Fuzzy Optimization and Decision Making
https://doi.org/10.1007/s10700-026-09477-1

Profiling the application of the 2-tuple linguistic model in marketing: a comprehensive analysis and future directions

Ziwei Shu[1] · José Javier Galán Hernández[2] · Álvaro Carrasco-Aguilar[3]

Received: 6 October 2025 / Accepted: 10 March 2026

Abstract
Customer opinions, preferences, and decision-makers' insights play a vital role in marketing by influencing product development, strategy, and customer experience. Computing with Words (CWW) offers an effective method for processing this qualitative information using linguistic terms instead of numerical values. This work aims to explore the application of one of the most widely used methodologies in CWW—the 2-tuple linguistic model—in marketing. It employs a combination of bibliometric analysis and a systematic literature review for a comprehensive analysis. Articles published between 2000 and 2024 on the Web of Science database are analyzed, incorporating Scopus´s Field-Weighted Citation Impact (FWCI) metrics to assess the impact of individual studies and the average influence of research in marketing-related areas. From an initial sample of 165 peer-reviewed articles, 90 were selected for analysis. The findings indicate that the 2-tuple linguistic model is primarily applied to decision-making problems, with Multiple Attribute Group Decision Making emerging as the most prominent theme due to its high centrality and high density in the strategic diagram, as well as its strong connections to various marketing-related areas. The 2-tuple linguistic model is widely applied in areas such as supplier management and product development and innovation, with digital transformation and consumer behavior representing potential directions for applying the model to address their respective marketing challenges. Using the FWCI, this work also identifies marketing-related areas within decision-making themes where the 2-tuple linguistic model is already applied but has limited influence, revealing opportunities for development and future research.

Keywords Marketing · 2-tuple linguistic model · Computing with words · Decision making · Comprehensive analysis

Extended author information available on the last page of the article

Published online: 27 March 2026

1 Introduction

Marketing is defined as "the management process responsible for identifying, anticipating and satisfying customer requirements profitably," a definition widely adopted by the Chartered Institute of Marketing (2015), emphasizing its core functions: understanding consumer needs, forecasting future demand, and creating products or services that fulfill these needs while ensuring profitability. Marketing encompasses a broad range of activities—from product development and advertising to distribution and sales—aimed at attracting customers and encouraging them to choose a business's products or services. A careful consideration of multiple factors is essential in marketing strategies, including consumer needs and preferences, components of the marketing mix (product, price, place, and promotion), and ongoing competitive analysis. This can enhance the effectiveness of marketing activities and align with overarching business goals.

In the modern data-driven era, Marketing Analytics has emerged as a fundamental discipline, defined as the systematic process of collecting, managing, analyzing, and interpreting data to bridge customer psychology and managerial decision-making (Basu et al., 2023). Moving beyond traditional descriptive reporting, it leverages business intelligence to quantify complex market structures and risk exposures by exploiting large volumes of quantitative data from Customer Relationship Management (CRM) systems—such as sales records, marketing interactions, contact center metrics—and financial performance indicators (Hye, 2025). However, decision-makers face a persistent challenge: the inputs are inherently heterogeneous. They must integrate this "hard" data with "soft" qualitative information (e.g., social media reviews, expert panel judgments), which is often vague, subjective, and difficult to process using standard statistical methods (Trung & Thanh, 2022).

This challenge is further intensified by increasingly complex consumer behavior, the growth of omnichannel interactions, and rising expectations for personalized experiences. As a result, marketers must move beyond purely quantitative metrics to capture the nuanced and subjective perceptions that shape consumer decision-making and guide product development and branding strategies (Lemon & Verhoef, 2016; Rust, 2020). In practice, much of marketing data is expressed in linguistic terms rather than precise numerical values. For example, customer feedback often includes subjective descriptors such as "good," "satisfactory," or "terrible," which convey personal evaluations rather than measurable numbers. Consumer behavior is also frequently described using likelihood-based expressions such as "likely," "unlikely," or "very likely to purchase." Likewise, product or service ratings are commonly framed in relative terms like "high," "low," or "average satisfaction." To effectively interpret and act upon this qualitative information, such as opinions, preferences, and emotional responses, there is a pressing need for methods that can process linguistic and imprecise data in a structured and meaningful way.

To address this complexity, the paradigm of Computing with Words (CWW), introduced by Zadeh (1996), offers a methodological solution. It enables the use of words or linguistic variables instead of numbers for computing and reasoning, offering a more natural representation of human thought processes. It can also handle linguistic information to model imprecise, vague, or qualitative concepts, allowing for decision-making (DM), inference, and control in situations where traditional quantitative approaches may be inadequate or infeasible. Among CWW methodologies, the 2-tuple linguistic model developed by Herrera and Martínez (2000) stands out for its ability to manage vague and uncertain information while minimizing information loss and preserving interpretability. Owing to these properties, the model has experienced substantial growth and wide applicability in decision analysis and marketing analytics, with numerous adaptations and extensions building on the original framework (Li & Yu, 2022; Martínez & Herrera, 2012). Unlike other fuzzy approaches that may lose information during translation, the 2-tuple model ensures that the linguistic nuances of consumer feedback are computed without information loss (Martínez & Herrera, 2012; Petrescu & Krishen, 2024). This capability significantly advances Decision Theory by offering a more granular approach to consensus reaching, and complements theoretical frameworks like Fuzzy Cognitive Mapping (Borrero-Domínguez & Escobar-Rodríguez, 2023) by allowing for precise simulation of causal relationships in uncertain environments. By feeding these processed variables into Multi-Criteria Decision Making (MCDM) frameworks and AI algorithms, organizations can harmonize conflicting criteria to generate robust, predictive, and prescriptive insights. Figure 1 shows the conceptual framework of how CWW and MCDM are integrated within the Marketing Analytics ecosystem to transform heterogeneous data into strategic decisions.

This work aims to provide a comprehensive analysis of the application of the 2-tuple linguistic model within this marketing framework. By combining a systematic literature review and bibliometric analysis, this work contributes both breadth and depth to understanding research trends, thematic developments, and knowledge gaps, while identifying how this methodology bridges the gap between qualitative ambiguity and quantitative rigor to address complex problems in supplier selection, product innovation, and consumer behavior analysis. Since Scopus and Web of Science (WoS) exhibit a high degree of overlapping content (Martín-Martín et al., 2021; Visser et al., 2021), and WoS applies more selective journal coverage (Singh et al., 2021), this work focuses on analyzing relevant articles from WoS published between 2000

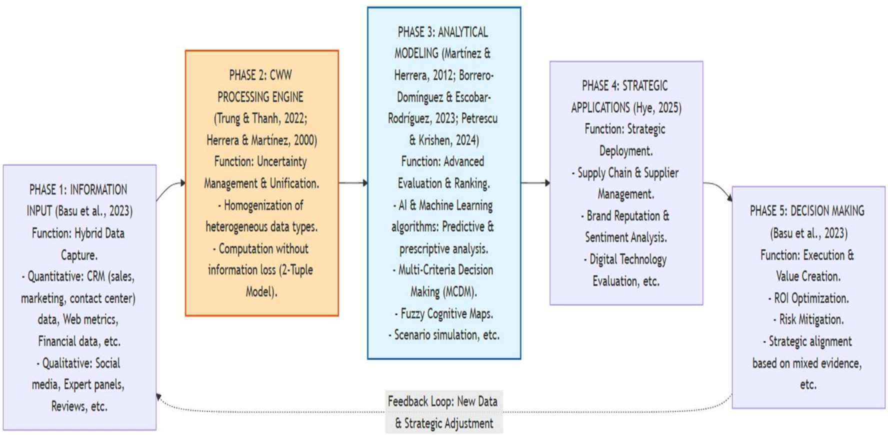

Fig. 1 Conceptual framework of CWW and MCDM integration in marketing analytics

and 2024, while incorporating Scopus's Field-Weighted Citation Impact (FWCI) to evaluate both the impact of individual studies and the average influence of marketing-related research. FWCI is included in this work because it is a field-normalized metric widely used to benchmark research impact fairly, regardless of differences in entity size, age, disciplinary profile, and publication-type composition (Purkayastha et al., 2019). Through a comprehensive analysis, the principal themes in which the 2-tuple linguistic model has been applied are used. The analysis also examines how these themes specifically relate to marketing-related areas. Potential directions for future research, as well as specific marketing-related areas where the 2-tuple linguistic model can be further developed, are also highlighted.

The remainder of this work is organized as follows. Section 2 provides a brief overview of concepts related to CWW and presents the fundamentals of the 2-tuple linguistic model. Section 3 describes the methodology used to search for, identify, select, and analyze studies on the application of the 2-tuple linguistic model in marketing. Section 4 presents the results of this analysis. Finally, Sect. 5 concludes the work, highlighting the implications for marketing analytics and potential directions for applying the 2-tuple linguistic model in future research.

2 Theoretical framework

This section provides a brief overview of concepts related to CWW and presents the fundamentals of the 2-tuple linguistic model.

2.1 Computing with words

In many DM problems, people often use linguistic information to express their opinions or perspectives, although it is vague, uncertain, or imprecise. Conceptualized by Zadeh (1996), CWW is a methodology in which words are used in place of numbers for computing and reasoning. This methodology aims to impart machines with a capability so that they can process linguistic information seamlessly as humans do. Linguistic information is subjective, as words can mean different things to different people, requiring computational techniques with linguistic operators to solve problems in the CWW process.

The computational process of CWW involves three steps: translation, manipulation, and retranslation (Yager, 1999), as shown in Fig. 2. The processes of translation and retranslation play a crucial role in CWW (Yager, 2004). Translation converts

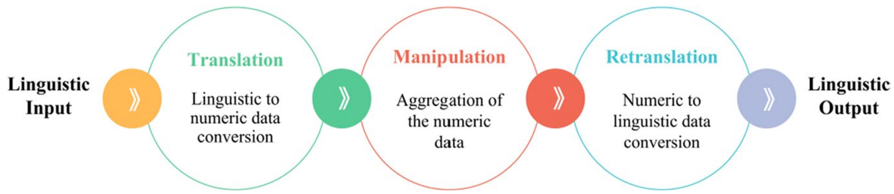

Fig. 2 Computational process of CWW, adapted from Yager (1999)

linguistic inputs into a machine-readable format for computational processing, while retranslation turns the results back into linguistic information that facilitates human comprehension.

CWW serves as a computational foundation for addressing DM problems that involve linguistic information, as it aligns closely with human reasoning, increases the reliability and adaptability of traditional decision models, and helps resolve uncertainties in DM processes that rely on linguistic inputs (Martínez et al., 2015). CWW is based on the use of linguistic variables and fuzzy logic. A linguistic variable is a variable whose values are words or phrases in a natural language (Zadeh, 1975). Each linguistic variable can be assigned one or more linguistic terms, which are in turn connected to numeric values through the mechanism of membership functions (Ren et al., 2015). A linguistic variable is characterized by $(X, T(X), U, G, M)$, where X is the name of the linguistic variable, $T(X)$ is the set of linguistic terms of X, U is the universe of discourse, G is a syntactic rule that generates the terms in $T(X)$, and M is a set of semantic rules that link each linguistic value in $T(X)$ to a fuzzy set. For example, when evaluating the "Restaurant Service," X is "Restaurant Service," $T(X) = \{VeryPoor, Poor, Average, Good, VeryGood\}$, U represents customer satisfaction scores or service quality ratings, G defines the syntactic rules for generating terms like "*Good*" or "*Very Good*," and M maps these terms to fuzzy sets that represent levels of service quality.

CWW has remained a field of interest for many researchers, with applications in risk assessment (Liu et al., 2010; Tymchuk et al., 2017), medicine (Gupta & Muhuri, 2018; Jain et al., 2017), human–computer interface (Tamir et al., 2019), natural language processing (Huseynova, 2020), autonomous unmanned intelligent systems (Kargin & Petrenko, 2023), industrial applications (Kali et al., 2023), and transportation problems (Pratihar et al., 2023). Gupta and Andreu-Perez (2022) classify CWW methodologies into five types based on how they model the semantics of linguistic information. The first type uses type-1 fuzzy sets, including methodologies like the Extension Principle-based CWW, Augmented Extension Principle-based CWW, and Intuitionistic Fuzzy Sets-based CWW. The second type relies on ordinal term sets, such as Symbolic Method-based CWW and Rough Sets-based CWW methodologies. The third type combines type-1 fuzzy sets to model the semantics of linguistic information with ordinal term sets to perform operations on the linguistic information, and the classic example is the 2-tuple linguistic model. The fourth type uses interval type-2 fuzzy sets for modeling the semantics of linguistic information and these semantics are represented as interval type-2 membership functions, for example, Perceptual Computing. Finally, the fifth type uses general type-2 fuzzy sets to model the semantics of linguistic information, including methodologies such as Linear General Type-2 Fuzzy Sets-based CWW and General Type-2 Fuzzy Sets-based CWW.

This work focuses on exploring one of the most widely used methodologies in CWW, the 2-tuple linguistic model, with its fundamentals presented in Sect. 2.2.

2.2 The 2-tuple linguistic model

Among the many CWW methodologies, the 2-tuple linguistic model, developed by Herrera and Martínez (2000), is widely used because it is easy to implement, captures linguistic information continuously within its domain to prevent information loss, and maintains the interpretability of the results (Martínez et al., 2015; Mi et al., 2014; Tai & Chen, 2009). The 2-tuple linguistic model preserves the computational process of CWW (as shown in Fig. 1) and aims to address information loss during the fusion of linguistic information (Herrera & Martinez, 2000). This model has been widely used for managing linguistic information in DM problems and is the foundation for various models in decision analysis (Martínez & Herrera, 2012). Many extensions of the 2-tuple linguistic model enhance CWW processes in complex DM frameworks, delivering satisfactory results in linguistic decision problems (Estrella et al., 2014). The 2-tuple linguistic model, along with its extensions, has been applied to solve various problems, such as the evaluation of tourist services (Bueno et al., 2021; Cheng et al., 2019), risk analysis (Wang et al., 2022), consumers' brand selection (Giráldez-Cru et al., 2023), customer relationship management (Shu et al., 2023a, 2025), hotel segmentation (Shu et al., 2023b), and healthcare services (Serrano-Guerrero et al., 2024).

The 2-tuple linguistic model represents linguistic information using a pair of linguistic values called a 2-tuple value (s_i, α), where $s_i \in S$ is a linguistic term with syntax and semantics, and $\alpha \in [-0.5,0.5)$ is a numerical value representing the symbolic translation. The definition of the 2-tuple linguistic model is as follows (Herrera & Martinez, 2000).

Definition 1 Let $S = \{s_0, ..., s_g\}$ be a set of linguistic terms, whose cardinality is $g + 1$. $\beta \in [0, g]$ is a value that represents the result of a symbolic aggregation operation. The function $\Delta : [0, g] \rightarrow \langle S \rangle = Sx[-0.5, 0.5)$ is used to convert β to 2-tuple value (s_i, α) as shown in Eq. (1):

$$\Delta\left(\beta\right) = \left(s_i, \alpha\right), with \begin{cases} i = round(\beta) \\ \alpha = \beta - i, \alpha \in [-0.5, 0.5) \end{cases} \tag{1}$$

where *round(·)* is the rounding operation; s_i has the nearest index label to β; and α represents a numerical value of the symbolic translation (i.e., the difference of information between a counting of information β assessed in the interval of granularity $[0, g]$ obtained after a symbolic aggregation operation and the closest value in $\{0, ..., g\}$ that indicates the index of the closest linguistic term in S).

The linguistic terms set may comprise three, five, seven, or more terms. However, the more terms the set contains, the more challenging it becomes for experts to use (Wang, 2009). A five-term set is commonly used in practice. For example, the linguistic terms used by TripAdvisor to evaluate hotel criteria are $Terrible = T, Poor = P, Average = A, VeryGood = VG, Excellent = E$. Thus, $S = \{s_0 = T, s_1 = P, s_2 = A, s_3 = VG, s_4 = E\}$ is a set of five linguistic terms used by TripAdvisor, as shown in Fig. 3.

The 2-tuple linguistic model can perform transformations between 2-tuple values and numerical values. The function Δ is bijective; its inverse function $\Delta^{-1} : \langle S \rangle = Sx[-0.5,0.5) \rightarrow [0, g]$ converts the 2-tuple value into its equivalent numerical value as follows:

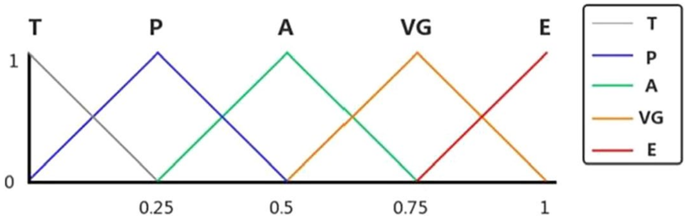

Fig. 3 The linguistic term set S used on TripAdvisor (Shu et al., 2023b)

$$\Delta^{-1}(s_i, \alpha) = i + \alpha = \beta \tag{2}$$

Remark 1 The conversion of a linguistic term into a 2-tuple value consists of adding a value 0 as symbolic translation, denoted as $s_i \in S \Rightarrow (s_i, 0)$.

The comparison of 2-tuple values, the negation operator of a 2-tuple value applied to handle inverse dimensions, and aggregation operators for 2-tuple linguistic computing are described as follows (Herrera-Viedma et al., 2004).

Definition 2 The comparison of linguistic information represented by 2-tuple values is performed according to an ordinary lexicographic order (Herrera & Martinez, 2000). Let (s_I, α_1) and (s_J, α_2) be two 2-tuple values, the operator is generated to compare their values as the following:

(i) If $I < J$, (s_I, α_1) is smaller than (s_J, α_2).
(ii) If $I = J$, when:
a. $\alpha_1 = \alpha_2$, (s_I, α_1) and (s_J, α_2) represent the same information.
b. $\alpha_1 < \alpha_2$, (s_I, α_1) is smaller than(s_J, α_2).
c. $\alpha_1 > \alpha_2$, (s_I, α_1) is larger than (s_J, α_2).
(iii) If$I > J$, (s_I, α_1) is larger than (s_J, α_2).

Definition 3 The negation operator of a 2-tuple value is defined as follows:

$$neg((s_i, \alpha)) = \Delta\left(g - \Delta^{-1}(s_i, \alpha)\right) = \Delta(g - \beta) \tag{3}$$

where $g + 1$ is the cardinality of S, $S = \{s_0, \ldots, s_g\}$.

The 2-tuple linguistic aggregation operator involves obtaining a value that summarizes a set of 2-tuple linguistic values (Estrella et al., 2014). As the 2-tuple linguistic model specifies the functions Δ and Δ^{-1}, which convert numerical values into 2-tuple values and vice versa without any information loss, it is possible to extend any numerical aggregation operator to handle 2-tuple values, such as the arithmetic mean operator and the weighted average operator (Herrera-Viedma et al., 2004).

3 Review methodology

This section details the methodology for searching, identifying, selecting, and analyzing studies on the application of the 2-tuple linguistic model in marketing, with an overview of the process presented in Fig. 4.

Section 3.1 defines specific research objectives that align with the overarching aim introduced in Sect. 1, ensuring the effective fulfillment of this work. Section 3.2 presents the selection of an appropriate database for the literature search and the development of a comprehensive search strategy to identify relevant studies for analysis. Section 3.3 shows the establishment of explicit inclusion and exclusion criteria to ensure the relevance and validity of the selected papers. These selected studies then form the basis for the bibliometric analysis and systematic literature review discussed in Sect. 3.4. Section 3.4 presents two complementary analyses to provide a comprehensive understanding of the application of the 2-tuple linguistic model in the field of marketing. A bibliometric analysis is conducted using SciMAT (Cobo et al., 2012), focusing on keyword co-occurrence to identify thematic clusters. These are visualized through a strategic diagram that outlines the thematic structure of the field over the entire study period. Meanwhile, a systematic literature review is performed through full-text content analysis of the selected papers. By integrating the results from both methods, the study provides a comprehensive view of the research field. The detailed analysis and interpretation of the findings are presented in Sect. 4.

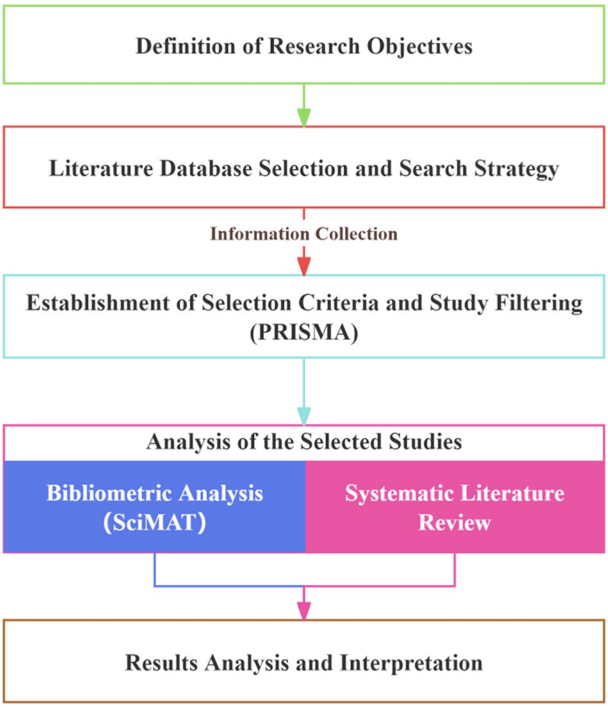

Fig. 4 Research methodology, adapted from Cobo et al. (2012) and (Page et al., 2020)

3.1 Definition of research objectives

This step involves defining specific research objectives to ensure alignment with the overarching aim outlined in Sect. 1: providing a comprehensive understanding of how the 2-tuple linguistic model is applied in marketing through a combination of systematic literature review and bibliometric analysis.

To achieve this comprehensive understanding, the following specific research objectives (ROs) have been defined:

- RO1: To identify key research themes in the application of the 2-tuple linguistic model in marketing and determine their importance through a strategic diagram analysis.
- RO2: To determine the marketing-related areas where the 2-tuple linguistic model has been predominantly applied.
- RO3: To assess the research impact of the 2-tuple linguistic model in these areas, measured by FWCI.
- RO4: To identify emerging or underexplored marketing-related areas where the 2-tuple linguistic model could provide valuable contributions in the future.

3.2 Literature databases selection and search strategy

This step involves selecting an appropriate database for the literature search and developing a comprehensive search strategy to identify relevant studies for the analysis.

Commonly accessible data sources include WoS and Scopus. This work selected WoS as the primary database because of its comprehensive coverage of high-quality, peer-reviewed journals across a wide range of disciplines. Although Scopus is also a valuable database, it has a high degree of overlap with WoS (Martín-Martín et al., 2021; Visser et al., 2021), which would result in numerous duplicate records if both databases were used for the same topic. To avoid unnecessary duplication of records, WoS was used to ensure a more streamlined and focused literature search on articles related to the application of the 2-tuple linguistic model in marketing between 2000 and 2024. Scopus was used solely to complement the article's FWCI, a field-normalized metric widely used to benchmark research impact fairly, regardless of differences in entity size, age, disciplinary profile, or publication-type composition (Purkayastha et al., 2019). It builds on the field-normalization approaches proposed by Lundberg (2007) and Waltman et al. (2011) by accounting for differences across document types, publication years, and research fields. FWCI applies harmonic rather than arithmetic averaging to calculate the expected number of citations for publications assigned to multiple fields; the detailed calculation procedure can be consulted in Purkayastha et al. (2019).

In accordance with the established objectives, a literature search was conducted at the end of January 2025 using a Topic Search (TS) with the following terms: "2-tuple linguistic model," "marketing," and their corresponding abbreviations (e.g., "2TL" for "2-tuple linguistic model"), as well as related synonyms (e.g., "advertising," "branding," "commercialization," "merchandising," "sales," "product," "promotion" for "marketing"). In WoS, a TS retrieves records where the specified terms appear in the Title, Abstract, or Author Keywords, providing a broader search than limiting it to the title or author keywords alone. The query used in WoS combined these terms with Boolean operators—OR for synonyms and abbreviations, AND for combining concepts—to ensure comprehensive coverage, that is, (TS=("2-tuple linguistic model" OR 2TL) AND TS=(marketing OR advertising OR branding OR commercialization OR merchandising …)), with the full query also including other relevant synonyms and abbreviations related to marketing.

The publication period was limited to articles published from 2000 to 2024. The preliminary search resulted in 165 papers. FWCI values for each article were retrieved manually from Scopus after the articles were collected from WoS. Articles were matched between WoS and Scopus using the Digital Object Identifier (DOI) to ensure accurate correspondence. For articles indexed in WoS but not found in Scopus, or for articles whose FWCI was not yet available in Scopus, the FWCI values were recorded as “NA”.

3.3 Establishment of selection criteria and study filtering

Establishing explicit inclusion and exclusion criteria for selecting studies is important. Figure 5 shows the process, adapted from the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) framework (Page et al., 2020), used to identify relevant and valid papers based on the established inclusion and exclusion criteria.

Duplicated articles that may appear for various reasons (e.g., corrections or different versions) in WoS were removed. Conference papers were also excluded, as they

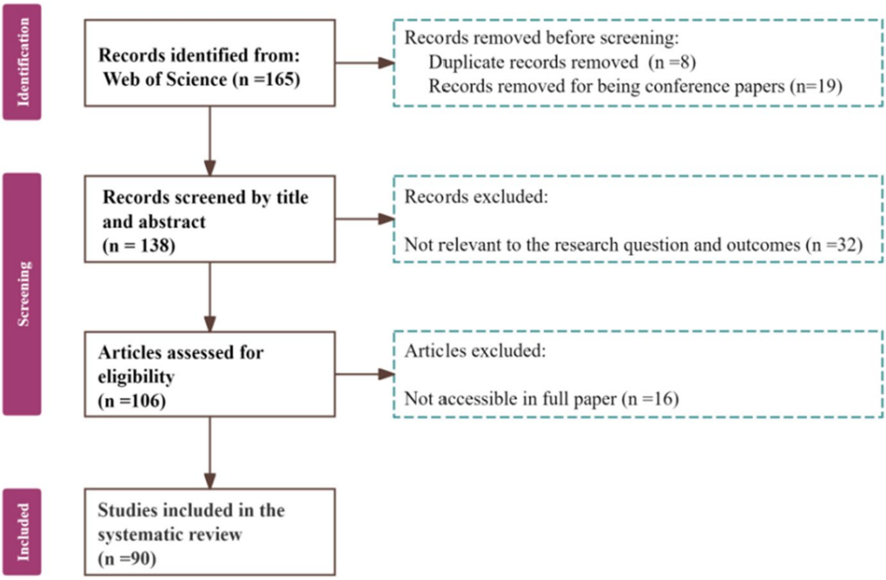

Fig. 5 Flow diagram of the study selection process, adapted from Page et al. (2020)

are usually not considered peer-reviewed articles. Titles and abstracts were reviewed to exclude irrelevant papers, such as those unrelated to the 2-tuple linguistic model or marketing. Only journal articles with full papers available were included to ensure a comprehensive understanding of the content, resulting in a final sample of 90 articles, published between 2008 and 2024.

3.4 Analysis of the selected studies

This step consists of two complementary approaches: a bibliometric analysis to identify thematic clusters based on the co-occurrence of keywords of selected papers (see Sect. 3.3.1), and a systematic literature review featuring an in-depth full-text analysis to extract content-driven perspectives (see Sect. 3.3.2).

3.4.1 Bibliometric analysis

Bibliometric analysis is a quantitative method that integrates mathematical and statistical techniques. This work conducts a bibliometric analysis, focusing on constructing strategic diagrams based on the co-occurrence of keywords from the articles selected in the previous step. This helps identify the principal themes in which the 2-tuple linguistic model has been applied.

SciMAT (Cobo et al., 2012), a useful tool for science mapping analysis, is employed to generate strategic diagrams. This tool maps the thematic structure of the research field over the designated study period by identifying thematic clusters based on the co-occurrence of keywords from the selected publications. These themes are then visualized through a strategic diagram that highlights the importance of each cluster in the co-occurrence analysis. In this work, keyword co-occurrence was normalized using the equivalence index in SciMAT. Clustering was performed using the simple centers algorithm with the default co-occurrence threshold defined in SciMAT, a minimum cluster size of 3 keywords, and a maximum cluster size of 12 keywords. Keywords were extracted from the author, source, and added terms, and then filtered according to frequency criteria before analysis. The thematic evolution was assessed using the inclusion index, while theme overlap was measured using the Jaccard index. Figure 6 illustrates the strategic diagram, in which themes are positioned according to their centrality and density, enabling the identification of four thematic categories.

As shown in Fig. 6, the diagram is based on two measures: centrality and density. Centrality, represented on the x-axis, indicates the degree to which the different themes—keyword clusters—are related to each other, while density, shown on the y-axis, reflects the extent to which the themes are well developed (Muñoz-Leiva et al., 2022). And the size of the nodes corresponds to the number of publications. The strategic diagram is divided into four quadrants, each offering a different interpretation as follows (Cobo et al., 2012):

- Motor themes (quadrant I): these themes exhibit both high centrality and high density, indicating they are well-developed and play a central role in the research field.

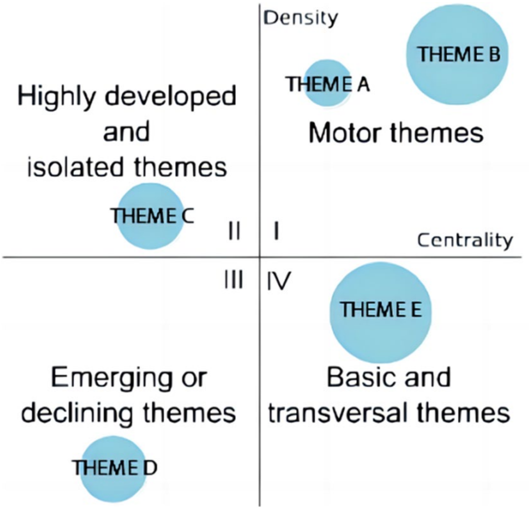

Fig. 6 Strategic diagram (Cobo et al., 2012; Muñoz-Leiva et al., 2022)

- Highly developed and isolated themes (quadrant II): these themes have high density but low centrality, indicating they are well-developed internally yet have limited connections to other themes, making them isolated.
- Emerging or declining themes (quadrant III): these themes show low centrality and low density, indicating they are either emerging or declining in importance within the field.
- Basic and transversal themes (quadrant IV): these themes have high centrality but low density, suggesting they are important for connecting different areas of research but are not yet well developed.

Based on the strategic diagram, the principal themes where the 2-tuple linguistic model has been applied can be identified. The related results are shown and explained in detail in Sect. 4.1.

3.4.2 Systematic literature review

A systematic literature review is a structured method involving the comprehensive identification, evaluation, and synthesis of existing studies. As its name suggests, it is a systematic procedure that includes the following stages: defining clear research questions, conducting a thorough search across selected literature databases, establishing explicit inclusion and exclusion criteria, selecting relevant studies based on predefined criteria, critically appraising the quality of the selected studies, extracting key data, and synthesizing the findings to draw meaningful conclusions. This structured approach ensures transparency and provides a reliable overview of the available evidence on a given topic.

In this work, a systematic literature review is conducted by performing full-text content analysis on the selected papers to uncover the specific application areas of the 2-tuple linguistic model in marketing. These areas include a wide range of marketing topics such as product development and innovation, pricing strategies, supplier evaluation and management, service quality assessment and improvement, customer relationship management, brand management, and other critical aspects of marketing operations and strategic DM. The related results are shown and explained in detail in Sect. 4.2.

4 Results analysis and interpretation

This section presents the results of the bibliometric analysis (see Sect. 4.1) and systematic literature review (see Sect. 4.2) on studies related to the application of the 2-tuple linguistic model in marketing. To enhance the visualization of the analysis results, this work integrates the outcomes of both methods into layered graphs (see Sect. 4.3). Moreover, the importance of each application area within its respective theme is evaluated using the FWCI indicator from Scopus, which serves as a more normalized alternative to mere citation counts.

4.1 Bibliometric analysis

This section presents the results of the bibliometric analysis from the SciMAT report, with a primary focus on the strategic diagram illustrating the quadrant to which each theme belongs. Figure 7 presents the strategic diagram for the full study period (2008–2024) without time slicing, comprising five thematic clusters.

As shown in Fig. 7, alongside the cluster "Multiple Attribute Decision Making (MADM)", "Multiple Attribute Group Decision Making (MAGDM)" also emerges as a motor theme due to its high centrality and density. These themes play a central role in the research field, being both internally cohesive and extensively connected with the rest of the domain. MAGDM is closely related to MADM, as it extends the analytical structure of MADM to contexts involving multiple decision-makers by integrating multi-attribute evaluation with the collaborative processes characteristic of Group Decision Making (GDM). The prominence of MAGDM can be attributed to the growing emphasis on collective decision-making in marketing and management, where preferences from multiple stakeholders, experts, or consumers must be aggregated under uncertainty. This trend aligns with the rise of participatory decision-making environments, consensus-reaching models, and group-based evaluation mechanisms applied in areas such as supplier management and customer experience management.

Interestingly, within the articles analyzed, "GDM" itself is classified as a basic and transversal theme, marked by high centrality but low density. This indicates that, although the theme "GDM" plays a key role in connecting various research areas (e.g., with "MADM"), it remains underdeveloped in terms of internal cohesion and conceptual maturity. Its lower density suggests that it functions more as a set of foundational concepts.

Moreover, the theme "MCDM" is classified as highly developed but isolated, characterized by high density and low centrality. This suggests that, despite its broader scope compared to MADM, within the articles analyzed in this work, MCDM is well-developed internally but has less extensive connections to other themes.

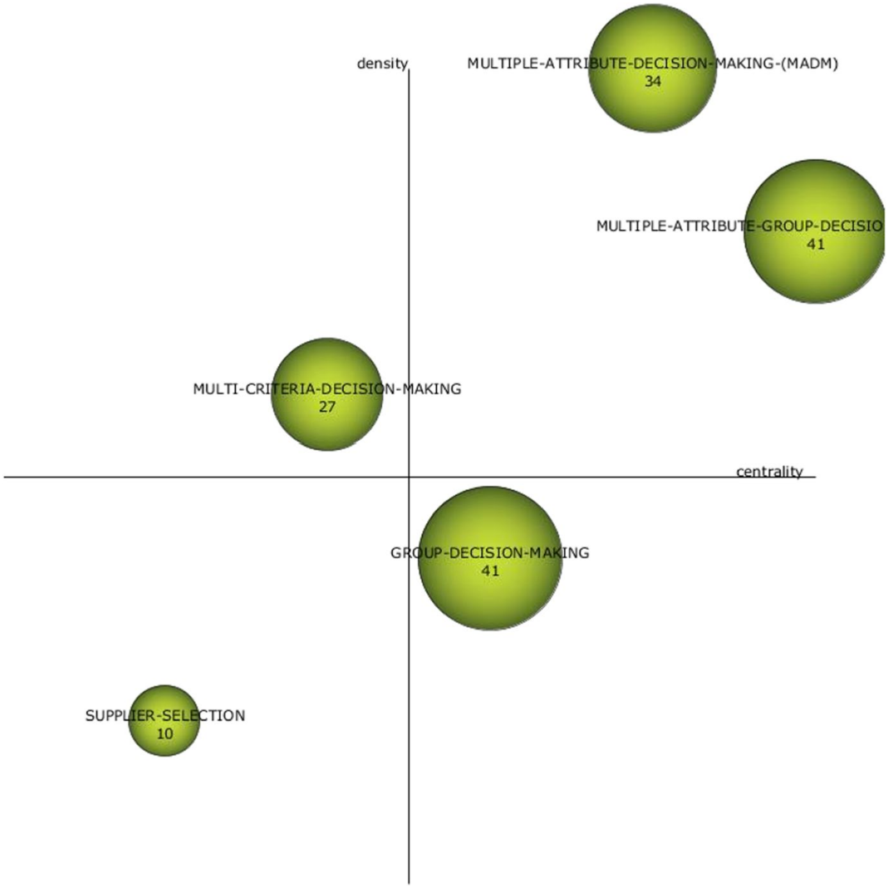

Fig. 7 Strategic diagram for the period from 2008 to 2024

The fifth theme, "Supplier Selection", is categorized as an emerging or declining theme due to its low centrality and low density. This suggests that, based on the analyzed literature, it has fewer connections to the core of the research field and a less consolidated internal development. However, it may still represent an emerging topic with potential for future growth. Unlike the other four themes, "Supplier Selection" is better understood as an application area, as it focuses on the practical implementation of DM methods rather than contributing to the development of core theoretical frameworks.

Notably, a closer examination of the SciMAT reports for each theme reveals that some articles are associated with more than one cluster. This overlap underscores the need for a deeper understanding of the relationships among MCDM, MADM, MAGDM, and GDM—all of which solve DM problems. Clarifying how these frameworks differ and interrelate is essential for accurately assigning each article to its most appropriate thematic cluster. A brief explanation of the relationships among these concepts is provided below (see also Fig. 8):

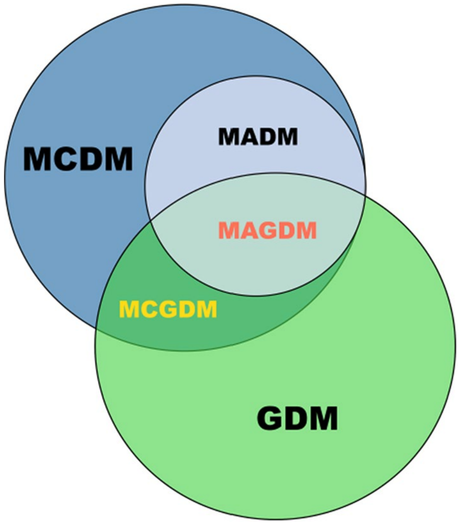

Fig. 8 Relationship of DM themes

- MCDM: a discipline that deals with decisions involving the choice of the best alternative from several potential candidates, subject to several criteria or attributes that may be concrete or vague (Uzun et al., 2021). It includes both individual and group DM settings and serves as the foundational field for more specific approaches.
- MADM: a type of MCDM that is applied to solve problems involving discrete decision variables and limited DM schemes (Feng et al., 2022).
- GDM: a process of making decisions within a group setting, utilizing a larger pool of expertise and viewpoints to reach conclusions (Hogg, 2001). It involves considering various perspectives and potential biases that may impact the final decision, and it may or may not involve multiple criteria.
- MAGDM: an intersection of MADM and GDM, where a group of decision-makers evaluates alternatives based on multiple attributes.
- Multi-Criteria Group Decision Making (MCGDM): an intersection of MCDM and GDM, where a group of decision-makers evaluates alternatives based on multiple criteria. It represents a broader category than MAGDM, as it integrates the full range of MCDM techniques within group settings, potentially encompassing both attribute-based (discrete) and criteria-based (continuous or hybrid) approaches. Although this type is not shown in Fig. 7, articles that fall under both MCDM and GDM simultaneously should be considered part of this category.

Based on the previous explanation of different DM themes, if an article falls under two or more cluster themes simultaneously, it will be reassigned to a more specific theme. For instance, an article categorized under both MCDM and GDM will be reclassified as MCGDM; if it belongs to both MADM and GDM, it will be assigned to MAGDM, and so on. The updated themes for each article can be found in Sect. 4.3.

4.2 Systematic literature review

This section presents the results of the systematic literature review, which complements the findings of the bibliometric analysis by offering deeper insights into the specific application areas of the 2-tuple linguistic model in marketing. Table 1 pres-

Table 1 Marketing-related areas and associated articles

Areas related to marketing	Article IDs [References]
Blockchain	77 (Khan & Ahmad, 2023)
Brand Management	12 (Cid-López et al., 2015a); 13 (Cid-López et al., 2015b); 19 (Li et al., 2017); 20 (Carrasco et al., 2017); 34 (Zhang et al., 2019); 47 (Giráldez-Cru et al., 2021); 61 (Zhang et al., 2023); 64 (Li, 2023); 65 (Sun et al., 2023)
Business Intelligence	62 (Chen, 2023a); 63 (Akram et al., 2023a)
Business performance evaluation	53 (Liu, 2022)
Consumer Behavior	38 (Giráldez-Cru et al., 2020); 44 (Mandal et al., 2021); 59 (Forghani et al., 2023); 69 (Giráldez-Cru et al., 2023)
Corporate financial management	76 (Mu, 2024)
Corporate Social Responsibility assessment	8 (Costa & Menichini, 2013)
Customer Experience Management	41 (Bueno et al., 2021); 57 (Marín Díaz & Carrasco González, 2023); 58 (Naz et al., 2023a)
Customer segmentation	42 (Martínez et al., 2021); 48 (Marín Díaz et al., 2021); 51 (Shu et al., 2023b)
Digital Marketing	10 (Mi et al., 2014); 49 (Forghani et al., 2022); 52 (Naz et al., 2023b); 67 (Marín Díaz et al., 2023); 72 (Shu et al., 2024); 89 (Wu et al., 2024)
Digital Transformation	60 (Marín Díaz & Galdón Salvador, 2023)
E-commerce	73 (Mao, 2024); 74 (Yang et al., 2024a); 75 (Xu, 2024)
Internal Marketing	3 (Fan et al., 2009a); 18 (Bao et al., 2017)
Knowledge Management	2 (Fan et al., 2009b); 4 (Tai & Chen, 2009)
Lean Management	15 (Wu et al., 2016)
Product Development and Innovation	5 (Wang, 2009); 7 (Li, 2012); 9 (Wang, 2013); 16 (Wang et al., 2016); 21 (Liu et al., 2017); 23 (Liu et al., 2018); 24 (Cid-López et al., 2018); 25 (Mi et al., 2018); 27 (Dursun & Arslan, 2018); 29 (Setti et al., 2019); 36 (Yuan et al., 2020); 54 (Geng et al., 2023); 55 (Chen et al., 2023); 68 (Zhong et al., 2023); 78 (Alamoodi et al., 2024); 86 (Zhang et al., 2024); 90 (Yang et al., 2024b)
Resource management and Investment	35 (Wang et al., 2019a); 50 (Wang, 2021)
Risk management	14 (Xing & Xing, 2016); 45 (Choudhary et al., 2021); 81 (Naz et al., 2024); 85 (Chang et al., 2024)
Service Quality	70 (Akram et al., 2023b)
Supplier management	1 (Wang, 2008); 6 (Dhouib & Elloumi, 2011); 11 (Crispim et al., 2015); 17 (Santos et al., 2017); 22 (Wan et al., 2017); 26 (Deng et al., 2018); 28 (Cheng et al., 2019); 30 (Sohaib et al., 2019); 31 (Wang et al., 2019b); 32 (Wei et al., 2019); 33 (Wang et al., 2019c); 37 (Wen et al., 2020); 39 (Wei et al., 2020); 40 (Zhang et al., 2020); 43 (Lizarelli et al., 2021); 56 (Chen, 2023b); 66 (Chung et al., 2023); 71 (Büyüközkan et al., 2023); 82 (Alballa et al., 2024); 84 (Galdón Salvador & Marín Díaz, 2024); 87 (Ahmad et al., 2024)
Sustainable Marketing	46 (Fan et al., 2021); 79 (Chen et al., 2024); 80 (Naz et al., 2023c); 83 (Ali et al., 2024); 88 (Mao et al., 2024)

ents the marketing-related areas identified in this work through a systematic literature review of 90 articles, along with their corresponding article IDs.

As shown in Table 1, "Supplier management" and "Product Development and Innovation" are two prominent marketing-related areas where the 2-tuple linguistic model has been widely applied. Many studies have used this model to support supplier selection and evaluation processes, as well as to optimize supply chain management. "Supplier Selection," previously identified as an emerging or declining theme in the bibliometric analysis, can, through the systematic literature review, be better understood as an application area that forms part of supplier management. Regarding product development and innovation, the 2-tuple linguistic model has been employed to assist in idea evaluation, project selection, and DM under uncertainty, helping organizations prioritize initiatives and allocate resources more effectively. These applications demonstrate the model's utility in various contexts of marketing.

4.3 Integrated findings

This section presents the combined results of the systematic literature review and bibliometric analysis. Figure 9 shows a layered network graph that integrates three types of information:

- thematic layers (large colored circles): are derived from the bibliometric analysis, with different colors used to distinguish them. For example, "Other" represents themes not directly related to DM methodologies identified through the bibliometric analysis (see also Fig. 8).
- marketing-related areas layers (medium-sized orange circles): are identified through the systematic literature review (e.g., "Supplier management," "Product Development and Innovation," "Digital Marketing," "Brand Management"; see also Table 1). The size of each orange node reflects the number of articles associated with that application area.
- article layer (small numbered nodes): display article IDs (see also Table 1) and indicate the number of articles linked to each application area within the corresponding theme.

As shown in Fig. 9, MAGDM, one of the high-density clusters identified in Fig. 7, emerges as the most dominant theme. It exhibits strong connections to several marketing-related areas, including "Supplier management," "Product Development and Innovation," "Customer Experience Management," and "Risk Management". For instance, the connection between MAGDM and Customer Experience Management research reflects the growing use of group-based preference modeling to capture heterogeneous consumer perceptions. From a theoretical perspective, MAGDM provides a structured framework for incorporating multiple criteria and stakeholder perspectives, with significant implications for consumer behavior modeling, service design, and strategic marketing decision-making. Methodologically, the integration of 2-tuple linguistic models within MAGDM further enhances its utility by improving the aggregation of heterogeneous preferences, capturing nuanced perceptions of product attributes, and supporting scenario-based decision-making, ultimately

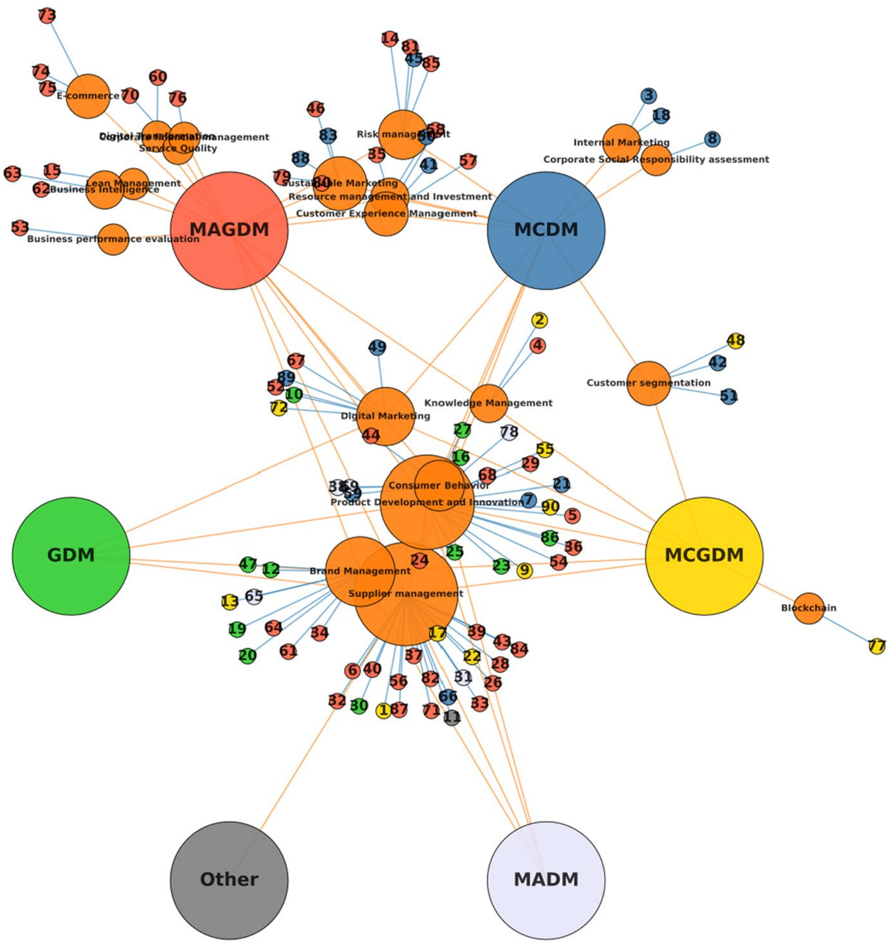

Fig. 9 Layered network graph of the combined results

enabling firms to develop more tailored offerings and refine marketing strategies under uncertainty.

MCDM also plays an important role, being linked to areas like "Digital Marketing," "Corporate Social Responsibility assessment," and "Customer segmentation," highlighting and underscoring innovation opportunities in marketing strategy, data-driven decision-making, and personalized customer experiences. Figure 10 presents a focused zoom on the MAGDM and MCDM themes to highlight their links with different marketing application areas. Moreover, GDM, MCGDM, and MADM exhibit fewer but still noticeable connections to marketing-related areas. In contrast, the "Other" theme has only a single connection, linking "Supplier management" to paper ID 11.

This work also investigates the importance of each application area within its respective themes, as it is evaluated using the FWCI indicator from Scopus, which serves as a more normalized alternative to mere citation counts. Figure 11 is a bubble

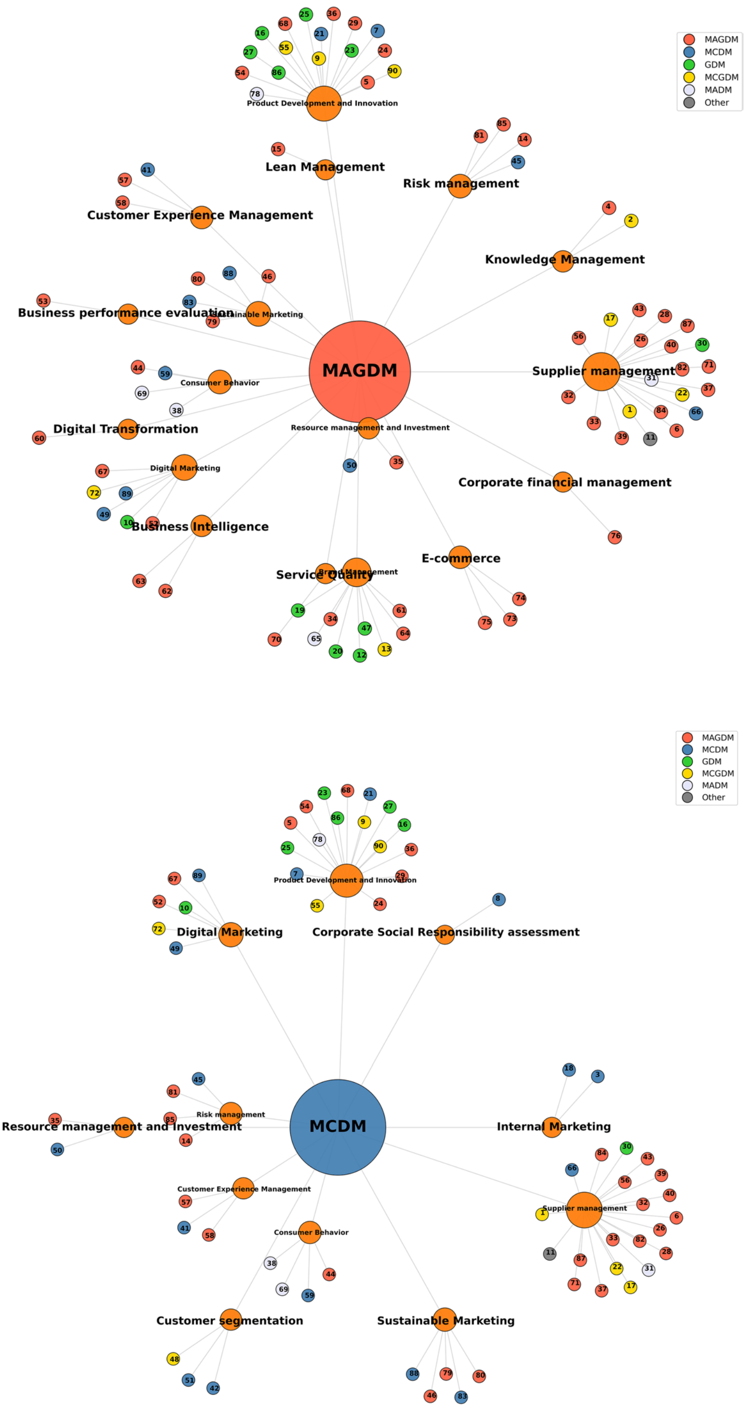

Fig. 10 Subgraphs of the layered network graph: MAGDM (top) and MCDM (bottom)

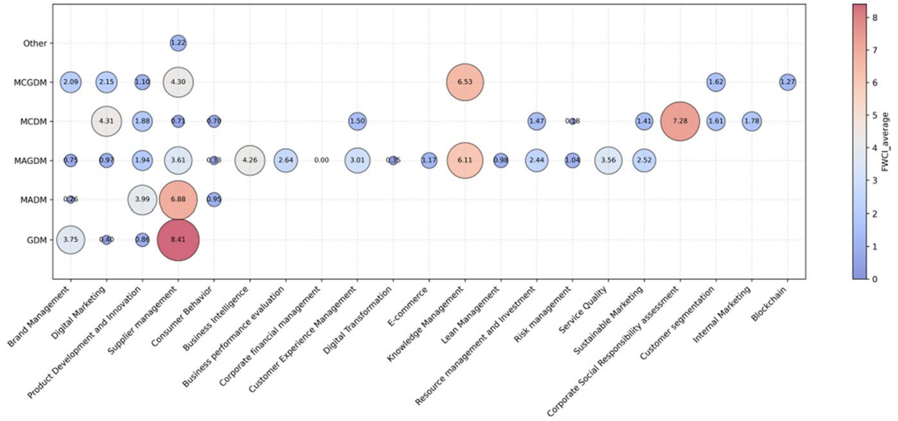

Fig. 11 FWCI average of each marketing-related area within each theme

chart where each point represents the FWCI indicator for each marketing-related area within each theme. The size of each bubble reflects the average FWCI for the papers related to that area, with larger bubbles indicating higher FWCI values.

As shown in Fig. 11, in both MADM and GDM themes, the marketing-related area "Supplier management" has higher average FWCI scores, suggesting a well-established or mature research cluster. In contrast, areas such as "Digital Marketing" (FWCI = 0.4 in GDM) and "Brand Management" (FWCI = 0.26 in MADM, although FWCI = 3.75 in GDM) have average FWCI scores below 1 (i.e., less than the average for similar publications), indicating less developed or emerging areas within these themes. Within the MAGDM theme, "Knowledge Management" (FWCI = 6.11) and "Business Intelligence" (FWCI = 4.26) show notably high FWCI scores, reflecting mature and highly impactful research. Conversely, "Corporate Financial Management" has an FWCI of 0, suggesting this area lacks sufficient citation data, suggesting minimal research influence or visibility in the field.

In the MCDM theme, "Corporate Social Responsibility assessment" (FWCI = 7.28) and "Digital Marketing" (FWCI = 4.31) exhibit higher citation impact, whereas "Risk Management" shows a lower score (FWCI = 0.18). For the MCGDM theme, "Knowledge Management" (FWCI = 6.53) and "Supplier Management" (FWCI = 4.3) stand out with higher average FWCI scores, indicating well-established areas. Especially compared to the other four DM themes (i.e., excluding the "Other" theme), MCGDM is the only theme where all marketing-related areas have an average FWCI score above 1, reflecting a consistently mature research cluster with strong impact.

Finally, the "Other" theme includes only the area of "Supplier management," with publications in this area cited 22% more than the average for similar works. However, when considered alongside Fig. 9, it can be concluded that despite having an FWCI greater than 1, this theme should be viewed more as an application area of marketing rather than as a standalone theme, as it does not have strong connections with other areas, especially when compared to more interconnected themes like MAGDM or MCDM.

5 Conclusions

This work provides a comprehensive understanding of how the 2-tuple linguistic model is applied in marketing by combining bibliometric analysis and a systematic literature review. This comprehensive analysis helps to identify themes that may be overlooked by bibliometric analysis alone due to keyword limitations or indexing inconsistencies. Furthermore, it bridges the marketing-related areas identified through the systematic literature review with those revealed by bibliometric analysis at the article level. This enhances analytical rigor by leveraging complementary strengths: bibliometric analysis quantitatively examines large volumes of scholarly publications to uncover trends and research themes, while the systematic review allows for a detailed examination of each article to verify and refine thematic classifications. Another contribution of this work is the use of the FWCI indicator as a normalized alternative to raw citation counts, allowing for more accurate comparisons of research impact in the field.

This work starts with a concise overview of the main CWW concepts and explains the basics and practical uses of the 2-tuple linguistic model. It then analyzes articles published between 2000 and 2024 from the WoS database (90 out of 165 publications) and incorporates Scopus-derived FWCI metrics to evaluate both the impact of individual articles and the average influence of research in marketing-related areas. The results of the bibliometric analysis, generated using SciMAT, focus primarily on the strategic diagram to identify the main themes in which the 2-tuple linguistic model has been applied. The findings show that the principal themes in which the 2-tuple linguistic model is applied are largely related to DM problems (e.g., MADM, MAGDM, MCDM, etc.). Among these, MAGDM stands out as the most prominent theme, not only because it is classified as a motor theme, but also due to its strong connections with various marketing-related areas.

According to the systematic literature review, the most prominent marketing-related areas where the 2-tuple linguistic model has been widely applied are "Supplier management" and "Product Development and Innovation". In terms of the importance of each application area within its respective theme, measured by the average FWCI score of each marketing-related area, MCGDM stands out as the only DM theme where all associated areas have an average FWCI score above 1, indicating a consistently strong research impact. High-impact marketing-related areas—identified by an average FWCI score of 4 or higher, include "Supplier management," "Digital Marketing," "Business Intelligence," "Product Development and Innovation," "Knowledge Management," and "Corporate Social Responsibility assessment." This demonstrates the well-established application of the 2-tuple linguistic model in these areas, along with a high level of research impact in marketing. Deepening the application of the 2-tuple linguistic model in these areas can further enhance DM processes in marketing contexts. A prime example is supplier management, where the 2-tuple linguistic model's integration with MADM or GDM methods has demonstrated a strong impact and practical utility in handling the linguistic information provided by decision makers, such as experts. On the other hand, lower-impact marketing-related areas (e.g., Digital Transformation, Consumer Behavior, etc.) may represent potential opportunities where the 2-tuple linguistic model could be applied to solve various DM problems in marketing.

To sum up, the objectives of this work have been successfully achieved. The insights presented highlight the current applications of the 2-tuple linguistic model in marketing and point to valuable opportunities for expanding its use across the field. However, several limitations should be acknowledged. This work relies primarily on WoS, which may introduce database bias, as WoS selectively indexes journals and may underrepresent certain fields or regions. We included only full-text journal articles, excluding conference papers and other publication types, which may limit the scope of our analysis. Moreover, the FWCI retrieved from Scopus has some constraints. FWCI is calculated only for publications indexed in Scopus, so articles not included in Scopus are excluded. It can also be strongly influenced by outlier publications, which may skew the interpretation of impact metrics. These limitations could be addressed in future work by using multiple databases, including additional publication types, or exploring more metrics less sensitive to outliers, providing a more comprehensive view of the field.

Acknowledgements The authors gratefully acknowledge the support provided by the project-PID2024-155289NB-I00 funded by MICIU/AEI/10.13039/501100011033 and ERDF/EU. They also wish to thank Universidad Complutense de Madrid, ENAE Business School, and Universidad Rey Juan Carlos for their continued support.

Author contributions Ziwei Shu conducts Conceptualization, Data Curation, Methodology, Software, Validation, Funding acquisition, Formal analysis, Investigation, Writing (Original Draft, Review and editing), and Visualization. José Javier Galán Hernández conducts Methodology, Software, Resources, Writing (Review and editing), Supervision, and Funding acquisition. Álvaro Carrasco-Aguilar conducts Writing (Review and editing), Investigation, Software, Visualization and Validation. All authors read and approved the final manuscript.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. This work was supported by the project PID2024-155289NB-I00 funded by MICIU/AEI/10.13039/501100011033 and ERDF/EU. This work was also supported by ENAE Business School, Center of Excellence in Digitalization (grant DIGIT–032026–JJGH).

Data availability The dataset supporting the analyses presented in this paper, as well as the corresponding SciMAT project file, are available from the corresponding author upon request.

Declarations

Competing interests The authors declare no competing interests.

References

Ahmad, U., Khan, A., Shhazadi, S. (2024). Extended ELECTRE I method for decision-making based on 2-tuple linguistic q-rung picture fuzzy sets. Soft Computing.

Akram, M., Bibi, R., & Deveci, M. (2023a). An outranking approach with 2-tuple linguistic fermatean fuzzy sets for multi-attribute group decision-making. *Engineering Applications of Artificial Intelligence, 121*, Article 105992.

Akram, M., Naz, S., Edalatpanah, S. A., & Samreen, S. (2023b). A hybrid decision-making framework under 2-tuple linguistic complex q-rung orthopair fuzzy Hamy mean aggregation operators. *Computational and Applied Mathematics, 42*(3), Article 118.

Alamoodi, A. H., Albahri, O. S., Deveci, M., Albahri, A. S., Yussof, S., Dinçer, H., Yüksel, S., & Mohamad Sharaf, I. (2024). Selection of electric bus models using 2-tuple linguistic T-spherical fuzzy-based decision-making model. *Expert Systems with Applications, 249*, Article 123498.

Alballa, T., Alamer, A., Nasir, K., Yousaf, A., Abdualziz Alhabeeb, S., & Abd El-Wahed Khalifa, H. (2024). A multiple attribute group decision making model based on 2-tuple linguistic pythagorean fuzzy dombi aggregation operators for optimal selection of potential global suppliers. *Heliyon, 10*(14), Article e34570.

Ali, Z., Hayat, K., & Pamucar, D. (2024). Analysis of Hamacher power aggregation operators for circular complex p, q-quasirung orthopair fuzzy 2-tuple linguistic sets and their application in green industry development. *Heliyon, 10*(17), Article e36799.

Bao, J., Johansson, J., & Zhang, J. (2017). Comprehensive evaluation on employee satisfaction of mine occupational health and safety management system based on improved AHP and 2-tuple linguistic information. *Sustainability, 9*(1), 133.

Basu, R., Lim, W. M., Kumar, A., & Kumar, S. (2023). Marketing analytics: the bridge between customer psychology and marketing decision-making. *Psychology & Marketing, 40*(12), 2588–2611.

Borrero-Domínguez, C., & Escobar-Rodríguez, T. (2023). Decision support systems in crowdfunding: a fuzzy cognitive maps (FCM) approach. *Decision Support Systems, 173*, Article 114000.

Bueno, I., Carrasco, R. A., Porcel, C., Kou, G., & Herrera-Viedma, E. (2021). A linguistic multi-criteria decision making methodology for the evaluation of tourist services considering customer opinion value. *Applied Soft Computing, 101*, Article 107045.

Büyüközkan, G., Uztürk, D., & Maden, A. (2023). Influential factor analysis for cloud computing technology service provider. *Technological Forecasting and Social Change, 192*, Article 122531.

Carrasco, R. A., Sánchez-Fernández, J., Muñoz-Leiva, F., Francisca Blasco, M., & Herrera-Viedma, E. (2017). Evaluation of the hotels e-services quality under the user's experience. *Soft Computing, 21*(4), 995–1011.

Chang, K.-H., Chen, Y.-J., & Liao, C.-C. (2024). A novel improved FMEA method using data envelopment analysis method and 2-tuple fuzzy linguistic model. *Annals of Operations Research, 341*(1), 485–507.

Chartered Institute of Marketing. (2015). Marketing and the 7Ps: A brief summary of marketing and how it work. CIM. https://www.cim.co.uk/media/4772/7ps.pdf

Cheng, T.-E., Wang, J., Zhang, D.-J., & Cao, M.-M. (2019). TODIM method for evaluating the service quality of boutique tourist scenic spot with 2-tuple linguistic information. *Journal of Intelligent & Fuzzy Systems, 37*(2), 2075–2083.

Chen, H. (2023a). A multi-attribute decision-making framework for enterprise competitive intelligence system evaluation with 2-tuple linguistic neutrosophic information. *Journal of Intelligent & Fuzzy Systems, 45*(4), 5955–5970.

Chen, S., Zhang, Y., & Gong, J. (2023). A systematic decision-making approach for quality function deployment based on hesitant fuzzy linguistic term sets. *Applied Sciences, 13*(24), 13104.

Chen, X. (2023b). An integrated fuzzy group decision-making model for construction enterprise contractor selection based on EDAS method and information entropy. *Journal of Intelligent & Fuzzy Systems, 45*(2), 3233–3245.

Chen, X., Yang, S., Hu, D., & Li, X. (2024). Sustainable mining method selection by a multi-stakeholder collaborative multi-attribute group decision-making method. *Resources Policy, 92*, Article 105043.

Choudhary, D., Choudhary, A., Shankar, R., Hicks, C. (2021). Evaluating the risk exposure of sustainable freight transportation: A two-phase solution approach. Annals of Operations Research.

Chung, H.-Y., Chang, K.-H., & Yao, J.-C. (2023). Addressing environmental protection supplier selection issues in a fuzzy information environment using a novel soft fuzzy AHP–TOPSIS method. *Systems, 11*(6), Article 293.

Cid-López, A., Hornos, M. J., Carrasco-González, R. A., & Herrera-Viedma, E. (2018). Prioritization of the launch of ICT products and services through linguistic multi-criteria decision-making. *Technological and Economic Development of Economy, 24*(3), 1231–1257.

Cid-López, A., Hornos, M. J., Carrasco, R. A., & Herrera-Viedma, E. (2015a). SICTQUAL: A fuzzy linguistic multi-criteria model to assess the quality of service in the ICT sector from the user perspective. *Applied Soft Computing, 37*, 897–910.

Cid-López, A., Hornos, M. J., Carrasco, R. A., & Herrera-Viedma, E. (2015b). A hybrid model for decision-making in the information and communications technology sector. *Technological and Economic Development of Economy, 21*(5), 720–737.

Cobo, M., López-Herrera, A., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: a new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology, 63*(8), 1609–1630.

Costa, R., & Menichini, T. (2013). A multidimensional approach for CSR assessment: the importance of the stakeholder perception. *Expert Systems with Applications, 40*(1), 150–161.

Crispim, J., Rego, N., & Pinho de Sousa, J. (2015). Stochastic partner selection for virtual enterprises: a chance-constrained approach. *International Journal of Production Research, 53*(12), 3661–3677.

Deng, X., Wang, J., Wei, G., & Lu, M. (2018). Models for multiple attribute decision making with some 2-tuple linguistic pythagorean fuzzy Hamy mean operators. *Mathematics, 6*(11), 236.

Dhouib, D., & Elloumi, S. (2011). A new multi-criteria approach dealing with dependent and heterogeneous criteria for end-of-life product strategy. *Applied Mathematics and Computation, 218*(5), 1668–1681.

Dursun, M., & Arslan, Ö. (2018). An integrated decision framework for material selection procedure: a case study in a detergent manufacturer. *Symmetry, 10*(11), 657.

Estrella, F. J., Espinilla, M., Herrera, F., & Martínez, L. (2014). FLINTSTONES: A fuzzy linguistic decision tools enhancement suite based on the 2-tuple linguistic model and extensions. *Information Sciences, 280*, 152–170.

Fan, J., Yan, F., & Wu, M. (2021). GLDS method for multiple attribute group decision making under 2-tuple linguistic neutrosophic environment. *Journal of Intelligent & Fuzzy Systems, 40*(6), 11523–11538.

Fan, Z.-P., Feng, B., Sun, Y.-H., & Ou, W. (2009b). Evaluating knowledge management capability of organizations: a fuzzy linguistic method. *Expert Systems with Applications, 36*(2, Part 2), 3346–3354.

Fan, Z.-P., Feng, B., & Suo, W.-L. (2009a). A fuzzy linguistic method for evaluating collaboration satisfaction of NPD team using mutual-evaluation information. *International Journal of Production Economics, 122*(2), 547–557.

Feng, J., Yan, Y., Huang, M., Du, Y., Lu, Z., & Li, B. (2022). A study on the multi-attribute decision theory and methods. *Procedia Computer Science, 214*, 544–551.

Forghani, E., Sheikh, R., Hosseini, S. M. H., & Sana, S. S. (2022). The impact of digital marketing strategies on customer's buying behavior in online shopping using the rough set theory. *International Journal of System Assurance Engineering and Management, 13*(2), 625–640.

Forghani, E., Sheikh, R., & Sana, S. S. (2023). Extraction of rules related to marketing mix on customers' buying behavior using rough set theory and fuzzy 2-tuple approach. *International Journal of Management Science and Engineering Management, 18*(1), 16–25.

Galdón Salvador, J. L., & Marín Díaz, G. (2024). Enhancing business decision making through a new corporate reputation measurement model: practical application in a supplier selection process. *Sustainability, 16*(2), Article 523.

Geng, X., Li, Y., Zhang, H., & He, J. (2023). Configuration optimization of product-service system design requirements based on hesitant information axiom. *Journal of Intelligent & Fuzzy Systems, 45*(5), 9007–9028.

Giráldez-Cru, J., Chica, M., & Cordón, O. (2021). A framework of opinion dynamics using fuzzy linguistic 2-tuples. *Knowledge-Based Systems, 233*, Article 107559.

Giráldez-Cru, J., Chica, M., & Cordón, O. (2023). An integrative decision-making mechanism for consumers' brand selection using 2-Tuple fuzzy linguistic perceptions and decision heuristics. *International Journal of Fuzzy Systems, 25*(1), 59–79.

Giráldez-Cru, J., Chica, M., Cordón, O., & Herrera, F. (2020). Modeling agent-based consumers decision-making with 2-tuple fuzzy linguistic perceptions. *International Journal of Intelligent Systems, 35*(2), 283–299.

Gupta, P. K., & Andreu-Perez, J. (2022). A gentle introduction and survey on computing with words (CWW) methodologies. *Neurocomputing, 500*, 921–937.
Gupta, P. K., & Muhuri, P. K. (2018). A novel approach based on computing with words for monitoring the heart failure patients. *Applied Soft Computing, 72*, 457–473.
Herrera, F., Martinez, L. (2000). A 2-tuple fuzzy linguistic representation model for computing with words. *IEEE Transactions on Fuzzy Systems*, 8(6), 746–752
Herrera-Viedma, E., Herrera, F., Martínez, L., Herrera, J. C., & López, A. G. (2004). Incorporating filtering techniques in a fuzzy linguistic multi-agent model for information gathering on the web. *Fuzzy Sets and Systems, 148*(1), 61–83.
Hogg, M. A. (2001). Group Processes, Social Psychology of. In: N. J. Smelser & P. B. Baltes (Eds.), International Encyclopedia of the Social & Behavioral Sciences, pp. 6417–6423.
Huseynova, F. (2020). Computing with Words in Natural Language Processing. In: R. A. Aliev, J. Kacprzyk, W. Pedrycz, M. Jamshidi, M. B. Babanli, & F. M. Sadikoglu (Eds.), 10th International Conference on Theory and Application of Soft Computing, Computing with Words and Perceptions—ICSCCW-2019, (pp. 621–625). Springer International Publishing.
Hye, A. (2025). Market analytics in the US livestock and poultry industry: using business intelligence for strategic decision-making. *International Journal of Business and Economics Insights, 5*(3), 170–204.
Jain, A., Gupta, D., Gupta, G., Aggarwal, S. (2017). Applications of computing with words in medicine: promises and potential. 2017 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), 1–6.
Kali, A., Shamoi, P., Zhangbyrbayev, Y., Zhandaulet, A. (2023). Computing with Words for Industrial Applications. In: K. Arai (Ed.), Intelligent Systems and Applications, (pp. 257–271). Springer International Publishing
Kargin, A., Petrenko, T. (2023). Knowledge Distillation for Autonomous Intelligent Unmanned System. In: W. Pedrycz & S.-M. Chen (Eds.), Advancements in Knowledge Distillation: Towards New Horizons of Intelligent Systems, (pp. 193–230). Springer International Publishing.
Khan, A., & Ahmad, U. (2023). Multi-criteria group decision-making based on 2-tuple linguistic q-rung picture fuzzy sets. *Granular Computing, 9*(1), Article 8.
Lemon, K. N., & Verhoef, P. C. (2016). Understanding customer experience throughout the customer journey. *Journal of Marketing, 80*(6), 69–96.
Li, C., & Yu, X. (2022). Consensus reaching model for counter-intuitive in D-S evidence theory and application under 2-tuple linguistic representation. *Engineering Applications of Artificial Intelligence, 112*, Article 104832.
Li, M. (2012). The extension of quality function deployment based on 2-tuple linguistic representation model for product design under multigranularity linguistic environment. *Mathematical Problems in Engineering, 2012*(1), Article 989284.
Li, R. (2023). An integrated group decision-making method for brand packaging design effect evaluation based on the 2-tuple linguistic Pythagorean fuzzy sets. *Journal of Intelligent & Fuzzy Systems, 45*(2), 2167–2177.
Liu, A., Zhu, Q., Liu, H., Lu, H., & Tsai, S.-B. (2018). A novel approach based on kano model, interval 2-tuple linguistic representation model, and prospect theory for apperceiving key customer requirements. *Mathematical Problems in Engineering, 2018*(1), 8192819.
Liu, H. (2022). Performance evaluation of family business strategic transition based on the 2-tuple linguistic neutrosophic number multiple attribute group decision making. *Journal of Intelligent & Fuzzy Systems, 44*, 1–13.
Liu, H.-C., You, X.-Y., Xue, Y.-X., & Luan, X. (2017). Exploring critical factors influencing the diffusion of electric vehicles in China: a multi-stakeholder perspective. *Research in Transportation Economics, 66*, 46–58.
Liu, J., Martínez, L., Wang, H., Rodríguez, R. M., & Novozhilov, V. (2010). Computing with words in risk assessment. *International Journal of Computational Intelligence Systems, 3*(4), 396–419.
Li, W., Yu, S., Pei, H., Zhao, C., & Tian, B. (2017). A hybrid approach based on fuzzy AHP and 2-tuple fuzzy linguistic method for evaluation in-flight service quality. *Journal of Air Transport Management, 60*, 49–64.
Lizarelli, F. L., Osiro, L., Ganga, G. M. D., Mendes, G. H. S., & Paz, G. R. (2021). Integration of SERVQUAL, analytical kano, and QFD using fuzzy approaches to support improvement decisions in an entrepreneurial education service. *Applied Soft Computing, 112*, Article 107786.
Lundberg, J. (2007). Lifting the crown—citation z-score. *Journal of Informetrics, 1*(2), 145–154.
Mandal, M., Mohanty, B. K., & Dash, S. (2021). Understanding consumer preference through fuzzy-based recommendation system. *IIMB Management Review, 33*(4), 287–298.

Mao, C. (2024). Enhanced group decision-making through an intelligent algorithmic approach for multiple-attribute credit evaluation with 2-tuple linguistic neutrosophic sets. *International Journal of Knowledge-Based and Intelligent Engineering Systems, 28*(1), 163–177.

Mao, Q., Gao, Y., & Fan, J. (2024). An integrated MCDM framework for tidal current power plant site selection based on interval 2-tuple linguistic. *Regional Studies in Marine Science, 74*, Article 103518.

Marín Díaz, G., Carrasco González, R. A. (2023). Fuzzy logic and decision making applied to customer service optimization. Axioms, 12(5), 448.

Marín Díaz, G., Carrasco, R. A., & Gómez, D. (2021). RFID: A fuzzy linguistic model to manage customers from the perspective of their interactions with the contact center. *Mathematics, 9*(19), Article 2362.

Marín Díaz, G., & Galdón Salvador, J. L. (2023). Group decision-making model based on 2-Tuple fuzzy linguistic model and AHP applied to measuring digital maturity level of organizations. *Systems, 11*(7), Article 341.

Marín Díaz, G., Galdón Salvador, J. L., & Galán Hernández, J. J. (2023). Smart cities and citizen adoption: exploring tourist digital maturity for personalizing recommendations. *Electronics, 12*(16), Article 3395.

Martínez, L., & Herrera, F. (2012). An overview on the 2-tuple linguistic model for computing with words in decision making: extensions, applications and challenges. *Information Sciences, 207*, 1–18.

Martínez, L., Rodriguez, R. M., Herrera, F. (2015). Linguistic Decision Making and Computing with Words. In: L. Martínez, R. M. Rodriguez, & F. Herrera (Eds.), The 2-tuple Linguistic Model: Computing with Words in Decision Making, (pp. 1–21). Springer International Publishing.

Martínez, R. G., Carrasco, R. A., Sanchez-Figueroa, C., & Gavilan, D. (2021). An RFM model customizable to product catalogues and marketing criteria using fuzzy linguistic models: case study of a retail business. *Mathematics, 9*(16), Article 1836.

Martín-Martín, A., Thelwall, M., Orduna-Malea, E., & Delgado López-Cózar, E. (2021). Google scholar, microsoft academic, scopus, dimensions, web of science, and opencitations' COCI: a multidisciplinary comparison of coverage via citations. *Scientometrics, 126*(1), 871–906.

Mi, C., Chen, Y., Zhou, Z., & Lin, C.-T. (2018). Product redesign evaluation: an improved quality function deployment model based on failure modes and effects analysis and 2-tuple linguistic. *Advances in Mechanical Engineering, 10*(11), 1687814018811227.

Mi, C., Shan, X., Qiang, Y., Stephanie, Y., & Chen, Y. (2014). A new method for evaluating tour online review based on grey 2-tuple linguistic. *Kybernetes, 43*(3/4), 601–613.

Mu, L. (2024). An integrated methodology for enterprise financial management capability evaluation based on EDAS technique and group decision making. *Journal of Intelligent & Fuzzy Systems, 46*(1), 2281–2296.

Muñoz-Leiva, F., Maria Eugenia, R., & Martí, B. (2022). Discovering prominent themes of the application of eye tracking technology in marketing research. *Cuadernos De Gestión, 22*, 97–113.

Naz, S., Fatima, S. S., Butt, S. A., & Tabassum, N. (2023b). A MAGDM model based on 2-tuple linguistic variables and power Hamacher aggregation operators for optimal selection of digital marketing strategies. *Granular Computing, 8*(6), 1955–1990.

Naz, S., Saeed, M. R., & Butt, S. A. (2023c). Multi-attribute group decision-making based on 2-tuple linguistic cubic q-rung orthopair fuzzy DEMATEL analysis. *Granular Computing, 9*(1), Article 12.

Naz, S., Shafiq, A., Butt, S. A., & Ijaz, R. (2023a). A new approach to sentiment analysis algorithms: extended SWARA-MABAC method with 2-tuple linguistic q-rung orthopair fuzzy information. *Engineering Applications of Artificial Intelligence, 126*, Article 106943.

Naz, S., Tasawar, A., Butt, S. A., Diaz-Martinez, J., & De-La-Hoz-Franco, E. (2024). An integrated CRITIC-MABAC model under 2-tuple linguistic cubic q-rung orthopair fuzzy information with advanced aggregation operators, designed for multiple attribute group decision-making. *The Journal of Supercomputing, 80*(19), 27244–27302.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ, 372, n71.

Petrescu, M., & Krishen, A. S. (2024). Marketing analytics in 2024 conferences: AI and data-driven decision-making. *Journal of Marketing Analytics, 12*(4), 743–745.

Pratihar, J., Dey, A., Khan, A., Banerjee, P., Pal, R. K. (2023). Computing with words for solving the fuzzy transportation problem. Soft Computing.

Purkayastha, A., Palmaro, E., Falk-Krzesinski, H. J., & Baas, J. (2019). Comparison of two article-level, field-independent citation metrics: field-weighted citation impact (FWCI) and relative citation ratio (RCR). *Journal of Informetrics, 13*(2), 635–642.

Ren, J., Gao, S., Tan, S., Dong, L., Scipioni, A., & Mazzi, A. (2015). Role prioritization of hydrogen production technologies for promoting hydrogen economy in the current state of China. *Renewable and Sustainable Energy Reviews, 41*, 1217–1229.

Rust, R. T. (2020). The future of marketing. *International Journal of Research in Marketing, 37*(1), 15–26.

Santos, LFdeOM., Osiro, L., & Lima, R. H. P. (2017). A model based on 2-tuple fuzzy linguistic representation and analytic hierarchy process for supplier segmentation using qualitative and quantitative criteria. *Expert Systems with Applications, 79*, 53–64.

Serrano-Guerrero, J., Bani-Doumi, M., Romero, F. P., & Olivas, J. A. (2024). A 2-tuple fuzzy linguistic model for recommending health care services grounded on aspect-based sentiment analysis. *Expert Systems with Applications, 238*, Article 122340.

Setti, D., Verona, M. N., Medeiros, B. B., & Restelli, A. (2019). Materials selection using a 2-tuple linguistic multi-criteria method. *Materials Research, 22*, Article e20180846.

Shu, Z., Carrasco González, R. A., García-Miguel, J. P., & Sánchez-Montañés, M. (2023b). Clustering using ordered weighted averaging operator and 2-tuple linguistic model for hotel segmentation: the case of TripAdvisor. *Expert Systems with Applications, 213*, Article 118922.

Shu, Z., Carrasco, R. A., Sánchez-Montañés, M., & García-Miguel, J. P. (2024). A multi-criteria decision support model for restaurant selection based on users' demand level: The case of Dianping.com. *Information Processing & Management, 61*(3), Article 103650.

Shu, Z., Llorens-Marin, M., Carrasco, R. A., & Romero, M. S. (2025). Customer electronic word of mouth management strategies based on computing with words: the case of Spanish luxury hotel reviews on TripAdvisor. *Electronics, 14*(2), Article 325.

Shu, Z., Torralba, M. H., Carrasco, R. A., & López, M. F. B. (2023a). Assessing customer satisfaction of London luxury hotels with the AHP method and the SERVPERF scale: A case study of customer reviews on TripAdvisor. *Procedia Computer Science, 221*, 73–80.

Singh, V. K., Singh, P., Karmakar, M., Leta, J., & Mayr, P. (2021). The journal coverage of web of science, scopus and dimensions: a comparative analysis. *Scientometrics, 126*(6), 5113–5142.

Sohaib, O., Naderpour, M., Hussain, W., & Martinez, L. (2019). Cloud computing model selection for e-commerce enterprises using a new 2-tuple fuzzy linguistic decision-making method. *Computers & Industrial Engineering, 132*, 47–58.

Sun, P., Cui, T., & Qi, S. (2023). MADM framework based on 2-tuple linguistic neutrosophic sets and its application to comprehensive evaluation of corporate cultural competitiveness. *Journal of Intelligent & Fuzzy Systems, 45*(5), 7921–7937.

Tai, W.-S., & Chen, C.-T. (2009). A new evaluation model for intellectual capital based on computing with linguistic variable. *Expert Systems with Applications, 36*(2, Part 2), 3483–3488.

Tamir, D., Neumann, S., Rishe, N., Kandel, A., Zadeh, L. (2019). Computing with Words—A Framework for Human-Computer Interaction. In: D. D. Schmorrow & C. M. Fidopiastis (Eds.), Augmented Cognition, (pp. 356–372). Springer International Publishing.

Trung, N. Q., & Thanh, N. V. (2022). Evaluation of digital marketing technologies with fuzzy linguistic MCDM methods. *Axioms, 11*(5), 230.

Tymchuk, O., Iepik, M., & Sivyakov, A. (2017). Information security risk assessment model based on computing with words. *MENDEL, 23*(1), 119–124.

Uzun, B., Ozsahin, I., Agbor, V. O., Uzun Ozsahin, D. (2021). Chapter 2—Theoretical aspects of multi-criteria decision-making (MCDM) methods. In I. Ozsahin, D. U. Ozsahin, & B. Uzun (Eds.), Applications of Multi-Criteria Decision-Making Theories in Healthcare and Biomedical Engineering, (pp. 3–40). Academic Press.

Visser, M., van Eck, N. J., & Waltman, L. (2021). Large-scale comparison of bibliographic data sources: scopus, web of science, dimensions, crossref, and microsoft academic. *Quantitative Science Studies, 2*(1), 20–41.

Waltman, L., van Eck, N. J., van Leeuwen, T. N., Visser, M. S., & van Raan, A. F. J. (2011). Towards a new crown indicator: some theoretical considerations. *Journal of Informetrics, 5*(1), 37–47.

Wang, J., Lu, J., Wei, G., Lin, R., & Wei, C. (2019b). Models for MADM with single-valued neutrosophic 2-tuple linguistic muirhead mean operators. *Mathematics, 7*(5), 442.

Wang, J., Lu, M., & Wei, G. (2019c). Models for multiple attribute decision making with some interval-valued 2-tuple linguistic pythagorean fuzzy bonferroni mean operators. *International Journal of Knowledge-Based and Intelligent Engineering Systems, 23*(4), 259–294.

Wang, J.-W. (2021). Multi-criteria decision-making method based on a weighted 2-tuple fuzzy linguistic representation model. *International Journal of Information Technology & Decision Making, 20*(02), 619–634.

Wang, P., Wang, J., Wei, G., Wei, C., & Wei, Y. (2019a). The multi-attributive border approximation area comparison (MABAC) for multiple attribute group decision making under 2-tuple linguistic neutrosophic environment. *Informatica, 30*(4), 799–818.

Wang, S.-Y. (2008). Applying 2-tuple multigranularity linguistic variables to determine the supply performance in dynamic environment based on product-oriented strategy. IEEE Transactions on Fuzzy Systems, 16(1), 29–39.

Wang, S.-Y. (2013). Applying the superior identification group linguistic variable to construct kano model oriented quality function deployment. *Technological and Economic Development of Economy, 19*(sup1), S304–S325.

Wang, W., Ding, L., Liu, X., & Liu, S. (2022). An interval 2-Tuple linguistic fine-kinney model for risk analysis based on extended ORESTE method with cumulative prospect theory. *Information Fusion, 78*, 40–56.

Wang, W.-P. (2009). Evaluating new product development performance by fuzzy linguistic computing. *Expert Systems with Applications, 36*(6), 9759–9766.

Wang, Z.-L., You, J.-X., & Liu, H.-C. (2016). Uncertain quality function deployment using a hybrid group decision making model. *Symmetry, 8*(11), 119.

Wan, S., Xu, G., & Dong, J. (2017). Supplier selection using ANP and ELECTRE II in interval 2-tuple linguistic environment. *Information Sciences, 385–386*, 19–38.

Wei, G., Wang, J., Lu, J., Wu, J., Wei, C., Alsaadi, F. E., & Hayat, T. (2020). VIKOR method for multiple criteria group decision making under 2-tuple linguistic neutrosophic environment. *Economic Research-Ekonomska Istraživanja, 33*(1), 3185–3208.

Wei, G., Wu, J., Wei, C., Wang, J., & Lu, J. (2019). Models for MADM with 2-tuple linguistic neutrosophic dombi bonferroni mean operators. *IEEE Access, 7*, 108878–108905.

Wen, T.-C., Chang, K.-H., & Lai, H.-H. (2020). Integrating the 2-tuple linguistic representation and soft set to solve supplier selection problems with incomplete information. *Engineering Applications of Artificial Intelligence, 87*, Article 103248.

Wu, P., Tang, T., Zhou, L., & Martínez, L. (2024). A decision-support model through online reviews: consumer preference analysis and product ranking. *Information Processing & Management, 61*(4), Article 103728.

Wu, Z., Xu, J., & Xu, Z. (2016). A multiple attribute group decision making framework for the evaluation of lean practices at logistics distribution centers. *Annals of Operations Research, 247*(2), 735–757.

Xing, Y.-J., & Xing, C. (2016). Model for evaluating the virtual enterprise's risk with 2-tuple linguistic information. *Journal of Intelligent & Fuzzy Systems, 31*(1), 193–200.

Xu, F. (2024). A 2TLNS-based exponential TODIM-EDAS approach for evaluating sustainable development of cross-border e-commerce platforms under uncertainty. *Journal of Intelligent & Fuzzy Systems, 46*, 1–16.

Yager, R. R. (1999). Approximate Reasoning as a Basis for Computing with Words. In: L. A. Zadeh & J. Kacprzyk (Eds.), Computing with Words in Information/Intelligent Systems 1: Foundations, pp. 50–77. Physica-Verlag HD.

Yager, R. R. (2004). Generalized OWA aggregation operators. *Fuzzy Optimization and Decision Making, 3*(1), 93–107.

Yang, Q., Chen, Z.-S., Zhu, J.-H., Martínez, L., Pedrycz, W., & Skibniewski, M. J. (2024b). Concept design evaluation of sustainable product-service systems: a QFD–TOPSIS integrated framework with basic uncertain linguistic information. *Group Decision and Negotiation, 33*(3), 469–511.

Yang, Y., Xia, D.-X., Pedrycz, W., Deveci, M., & Chen, Z.-S. (2024a). Cross-platform distributed product online ratings aggregation approach for decision making with basic uncertain linguistic information. *International Journal of Fuzzy Systems, 26*(6), 1936–1957.

Yuan, J., Zhang, Z. M., Yüksel, S., & Dinçer, H. (2020). Evaluating recognitive balanced scorecard-based quality improvement strategies of energy investments with the integrated hesitant 2-tuple interval-valued Pythagorean fuzzy decision-making approach to QFD. *IEEE Access, 8*, 171112–171128.

Zadeh, L. A. (1975). The concept of a linguistic variable and its application to approximate reasoning—I. *Information Sciences, 8*(3), 199–249.

Zadeh, L. A. (1996). Fuzzy logic = computing with words. IEEE Transactions on Fuzzy Systems, 4(2), 103–111.

Zhang, Q., Jiang, K., Yan, M., & Ma, J. (2019). A competitive multiattribute group decision-making approach for the game between manufacturers. *Computational Intelligence and Neuroscience, 2019*(1), 8389035.
Zhang, S., Wei, G., Alsaadi, F. E., Hayat, T., Wei, C., & Zhang, Z. (2020). MABAC method for multiple attribute group decision making under picture 2-tuple linguistic environment. *Soft Computing, 24*(8), 5819–5829.
Zhang, S., Zhu, F., Deveci, M., & Liu, X. (2024). Consensus-oriented linguistic multi-criteria group sorting method incorporating dynamic trust management. *Information Fusion, 112*, Article 102539.
Zhang, Y., Cai, Q., Wei, G., & Chen, X. (2023). Model for evaluating the airline business operations capability based on 2TLPF-TOPSIS method and entropy weight. *Journal of Intelligent & Fuzzy Systems, 44*(4), 5745–5758.
Zhong, Y., Li, G., Chen, C., Jin, T., & Liu, Y. (2023). Reliability allocation method based on 2-tuple linguistic weighted muirhead mean operator and 2-tuple linguistic best-worst method. *IEEE Transactions on Reliability, 72*(2), 542–551.

Authors and Affiliations

Ziwei Shu[1] · José Javier Galán Hernández[2] · Álvaro Carrasco-Aguilar[3]

✉ Ziwei Shu
ziweishu@ucm.es

[1] Department of Marketing, Faculty of Statistics, Complutense University of Madrid, 28040 Madrid, Spain

[2] ENAE Business School, 30100 Murcia, Spain

[3] Rey Juan Carlos University, 28933 Madrid, Spain