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HYBRID DECISION MAKING MODEL-UNITISING FOR THE ANALYSIS OF COMPETITIVE INTELLIGENCE, GREEN MARKETING AND GREEN PURCHASE INTENTION IN THE PURSUIT OF SUSTAINABILITY

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Annotation. With intensifying global competition and increased consumer desire for sustainable products, organisations must now incorporate competitive intelligence, green marketing, and green purchase intentions into a simultaneous process involving multiple criteria decision-making (MCDM). Most research on this topic has investigated one of these factors at a time and no model has been developed to demonstrate their congruent relationship in a fuzzy decision-making process. This lack of an integrated model does not allow for a full examination of these factors regarding sustainability and sustained competitive advantage. In this research, an integrated approach that employs fuzzy multi-criteria decision-making (FMCDM) techniques to assess and rank sustainability strategies is proposed. The fuzzy Delphi technique was employed to determine 24 criteria grouped across four dimensions competitive intelligence, green marketing, green purchase intention and sustainability and validate that with identified experts. Then, the criteria were employed in the analysis of four strategic alternatives: supply chain transparency, value-based green marketing, reduction of resource consumption, and investment in green innovation which were analysed within three FMCDM methods SECA, COCOSO and MARCOS. The robustness of results was confirmed through sensitivity analysis and cross-method comparison. Findings indicate that that investing in green innovation is the most effective strategy for increasing brand value and reducing environmental impact. Supply chain transparency and resource consumption reduction are next in priority. Raising the importance of green purchase intention emphasises supply chain transparency. The model offers managers a practical framework to prioritise

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sustainability strategies amid market uncertainties, and companies like P&G can use it to boost green initiatives and customer loyalty.

Keywords: competitive intelligence, green marketing, green purchase intention, sustainability, fuzzy, SECA, COCOSO, MARCOS.

JEL classification: C4, D81, M31, Q56.

Introduction

With increasing global competition, companies are continually challenged to meet strict environmental regulations, adapt to shifting consumer preferences for sustainable alternatives, and position themselves competitively (Giovannoni, 2013). This convergence produces multifaceted decision-making contexts full of uncertainty, where traditional methods often fail to produce meaningful actions in pursuit of economic goals that tap into economic, social, and environmental performance (Raihan, 2024). For example, The consumer goods industry, including multinationals such as Procter and Gamble, is under pressure to optimise supply chains, revise marketing and advertising strategies, and even influence consumer behaviour, all of which demand advanced analytic frameworks beyond traditional statistics or descriptive analytics(Alicke, Rexhausen, Seyfert, 2017). In such contexts, organisations need robust analytical tools to successfully determine the best effective strategies approach to improving sustainable performance(Singh, El-Kassar, 2019).

In this regard, three theoretical frameworks: competitive intelligence, green marketing, and green purchase intention, underpin sustainability strategies. Competitive intelligence is an organisation's ability to identify and process market and competitor information to make informed choices (Ranjan, Foropon, 2021). Green marketing focuses development strategies that profitably balance environmental requirements against consumer expectations and requirements (Cavallo, 2021). Green purchase intention reflects consumers' attitudes and behaviours concerning selecting environmentally friendly products.

Despite the increase in literature published on sustainable performance, prior studies have mostly examined competitive intelligence (Bulley *et al.*, 2014), green marketing (Dutta, 2012), and green purchase intention (Cheng *et al.*, 2022) separately and have recommended traditional statistical modeling techniques. Although these are valuable findings, they fall short of examining the interaction between these elements or the uncertainties attached to consumers' judgments and the surrounding environment. The lack of an overarching framework that blends these aspects in a way that can support strategic decision-making under conditions of ambiguity is noticeable (Hasanpoor *et al.*, 2017). Few research have investigated the relationships between these ideas in the context of multicriteria decision-making models, especially in the ambiguous and uncertain circumstances that characterise sustainable development. (Ansu-Mensah, 2021). For instance, Chung (2020) discussed how to leverage a green marketing orientation to develop sustainability projects, but did not discuss how to use competitive intelligence to identify green market opportunities. There are some studies (Keshavarz-Ghorabaee, 2018) that focus on using fuzzy methods to reduce uncertainty; however, these studies have mainly studied sustainable supplier selection and hence did not analyse broader organisational strategies. This research gap prevents organisations from developing a holistic understanding of how these factors impact sustainability strategies and calls for the need to develop a new integrated framework.

This study addresses these shortcomings by suggesting that competitive intelligence will increase the effectiveness of green marketing via awareness about market tendencies and competitor behaviour, thus affecting consumers' views on green products and increasing green purchasing intention. Understanding this interconnected chain of influence requires a unified analytical framework to appreciate implications for strategy. The contribution of research linking these three elements is to provide a hybrid FMCDM model that utilises fuzzy SECA, fuzzy COCOSO, and fuzzy MARCOS techniques to benchmark strategies with noise and uncertainty. In effect, this framework not only provides conceptual components but also allows a robust analytic framework which examines how these components work together to create sustainable processes.

This research aims to develop, validate, and and assess a robust FMCDM framework that incorporates competitive intelligence, green marketing, and green purchase intention to facilitate sustainable strategic decision-making. To accomplish this, the research will provide answers to the following questions:

RQ1: How can these criteria be analysed and ranked using fuzzy multicriteria decision-making methods?

RQ2: What factors influence competitive intelligence, green marketing, and green purchase intention in the context o sustainability?

RQ3: How are strategic alternatives ranked based on their impact on these dimensions and sustainability outcomes?

The model provided by the present study, is useful in practice, especially for marketing managers, brand managers, and decision makers in manufacturing and consumer products organisations that are working towards achieving sustainable development goals. The model provides them with a structured decision-support tool to prioritise strategies under uncertainty- strategies that will achieve environmental and social goals while providing insight into developing effective green marketing strategies from the perspective of market trends and competitor activity. For example, the proposed model could be utilised in decision-making processes to construct green advertising strategies, develop eco-friendly products, and find opportunities to compete in sustainability driven markets. In this way, this research advances the theoretical foundation of sustainable marketing while also offering a comprehensive and practical framework to guide strategic decision-making in real-world applications.

The structure of this article is organised as follows. Initially, an extensive review of the literature is presented, covering the core principles of competitive intelligence, green marketing, and the intention to engage in green purchasing. The following section outlines the methodology, which explains the hybrid fuzzy MCDM framework by integrating fuzzy SECA, fuzzy COCOSO, and fuzy MARCOS. The outcomes of the model's application are then presented. Subsequently, the results and their significance for both theoretical understanding and practical application are examined. The study's main contributions are highlighted in the closing part, which also offers possible avenues for further research in this significant area.

1. Theoretical background

1.1 Competitive Intelligence

Competitive intelligence is a strategic process where businesses gather and evaluate data to gain insights into their competitors. Understanding competition's capabilities and strengths serves as a good basis for enhancing market position and strategic planning (Hasanpoor *et al*., 2017). Another category of information includes customer data, cost information, pricing, and research and development processes.

Organisations have been using competitive intelligence for many years and frequently do so without even knowing about its existence. Most of the time, its usage would be seen in strategic planning, marketing, financial planning, policy making, and re-engineering processes for the organisation to keep on sustaining itself (Markovich, 2019). Managers would always try to find some source of information that would do it for their decision-making. Because with the increasing changes as well as the developments of the world today, an organisation can no longer afford to keep itself indifferent to this information. This is precisely where the emergence of competitive intelligence is observed (Markovich, 2019), for it provides essential and pertinent information regarding their competitors and the broader competitive landscape. They can utilise the analysis of this information in their planning and strategising processes. The main purpose of conducting competition data analysis is to acquire better knowledge regarding an industry and competitors, thus enabling a more informed decision-making process, a strategy formulation with competitive advantages, and achievement of quicker results to place the company higher than its rivals (Fleisher, 2015).

Recent research indicates that organisations employing competitive intelligence tools for market analysis and forecasting consumer behaviour can formulate more effective green marketing strategies, thereby drawing a larger customer base (Keshavarz-Ghorabaee, 2018; Hasanpoor *et al*., 2017). For example, a study conducted in the Indian petrochemical industry demonstrated that competitive intelligence helps companies accurately identify customer needs and more effectively introduce low-carbon products to the market. In addition, manufacturers of organic and sustainable products with precise information on shifts in customer preferences can optimise their products based on this data and adopt more suitable advertising strategies (Krakowski, 2023).

1.2 Green Marketing

Green marketing encompasses a comprehensive set of activities intended to promote and enable exchanges that fulfill human needs and wants while reducing negative and damaging effects and destructive impacts on the environment (Ransure, 2017). However, it would certainly be better to define green marketing, emerging alongside the modern green movement and based onto social and ecological marketing conceptualisations, as ‘An integrated management process of identifying, predicting, and delivering the needs of the client and the society simultaneously with the needs of profit and sustainability’ (Narimanfar, 2022).

Green marketing includes strategies for promoting goods and services that have as little of an adverse effect on the environment as possible. This concept includes various initiatives such as developing eco-friendly products, utilising recyclable packaging materials, conducting educational advertising campaigns, and incorporating sustainable methods into supply chain management (Ransure, 2017; Gelderman, 2021). Research has shown that consumers who receive sufficient information about the advantages of sustainable products via green marketing are more likely to choose these products (Pancić, 2023; Chockalingam, 2016).

1.3 Green Purchase Intention

Consumer purchase intention is crucial in determining green marketing strategies. A purchase encompasses any item or service that consumers consider and intend to obtain. Consumer purchase intention acts as a springboard for green marketing strategies to warrant their invocation. From the perspective of the consumer, this entails thinking about something and planning on acquiring it (Chen, 2012). Likewise, another interpretation describes purchase intention as indicators of how much individuals are willing to exert effort or the level of effort they plan to put into performing that behaviour' (Shanbhag, 2023). Such influences causing consumers to change their choice of a product are typical goals in green marketing-oriented ecopreneurship: availability of greener alternatives, environmental awareness, and promotion of sustainability (Kardos, *et al*., 2019). Market trends frequently dictate consumer capabilities in consumer behaviour (Liu, 2024) for evaluating availability, value, price, and quality as competing commodities, thus leading to customised marketing actions (Pagala *et al*., 2024). A constant promotion of eco-friendly living requires the teaching of awareness by combining eco-products consumption to facilitate the shift from conventional products to environmentally sustainable alternatives (Abasi *et al*., 2013). Research has shown that green products are impactful (Abasi *et al*., 2013). Green purchase intention is defined as the probability and desire for individuals to favour products with environmentally friendly attributes rather than traditional alternative goods. Chen and Ching (2012) also stated that 'If a customer is committed to a specific green product, then the goal of achieving it has likely been surpassed, which is essentially the result of the purchase'. Consequently, the decision to purchase eco-friendly items might be influenced by consumers' views. Customers' propensity or desire to buy such goods is therefore referred to as 'green purchase intention'.

Green purchase intention represents consumers' readiness to acquire eco-friendly products and is recognised as a key indicator of effective green marketing outcomes. According to studies, various factors influence green purchase intention, among which the most significant include environmental awareness, individual values, brand trust, and social influences (Shafiq *et al*., 2024). Studies have indicated that people who are more aware of the benefits of sustainable products are more inclined to select them while making purchases.

1.4 Sustainability

For two decades, such environmental issues as climate change, loss of biodiversity, and socio-economic inequality have been gathering excreasing concern from the public (Raihan, 2024). The concept became widely recognised following the launch of the United Nations 2030 Agenda for Sustainable Development. Breuer (2023) argued for a need to emphasise addressing each of the three dimensions-values: environmental, social, and economic, in the research while becoming aware of the dual goals of protecting enterprises' financial performance. In aidditon, the welfare of people and the environment were observed to be included in sustainable development. The ability of a system to continue over time without experiencing deterioration or depletion of the accessible vital resource on which it depends is known as sustainability in the contemporary context (Das *et al*., 2023). Therefore, the sustainability paradigm focuses on satisfying current demands while maintaining the potential of future generations to satisfy their own. From the concept mentioned above, it is recommended that organisations implement sustainable business models that utilise available resources efficiently through practices that safeguard the well-being and prosperity of both current and future generations. (Roy, Show, 2023).

1.5 MCDM

Roy defines MCDAM as a design support and computational tool that, with the aim of guiding decision-makers toward a reasonable choice, provides the ability to compare costs and/or scenarios based on various and often conflicting criteria (Zavadskas, 2011). Generally, assessing and selecting specific Green

Supply Chain Management (GSCM) practices in an organisation will be characterised by several steps which will start with an inventory of all potential alternatives and the dimensions used to assess those alternatives. Subsequently, the performance ratings of the GSCM practice alternatives need to be assessed, along with the determination of the weights for each evaluation criterion and any sub-criteria that may exist. Ultimately, these ratings and weights must be combined to calculate an overall performance index for each alternative, considering all criteria necessary to support the identification of the most appropriate option. (Dursun, Karsak, 2010).

Uncertainty is a fact of life in human decision-making, with it often stemming from subjective valuations and imprecision. To the effectiveness model under uncertainty, intuitionistic fuzzy numbers are employed to represent the evaluations made by decision makers. This approach is favoured because intuitionistic fuzzy numbers are particularly effective at addressing uncertainty in decision-making scenarios. Additionally, they provide a straightforward method for expressing subjective evaluations through degrees of membership and non-membership (Nguyen, Young, 2019).

1.6 Literature Review

In ‘The Effect of Green Marketing on Consumers’ Purchase Intention’, Ansar (2013) examined how green marketing influences consumers’ intentions to make purchases. Utilising mediating variables such as price, advertising, and packaging, he distributed questionnaires and tested the data collected. Green marketing has been observed to have a favourable and substantial impact on consumers’ intentions to make purchases. Similarly, ‘Investigation of The Influence of Green Marketing Strategies on Consumer Buying Behaviour’, a study by Rahbar and Abdul (2011), looked into how Malaysian customers’ purchasing decisions were affected by green marketing and its instruments. The scholars distributed questionnaires and analysed the data they received; it was found that green marketing and its tools do affect consumers’ purchasing behaviour and have a great positive effect on their buying decisions.

Mohammad *et al*. (2024) carried out research investigating the joint impacts of the Blue-Green Market on purchase intention. Through the assistance of detailed analysis and statistical tests, A significant correlation was identified between the elements of the Blue-Green Market and consumers’ intentions to make purchases. Future research can investigate the determined relationships more in detail and examine potential mediating and moderating variables. In addition, another study investigated how green advertising influences consumers’ intentions to purchase, revealing that individuals who encounter trustworthy environmentally friendly products are more likely to be chosen after seeing green marketing (Tsai, 2025).

The remaining articles are examined using a review table. Multiple global studies that correspond with the established research variables, methodologies, and criteria, along with the research method, case study, theoretical contributions, and conclusions spanning from 2015 to 2024 are reviewed (*Appendix 1*). The aim is to deliver a thorough and all-encompassing overview of relevant international research activities, emphasising their connection to the exist in each framework.

Recent studies in the field of green marketing and consumer intentions toward environmentally friendly purchases has identified a significant challenge: the lack of a holistic and unified framework to assess the influence of competitive intelligence alongside green marketing and green purchase intention. One of the key elements impacting strategic decision-making is competitive information, which is essential for marketing strategy optimisation. (Karamaşa *et al*., 2021). In this context, employing advanced approaches such as FMCDM can aid in developing more accurate and practical models. According to recent research, it is indicated that fuzzy decision-making strategies can reduce the uncertainties in consumer behaviour analysis and offer a more comprehensive understanding of the elements driving sustainable purchasing decisions (Pamucar *et al.*, 2024).

Table 2. Criteria, sub-criteria and reference of authors

Criteria		**Sub-criteria**	**Reference**
Competitive intelligence		Competitor analysis Market trends Innovation Forecasting sustainable product	Olszak, (2014) Calof (2020) Linton, Yeomans (2003)
Green marketing		Recyclable packaging Reducing the carbon footprint Green and competitive pricing Commitment to social responsibility	Arnaud (2017) Carvalho *et al*. (2016) Ülkü, Hsuan (2017) Arroyave *et al*. (2021)
Green purchase intention		Positive green brand image Brand loyalty Customer environmental awareness Consumers' perceptions of the economic benefits of green products	Chen (2010) Gholamveisy *et al*. (2023) Hammami *et al*. (2018) Choshaly (2017)
Sustainability	Social	Diversity and inclusion Humanitarian projects: Education and empowerment of communities Creating a safe work environment	Roberson (2006) Joireman (2023) Mezirow (2007) Clarke *et al*. (2016)
	Economic	Innovation in products Sustainable supply chain management Financial transparency Creating value for the customer	Kanagal (2015) Seuring *et al*. (2008) Lowenstein (1996)
	Environmental	Reducing greenhouse gases in production Use of recycled materials Water resource management in production Renewable energy sources	Gholamveisy *et al*. (2024) Seif *et al*. (2024) Ahmed *et al*. (2024) Lamnatou *et al*. (2021)

Source: created by the authors.

One of the primary benefits of employing fuzzy modeling in this field lies in its capacity for effective analysis subjective and qualitative variables that influence decision-making related to green marketing. A study within the automotive industry highlights the significant contribution of FMCDM techniques in investigating various domains, such as choosing and evaluating green suppliers (Ghosh *et al.*, 2023). These implications signify that it is essential to develop a more appropriate overall framework that incorporates both the competitive intelligence, green marketing, and the green purchase intentions research streams. However, existing studies show that most prior research has primarily been based on traditional statistical analysis methods such as structural equation modeling (SEM) or regression analysis. In contrast, recent research shows that combining fuzzy methods with decision-making modeling can help improve the accuracy and predictability of models. In addition, the incorporation of competitive intelligence and digital green marketing is significant in order to enhance green purchase intention. This means that companies utilising analytical data to identify green customer behaviors are able to design more effective marketing campaigns and achieve greater impact. This combination can assist organisations in more optimally formulating their green marketing strategies and better examining how competitive intelligence influences the intention to engage in green purchasing.

The investigation of criteria presented in *Table 2*, which outlines the criteria, sub-criteria, and corresponding author references, provides a structured foundation for evaluating the key dimensions of the study. This integrated overview not only clarifies the analytical framework but also strengthens the methodological coherence of the research.

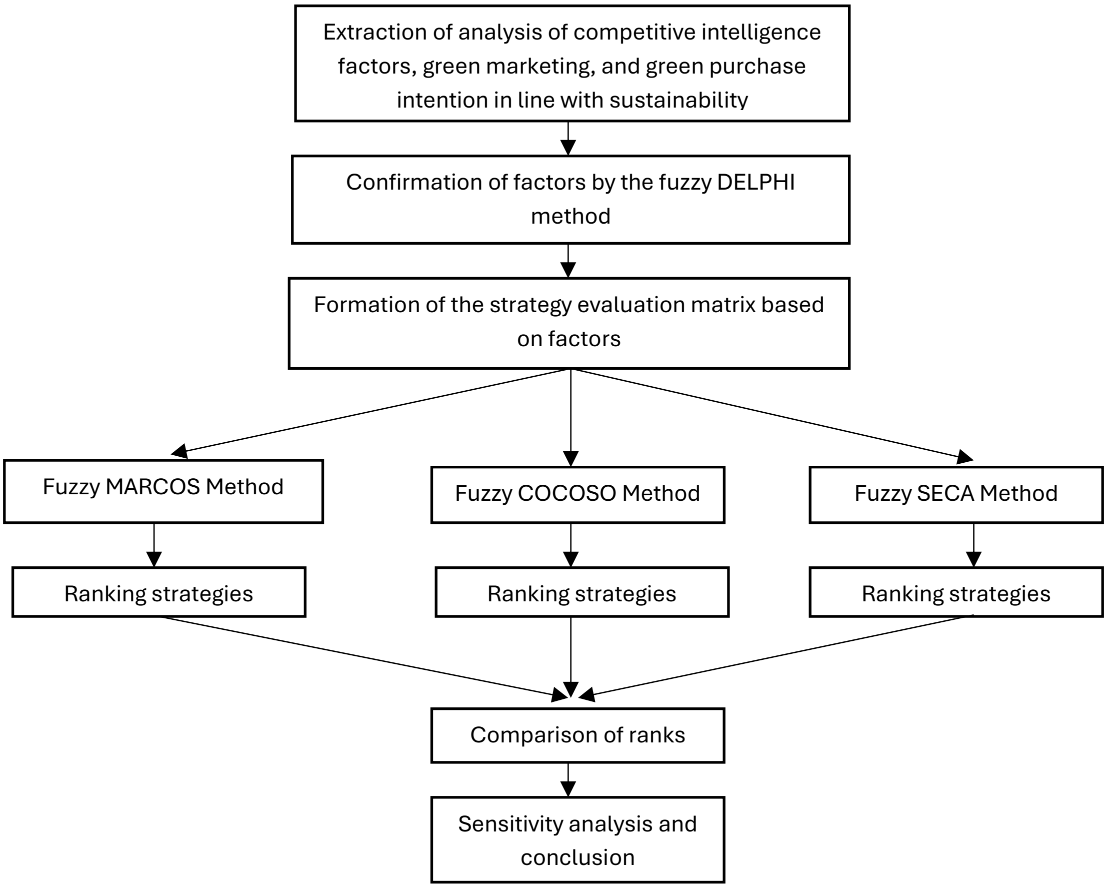
2. Methodology

The goal of the research is to rank strategic options/influencing factors according to the issues of competitive intelligence. Green marketing and the intention to purchase environmentally friendly products are closely linked to the concept of sustainability. The first phase consists of the identification and validation of influencing factors, which is achieved by using a fuzzy Delphi approach, which has been used widely for the identification, validation, or screening of factors (Keshavarz-Ghorabaee *et al.*, 2018; Markovich, 2019). Given that this problem is option-oriented, i.e. strategic options are to be ranked, option-based methods are employed.

In this study, three methods are utilised: fuzzy SECA, fuzzy COCOSO, and fuzzy MARCOS. To select ranking methods, two distinct approaches were considered. The first is based on mathematical optimisation models, whereas the second is based on non-optimisation models. Specifically, fuzzy SECA is grounded in an optimisation model, while fuzzy COCOSO and fuzzy MARCOS are based on non-optimisation models. The fuzzy MARCOS approach evaluates alternatives by calculating the distance ratio relative to ideal solutions, while the fuzzy COCOSO technique assesses options using a combination of weighted sum and product ratios. In this research, the fuzzy Delphi method was employed for screening purposes (Ebrahimi & Bridgelall, 2021), and was conducted in a single stage.

2.1 Data Set

The expert panel consisted of 10 senior managers and sustainability analysts from the fast-moving consumer goods (FMCG) sector that includes experts who had experience to compete at Procter and Gamble (P&G). All 10 of the experts provided background information which included at least 10 years of experience and a master's degree. In the options evaluation questionnaire, raw data from 10 experts was used to rate the strategies based on the criteria. The fuzzy Delphi calculations used the opinions of the same 10 experts to validate the screening factors.



Source: created by the authors.

Figure 1. **Conceptual Framework**

Figure 2 illustrates the step-by-step research methodology employed, reflecting the study's exploratory approach.

2.2 Fuzzy Delphi Method

The fuzzy Delphi approach is employed to assess and filter the research variables. The procedure for this method is detailed as follows (Eghbali *et al.*, 2023). First, research indicators are determined by thoroughly examining the theoretical underpinnings relevant to the study. Then the insights from decision-making specialists are gathered. Once the criteria have been established, a panel of experts relevant to the research subject is assembled to participate in the decision-making process, and linguistic variables presented in *Table 3* are used to express the importance of each indicator.

Table 3. Linguistic Terms and Fuzzy Delphi Values

Triangular fuzzy values	Language expressions
(0, 0.1, 0.3)	Very low
(0.1, 0.3, 0.5)	low
(0.3, 0.5, 0.7)	medium
(0.5, 0.7, 0.9)	high
(0.7, 0.9, 1)	Very high

Source: created by the authors.

Finally, the indicators are validated and screened. In the present research, a threshold value of 0.7 has been assumed (Eghbali *et al*. 2023). To achieve this, the initial step involves determining the triangular fuzzy values corresponding to the experts' opinions. Subsequently, in order to obtain the mean opinion from n respondents, the fuzzy average is computed according to the specified Equation 1 (Eghbali *et al*., 2023).

$$\tilde{a}_{ij} = \left(\min\,(l_{ij}), \frac{1}{n}\sum m_i\,, \max\,(u_{ij})\right), \quad i = 1,2,\dots,n \; j = 1,2,\dots,m \tag{1}$$

In the above relationship, 'i' indexes all the experts, while 'j' indexes all the multiple criteria for decision-making. In addition, the defuzzified value corresponding to the mean fuzzy number is determined using Equation 2.

$$Crisp = \frac{l_j + m_j + u_j}{3} \tag{2}$$

2.3 Fuzzy SECA Technique

A novel MCDM framework that integrates the SECA technique, fuzzy number theory, the α-cut approach, and the SMART method is introduced. In the suggested method, both the assessment of alternatives and the evaluation of criteria within an MCDM problem are conducted concurrently. The foundation of SECA methodologies lies in a deterministic multi-objective mathematical framework, which generates precise numerical weights for the objective criteria as well as anticipated performance values for the alternatives. However, the proposed way is acceptable under uncertainty and integrates the weights with some subjective criteria, which are derived from decision-makers' opinions, according to SMART (Keshavarz-Ghorabaee *et al*., 2018). In addition, the α-cut of fuzzy number provides time intervals in evaluation and analysis of the criteria and options (Ulutaş *et al*., 2021).

Step 1. Problem definition and identification using the judges' opinions. The MCDM problem is formulated by the decision-makers. Generally, it is necessary for each expert to define multiple alternatives and criteria. Active engagement and cooperation during this phase are essential to achieve a rational agreement regarding the problem's framework. Once a range of alternatives and criteria have been established, the final selection of validated options and criteria can be determined by identifying the shared elements among the perspectives of different decision-makers.

Step 2. Collection of preliminary assessments of criteria from all decision makers. Each expert in the decision-making group must conduct an initial evaluation of the criteria. To gather the experts' opinions, Likert scales, linguistic factors, and additional scoring methods can be used. Within the framework of the proposed methodology, assessments are conducted using a scale ranging from 0 to 10, where 0 represents the lowest level of importance and 10 signifies the highest level of importance for each criterion.

Step 3. Preliminary evaluation of how each option performs relative to the established criteria. At this stage, linguistic variables are employed to capture the perspectives of decision-makers regarding the effectiveness of each option. The strength of linguistic variables is that it allows a rather easy conversion into triangular fuzzy numbers which represent the assessment process involves a degree of uncertainty. In this context, the linguistic variables outlined in *Table 4* are utilised.

Table 4. Fuzzy Numbers and Linguistic Variables

Linguistic variables	Fuzzy value
Very Low	(1, 1, 3)
Low	(1, 3, 5)
Medium	(3, 5, 7)
High	(5, 7, 9)
Very High	(7, 9, 11)

Source: created by the authors.

Step 4. Determination of the weight of subjective criteria. When applying the SMART approach to determine the weights of subjective criteria, the evaluations provided by experts in *Step 3* are utilised. Let I_{jk} denote the significance or score assigned to the *j-th* criterion by decision-maker *k*. Subsequently, it is essential to utilise Equation (3) in order to determine the subjective weight assigned to each criterion (w_j^s).

$$w_j^s = \frac{\sum_k I_{jk}}{\sum_k \sum_j I_{jk}} \tag{3}$$

Step 5. Formation of the fuzzy decision matrix. Using *Table 1*, the evaluation of options against criteria is converted into fuzzy numbers. Input from multiple experts can be utilised, and their responses then combined using the arithmetic mean method.

Step 6. Formation of the interval matrix. In this section, the α-cut approach is utilised to derive an interval-based decision matrix. As stated earlier, $\widetilde{x_{ij}}$ denotes the elements within the fuzzy set. In this section, the α-cut method is applied to obtain an interval decision matrix. $\widetilde{x_{ij}}$ represents elements of the fuzzy decision matrix, which are defined as triangular fuzzy numbers $\tilde{x}_{ij} = (x_{ij}^l, x_{ij}^m, x_{ij}^u)$. Equation 4 is used to obtain the elements of the interval decision matrix.

$$(\tilde{A})_\alpha = [x_\alpha^L, x_\alpha^u] = [(m-l)\alpha + l, -(u-m)\alpha + u] \tag{4}$$

Step 7. Normalisation of the interval decision matrix. The interval matrix is standardised by applying Equation 5. Here, *BC* indicates criteria with a benefit nature, whereas *NC* indicates criteria with a cost nature.

$$x_{ij}^{N\propto} = \begin{cases} \left[\frac{x_{ij}^{L\propto}}{Ux_j}, \frac{x_{ij}^{U\propto}}{Ux_j}\right] if\ j \in BC \\ \left[\frac{Lx_j}{x_{ij}^{U\propto}}, \frac{Lx_j}{x_{ij}^{L\propto}}\right] if\ j \in NC \end{cases} \tag{5}$$

Step 8. Determation of the definite decision matrix. By applying Equation 4, the interval normal matrix is obtained, which is then converted into a definite matrix. In fact, the definitive matrix is obtained by calculating the mean of its lower and upper boundaries. According to Equation 6, the elements of this matrix are denoted as $x_{ij}^{C\alpha}$.

$$x_{ij}^{C\propto} = \frac{x_{ij}^{NL} + x_{ij}^{NU}}{2} \tag{6}$$

Step 9. Determination of the σ_j^C and values for each criterion. Two key parameters integral to the SECA method are computed. These calculations utilise the deterministic decision matrix obtained in *Step 8* and adhere to the same formulas as those employed in the original SECA approach. Specifically, Equations 7 and 8 are applied to establish these parameter values.

$$\sigma_j^C = \frac{\sigma_j}{\sum_l \sigma_l} \tag{7}$$

$$\pi_j^C = \frac{\pi_j}{\sum_l \pi_l} \tag{8}$$

In this sense, in Equation 5, the standard deviation for each column within the deterministic decision matrix is represented as σ_j, whereas in Equation 6, π_j is the scalar quantity that defines a difference between the specific criterion and the others. The values of $\pi_j v$ j are determined by evaluating the correlation between the *jth* and *lth* columns of the matrix, denoted as (r_{jl}), in accordance with Equation 9.

$$\pi_j = \sum_{l=1}^{m} (1 - r_{jl}) \tag{9}$$

Step 10. Formulation of two models using the SECA method. One mathematical model incorporates the lower bound, while the other model incorporates the upper bound of the interval decision matrix. Model number 10 is based on the lower bound. By solving this model, the values of the criteria weights and the scores of the options are obtained.

$$Max\ Z^L = \lambda_a^L - \beta(\lambda_b^L + \lambda_c^L + \lambda_d^L) \tag{10}$$

$$\lambda_a^L \leq S_i^L\ \forall i \in \{1,2,\dots,n\} \tag{10a}$$

$$s_i^U = \sum_{j=1}^{m} w_{j2} x_{ij}^{NU}\ \forall i \in \{1,2,\dots,n\} \tag{10b}$$

$$\lambda_b^L = \sum_{j=1}^{m} (w_{j1} - \sigma_j^C)^2 \tag{10c}$$

$$\lambda_c^L = \sum_{j=1}^{m} (w_{j1} - \pi_j^C)^2 \tag{10d}$$

$$\lambda_d^L = \sum_{j=1}^{m} (w_{j1} - w_j^s)^2 \tag{10e}$$

$$\sum_{j=1}^{m} w_{j1} = 1 \tag{10f}$$

$$w_{j1} \leq 1\ \forall i \in \{1,2,\dots,m\} \tag{10g}$$

$$w_{j1} \geq \varepsilon\ \forall i \in \{1,2,\dots,m\} \tag{10h}$$

2.4 The Fuzzy COCO Method

The fuzzy COCO approach is employed to prioritise research alternatives. The development of this method draws upon previous studies, especially those conducted by other researchers, such as Stanković *et al*. (2020). The following research steps are outlined.

Step 1. Formation of the decision matrix. Consider the following decision-making matrix, which represents the perspectives of the individuals involved.

$$\widetilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix} i = 1,2, \ldots, m;\ j = 1,2, \ldots, n$$

Each column corresponds to a selection criterion, and each row designates one option. The variable X_{ij} represents the pair between the *i-th* option and the *j-th* criterion. In this particular research, the evaluation of alternatives for each criterion was conducted using the linguistic terms and corresponding fuzzy numbers presented in *Table 1*.

Step 2. Normalisation of the decision matrix. Normalisation is a common procedure applied in nearly all MCDM approaches. Rsearchers should proceed by normalising the decision matrix, according to Equations 11 and 12. Equation 11 is used for criteria with a benefit nature, while Equation 12 is used for criteria with a cost nature.

$$\tilde{r}_{ij} = \left(r_{ij}^{l}, r_{ij}^{m}, r_{ij}^{u}\right) = \frac{\tilde{z}_{ij} - \min\left(\tilde{z}_{ij}\right)}{\max\left(\tilde{z}_{ij}\right) - \min\left(\tilde{z}_{ij}\right)} \quad (11)$$

$$\tilde{r}_{ij} = \left(r_{ij}^{l}, r_{ij}^{m}, r_{ij}^{u}\right) = \frac{\max\left(\tilde{z}_{ij}\right) - \tilde{z}_{ij}}{\max\left(\tilde{z}_{ij}\right) - \min\left(\tilde{z}_{ij}\right)} \quad (12)$$

Step 3. Calculatio of the weighted sum and weighted product values. This step involves the computation of weighted sum (S) and weighted power (P) values for each option, based on Equations 13 and 14. In this set of equations, *Wj* represents the weight of the criterion, which in this study was calculated using the fuzzy SECA method and is part of the input to the fuzzy COCOSO method.

$$\tilde{S}_{ij} = \left(S_{ij}^{l}, S_{ij}^{m}, S_{ij}^{u}\right) = \sum_{j=1}^{n} \widetilde{W}_{jc}\tilde{r}_{ij} \quad (13)$$

$$\tilde{P}_{ij} = \left(P_{ij}^{l}, P_{ij}^{m}, P_{ij}^{u}\right) = \sum_{j=1}^{n} \left(\tilde{r}_{ij}\right)^{\widetilde{W}_{jc}} \quad (14)$$

Step 4. Determination of the evaluation score of options based on three strategies. The scores of the alternatives are derived using three different approaches to create Equations 15 to 17. In Equation 15, the WSM and WPM scores are considered together as their arithmetic mean. Equation 16 captures the relative scores of WSM and WPM using other preferential approaches to the best alternatives, and Equation 17 is considered as a compromise between the WSM and WPM approaches. In this case, λ is chosen by the decision maker and offers a large degree of flexibility within the limits of 0.5.

$$k_{ia} = \frac{\tilde{P}_i + \tilde{S}_i}{\sum_{i=1}^{m}(\tilde{P}_i + \tilde{S}_i)} \quad (15)$$

$$k_{ib} = \frac{\tilde{S}_i}{\min(\tilde{S}_i)} + \frac{\tilde{P}_{i_i}}{\min(\tilde{P}_i)} \quad (16)$$

$$k_{ic} = \frac{\lambda\tilde{S}_i + (1-\lambda)\tilde{P}_i}{\lambda\max(\tilde{S}_i) + (1-\lambda)\max(\tilde{P}_i)}; 0 \le \lambda \le 1 \quad (17)$$

Step 5. Defuzzification of k_{ia} ، k_{ib} و k_{ic}. In this step, using Equations 18– 20, the fuzzy values obtained in *Step 4* are subjected to defuzzification.

$$k_{ia} = \frac{k_{ia}^{l} + k_{ia}^{m} + k_{ia}^{u}}{3} \quad (18)$$

$$k_{ib} = \frac{k_{ib}^{l} + k_{ib}^{m} + k_{ib}^{u}}{3} \quad (19)$$

$$k_{ic} = \frac{k_{ic}^{l} + k_{ic}^{m} + k_{ic}^{u}}{3} \quad (20)$$

Step 6. Determination of the final score and ordering the options. The final score, according to Equation 21, is presented. It is a sum of the geometric mean and the arithmetic mean of three strategies from the preceding step. Accordingly, a higher score (k) indicates superiority for that option.

$$k_i = (k_{ia}k_{ib}k_{ic})^{1/3} + \frac{1}{3}(k_{ia} + k_{ib} + k_{ic}) \quad (21)$$

The Marcus fuzzy method is used for ranking research options.

The following outlines the steps involved in this method (Majeed *et al.*, 2022).

Step 1. Creation of an initial fuzzy decision matrix. MCDM approaches involve identifying a group of *n* criteria and *m* alternatives.

Step 2. Creation of a generalised initial fuzzy matrix. This generalisation involves identifying the anti-ideal fuzzy solution Ã (AI) and the ideal fuzzy solution Ã (ID) in accordance with Equation 22.

$$\tilde{X} = \begin{matrix} \tilde{A}(AI) \\ \widetilde{A_1} \\ \tilde{A}_2 \\ \dots \\ \tilde{A}_m \\ \tilde{A}_{(ID)} \end{matrix} \begin{bmatrix} \tilde{x}_{ai1} & \tilde{x}_{id2} & & \tilde{x}_{ain} \\ \tilde{x}_{11} & \tilde{x}_{12} & \vdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \dots & \tilde{x}_{2n} \\ \dots & \dots & \vdots & \dots \\ \tilde{x}_{m1} & \tilde{x}_{22} & \dots & \tilde{x}_{mn} \\ \tilde{x}_{id1} & \tilde{x}_{id2} & & \tilde{x}_{idm} \end{bmatrix} \quad (22)$$

Fuzzy A ̃(AI) represents the least favourable option, whereas fuzzy A ̃(ID) demonstrates the highest level of performance among the alternatives. The definitions of A ̃(AI) and A ̃(ID) vary according to the criterion type and are established based on Equations 23 and 24.

$$\tilde{A}(AI) = \min_i \tilde{x}_{ij} \ if \ j \in B \ and \ \max_i \tilde{x}_{ij} \ if \ j \in C \quad (23)$$

$$\tilde{A}(ID) = \min_i \tilde{x}_{ij} \ if \ j \in B \ and \ \max_i \tilde{x}_{ij} \ if \ j \in C \quad (24)$$

Step 3. Creation of a normalised fuzzy matrix = $[\widetilde{n_{ij}}]$ *m×m N* ,̃ which is obtained using Equations 25 and 26:

$$\tilde{n}_{ij} = (n_{ij}^l, n_{ij}^m, n_{ij}^u) = \left(\frac{x_{id}^l}{x_{ij}^u}, \frac{x_{id}^l}{x_{ij}^m}, \frac{x_{id}^l}{x_{ij}^l}\right) if \ j \in C \quad (25)$$

$$\tilde{n}_{ij} = (n_{ij}^l, n_{ij}^m, n_{ij}^u) = \left(\frac{x_{id}^l}{x_{ij}^u}, \frac{x_{id}^m}{x_{ij}^u}, \frac{x_{id}^u}{x_{ij}^u}\right) if \ j \in B \quad (26)$$

In these equations, the elements x_{ij}^l، x_{ij}^m، x_{ij}^u و x_{id}^l، x_{id}^m، x_{id}^u represent the elements of the matrix X ̃.

Step 4. Determination of the weighted fuzzy matrix V ̃. The weighted fuzzy matrix (V) ̃is obtained by performing a multiplication of the normalised matrix N ̃with the fuzzy weight coefficients assigned to each criterion, denoted as *w ̃j*, as described in Equation 27.

$$\tilde{v}_{ij} = (v_{ij}^l, v_{ij}^m, v_{ij}^u) = \tilde{n}_{ij} \otimes \tilde{w}_j = (n_{ij}^l \times w_j^l, n_{ij}^m \times w_j^m, n_{ij}^u \times w_j^u) \quad (27)$$

Step 5. Computation of the fuzzy matrix $\widetilde{S}_i$, according to Equation 28.

$$\tilde{S}_i = \sum_{i=1}^{n} \widetilde{v_{ij}} \quad (28)$$

In this relation, $\tilde{S}_i\ (s_i^l, s_i^m, s_i^u)$ denotes the aggregate of the components within the weighted fuzzy matrix $\tilde{V}$.

Step 6. Determination of the desirability level for each alternative option $\widetilde{K}_i$ *by applying Equations 29 and 30.*

$$\widetilde{K}_i^- = \frac{\tilde{S}_i}{\tilde{S}_{ai}} = \left(\frac{s_i^l}{s_{ia}^u}, \frac{s_i^m}{s_{ai}^m}, \frac{s_i^u}{s_{ai}^l}\right) \quad (29)$$

$$\widetilde{K}_i^+ = \frac{\tilde{S}_i}{\tilde{S}_{ai}} = \left(\frac{s_i^l}{s_{ia}^u}, \frac{s_i^m}{s_{ai}^m}, \frac{s_i^u}{s_{ai}^l}\right) \quad (30)$$

Step 7. Determination of the fuzzy matrix $\tilde{T}$ *by applying Equation 31.*

$$\tilde{T}_i = \tilde{t}_i = (t_i^l, t_i^m, t_i^u) = \widetilde{K}_i^- \oplus \widetilde{K}_i^+ = (k_i^{-l} + k_i^{-l}, k_i^{-m} + k_i^{+m}, k_i^{-u} + k_i^{+u}) \quad (31)$$

Then, using Equation 32, the determination of a new fuzzy number $\widetilde{D}$ is performed.

$$\widetilde{D} = (d^l, d^m, d^u) = \max_i \tilde{t}_{ij} \quad (32)$$

Subsequently, by applying the formula $=\frac{1+4m+u}{6}\ df_{crisp}v$, the fuzzy number ($\widetilde{D}$) is converted into a crisp value, denoted as *df_crisp*.

Step 8 involves calculating the utility functions with respect to both the ideal solution ($\widetilde{K_i^+}$) f and the anti-ideal solution ($\widetilde{K_i^-}$) f, utilising Equations 33 and 34.

$$f(\widetilde{K}_i^+) = \frac{\widetilde{K}_i^-}{df_{crisp}} = \left(\frac{k_i^{-l}}{df_{crisp}}, \frac{k_i^{-m}}{df_{crisp}}, \frac{k_i^{-u}}{df_{crisp}}\right) \tag{33}$$

$$f(\widetilde{K}_i^-) = \frac{\widetilde{K}_i^+}{df_{crisp}} = \left(\frac{k_i^{+l}}{df_{crisp}}, \frac{k_i^{+m}}{df_{crisp}}, \frac{k_i^{+u}}{df_{crisp}}\right) \tag{34}$$

After that, one must perform phase-out for $\widetilde{K_i^+}, \widetilde{K_i^-}, f(\widetilde{K_i^+}), f(\widetilde{K_i^-})$ and apply *Step* 9, which refers to the determination of the utility function of alternatives fK_i by using Equation 35.

$$f(K_i) = \frac{\widetilde{K_i^+} + \widetilde{K_i^-}}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}}; \tag{35}$$

Step 10. Arrangement of the alternatives according to the final calculated values of their utility functions. Ideally, the preferred option is the one that achieves the maximum utility function value.

2.5 Introduction of Research Factors

Table 1 presents the factors related to competitive intelligence, green marketing, and green purchase intention in the context of sustainability, which were identified through a review of relevant literature and previous research. These factors were assessed utilising the fuzzy Delphi technique.

Table 5. Criteria and Sub-Criteria

Criteria	Sub Criteria	Code	Fuzzy score	Crisp Score	result
Competitive intelligence	Competitor analysis	**A1**	(0.5,0.86,1)	0.787	Accept
	Market trends	**A2**	(0.3,0.84,1)	0.713	Accept
	Innovation	**A3**	(0.5,0.84,1)	0.780	Accept
	Forecasting sustainable product	**A4**	(0.5,0.86,1)	0.787	Accept
Green marketing	Recyclable packaging	**B1**	(0.5,0.82,1)	0.773	Accept
	Reducing the carbon footprint	**B2**	(0.3,0.8,1)	0.700	Accept
	Green and competitive pricing	**B3**	(0.5,0.82,1)	0.773	Accept
	Commitment to social responsibility	**B4**	(0.3,0.86,1)	0.720	Accept

Table 5 (*continuation*). Criteria and Sub-Criteria

Criteria	Sub Criteria		Code	Fuzzy score	Crisp Score	result
Green purchase intention	Positive green brand image		**C1**	(0.3,0.84,1)	0.713	Accept
	Brand loyalty		**C2**	(0.3,0.82,1)	0.707	Accept
	Customer environmental awareness		**C3**	(0.5,0.82,1)	0.773	Accept
	Consumers' perceptions of the economic benefits of green products		**C4**	(0.3,0.8,1)	0.700	Accept
Sustainability	Social	Diversity and inclusion	**D11**	(0.5,0.84,1)	0.780	Accept
		Humanitarian projects	**D12**	(0.5,0.86,1)	0.787	Accept
		Education and empowerment of communities	**D13**	(0.3,0.82,1)	0.707	Accept
		Creating a safe work environment	**D14**	(0.5,0.86,1)	0.787	Accept
	Economic	Innovation in products	**D21**	(0.5,0.88,1)	0.793	Accept
		Sustainable supply chain management	**D22**	(0.5,0.84,1)	0.780	Accept
		Financial transparency	**D23**	(0.5,0.9,1)	0.800	Accept
		Creating value for the customer	**D24**	(0.5,0.86,1)	0.787	Accept
	Environment	Reducing greenhouse gases in production	**D31**	(0.3,0.82,1)	0.707	Accept
		Use of recycled materials	**D32**	(0.5,0.82,1)	0.773	Accept
		Water resource management in production	**D33**	(0.3,0.84,1)	0.713	Accept
		Renewable energy sources	**D34**	(0.3,0.86,1)	0.720	Accept

Source: created by the authors.

The findings confirm the validity of all identified factors. The criteria and their corresponding sub-criteria are detailed in *Table 5*.

3. Results

Initially, the fuzzy decision matrix is developed based on evaluations provided by ten experts, using the fuzzy scale presented in *Table 1*. The distance matrix itself is then constructed according to Equation 4 and presented in *Table 2*, which has more information in the columns pertaining to the 24 research sub-criteria and options ranging from 1 to 4 in the rows. Subsequently, based on Equations 3, 7, and 8, the values of σj, π_j, and Wj are presented in *Table 6*.

Table 6. Normal Interval Matrix

	A1	A2	....	D31	D32	D33	D34
S1	[3.8,5.6]	[4.6,6.4]	....	[2,3.6]	[6.2,8.2]	[3.9,5.8]	[3.3,5]
S2	[3.6,5.2]	[5.2,7.2]	....	[3.4,5.2]	[4.5,6.2]	[3.9,5.6]	[3.3,5.2]
S3	[3.1,4.8]	[3.8,5.6]	....	[5,6.8]	[5.8,7.8]	[6.6,8.6]	[4.2,6]
S4	[5,6.8]	[4.6,6.4]	....	[6.4,8.4]	[7,9]	[6,8]	[3.7,5.4]

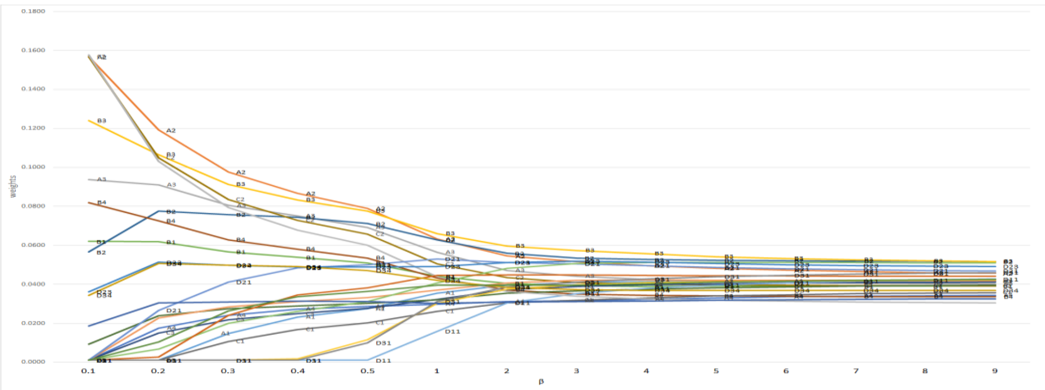
Source: created by the authors.

Table 7. Value of σ_j، π_j و W_j

	σ_j	π_j	W_j
A1	0.0365	0.0344	0.0578
A2	0.0254	0.0536	0.0506
A3	0.0351	0.0420	0.0405
A4	0.0379	0.0351	0.0376
...	...	...	...
D31	0.0705	0.0373	0.0405
D32	0.0367	0.0314	0.0347
D33	0.0507	0.0381	0.0462
D34	0.0212	0.0440	0.0477

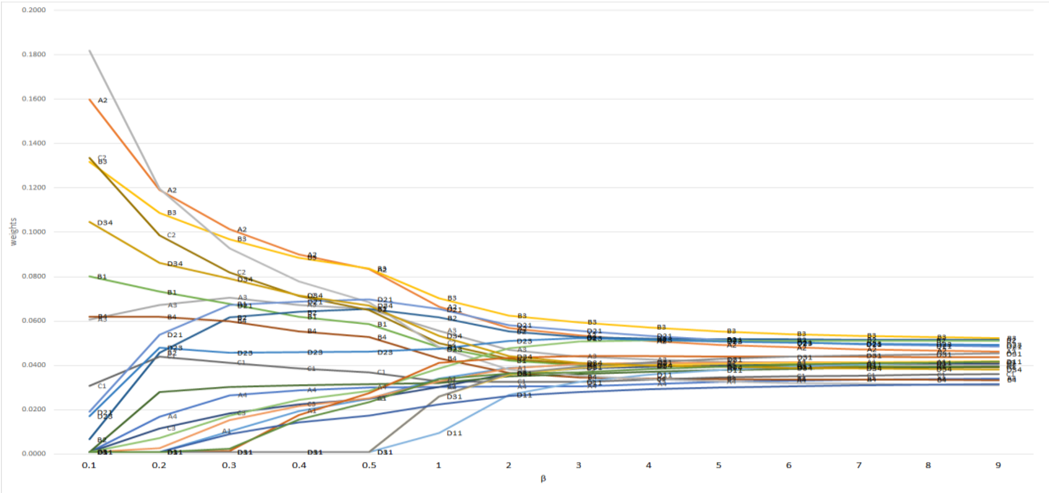
Source: created by the authors.

Using Equation 10, a nonlinear optimisation model was developed and solved with Lingo software. In this model, experiments were conducted for the parameter beta values from 0.1 to 9. During each run, weights for all criteria and scores for all alternatives were obtained accordingly. The weights of the criteria (C) and the scores of the options (S) for various β values are presented in *Figures 2–5*, respectively. Accordingly, convergence was achieved at β ≥ 6, so at β = 6. *Table 7* illustrates how the criteria weights and option scores can be extracted. Based on this, the option 'Investing in green innovation: Developing new products with sustainable features (S4)' was first. The second and third options were 'Supply chain transparency: optimising the supply chain and reducing environmental impacts (S1)', and 'Reducing resource consumption: improving production processes and reducing energy and raw material consumption (S3)'.



Source: created by the authors.

Figure 2. **Changes in Lower Bound (L) Criteria Weights for Different β Values**



Source: created by the authors.

Figure 3. **Changes in Upper Bound (U) Criteria Weights for Different β Values**

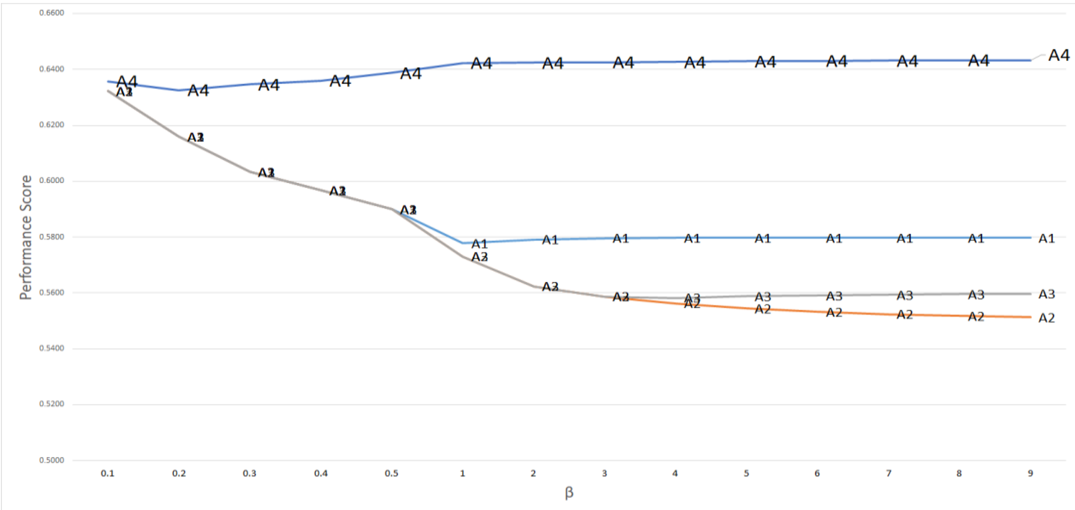


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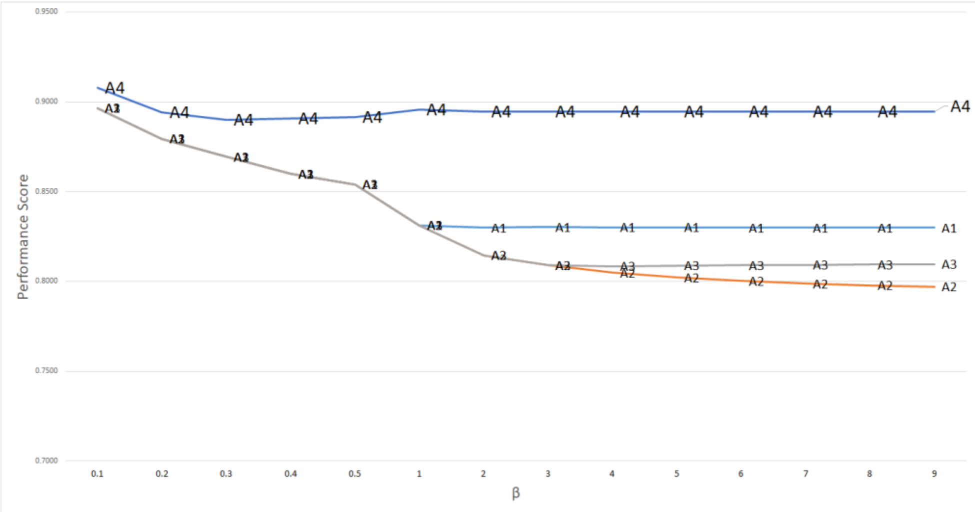
Figure 4. **Lower Bound (L) Variations of Alternative Scores for Different β Values**



Source: created by the authors.

Figure 5. **Lower Bound (L) Variations of Alternative Scores for Different β Values**

Table 8. Final Scores and Rankings of Criteria and Alternative

Alternative					
Name	Code	Interval Weight	Crisp Weight		Rank
Supply chain transparency: Optimising the supply chain and reducing environmental impacts	**S1**	[0.58,0.83]	0.7048		2
Focused advertising for green values: Raising customer awareness of sustainable products	**S2**	[0.553,0.8]	0.6767		4
Reducing resource consumption: Improving production processes and reducing energy and raw material consumption	**S3**	[0.559,0.809]	0.6841		3
Investing in green innovation: Developing new products with sustainable features	**S4**	[0.643,0.895]	0.7688		1
Competitor analysis	**A1**	[0.041,0.042]	0.0415		10
Market trends	**A2**	[0.047,0.048]	0.0477		6
Innovation	**A3**	[0.041,0.041]	0.0412		12
Forecasting sustainable product	**A4**	[0.033,0.034]	0.0333		22
Recyclable packaging	**B1**	[0.039,0.04]	0.0393		17
Reducing the carbon footprint	**B2**	[0.052,0.052]	0.0519		2
Green and competitive pricing	**B3**	[0.053,0.054]	0.0537		1
Commitment to social responsibility	**B4**	[0.034,0.034]	0.0337		21
Positive green brand image	**C1**	[0.035,0.035]	0.0349		20
Brand loyalty	**C2**	[0.039,0.04]	0.0395		16
Customer environmental awareness	**C3**	[0.04,0.041]	0.0405		14
Consumers' perceptions of the economic benefits of green products	**C4**	[0.039,0.039]	0.0386		18
Diversity and inclusion	**D11**	[0.039,0.041]	0.0401		15
Humanitarian projects	**D12**	[0.041,0.042]	0.0417		9
Education and empowerment of communities	**D13**	[0.031,0.032]	0.0318		23
Creating a safe work environment	**D14**	[0.041,0.042]	0.0414		11
Innovation in products	**D21**	[0.048,0.05]	0.0492		5
Sustainable supply chain management	**D22**	[0.051,0.051]	0.0511		3
Financial transparency	**D23**	[0.05,0.05]	0.0502		4
Creating value for the customer	**D24**	[0.044,0.044]	0.0441		8

Table 8 (*continuation*). Final Scores and Rankings of Criteria and Alternative

Criteria					
Name	Code	Interval Weight	Crisp Weight		Rank
Reducing greenhouse gases in production	**D31**	[0.044,0.045]	0.0443		7
Use of recycled materials	**D32**	[0.031,0.032]	0.0314		24
Water resource management in production	**D33**	[0.04,0.042]	0.0410		13
Renewable energy sources	**D34**	[0.037,0.039]	0.0379		19

Source: created by the authors.

3.1 Validation

The alternates are rearranged through the fuzzy SECA method with respect to the validations done by fuzzy COCOSO and fuzzy MARCOS methods. The summary of fuzzy COCOSO results in *Table 6* suggests that the highest rank was assigned to option S4, 'Investing in green innovation: Developing new products with sustainable features'. Options S1 and S3 were ranked second and third, respectively. *Table 9* illustrates the results obtained by means of the fuzzy MARCOS method, which also indicates that the ranking of alternatives closely follows that obtained through fuzzy COCOSO and fuzzy SECA. It could be concluded that the ranking of alternatives through all the methods is consistent, as based on *Figure 6*.

Table 9. Final Scores and Rankings of the Options as Decided by the Fuzzy COCOSO Method

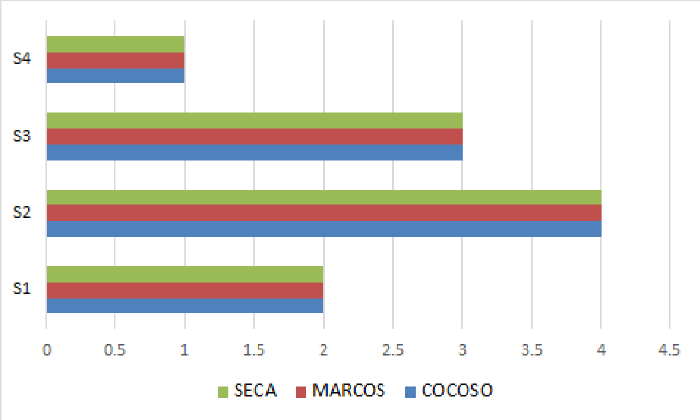
	K_a^{fuzzy}	K_b^{fuzzy}	K_c^{fuzzy}	$K_a^{defuzzy}$	$K_b^{defuzzy}$	$K_c^{defuzzy}$	K	Rank
S1	(0.164,0.25,0.365)	(2.464,5.094,7.581)	(0.651,0.955,0.993)	0.260	5.046	0.866	3.101	2
S2	(0.134,0.248,0.364)	(2,4.748,7.237)	(0.531,0.95,0.989)	0.249	4.662	0.823	2.896	4
S3	(0.164,0.249,0.365)	(2.309,4.932,7.42)	(0.651,0.952,0.991)	0.259	4.887	0.865	3.035	3
S4	(0.223,0.253,0.368)	(3.433,5.65,8.131)	(0.884,0.966,1)	0.281	5.738	0.950	3.476	1

Source: created by the authors.

Table 10. Final Scores and Rankings of the Alternative in the Fuzzy MARCOS Method

	K^-	K^+	$f(K^-)$	$f(K^+)$	F(k)	rank
S1	1.473	0.862	0.332	0.567	0.489	2
S2	1.396	0.816	0.314	0.537	0.438	4
S3	1.432	0.837	0.322	0.551	0.461	3
S4	1.638	0.960	0.369	0.631	0.605	1

Source: created by the authors.



Source: created by the authors.

Figure 6. **Comparing the Rankings of the Alternative**

As illustrated by *Figure 6*, the evaluation of process began with the fuzzy SECA approach to prioritise the strategic alternatives. To determine the strength and reliability of the results, additional methods were utilised; fuzzy COCOSO and fuzzy MARCOS methods were applied for cross-validation. The findings of all three models agreed and showed consistency, indicating that the ranking of the strategies remained consistent by applying different computational in all cases. For instance, strategy S4 'Investing in green innovation' secured the highest rank.

This alignment of rankings across parallel methods, along with the findings derived from the suggested models' stability and reliability, are validated by the sensitivity analysis. The sensitivity analysis across five weighting situations again verified the robustness of the ranking. S4 secured the top position in four out of the five evaluated alternative scenarios. This ranking is attributed to specific criteria that significantly impact its assessment; it appears that S4 is led by high-weight criteria such as 'green and competitive price' (B3), 'reducing carbon footprint' (B2), and 'financial transparency' (D23). These criteria had the highest crisp weights in the model establishment (B3 = 0.0537, B2 = 0.0519, D23 = 0.0502) and can be characterised with respect to the features of green innovation strategies. S4 did score well in terms of these particular sub-criteria, thus explaining why it was leading.

In contrast, S2 'focused green advertising' and other options (e.g., S14) had lower overall total scores because of its overall performance on the high-weighted criteria. More importantly, it hhas stronger association with low-weight sub-criteria related to 'brand loyalty' or 'environmental awareness'. The findings imply that strategies related to environmental impact, cost-effectiveness, and transparency, have the greatest potential to shape sustainable strategic priorities. Thus, pursuing green innovation not only appears to be efficient from a ranking perspective, but most proportionately aligns with 'high' sustainability drivers, making it a strategic lever for firms pursuing competitive advantage in the long-term.

To statistically confirm the convergence of rankings among the three FMCDM methods (SECA, COCOSO, and MARCOS), Kendall's coefficient of concordance (W) was determined. The value of Kendall's W = 0.93 indicates a very high level of agreement among the methods. Additionally, Spearman's rank correlation coefficients were computed between the models:

SECA vs COCOSO: ρ = 0.94;

SECA vs MARCOS: ρ = 0.91;

COCOSO vs MARCOS: ρ = 0.95.

All correlation coefficients demonstrated statistical significance ($p < 0.01$), indicating a high degree of reliability in the rankings across the employed models. The statistical confirmation provides sufficient evidence for the reliability, robustness, and internal consistency of a decision-making framework.

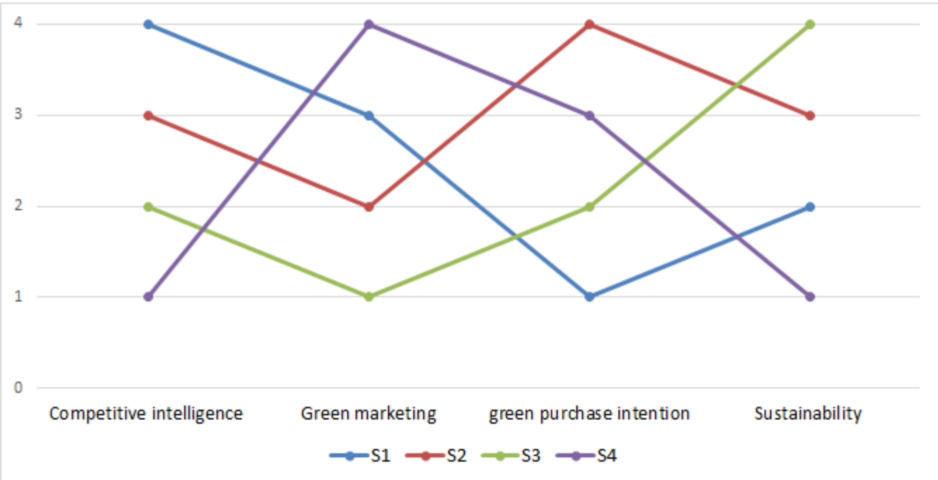
Table 11. Comparing the Rankings of the Alternative

Strategy	SECA Score	COCOSO Score	MARCOS Score
S1	0.47	0.50	0.49
S2	0.42	0.43	0.44
S3	0.51	0.52	0.50
S4	0.58	0.59	0.61

Source: created by the authors.

3.2 Sensitivity Analysis

The sensivity analysis carried out through two distinct methods is provided. First, the ranking of options is determined for each main criterion. Then, the stability and ranking of the options are examined by varying the importance assigned to each criterion. *Figure 7* presents the ranking of alternatives according to each primary criterion. Accordingly, regarding the two criteria of *competitive intelligence* and *sustainability*, the option 'Investing in green innovation: Developing new products with sustainable features (S4)' holds the first rank. For the *green marketing* criterion, the option 'Reducing resource consumption: Improving production processes and reducing energy and raw material consumption (S3)' secures the top position. Additionally, for the *green purchase intention* criterion, the option 'Supply chain transparency: Optimising the supply chain and reducing environmental impacts (S1)' is ranked first.

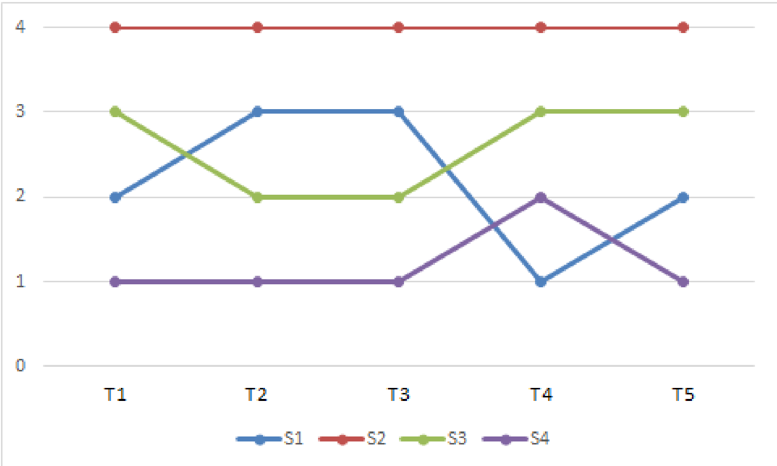


Source: created by the authors.

Figure 7. **Rankings of the Alternative by Criteria**

Figure 8 presents the ranking of options across five scenarios involving changes in criterion weights. These five scenarios are defined below:

- T1 = Equal weighting for all criteria.
- T2 = All other criteria's weights have not altered; however, the sub-criterion *competitive intelligence* now has a higher weight.
- T3 = The weights for all other criteria have not changed, but the weight given to the sub-criterion *green marketing* has been raised.
- T4 = While the weights of the other criteria stayed the same, the sub-criterion Green *purchase intention* was given more weight.
- T5 = The weights for all other criteria stayed the same, but the weight given to the sub-criterion *sustainability* was raised.



Source: created by the authors.

Figure 8. **Rankings of the Alternative Relative to Scenarios of Changing Criteria Weights**

As shown in *Figure 7* and *Figure 8*, the alternative 'Investing in Green Innovation: Developing New Products with Sustainable Features (S4)' was the priority in scenarios T1, T2, T3, and T5. This means that when all criteria are weighted equally, implying that each criterion in the model holds the same importance, or when the weight of any sub-criterion within competitive intelligence, green marketing, or sustainability increases, the option 'Investing in Green Innovation: Developing New Products with Sustainable Features (S4)' remains the top choice. In contrast, when the weight of the sub-criterion 'Green Purchase Intention' increases (scenario T4), the option 'Supply Chain Transparency: Optimising the Supply Chain and Reducing Environmental Impacts (S1)' becomes the highest-ranked. In addition, the alternative 'Targeted Advertising for Green Values: Increasing Customer Awareness of Sustainable Products (S2)' ranked last (fourth) in all scenarios.

3.3 Answers to Research Questions

Answer to RQ1. The study employed a structured hybrid FMCDM framework that integrates SECA, COCOSO and MARCOS methods to analyse and rank sustainability strategies. The fuzzy Delphi method was first used to validate 24 sub-criteria across four main constructs. The SECA model then provided a cohesive framework for decision-making by simultaneously evaluating the performance levels of the alternatives and the criteria weights. The robustness of the rankings was verified via two parallel FMCDM models and sensitivity analysis.

Answer to RQ2. Among the 24 validated criteria, 'green and competitive pricing' (B3), 'reducing the carbon footprint' (B2), and 'financial transparency' (D23) were assigned the highest weights, suggesting their dominant influence in sustainability-oriented strategy selection. These findings suggest that a pricing strategy, environmental performance, and accountability mechanisms are the most significant influence on green strategic decisions.

Answer to RQ3. The findings indicated that S4 (investment within green innovation) was ranked as the number one strategic alternative among the three fuzzy methods. This strategy aligns well with the weighted criteria and performance in the environmental and economic dimension. The validation of the strategy across all methods and scenarios confirms that it is the primary component of sustainable development planning.

4. Discussion

In the context of sustainability, this research was conducted to develop an integrated model utilising FMCDM methods to examine competitive intelligence, green marketing, and the intention to make environmentally friendly purchases. The fuzzy Delphi approach was used to identify and categorise this sector into four primary aspects: competitive intelligence, green marketing, green purchase intention, and sustainability. The classification has delivered valuable insight into sustainability-related corporate strategy evaluation and development. Chung (2020) showed that green marketing strategies favourably affect purchase intention by enhancing brand image and increasing consumers' environmental awareness, validating this result as lying in line with the current work which evidences the benefits of green marketing on green purchase intention. Furthermore, Wang *et al*. (2022) also demonstrated that green marketing orientation can lead to sustainable development in green food consumption, which echoes the finding of the study-the impact of green marketing on sustainable development. The studies focusing on the role of green strategies in enhancing sustainable consumption form the reason for their being similar.

Four strategic alternatives were introduced and analysed using the fuzzy SECA method: supply chain transparency (S1), green values-centered marketing strategies (S2), reduction of resource consumption (S3), and investment in green innovation (S4). The rank obtained from this analysis indicated that, both ranked first, investment in green innovations would be the most effective strategy for attaining sustainability goals and adding value to the company. Further, supply chain transparency (S1) and reduction of resource consumption (S3) were in second and third place. This indicates the importance of two other key aspects in sustainability strategies, one of which is improving transparency and trust in the supply chain. This approach enhances brand reputation and fosters customer loyalty, while simultaneously decreasing the use of energy and raw materials, which is essential for minimising costs and mitigating environmental effects.

To validate the substantiation of the results, evaluations were also conducted with fuzzy COCOSO and fuzzy MARCOS approaches. The validation process demonstrated that all three methods produced an identical final ranking of the options, and once again, investments in green innovation (S4) were ranked first. This issue demonstrates the strength of the proposed model and its consistency with the aims of the research.

In addition, to determine how changes in the criteria weights affect the ranking results, sensitivity analysis was carried out. This evaluation encompassed five distinct scenarios, each involving separate adjustments to the significance assigned to the main criteria. The results showed that the option of investment in green innovation (S4) remained in first place in four out of five scenarios. Only in the scenario where the weight of criteria related to green purchase intention was increased did the first choice is supply chain transparency (S1). The sensitivity analysis was conducted under five different weighting scenarios (T1–T5), each emphasising a particular main criterion. The resultsreveal that S4 (green innovation) remained the top-ranked strategy in four out of five scenarios, indicating strong stability and dominance across a wide range of evaluation perspectives. However, under T4, when the weight of green purchasing intention (GPI) criteria was elevated, S1 (supply chain transparency) was ranked first.

This transition indicates that user-oriented factors such as brand trust, green perception, and eco-focused behaviours are more closely linked to supply chain transparency, as compared to innovation initiatives. Besides, as the importance of the sustainability dimension increased (scenario T5), the ranking of S3 (resource consumption reduction) improved. This indicates that S3 is more closely linked with direct environmental effects (i.e., emissions, energy consumption), making it more of an option under sustainability-based conditions.

These patterns demonstrate that different strategic alternatives respond differently to shifts in evaluation priorities. While S4 is durable in the various circumstances, S1 and S3 can exhibit advantages against an environmental perspective or a consumer driven perspective, respectively. This highlights the importance of context-specific strategy alignment in sustainability decision-making.

Procter & Gamble (P&G) is a prominent producer of consumer goods and is recognised globally as one of the leading companies in the industry. P&G continues having significant impact on global sustainability practices and marketing practices. The results from this study show that ecological innovation (S4) investments become very critical for multinational firms like P&G and open a new avenue towards improved market competitiveness and its brand reputation. Through the insights gained from the research, P&G can shift their attention to create greener products, only with new characteristics. This process not only reduces damage to the environment, but also reinforces eco-friendly values in the minds of consumers leading them to view P&G as a positive and responsible brand.

Conclusions

Green innovation as a source of competitive advantage. For P&G, adopting green innovation could mean developing sustainable products, e.g. packaging that uses recycled materials or uses renewable energy sources. These efforts would generally respond to global efforts on environmental, sustainability and access/removal/sanitation agendas; and could help enhance the company's size of market share for green goods.

Supply chain transparency to build customer trust. The results of this research can be utilised by P&G to improve supply chain transparency (S1). This can build more trust with customers, and improve the brand equity in locations were consumer are more concerned with environmental matters.

Reducing resource consumption and optimising processes. The option to reduce resource consumption (S3), which ranked third, can be introduced to P&G as an effective strategy for lowering production costs and improving efficiency. By optimising production processes and decreasing energy and raw material use, By doing so, the company is able to minimise its environmental footprint while simultaneously enhancing its profitability.

Creating differentiation using green marketing. Although the option for marketing that focuses on green values (S2) did not rank highly, P&G may seek green marketing as a means to inform consumers on its sustainability achievements, thereby increasing customer awareness and raising demand for sustainable products.

The findings of this research carry considerable implications for theoretical frameworks as well as a range of practical applications in the areas of green marketing, competitive intelligence, and sustainability. From a theoretical perspective, the model includes FMCDM approach in competitive intelligence analysis, green marketing, and green purchasing intentions. SECA, COCOSO and MARCOS in fuzzy environment represent a suitable framework for addressing uncertainty and complexity in sustainability decision-making. The proposed hybrid model adds to existing research on sustainability and competitive intelligence, and green marketing by sharing an empirical calibration of sophisticated analysis tools that connect qualitative consumer behaviour and quantitative strategic direction, thereby deepening our knowledge of intersecting discourses a relationship in which these reporting behaviours participate actively in defining forms of sustainable development.

The confirmation of all the existing elements by fuzzy Delphi technique also corroborates the significance of competitive intelligence due to the fact that current research emphasises competitive intelligence as an essential component of success for increasing the efficacy of green marketing and its importance in formulating strategies [5, 12]. The highlighting of 'investment in green innovation' as the number one strategy (S4) evidences its importance as a mechanism for advancing corporate sustainability and competitiveness. Multinational companies, such as Procter & Gamble (P&G), evidence strategic orientation to developing innovative, green products with sustainable attributes, or more environmentally friendly reduced footprints, both of which create brand value and address consumer preferences for environmentally friendly products. The high ranking of 'supply chain transparency' (S1) suggests that businesses should invest in transparent practices to build consumer trust and loyalty, a finding particularly relevant to those markets in which environmental accountability is under increased scrutiny. Additionally, the 'reduction of resource consumption' (S3) offers the twofold benefit of improving cost effectiveness while also reducing environmental impacts, providing pragmatic guidance for operational improvements. Despite a lower ranking of the 'targeted advertising for green values' (S2), it is still an effective means of raising awareness. It is also proposed that firms combine innovation and openness with targeted communication strategies in order to reinforce their sustainability efforts.

The study has a some limitations. First, it is dependent on the expert judgement (through the fuzzy Delphi technique) to identify the criteria and evaluate options, which could bring subjectivity and bias into the findings, calling for additional empirical validation in practice. An additional limitation of this article is its narrow focus on only four particular strategies: supply chain transparency, value-based green marketing, reduction of resource consumption, and investment in green innovation, thus potentially neglecting other sustainability strategic options and reducing the model's applicability in different industries or contexts.

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KONKURENCINĖS ŽVALGYBOS, ŽALIOSIOS RINKODAROS IR ŽALIOJO PIRKIMO PLANŲ ANALIZĖS HIBRIDINIS SUVIENYTAS SPRENDIMŲ PRIĖMIMO MODELIS TVARUMUI PASIEKTI

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Santrauka. Dėl intensyvėjančios pasaulinės konkurencijos ir augančio vartotojų poreikio įsigyti tvarius produktus organizacijos privalo integruoti konkurencinę žvalgybą, žaliąją rinkodarą ir žaliojo pirkimo strategijas į sinchronizuotą procesą, apimantį daugiakriterį sprendimų priėmimą (MCDM). Dauguma šios srities tyrimų nagrinėjo tik po vieną iš šių veiksnių, ir iki šiol nebuvo sukurtas modelis, kuris leistų įvertinti jų suderinamumą neapibrėžtame sprendimų priėmimo procese. Integruoto modelio trūkumas riboja galimybes nuodugniai analizuoti su tvarumu ir ilgalaikiu konkurenciniu pranašumu susijusius veiksnius. Šiame tyrime siūlomas integruotas metodas, kuriame taikomos neapibrėžtos daugiakriterės sprendimų priėmimo (FMCDM) technikos, siekiant įvertinti ir suskirstyti tvarumo strategijas. Neapibrėžta Delphi technika buvo taikyta 24 kriterijams, suskirstytiems į keturias dimensijas (konkurencinė žvalgyba, žalioji rinkodara, žaliojo pirkimo planai ir tvarumas), siekiant juos nustatyti ir patvirtinti kartu su identifikuotais ekspertais. Tada kriterijai pritaikyti analizuojant keturias strategines alternatyvas: tiekimo grandinės skaidrumą, vertės pagrįstą žaliąją rinkodarą, išteklių suvartojimo mažinimą ir investicijas į žalias inovacijas. Alternatyvos buvo analizuojamos taikant tris FMCDM metodus: SECA, COCOSO ir MARCOS. Rezultatų patikimumas buvo patvirtintas atliekant jautrumo analizę ir lyginant taikytus metodus. Rezultatai rodo, kad investicijos į žaliąsias inovacines technologijas yra veiksmingiausia strategija, padedanti didinti prekių ženklo vertę ir mažinti poveikį aplinkai. Toliau pagal prioritetą – tiekimo grandinės skaidrumas ir išteklių suvartojimo mažinimas. Didinant žaliojo pirkimo tikslų svarbą, pabrėžiamas tiekimo grandinės skaidrumas. Šis modelis vadovams pateikia praktišką sistemą, leidžiančią nustatyti tvarumo strategijų prioritetus esant rinkos neapibrėžtumui, o tokios įmonės kaip P&G gali jį taikyti siekdamos skatinti žaliąsias iniciatyvas ir klientų lojalumą.

Reikšminiai žodžiai: konkurencinė žvalgyba; žalioji rinkodara; žalioji pirkimo planai; neapibrėžtumas; SECA; COCOSO; MARCOS.

Appendix 1

Table 1A. Literature Reviews of International Studies from 2015 to 2024

Author	Title	Criteria Used	Decision-Making Method	Case Study	Conclusion	Theoretical Foundation	Theoretical Contribution
Nguyen (2019)	'Greenwash and Green Purchase Intention'	Greenwash, Green Skepticism	Multivariate Analysis	Vietnamese Consumers	Greenwash negatively affects purchase intentions, mediated by skepticism.	C-A-B Paradigm	Emphasises the influence of greenwashing on consumer decision-making.
Jamal *et al*. (2021)	'Green purchase intention: The power of success in green marketing'	Exogenous and Endogenous Variables	Structural Equation Modelling	Yogyakarta, Indonesia	Significant relationships between variables affecting green purchase intention were identified.	Not specified	Offers an understanding of the mechanisms driving green marketing within a developing region.
Hermayanti (2024)	'Green Customer Value and Green Marketing as Encouraging Support'	Green Customer Value	Quantitative Approach	Indonesia	Green customer value affects green marketing, which subsequently shapes green purchase intention.	Not specified	Integrates consumer values with marketing strategies for sustainability.
Li *et al*. (2024)	'Environmental Regulations, Green Marketing, and Consumers' Intentions'	Environmental Regulations	Regression Analysis	China	Environmental regulations enhance purchase intentions, with green marketing as a mediator.	Not specified	Explores regional differences in the impact of regulations and marketing.
Akram *et al*. (2024)	'Exploring the roles of green marketing tools and motives'	Green Marketing Tools	Not specified	China and India	Green marketing strategies have a beneficial impact on brand image and consumer trust, which in turn increase the likelihood of purchase.	Not specified	Examines cross-cultural impacts of marketing strategies on consumer behaviour.
Kamalanon (2022)	'Why Do We Buy Green Products?'	Environmental Concerns	Structural Equation Modelling	Not specified	Environmental concern and perceived company image	Extended TPB Model	Extends the theory of planned behaviour to include

					significantly influence purchase intention.		environmental concerns.
Febriani (2019)	'Pengaruh Green Marketing Mix Terhadap Green Product Purchase Intention'	Green Marketing Mix	Path Analysis	Jakarta, Indonesia	The green marketing mix exerts a positive impact on consumer attitudes, subsequently shaping their intentions to purchase.	Not specified	Emphasises the intermediary function of consumer attitudes in determining the success of green marketing initiatives.

Source: created by the authors.