA implementation. Determining the importance and priority of these solutions can save time and thus introduce the best solution for more effortless SEA execution. Therefore, in this study, the SEA executive solutions are ranked according to the importance of the identified drivers to be more effective in achieving the SEA. This means that the drivers' weight effectively ranks the executive solutions. According to respondents, the maximum amount is used to rank executive solutions. As shown in Table 12, the presenting SEA standard (SEA mandatory) has the highest value, and raising community awareness has the lowest value among the SEA executive solutions. (Dong & Hauschild, 2017) It was stated that legal rules must accompany some environmental goals and indicators. So far, many countries and regions have developed their government information disclosure systems, and at present, environmental disclosure in Europe and the United States has led to the creation of complete systems that contain specific legal assurance and enforcement mechanisms (Kosajan et al., 2018; Pizzi et al., 2023). Therefore, since the standards are the applicable rules as well as the guidelines for the implementation of these rules, which aim to achieve the desired level of order and compliance with the regulations, it can be argued that SEA mandatory is the most desirable solution for the complete and accurate the SEA execution. In addition, obtaining environmental certifications and environmental auditing are some of the most critical solutions in the SEA execution that can be used in case of delay in submitting the standard or other problems. This reiterates the ranking of executive solutions based on identified drivers, keeping the audience informed and engaged in the discussion.

The SEA is similar to takaful or cooperation in Islamic Sharia, which embodies the idea of 'mutual assistance between groups' (Mohd Zain et al., 2024), which by embracing the principles of responsible governance, social welfare, and environmental sustainability, businesses can

enhance their product supply, raise stakeholder social awareness, and achieve their financial and ethical objectives.

There is no doubt that the importance of sustainability is clear and that the results mostly show that this approach leads to more profitability and an increase in stock value, therefore is completely unjustified to not move towards it. But its faster implementation requires guarantees and mandatory laws, as well as giving importance to corporate social responsibility committees, which need more attention. Based on this, we can rely on the logical alignment of the results of SEA drivers and solutions in this research.

7. Conclusions and main implications of the research

Due to the high importance of SEA in many countries and organizations that still do not pay much attention to this approach, there is a need to identify its drivers and provide executive solutions. It is difficult to execute all the solutions simultaneously due to various limitations. Therefore, ranking these solutions is necessary to execute them step by step. This study provides a scientific framework for ranking the SEA executive solutions along with the importance of SEA drivers using a fuzzy AHP-TOPSIS technique.

This study identified 22 drivers and 6 executive solutions through a review of research literature and expert opinions. The study results showed that sustainable economic development, increasing stock value, management environmental commitment, corporate social responsibility, allocation of environmental costs to the same process, and reducing emissions and greenhouse gas emissions are 6 critical drivers in the SEA. Also, the results of prioritization of the SEA executive solutions showed that the presenting SEA standards (SEA mandatory) (ES4) is the most important among the SEA executive solutions. Therefore, if governments first try to provide a comprehensive and accurate standard for the implementation of SEA by organizations and enforce it like other accounting standards; finally, sustainable economic development, increasing stock value, CSR, allocating environmental costs to the same process, and reducing emissions and emissions are readily available. As a result, paying attention to the prioritization of these drivers and solutions can significantly impact the identification of further benefits of the SEA and its execution. The proposed framework presents a valid and reliable new approach to rank the SEA drivers and executive solutions, which is one of the main contributions of this study.

7-1. The main implications of the research

Although we expect legitimate behavior from organizations that is compatible with the environment and society, organizational legitimacy is achieved when the organization voluntarily gives importance to sustainability. From the point of view of New institutional sociology (NIS), organizations face several external stakeholders to guarantee and validate their reputation and existence in the market, which indicates an external force to perform legitimate behaviors. Also, the coercive and normative pressure proposed in the institutional theory informs the necessity of an external power to perform correct behaviors. In this regard, the results of this research are entirely based on these cases. This research shows that providing SEA standards (mandatory SEA) is the most critical solution to achieving SEA. These results highlight the role of NIS theory and coercive pressures in institutional theory. Also, obtaining an environmental certificate, the second most crucial solution for implementing SEA, pays attention to the normative dimension of institutional theory, which shows that if organizations are required to obtain environmental certificates, this can be considered a norm suitable to achieve SEA.

Therefore, the findings of this research have practical implications for government legislative bodies and professional accounting associations to provide and pay more attention to mandatory SEA guidelines and standards, and also standard-setting institutions in developing countries that have not paid attention to SEA so far, that focus on its development.

Environmental protection organizations can contribute a lot to the expansion of environmental certificates and emphasis on obtaining them by organizations in the path of more implementation of SEA. Also, policy makers and audit institutions can monitor the performance of organizations more with environmental audit.

The social implications of this article are mostly for organizations to pay more attention to the field of CSR, as well as managers who should strengthen their social and environmental obligations. This ultimately leads to the awareness of the social stakeholders of the company's performance and improving their image and increasing the value of their shares, which is the ultimate goal of any organization.

Finally, the present study stimulates more theoretical and empirical work on social and environmental accounting and its relationship with increasing stock value, investigating managers' environmental commitment, as well as methods for allocating social and environmental costs to processes.

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