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# Designing the Optimal Model for Green Management of the National Super League Sports Events

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## ABSTRACT

The environmental consequences of hosting and organizing sports events attended by large audiences have become one of the major concerns for event organizers. Therefore, the aim of this study was to design an optimal model for green management of the national Super League sports events. The present research employed an exploratory mixed-methods design (qualitative–quantitative). The qualitative population consisted of knowledgeable experts in the research field, including environmental specialists, university faculty members, managers of sports venues and facilities, contractors and engineers involved in the design and construction of sports facilities, and managers of civil engineering units in the General Directorates of Sports and Youth engaged in the construction and equipping of sports venues. Participants were selected using the snowball sampling method. The quantitative population included spectators, operational and headquarters managers of the league organization, personnel of the municipal transportation fleet, and human resources engaged in sports event operations. The research instrument was a questionnaire developed from the qualitative phase of the study. Data analysis was performed using SPSS and Smart PLS statistical software ($P \leq 0.05$). The results indicated that 15 axial codes, categorized into four variables—green management of sports stadiums, transportation system management, energy resource management, and environmental management—significantly explained green management of sports events. Moreover, the variable of energy resource management had the highest path coefficient. Accordingly, it is recommended that league organization managers and executive managers of sports federations reduce the environmental challenges of sports events to the lowest possible level by establishing a green management portal, implementing green management indicators, and employing managers knowledgeable and familiar with green facilities in the management of sports venues.

***Keywords:*** *Green management, event industry, transportation system management, energy resource management*

## 1. Introduction

In recent decades, the issue of environmental sustainability has emerged as a key priority for governments, organizations, and communities worldwide, and the sports industry is no exception. Large-scale sporting events, such as national leagues, attract significant numbers of spectators and require substantial infrastructure, energy, transportation, and waste management systems. These factors inevitably generate environmental impacts, including increased carbon emissions, resource depletion, and waste generation, which pose challenges for sustainable development in the sports sector (Atalay, 2021; Collins et al., 2019; Gallo et al., 2020). Consequently, the concept of green management has gained increasing attention among policymakers, stadium managers, and researchers, emphasizing the need to minimize the ecological footprint of sporting events while ensuring their economic and social viability (Daddi et al., 2022; Trendafilova et al., 2022).

The adoption of green management practices in sports venues involves the integration of environmental principles into all stages of event planning, design, implementation, and evaluation (Pourhasan et al., 2022; Salimi & Labaf, 2024). This approach is rooted in the broader framework of sustainable development, which seeks to balance environmental, social, and economic objectives (Ansari Ardali et al., 2022; Zare Abandansari et al., 2022). In the context of sports, sustainable development encompasses the design and construction of environmentally friendly facilities, efficient use of resources, reduction of greenhouse gas emissions, and promotion of eco-friendly transportation options (Francis et al., 2023; Herolda et al., 2024; Kassens-Noor, 2019). Implementing such measures not only mitigates environmental harm but also enhances the reputation of sports organizations, attracts environmentally conscious sponsors, and fosters positive community engagement (Campillo-Sánchez et al., 2021; Kabudani et al., 2021).

The environmental challenges associated with sports events are multifaceted. Stadium construction and operation consume vast amounts of energy and materials, while match-day activities lead to considerable waste production and traffic congestion (Azaza et al., 2019; Katsaprakakis et al., 2019; Manni et al., 2018). For example, energy use in stadiums can be optimized through renewable energy integration, efficient lighting systems, and smart resource management (Azizi et al., 2024; Bouraiou et al., 2020). Likewise, transportation systems for spectators and staff significantly contribute to the carbon footprint of events, making sustainable mobility strategies—such as public transport optimization, carpooling incentives, and low-emission vehicle use—critical (Herolda et al., 2024; Kassens-Noor, 2019). These measures align with international calls for reducing carbon emissions in line with climate change mitigation targets (Luo & Chen, 2023; Lyu, 2024).

In Iran, the growing interest in sustainable sports management has led to research initiatives aimed at identifying the requirements, barriers, and strategies for implementing green management in sports venues (Ansari Ardali et al., 2022; Pourhasan et al., 2022; Salimi & Labaf, 2024). Studies have explored aspects such as the role of green human resource management (Aibaghi Esfahani et al., 2018; Azizi et al., 2024; Sepahvand et al., 2019), governmental policy support (Goodarzi et al., 2022), and the application of cultural values in promoting environmental practices (Daneshgar et al., 2023; Ghezelsefloo & Choori, 2023). Furthermore, there is a recognized need for context-specific green management models that reflect the operational realities and socio-cultural characteristics of the Iranian sports industry (Darabi & Azafi, 2022; Fathollahi Parvaneh et al., 2023; Moradi et al., 2023).

Internationally, the concept of environmental sustainability in sports has been enriched by a growing body of literature and case studies. Research in Europe and North America has highlighted the role of stadium design, event logistics, and policy frameworks in reducing the ecological impact of sports events (Collins et al., 2019; Daddi et al., 2022; Francis et al., 2023). Strategies such as energy flow mapping (Azaza et al., 2019), zero-energy stadium design (Manni et al., 2018), and integration of renewable energy sources (Bouraiou et al., 2020) have proven effective in achieving substantial reductions in resource consumption. Additionally, spectator behavior plays a crucial role, as demonstrated by studies on modal transportation choices and their carbon implications (Herolda et al., 2024; Kassens-Noor, 2019). The willingness of audiences to support environmentally sustainable practices, such as paying more for green stadium experiences, further emphasizes the potential for market-driven change (Lyu, 2024).

Despite these advances, challenges remain in operationalizing green management in sports events. These include financial constraints, resistance to change, lack of technical expertise, and insufficient regulatory enforcement (Amirhosseini et al., 2021; Jafari et al., 2020; Kabudani et al., 2021). In some cases, environmental measures are implemented only superficially—so-called "greenwashing"—without meaningful reductions in environmental impact (Collins et al., 2019; Gallo et al., 2020). Overcoming these barriers requires a comprehensive approach that integrates stakeholder engagement, education, and capacity building (Atalay, 2021; Campillo-Sánchez et al., 2021). Moreover, alignment with global frameworks, such as the United Nations Sustainable Development Goals, can provide both guidance and legitimacy for local initiatives (Campillo-Sánchez et al., 2021; Trendafilova et al., 2022).

From a policy perspective, the role of government is critical in setting environmental standards for sports facilities, providing incentives for green investments, and ensuring compliance through monitoring and enforcement (Darabi & Azafi, 2022; Goodarzi et al., 2022). In addition, collaboration between the public and private sectors can enhance resource mobilization and facilitate the adoption of innovative technologies (Bouraiou et al., 2020; Luo & Chen, 2023). For example, renewable energy integration in stadiums—ranging from solar panels to energy storage systems—can significantly reduce operational costs while contributing to environmental goals (Azaza et al., 2019; Katsaprakakis et al., 2019; Manni et al., 2018).

In the Iranian context, research has emphasized that cultural adaptation is essential for the success of environmental initiatives in sports (Daneshgar et al., 2023; Ghezelsefloo & Choori, 2023). Green advertising campaigns grounded in indigenous values, combined with public education programs, can enhance community acceptance and participation in sustainability efforts (Amirhosseini et al., 2021; Fathollahi Parvaneh et al., 2023). Likewise, integrating green principles into human resource management—such as eco-oriented recruitment, training, and performance evaluation—can create an organizational culture supportive of sustainability (Aibaghi Esfahani et al., 2018; Azizi et al., 2024; Sepahvand et al., 2019).

Another crucial dimension is the integration of environmental management into the operational planning of sports events (Ansari Ardali et al., 2022; Pourhasan et al., 2022; Salimi & Labaf, 2024). This involves coordinating multiple components, including waste management systems, sustainable catering services, eco-friendly merchandising, and environmentally responsible sponsorships (Daddi et al., 2022; Francis et al., 2023). The management of transportation systems, in particular, requires careful planning to balance accessibility with environmental performance (Herolda et al., 2024; Kassens-Noor, 2019).

Given the complexity and interdependence of these factors, a systemic approach is necessary to develop a robust model for green management of national sports league events. Such a model should encompass infrastructure design, energy and resource efficiency, waste reduction, sustainable mobility, and stakeholder engagement (Darabi & Azafi, 2022; Goodarzi et al., 2022; Moradi et al., 2023). Moreover, it must be adaptable to evolving technologies, changing environmental regulations, and shifting public expectations (Campillo-Sánchez et al., 2021; Trendafilova et al., 2022).

In summary, the existing literature underscores both the urgency and the opportunity for integrating green management principles into the organization of large-scale sporting events. While international experiences offer valuable insights, context-specific models are needed to address the unique operational, cultural, and policy environments of different countries (Ansari Ardali et al., 2022; Salimi & Labaf, 2024; Zare Abandansari et al., 2022). For Iran's Super League events, this means designing a comprehensive, evidence-based framework that leverages best practices, aligns with sustainable development goals, and engages all relevant stakeholders—from government bodies and sports federations to stadium managers, athletes, and spectators (Fathollahi Parvaneh et al., 2023; Moradi et al., 2023; Pourhasan et al., 2022). The present study addresses this need by developing an optimal model for the green management of national Super League sports events, grounded in both global research and local realities.

## 2. Methods and Materials

This study was a descriptive research project implemented using an exploratory mixed-methods approach (qualitative–quantitative). All data were collected from three national Super League sports events in volleyball, basketball, and football during the second half of the season. The qualitative population consisted of environmental experts, university faculty members, managers of sports venues and facilities, contractors and engineers involved in the design and construction of sports facilities, and managers of civil engineering units in the General Directorates of Sports and Youth engaged in the construction and equipping of sports venues. Participants were selected through judgmental snowball sampling and participated in semi-structured interviews using the grounded theory method until theoretical saturation was reached. In this stage, the interview locations and scheduling were determined at the discretion of the interviewees. All interviews began with an explanation of the participants' demographic characteristics, followed by the primary research questions specified in the interview guide. Additionally, when necessary, based on participants' responses and in order to obtain more comprehensive information, follow-up questions were posed to uncover hidden aspects of the research topic. At the end of each interview, participants were asked to mention any issue or point that might have been overlooked. All factors influencing green management of sports events were identified by the fourteenth interview, and theoretical saturation occurred; however, to ensure completeness, the process continued to the final interview, and interviews were conducted with all expert groups. The components reported from the qualitative phase of the research were classified as open codes using MAXQDA20 software and were ultimately organized into 15 axial codes and four selective codes: green management of sports stadiums, transportation system management, energy resource management, and environmental management.

To ensure the reliability of the axial codes, the inter-coder reliability method was used by selecting four interviews at a specified time interval (30 days). The percentage agreement between the two coders, calculated using Scott's coefficient, indicated desirable reliability for the selective codes in the qualitative phase of the study ($\alpha > 0.81$). The data collection tool in the quantitative phase was a questionnaire extracted from the qualitative phase. This questionnaire was developed based on a five-point Likert scale (1 = very low to 5 = very high). The initial questionnaire was reviewed by seven university faculty members in sports management with expertise in sports facility and venue management to utilize their expert opinions and corrective suggestions, as well as to assess face and content validity. Based on their feedback, minor modifications were made to the wording of some items to make them easier for respondents to understand. Ultimately, the internal reliability of the questionnaire was confirmed in a pilot study involving 40 participants from the statistical population using Cronbach's alpha method ($\alpha \geq 0.78$). The quantitative research population included spectators, operational and headquarters managers of the league organization, municipal transportation fleet personnel, and human resources involved in executing sports events. Considering the minimum required sample size per variable in structural equation modeling studies ($2 \leq n \leq 10$), a total of 170 participants were selected through purposive sampling.

For data analysis, after confirming the model fit indices based on the three types of fit (structural fit, measurement fit, and overall model fit), the data were analyzed using the partial least squares (PLS) technique with Smart PLS-4 software, along with SPSS software.

## 3. Findings and Results

The first part of the findings relates to the descriptive results concerning the demographic characteristics of the participants in the interviews, as shown in Table 1. The results of the educational analysis indicated that most interview participants held a doctoral degree (8 individuals). Another part of the descriptive results showed that most interviewees were aged 51 years or older (12 individuals). The descriptive analysis of the interviewees' demographic characteristics further indicated that most participants were male (11 individuals). Finally, the results revealed that university faculty members and sports venue managers each had the highest frequency among the interviewees (3 individuals each).

**Table 1**

*Demographic characteristics of the qualitative research sample*

| Variable | Component | Frequency | Percentage | Respondent Position | Title | Frequency | Percentage |
|---|---|---|---|---|---|---|---|
| Education | Master's degree | 6 | 42.9 | University faculty | 3 | 21.4 | |
| | Doctoral degree | 8 | 57.1 | Contractor for sports facility construction | 2 | 14.3 | |
| Age | 41–50 years | 2 | 14.3 | Expert at the Company for the Development and Maintenance of Sports Venues | 2 | 14.3 | |
| | 51 years and older | 12 | 85.7 | Environmental expert | 2 | 14.3 | |
| Gender | Male | 11 | 78.6 | Sports venue manager | 3 | 21.4 | |
| | Female | 3 | 21.4 | Expert in civil engineering units of the General Directorates of Sports and Youth | 2 | 14.3 | |

After completing the fourteenth interview and coding all conducted interviews, it was determined that theoretical saturation had been achieved. In the open coding stage, a total of 93 initial concepts emerged from the interviews. A more detailed examination of the recorded codes revealed that although many codes were expressed in different forms and wording, they had similar meanings and concepts. Therefore, these codes were merged, resulting in 75 open codes. The open codes obtained from the interview process were ultimately categorized into 15 subcategories and four main categories, as presented in Table 2.

**Table 2**

*Factors influencing green management of national Super League sports events*

| Main Category | Subcategory | Number of Open Codes |
|---|---|---|
| Green management of sports stadiums | Technological equipment | 8 |
| | Green materials and supplies | 4 |
| | Sanitation facilities | 3 |
| | Waste disposal | 4 |
| | Green food packaging system | 3 |
| Transportation system management | Optimization of public fleet | 4 |
| | Standard fuel | 3 |
| | Dedicated event route | 3 |
| Energy resource management | Lighting sensors | 3 |
| | Use and substitution of renewable resources | 4 |
| | Smart water and electricity consumption systems | 5 |
| Environmental management | Green civil engineering management | 8 |
| | Green space development | 6 |
| | Pollution source management | 5 |
| | Development of environmental culture | 7 |
| Green management of sports events | – | 5 |

As shown in Table 2, the factors influencing the green management of large sports events comprise four main categories—green management of sports stadiums, transportation system management, energy resource management, and environmental management—and fifteen subcategories: technological equipment, green materials and supplies, sanitation facilities, waste disposal, green food packaging system, optimization of public fleet, standard fuel, dedicated event route, lighting sensors, use and substitution of renewable resources, smart water and electricity consumption systems, green civil engineering management, green space development, pollution source management, and development of environmental culture.

In the quantitative results section, the demographic characteristics of the sample responding to the research questionnaires are first presented, with the statistics shown in Table 3. The results indicated that most participants in the study had a history of attending sports events for 7 years or more (79 individuals). Furthermore, regarding gender, it was found that male participants had the highest frequency (122 individuals). Finally, the analysis of the demographic characteristics of the studied sample revealed that most participants were aged 41 years or older (71 individuals).

**Table 3**

*Demographic characteristics of the quantitative research sample*

| Variable | Component | Frequency | Percentage |
|---|---|---|---|
| History of participation in sports events | 1–3 years | 35 | 20.6 |
| | 4–6 years | 56 | 32.9 |
| | 7 years and above | 79 | 46.5 |
| Gender | Male | 122 | 71.8 |
| | Female | 48 | 28.2 |
| Age | 20–30 years | 43 | 25.3 |
| | 31–40 years | 56 | 32.9 |
| | 41 years and above | 71 | 41.8 |

Table 4 presents the descriptive analysis results of the research variables. The findings show that the mean and standard deviation of the variables—sports stadium management, transportation system management, energy resource management, environmental management, and green management of sports events—were respectively 3.13 ± 0.81, 3.29 ± 0.77, 3.23 ± 0.79, 3.36 ± 0.69, and 3.19 ± 0.72.

**Table 4**

*Description of research variables*

| Variable | N | Mean | Std. Deviation |
|---|---|---|---|
| Sports stadium management | 170 | 3.13 | 0.81 |
| Transportation system management | 170 | 3.29 | 0.77 |
| Energy resource management | 170 | 3.23 | 0.79 |
| Environmental management | 170 | 3.36 | 0.69 |
| Green management of sports events | 170 | 3.19 | 0.72 |

In the inferential results section, the quality of the structural model was first assessed based on criteria such as reliability and validity (convergent and discriminant). Composite reliability, Cronbach's alpha, and factor loadings were among the criteria used to evaluate the reliability of the structural model. The composite reliability and Cronbach's alpha coefficients calculated for each variable should be greater than 0.70, and the reported coefficients in Table 5 confirm this requirement. In addition, factor loadings should be higher than 0.50, and Figure 1 confirms that these values exceed the threshold of 0.50. Considering the results in Table 5 and the factor loadings of each item in Figure 1, it can be stated that the structural model has acceptable reliability.

**Table 5**

*Reliability indices of the structural research model*

| Variable | Composite Reliability | Cronbach's Alpha |
|---|---|---|
| Sports stadium management | 0.887 | 0.876 |
| Transportation system management | 0.901 | 0.894 |
| Energy resource management | 0.921 | 0.911 |
| Environmental management | 0.856 | 0.843 |
| Green management of sports events | 0.871 | 0.866 |

For the assessment of convergent validity, the Average Variance Extracted (AVE) was used. Moreover, to evaluate discriminant validity, the HTMT index was applied. For each variable, AVE should be greater than 0.50, and for the HTMT index, the coefficients should be less than 0.85. The statistics in Table 6 confirm the adequacy of both convergent and discriminant validity for the variables in the structural model.

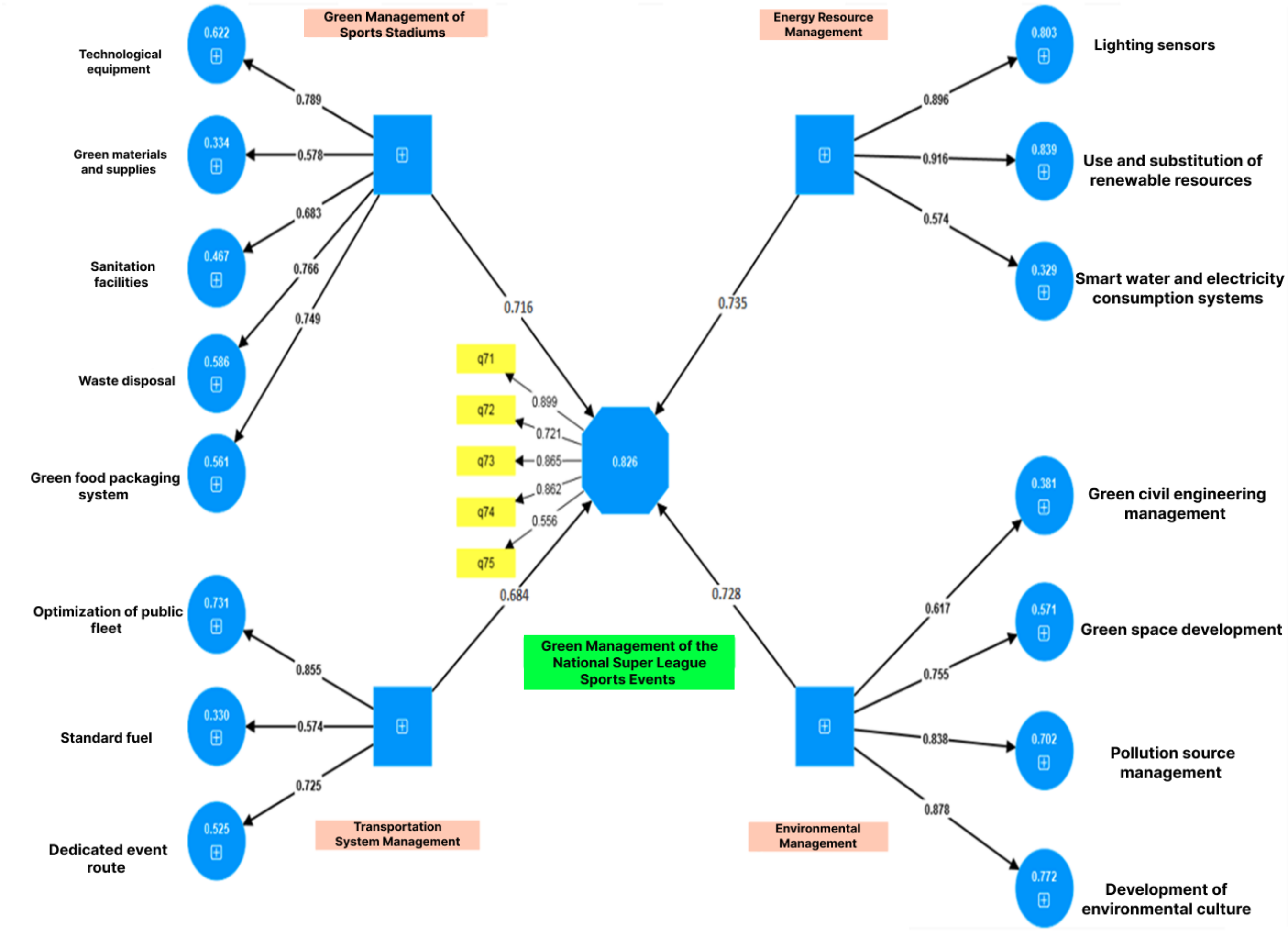
**Table 6**

*Validity indices of the structural research model*

| No. | Constructs | 1 | 2 | 3 | 4 | 5 | AVE |
|---|---|---|---|---|---|---|---|
| 1 | Sports stadium management | 0.547 | | | | | |
| 2 | Transportation system management | 0.716 | 0.794 | | | | 0.591 |
| 3 | Energy resource management | 0.767 | 0.698 | 0.792 | | | 0.624 |
| 4 | Environmental management | 0.759 | 0.784 | 0.739 | 0.841 | | 0.607 |
| 5 | Green management of sports events | 0.781 | 0.776 | 0.693 | 0.749 | 0.834 | 0.587 |

**Figure 1**

*Tested research model in standardized estimation mode*




The estimated Goodness of Fit (GOF) coefficient was 0.483, confirming the appropriateness of the overall model fit. After ensuring the quality, validity, and reliability of the structural model, the research hypotheses were tested, and the results are presented in Table 7. The findings indicated that sports stadium management had a positive and significant effect on green management of sports events (β = 0.716, t = 9.788). Another finding showed that transportation system management had a positive and significant effect on green management of sports events (β = 0.684, t = 9.548). Furthermore, the results revealed that energy resource management had a positive and significant effect on green management of sports events (β = 0.735, t = 11.478). Finally, environmental management was found to have a positive and significant effect on green management of sports events (β = 0.728, t = 9.826).

**Table 7**

*Direct Effects Between Research Variables*

| Effects in the Model | Path (Beta) | t-value | Significance Level |
|---|---|---|---|
| Sports stadium management → Green management of sports events | 0.716 | 9.788 | 0.001 |
| Transportation system management → Green management of sports events | 0.684 | 9.548 | 0.001 |
| Energy resource management → Green management of sports events | 0.735 | 11.478 | 0.001 |
| Environmental management → Green management of sports events | 0.728 | 9.826 | 0.001 |

**Figure 2**

*Tested research model in significance numbers mode*


## 4. Discussion and Conclusion

The results of the present study, which aimed to evaluate and prioritize marketing strategies for small and medium-sized service enterprises (SMEs) operating under uncertainty using a fuzzy multi-criteria decision-making approach, provide important insights into the strategic priorities of firms in competitive and dynamic environments. The findings indicate that "strategic marketing" emerged as the most influential and highest-priority criterion, followed by "innovation" and "product." "Technology" ranked fourth, while "organization" and "customer" held the lowest priorities. In addition, the fuzzy DEMATEL analysis revealed that technology, customer, and product variables functioned as causal drivers within the network of internal relationships, exerting more influence than they received. Conversely, marketing, innovation, and organization were identified as effect variables, being more influenced by other factors than influencing them. This structural differentiation between causal and effect variables offers a nuanced understanding of where strategic interventions should be focused.

The prominence of strategic marketing as the highest-priority criterion is consistent with previous research emphasizing the centrality of coherent, targeted, and adaptive marketing efforts in enhancing SMEs' competitiveness in volatile environments (Otto, 2024; Williams & Green, 2022). Strategic marketing facilitates the alignment of market segmentation, value proposition, and brand positioning with evolving customer needs, enabling firms to maintain relevance and responsiveness (Alizadeh et al., 2024; Andersson et al., 2024). Moreover, digital marketing capabilities—integral to modern strategic marketing—are shown to significantly enhance purchase intention through mechanisms of engagement and trust (Otopah et al., 2024; Zhang, 2024), corroborating the emphasis on marketing as the central lever in the current findings.

Innovation's second-place ranking in the prioritization is also aligned with the literature, which repeatedly underscores the role of innovation, particularly open innovation, in enabling SMEs to respond quickly to market changes and technological disruptions (Kim & Park, 2022; Yang & Jiang, 2023). Innovation supports differentiation, which is essential for sustaining competitive advantage when competing with resource-rich larger firms (Asgari et al., 2024; García, 2021). The positive causal influence of product-related criteria further reinforces the argument that innovation is not an abstract organizational function but a concrete driver of market offerings, shaping both consumer perceptions and purchase behaviors (Hallberg, 2023; Zhang & Lee, 2023).

The identification of technology as a causal driver with the highest influence on other variables confirms the growing recognition of technology as both an enabler and a strategic asset (Ahi et al., 2022; Andersson et al., 2024). In the context of SMEs, technology enhances marketing reach, operational efficiency, and customer interaction quality (Lee & Chen, 2023; Otto, 2024). Advanced data analytics, artificial intelligence, and digital platforms facilitate more personalized and timely engagement, leading to stronger customer relationships and improved business performance (Alizadeh & Foroughi, 2023; Zhang, 2024). The fact that technology holds a pivotal causal position in the relationship network suggests that investments in technological infrastructure can yield spillover benefits for marketing, innovation, and customer-related performance metrics.

Interestingly, customer-related variables, despite being ranked lowest in priority in the overall weighting, were found to be causal drivers in the fuzzy DEMATEL analysis. This suggests that while customers may not be perceived as an immediate strategic priority compared to marketing or innovation, their complexity, segmentation, and purchasing behaviors significantly influence the effectiveness of other strategic areas (Jackson & Brown, 2022; Otopah et al., 2024). This paradox can be interpreted in light of research showing that trust and engagement—critical elements of customer relationships—mediate the impact of marketing strategies on purchase intentions (Otto, 2024; Williams & Green, 2022). Thus, even if customers are ranked lower in direct priority, their role as a causal factor in the system indicates a need for more nuanced customer-centric strategies.

The product criterion's causal influence aligns with empirical evidence that product quality, innovation, and post-sales support play a decisive role in determining purchase decisions (García, 2021; Kim & Park, 2022). In competitive markets, products that integrate innovative features, high reliability, and relevant branding outperform those relying solely on promotional efforts (Baykaso˘glu et al., 2020; Hallberg, 2023). Moreover, consumer co-creation in product development, as highlighted in previous research, increases the perceived value and strengthens the relationship between the firm and its customers (García, 2021; Yang & Jiang, 2023). The current findings reinforce the view that product strategy must be considered not just as a functional aspect of operations but as a driver of broader marketing effectiveness.

Conversely, the classification of marketing, innovation, and organization as effect variables suggests that these areas are more reactive to changes in other domains, particularly technology and product development. This is consistent with studies indicating that marketing strategies in SMEs often depend heavily on available technological capabilities, product portfolios, and the structure of customer relationships (Alizadeh et al., 2024; Andersson et al., 2024). Organizational structure and culture, while important for long-term adaptability, may not exert strong causal influence in the short term (Asgari et al., 2024; Jahangiri et al., 2020). Instead, they serve as enabling environments in which more directly impactful variables—technology, product, and customer engagement—can operate effectively.

The application of fuzzy multi-criteria decision-making in this study provided a robust analytical framework for capturing both qualitative judgments and quantitative assessments, enabling a more accurate prioritization under uncertainty (Baykaso˘glu et al., 2020; Feng & Chan, 2022). This methodological approach aligns with calls in the literature for decision-support tools that can accommodate the ambiguity inherent in expert evaluations, especially in dynamic markets (Ahi et al., 2022; Yang & Jiang, 2023). The integration of fuzzy DEMATEL and ANP not only allowed the identification of causal and effect variables but also provided a precise ranking of strategic priorities, offering actionable guidance for managers.

A noteworthy implication of the findings is that SMEs should focus their limited resources on strengthening causal variables—particularly technology, product, and customer factors—as these have the potential to trigger positive changes across the entire strategic system (Otto, 2024; Zhang, 2024). Marketing and innovation, while important, may achieve greater impact when supported by strong technological foundations and customer-driven insights. This is consistent with research indicating that the integration of technology into customer relationship management and product innovation amplifies the overall effectiveness of marketing strategies (Alizadeh & Foroughi, 2023; Lee & Chen, 2023).

In sum, the study's results resonate with and extend prior literature on digital marketing, innovation, and strategic management in SMEs. The identification of causal and effect variables provides a system-level perspective on strategic priorities, moving beyond isolated factor analysis toward a holistic understanding of interdependencies (Andersson et al., 2024; Williams & Green, 2022). By applying fuzzy decision-making techniques, this research bridges the gap between theory and practice, offering a decision-support framework that can be adapted to other contexts facing uncertainty and complexity.

While the study provides valuable insights, several limitations should be noted. First, the sample size was limited to a relatively small group of experts from SMEs in a specific geographic region, which may affect the generalizability of the results to other sectors or regions. Second, the reliance on expert judgments, while suitable for fuzzy multi-criteria analysis, introduces the potential for subjective bias, especially in prioritizing criteria. Third, the study's cross-sectional design limits its ability to capture changes in strategic priorities over time, particularly in rapidly evolving technological and market contexts. Finally, although the integration of fuzzy DEMATEL and ANP offers robust analytical capabilities, the complexity of the methodology may pose challenges for replication by practitioners without specialized knowledge.

Future research could expand the scope by including a larger and more diverse set of SMEs across different industries and geographic regions to enhance external validity. Longitudinal studies would be valuable in examining how strategic priorities shift over time, especially in response to technological disruptions or macroeconomic changes. Comparative studies between SMEs and large enterprises could also reveal differences in strategic emphasis and resource allocation. Additionally, integrating customer survey data alongside expert evaluations could provide a more comprehensive understanding of how end-user perceptions align with managerial priorities. Finally, testing the proposed decision-making framework in experimental or real-world strategic planning scenarios could help validate its practical applicability and refine its components.

Practitioners should focus on strengthening causal variables such as technology, product development, and customer engagement, as improvements in these areas are likely to yield broad systemic benefits. Investments in digital infrastructure and data analytics capabilities can enhance both marketing and innovation outcomes. Managers should also adopt a more integrated approach to strategy, ensuring that marketing and innovation activities are directly informed by technological capabilities and customer insights. Regular reassessment of strategic priorities using tools like fuzzy MCDM can help organizations remain agile and responsive in uncertain environments. Finally, fostering cross-functional collaboration between marketing, R&D, and IT teams can maximize the synergies among the most influential strategic areas.

## Authors' Contributions

Authors contributed equally to this article.

## Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

## Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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## Declaration of Interest

The authors report no conflict of interest.

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## Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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