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Mapping service capabilities using ISM and fuzzy DEMATEL

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In the present competitive landscape, small enterprises (SEs) must consistently strive to enhance and sustain their position by utilizing suitable capabilities. Recognizing such advancements is mostly linked to service capabilities and resources. Nonetheless, there is a lack of research focused on evaluating service capabilities in isolation or from a purely functional perspective to ascertain the criteria associated with service capabilities in small firms supported by hybrid methodologies. Consequently, employing the resource-based view (RBV), the current study examined the links among these criteria and analyzed their interdependencies and strengths. The present study utilized interpretive structural modeling (ISM) and fuzzy decision-making trial and evaluation laboratory (fuzzy DEMATEL) methodologies for this objective. The findings indicated that the criterion analysis and formulation of the strategy is of greater significance than other criteria. The research findings about service capacities are examined for practical insights.

Keywords Service capabilities, Small enterprises, Resource-based view, Interpretive structural modeling, Fuzzy DEMATEL

In nowadays' as a substitute aggressive business agency environment, small companies (SEs) face wonderful pressure to maintain and decorate their market function thru leveraging particular competencies. Provider competencies, defined due to the fact the complicated bundles of talents and knowledge that permit corporations to coordinate sports and make use of property correctly[1], are vital drivers of competitive advantage, mainly for SEs aiming to differentiate themselves in service shipping. The aid-primarily based view (RBV) underscores that organizational assets and competencies, whilst managed effectively, create cost and foster sustainable competitive blessings[2–4]. As customer support has grown to be a strategic essential over the last a few years[5], information and optimizing carrier skills is critical for SEs to attain advanced overall performance and customer pride.

The incentive for this examines stems from the growing significance of carrier abilities in permitting SEs to compete in dynamic markets, coupled with the dearth of systematic frameworks to analyze those capabilities. Despite their economic significance, SEs often lack the assets and realize-a way to strategically manipulate issuer skills, primary to suboptimal universal performance and overlooked market possibilities. Modern-day research predominantly focuses on large firms or examines capabilities with regards to performance consequences, leaving a essential hole in understanding company abilities in isolation inside SEs. Moreover, the absence of superior methodologies, which include interpretive structural modeling (ISM) and fuzzy preference-making trial and evaluation laboratory (fuzzy DEMATEL), to map and prioritize provider functionality standards hinders SEs' capability to increase focused strategies. This look at is stimulated with the useful resource of the need to provide SEs with a strong, proof-based framework to understand, prioritize, and manipulate company abilities, thereby improving their aggressive positioning and contributing to both academic and sensible advancements in provider manipulate.

Preceding studies has considerably explored the relationship between organizational capabilities and firm standard overall performance, emphasizing the function of belongings and competencies in achieving competitive blessings[6–9]. T-S (Takagi-Sugeno) fuzzy systems, a fuzzy approach for modeling and controlling complex systems, have been used[10,30]. But gift research normally focuses on huge companies or examines competencies at the facet of performance results, regularly overlooking carrier capabilities in isolation, specifically inside the context of SEs. Furthermore, even as a few researches have conceptualized skills and measured their fee[3], few have systematically analyzed the interrelationships among service capability standards the use of advanced hybrid methodologies including interpretive structural modeling (ISM) and fuzzy decision-making trial and evaluation laboratory (fuzzy DEMATEL). Moreover, the utility of those techniques to map provider skills and verify their interdependencies stays underexplored.

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This examine addresses numerous essential research gaps. First, there is a loss of complete studies that isolate and systematically observe service abilities in SEs, as earlier research regularly integrates those abilities with different organizational functions or overall performance metrics. 2nd, the use of hybrid multi-requirements choice-making (MCDM) strategies, which consist of ISM and fuzzy DEMATEL, to map and examine company capability standards is extensively absent within the literature. 1/3, no studies have recognized and prioritized the standards associated with provider skills in SEs the usage of the one's hybrid strategies. To fill the ones gaps, this have a look at employs ISM to establish the hierarchical relationships among provider capability standards and fuzzy DEMATEL to quantify their interdependencies and strengths, imparting a nuanced information of methods those standards interact internal SEs.

The contributions of this take a look at are manifold. It provides the number one complete overview of provider talents in SEs, studying them independently the use of a hybrid ISM-fuzzy DEMATEL method. By figuring out thirteen key standards and mapping their relationships, the have a take a look at gives a based version that complements strategic technique in provider organizations. Moreover, it introduces a singular technique for calculating weights in fuzzy DEMATEL, enriching the methodological toolkit for functionality analysis. Those contributions provide practical insights for SE managers to prioritize important issuer competencies and enhance organizational average overall performance.

The paper is established as follows: segment 2 opinions the literature on service functionality standards and establishes the theoretical foundation. Segment 3 outlines the studies technique, detailing the application of ISM and fuzzy DEMATEL. Phase 4 presents the consequences and discusses their implications for SEs. Sooner or later, phase 5 concludes with managerial insights, barriers, and tips for future research.

Literature review on service capabilities

The resource-based view (RBV) posits that corporations gain sustainable aggressive blessings through successfully coping with precise resources and capabilities which might be valuable, uncommon, inimitable, and non-substitutable[2,3]. Talents, described as complicated bundles of talents and accumulated knowledge that enable corporations to coordinate sports and utilize belongings[1], are important to this framework. Within the context of small corporations (SEs), service competencies encompassing the capability to deliver advanced customer support and coordinate provider-associated techniques are vital for differentiation and performance in competitive markets[5]. In spite of large research on organizational abilities, the literature on service talents in SEs stays fragmented, with restrained consciousness on their systematic mapping and interdependencies. This section reviews the literature on service capabilities, categorizes them into four key dimensions, and identifies 13 criteria grounded in previous research to shape the basis of this studies.

Evolution of service capability research

The RBV has been a cornerstone for knowledge how talents make a contribution to company overall performance[6,10]. Early studies emphasized tangible sources but advanced to focus on intangible skills, together with managerial and organizational competencies, as key drivers of aggressive advantage[3]. Over the last a long time, customer support has emerged as a strategic imperative, prompting studies into service-specific talents[5]. Studies by way of Skaggs and Galli-Debicella[11] and Cruz-Ros and Gonzalez-Cruz[6] underscore the need to take a look at carrier abilities holistically, as they integrate more than one useful area to create client value. However, most studies focus on massive firms or integrates carrier abilities with performance effects, leaving an opening in know-how their isolated dynamics in SEs[7–9].

Dimensions and criteria of service capabilities

Carrier competencies may be classified into 4 dimensions: managerial abilities, organizational talents, marketing abilities, and carrier best competencies[6]. Each measurement encompasses precise criteria that together allow firms to deliver superior carrier. The subsequent subsections detail these dimensions and identify the 13 standards primarily based at the literature.

Managerial capabilities

Managerial capabilities refer to the competencies, values, and orientations of top control groups in making strategic choices and driving organizational performance[6]. These talents are important for SEs, wherein leadership and strategic foresight regularly decide marketplace positioning. The literature identifies several key criteria:

- Identity and assessment of possibilities: Buil-Fabregá et al.,[12] highlight the importance of managerial ability to apprehend and verify market possibilities, permitting companies to align assets with marketplace desires.
- Continued innovation: Innovation in managerial processes sustains competitive advantage, as noted by Ander and Helfat[13].
- Managerial human capital: The knowledge and expertise of managers, as discussed by Ander and Helfat[13], enhance decision-making quality.
- Managerial social capital: Relationships and networks built by managers facilitate resource access and collaboration[13].
- Managerial cognition: The cognitive frameworks managers use to interpret market dynamics shape strategic choices[13].
- Leadership: Transformational leadership, as emphasized by Cruz-Ros and Gonzalez-Cruz[6], drives organizational alignment and motivation.
- Entrepreneurship: Entrepreneurial orientation, including risk-taking and proactiveness, fosters innovation in SEs[14].

- Analysis and formulation of the strategy: Strategic planning, as outlined by Skaggs, et al.[11], integrates resources and capabilities to achieve competitive goals.

Organizational capabilities
Organizational capabilities replicate a firm's potential to integrate and coordinate sources and strategies to reap operational efficiency[15]. For SEs, these capabilities are critical for scaling carrier shipping. The literature identifies:

- Firm size: Chung et al.,[16] notes that firm size influences resource availability and operational scope, impacting service capability development.
- Operational capabilities: Wu et al.,[15] emphasize the role of operational processes in delivering consistent service outcomes.
- Formal and informal learning processes: Guo et al.,[17] highlight learning as a mechanism for capability enhancement.
- Standardization and task design: Cruz-Ros and Gonzalez-Cruz[6] argue that standardized processes and task designs improve service reliability.
- Differentiation of activities and level of centralization: Decentralized structures enhance flexibility in service delivery[6].
- Internal communication: Effective communication channels, as noted by Cruz-Ros and Gonzalez-Cruz[6], ensure alignment across organizational units.
- Planning, control, and integration of activities: Strategic planning and control systems integrate diverse activities to support service goals[6].

Marketing capabilities
Marketing talents embody the talents and activities that convert resources into market-associated cost[18]. In SEs, those abilities are essential for patron acquisition and retention. The literature identifies:

- New product development: Vorhies and Harker[19] emphasize the role of product innovation in meeting customer needs.
- Pricing: Competitive pricing strategies enhance market positioning[18].
- Channel management: Effective distribution channels ensure service accessibility[18].
- Marketing communications: Promotional activities build brand awareness and customer engagement[18].
- External communication: Cruz-Ros and Gonzalez-Cruz[6] highlight the importance of external stakeholder communication for reputation management.
- Market orientation: A market-oriented approach, as discussed by Skaggs and Galli-Debicella[11], aligns services with customer expectations.
- Operational marketing: Tactical marketing activities, such as campaigns, drive short-term service performance[20].

Service quality capabilities
Service first-class capabilities replicate the company's potential to deliver reliable, responsive, and consumer-centric offerings[21]. These are in particular important for SEs, where client pride drives loyalty. The literature identifies:

- Customer-employee interaction: Kang and James[21] note that positive interactions enhance service perceptions.
- Service environment: The physical and ambient conditions of service delivery influence customer experiences[21].
- Outcome: The tangible results of service delivery, such as reliability, are critical for customer satisfaction[21].
- Physical quality: The tangible aspects of service, such as facilities, contribute to quality perceptions[6].
- -Interactive quality: The quality of interpersonal interactions during service delivery shapes customer trust[6].
- Corporate (image) quality: A strong corporate image reinforces service credibility[6].

Research gaps and justification for criteria selection
While the literature presents a sturdy foundation for know-how service abilties, numerous gaps persist. First, few research isolate service skills in SEs, frequently analyzing them alongside performance or inside larger corporations[6,7]. 2d, the interrelationships among carrier capability criteria are hardly ever explored, restricting insights into their hierarchical and causal dynamics[43]. Third, the software of hybrid ISM-fuzzy DEMATEL to map carrier capability standards is underexplored, with recent research focusing on other domains like deliver chains[22] or manufacturing[23]. 0.33, using advanced MCDM strategies, together with those incorporating AI or grey principle[24], has no longer been extended to service skills. This study addresses those gaps by supplying a comprehensive framework for SEs, leveraging ISM to map hierarchical relationships and fuzzy DEMATEL to quantify interdependencies, enriched by using insights from current MCDM improvements.

MCDM methods, including ISM and DEMATEL, are widely used to investigate complicated interrelationships amongst criteria in organizational contexts. ISM establishes hierarchical structures by means of identifying using and dependence powers[25], whilst DEMATEL quantifies causal relationships and criterion weights[26]. Recent improvements in MCDM have added delicate techniques, consisting of total Interpretive Structural Modeling (TISM), gray-DEMATEL, and Fermatean fuzzy set (FFS)-based totally techniques, which offer improved interpretability and robustness.

The 13 criteria identified above—spanning managerial, organizational, marketing, and service quality capabilities—are drawn from seminal works[6,11–13,15–18,20,21,27] to comprehensively represent service capabilities in SEs. These criteria were selected for their recurring prominence in the literature and their relevance to SEs' service delivery challenges, ensuring a robust foundation for the study's analysis (see Table 1).

Research map and background of ISM and fuzzy DEMATEL techniques and their application to mapping service capabilities

Opting methodology appertains to the objective and essence of the research subject and its implementation facilities. Thus, the methodology of a research can be selected when its subject essence, objectives, and broadness are identified. In this paper, a mixed research method is used. The essence of a research subject refers to when the researcher goes in search of the outcomes of a solution to social problems or the outcome of prevailing measures, and the research objective is to conduct a precise social study on the consequence of a scheme which is applied to a social problem[28]. In this paper, required information was collected through library-based and extensive survey and by interview method. Data on conceptual relationship between attributes were collected was through a questionnaire which was composed of questions about service capabilities. In this regard, in the present study, experts' viewpoints were used in the solution methodology. Our study considered 13 criteria which were taken from the literature and also discussions with SEs experts through a three-hour presentation with ten SEs experts each of whom had more than fifteen years' experience. Formation control in multi-agent systems is related to service capabilities or small firms, the use of fuzzy methods is conceptually aligned with fuzzy DEMATEL, as both use fuzzy logic to model complex relationships[37]. The experts were classified based on their designations as executives, supervisors, and senior managers. Of the 10 experts, 2 experts were from academia; 3from supplements firms, 1from plastic waste recycling firms, 2from steel parts industries, and 2from leather artifacts firms. The main objectives of this research were: (1) Identifying and listing the criteria related to

Dimensions	Description	Criteria	Research study
Managerial capabilities	Integrate of trick, values, and orientation that top management teams acquire to perform their tasks and make organizational decisions	Identification and evaluation of opportunities	12
		Continued innovation	
		Managerial human capital	13
		Managerial social capital	
		Managerial cognition	
		Leadership	6
		Entrepreneurship	14
		Analysis and formulation of the strategy	11
Organization capabilities	The ability of the organizations to format and integrate organizational resources and capabilities	Firm size	16
		Operational capabilities	15
		Formal and informal learning processes	17
		Standardization and task design	6
		Differentiation of activities and level of centralization	
		Internal communication	
		Planning, control, and integration of activities	
Marketing capabilities	A set of complex marketing capabilities, skills, knowledge, and activities by which firms convert available resources into market-related value yields	New product development	18
		Pricing	
		Channel management	
		Marketing communications	
		External communication	6
		Market orientation	
		Operational marketing	20
Service quality capabilities	The extent to which employees are satisfied with their ability to deliver the set of processes that enable rapid, reliable, secure service provision to customers	The customer-employee interaction	21
		The service environment	
		The outcome	
		Physical quality	6
		Interactive quality	
		Corporate (image) quality	

Table 1. Taxonomy of the service capabilities.

service capabilities and determining the relationships between these criteria; and (2) Determining and analyzing interdependencies among these criteria and their strengths. Figure 1 shows the map of the research.

The interpretive structural modeling method

ISM is an approach to identify interrelationships between agents from the commended list[29,30]. This approach is a computer-based and interactive learning process that enables individuals or groups to develop a map of complex relationships between many elements involved in a complex condition[25,31]. In other words, ISM is a better approach to solve the complexity of relationships between many agents[32] and depict the interacting criteria within the system in accordance with a structured model that contains graphics as well as words[33]. Kannan et al.[25] summarized that the fundamental concept of ISM is to decompose a complicated agent into several agents by utilizing the experts' practical experience and knowledge in order to construct a multilevel structural model. In recent years, ISM method has been successfully applied in many fields (see Table 2).

To implement the ISM technique, the relationships between and priorities of the criteria in a system must be based on the following process that has been adopted from previous studies[25,28,37–39]:

Step1: Identify and list the criteria related to service capabilities.

In this study, 13 criteria were identified by reviewing the related literature and conducting interviews with experts.

Step2: Collect data and establish structural self-interaction matrix.

At this stage, the problem criteria were examined in pair-wise comparisons in which the expert used the following symbols to determine the relationships between the criteria:

V: criterion i will help to achieve criterion j;

A: criterion i will be achieved only through criterion j;

X: criteria i and j help will help achieve each other; and.

O: criteria i and j are unrelated.

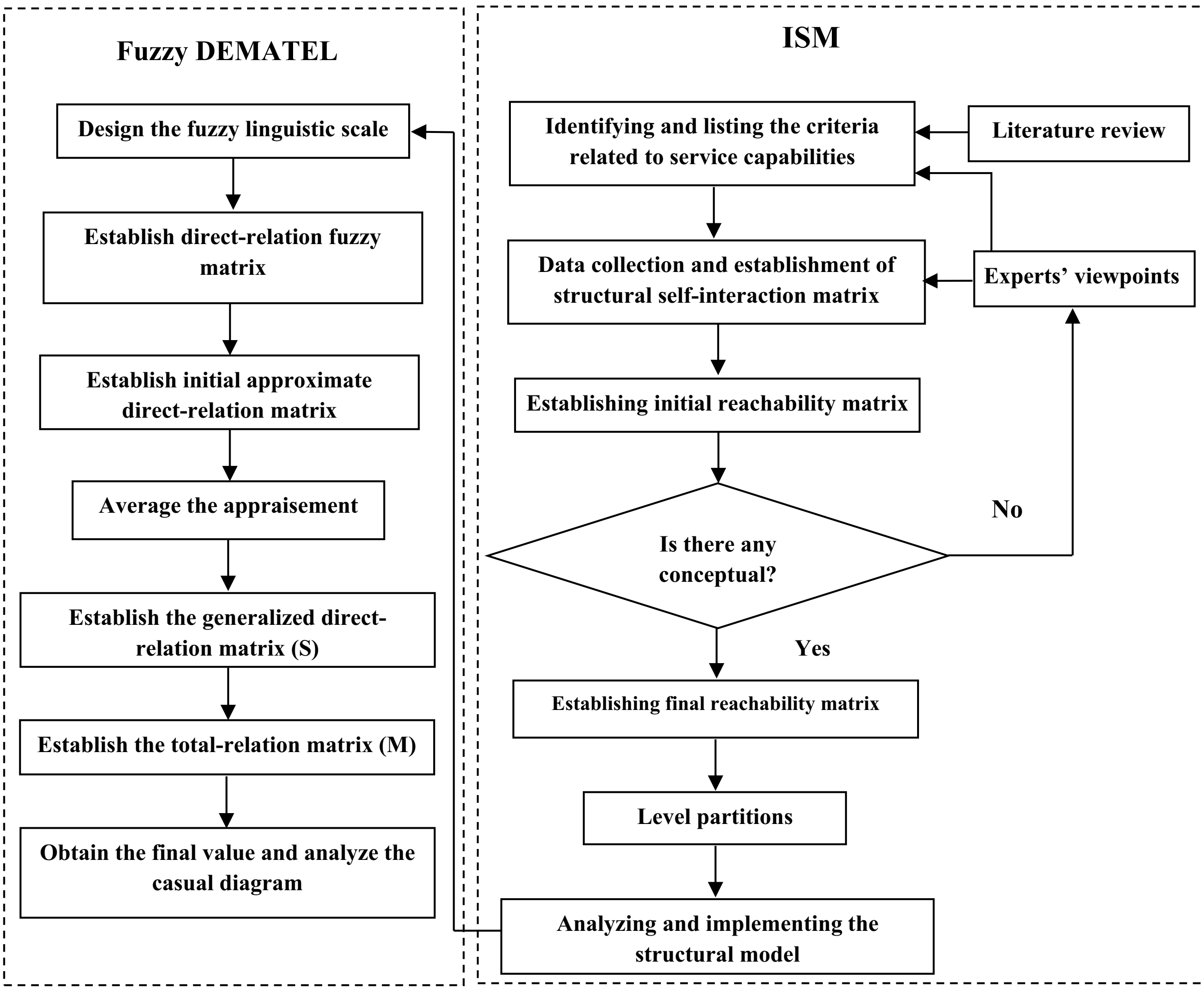

Fig. 1. Research map.

Research study	Criteria	Applied fields
34	Impact, proliferation, cost to be incurred, difficulty and complexity level, acceptability, awareness, preparedness, timeframe for implementation	To refine the classification of variables in the conceptual framework as driver, linkage, autonomous and dependent variables with a positive or negative orientation
35	Government constraints, financial constraints, sector constraints, company constraints, lack of demand	The ISM-based model's potential usefulness in providing a critical framework for thinking about GBMs and for a new policy debate
36	Human rights issue, underage labor, long working hours, pollution, safeguarding mechanism, feminist labor issue, organizational legal responsibilities, environment, community	Framework was proposed to analyze the CSR issues with the assistance of interpretive structural modeling (ISM) approach

Table 2. A review of ISM in previous studies.

J	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
I													
Leadership (L)	-	A	O	V	O	V	O	V	O	A	V	A	A
Entrepreneurship (E)		-	O	V	O	V	O	O	O	O	A	O	A
Strategy (S)			-	O	A	V	O	V	X	A	O	O	O
Task (T)				-	A	A	O	A	O	A	A	A	A
Centralization (C)					-	V	O	V	O	V	V	O	O
Internal communication (IC)						-	A	V	X	A	X	A	A
Activities (A)							-	O	O	V	O	O	O
External communication (EC)								-	X	A	A	O	O
Operational marketing (OM)									-	O	O	O	O
Market orientation (MO)										-	V	A	A
Physical quality (PQ)											-	A	A
Interactive quality (IQ)												-	O
Corporate quality (CQ)													-

Table 3. Structural self-interaction matrix (SSIM).

For this purpose, a questionnaire was designed, whose whole idea is presented in Table 3. As indicated, 13 selected criteria are presented in the rows and columns of the table, and the experts were asked to specify the type of relationship between criteria using the symbols, and it was asked to. Then they were interviewed regarding the cells with different opinions in the questionnaires.

Step3: Establish initial reachability matrix.

In this step, by converting the symbols V, A, X, and O into binary digits (zero and ones) for each cell, SSIM was transformed into the initial reachability matrix. This transformation was done based on the following rules:

- If criterion in the cell (i, j) in SSIM is V, the criteria in the cell (i, j) and cell (j, i) of the initial reachability matrix should be 1 and 0, respectively.
- If criterion in the cell (i, j) in SSIM is V, the criteria in the cell (i, j) and cell (j, i) of the initial reachability matrix should be 0 and 1, respectively.
- If criterion in the cell (i, j) in SSIM is X, the criteria in both cell (i, j) and cell (j, i) of the initial reachability matrix should be 1.
- If criterion in the cell (i, j) in SSIM is O, the criteria in both cell (i, j) and cell (j, i) of the initial reachability matrix should be 0.

Using these rules, the initial reachability matrix given in Table 4 was composed.

Step 4: Establish final reachability matrix.

After the initial access matrix was obtained, the final reachability matrix could be obtained through transitivity rule based on transitory in mathematic logic (i.e. if a criterion '1' is related to '2' and '2' is related to '3', then '1' is necessarily related to '3'). Transitivity is a fundamental assumption in ISM. That is to say the criteria having indirect impact on other criteria are considered and the two criteria which are correlated after exerting this logic are shown as*1. The method was to obtain a reachability matrix using Euler's theorem, in which the equations are as follows (1, 2):

$$\mathrm{A} + \mathrm{I} \tag{1}$$

$$\mathrm{M} = (\mathrm{A} + \mathrm{I})^{\mathrm{n}} \tag{2}$$

	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
(L)	1	0	0	1	0	1	0	1	0	0	1	0	0
(E)	1	1	0	1	0	1	0	0	0	0	0	0	0
(S)	0	0	1	0	0	1	0	1	1	0	0	0	0
(T)	0	0	0	1	0	0	0	0	0	0	0	0	0
(C)	0	0	1	1	1	1	0	1	0	1	1	0	0
IC)	0	0	0	1	0	1	0	1	1	0	1	0	0
(A)	0	0	0	0	0	1	1	0	0	1	0	0	0
(EC)	0	0	0	1	0	0	0	1	1	0	0	0	0
(OM)	0	0	1	0	0	1	0	1	1	0	0	0	0
(MO)	1	0	1	1	0	1	0	1	0	1	1	0	0
(PQ)	0	1	0	1	0	1	0	1	0	0	1	0	0
(IQ)	1	0	0	1	0	1	0	0	0	1	1	1	0
(CQ)	1	1	0	1	0	1	0	0	0	1	1	0	1

Table 4. Initial reachability matrix.

	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
(L)	1	1*	1*	1	0	1	0	1	1*	0	1	0	0
(E)	1	1	1*	1	0	1	0	1*	1*	0	1*	0	0
(S)	1*	1*	1	1*	0	1	0	1	1	0	1*	0	0
(T)	0	0	0	1	0	0	0	0	0	0	0	0	0
(C)	1*	1*	1	1	1	1	0	1	1*	1	1	0	0
(IC)	1*	1*	1*	1	0	1	0	1	1	0	1	0	0
(A)	1*	1*	1*	1*	0	1	1	1*	1*	1	1*	0	0
(EC)	1*	1*	1*	1	0	1*	0	1	1	0	1*	0	0
(OM)	1*	1*	1	1*	0	1	0	1	1	0	1*	0	0
(MO)	1	1*	1	1	0	1	0	1	1*	1	1	0	0
(PQ)	1*	1	1*	1	0	1	0	1	1*	0	1	0	0
(IQ)	1	1*	1*	1	0	1	0	1*	1*	1	1	1	0
(CQ)	1	1	1*	1	0	1	0	1*	1*	1	1	0	1

Table 5. Final reachability matrix.

Where A is the initial reachability matrix, I show the unit matrix, n demonstrates the powers, and M demonstrates the final reachability matrix. The operation of n-multiple bringing about the matrix must be based on the Boolean rule (i.e. 1*1 = 1, 1 + 1 = 1). The result of the transitivity can be seen in Table 5. Considering transition relation, the numbers marked as * in the table indicate that they are zero in the matrix of initial reachability and after the compatibility of the number 1 (The ISM model developed is reviewed to check for conceptual inconsistency, and necessary modifications are made).

Step 5: Level partitions.

The reachability matrix was classified into different levels. Using the final reachability matrices, the reachability and antecedent sets were obtained for each criterion. The reachability set consisted of all criteria which were affected by that criterion (number "1" in row for each criterion), whereas the antecedent set consisted of all criteria that affected the criterion (number "1" columns for each criterion). Then the intersection of these sets was obtained for all of the criteria. The criteria whose reachability and antecedent sets were the same were the highest level criteria in the ISM hierarchy (level 1). After the first iteration, the criteria forming level 1 were removed, and similarly, the above mentioned process was continued with the remaining criteria until the levels of each criterion in the next levels of ISM hierarchy could be recognized with iterations. The identified levels aided with building the digraph and the final model of ISM. In the current study, one- to four-level criteria were obtained in four repetitions. Briefly, the final results of this leveling are presented in Table 6.

Step 6: Analyze and implement the structural model.

Given the variables levels and final reachability matrix, ISM model is plotted. So, the criteria are set up from top to bottom according to their level. In current study, the criteria were classified into 4 levels (see Fig. 2). The relationship between criteria j and i is demonstrated by an arrow pointing from i to j. The resulting graph is called a digraph. By removing transitivities as explained in the ISM methodology, the digraph was finally converted into the ISM model for service capabilities.

As shown in Fig. 3, criteria of (CQ), (IQ), (A), and (C) are very fundamental criteria as they form the base of the ISM hierarchy.

Criteria	Reachability set	Antecedent set	Intersection set	Level
(L)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(E)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(S)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(T)	T	L, E,S, T,C, IC, A,EC, OM, MO, PQ, IQ, CQ	T	1
(C)	L, E,S, T,C, IC, EC, OM, MO, PQ	C	C	4
(IC)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(A)	L, E,S, T,IC, A,EC, OM, MO, PQ	A	A	4
(EC)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(OM)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(MO)	L, E,S, T,IC, EC, OM, MO, PQ	C, A,MO, IQ, CQ	MO	3
(PQ)	L, E,S, T,IC, EC, OM, PQ	L, E,S, C,IC, A,EC, OM, MO, PQ, IQ, CQ	L, E,S, IC, EC, OM, PQ	2
(IQ)	L, E,S, T,IC, EC, OM, MO, PQ, IQ	IQ	IQ	4
(CQ)	L, E,S, T,IC, EC, OM, MO, PQ, CQ	CQ	CQ	4

Table 6. Levels of criteria.

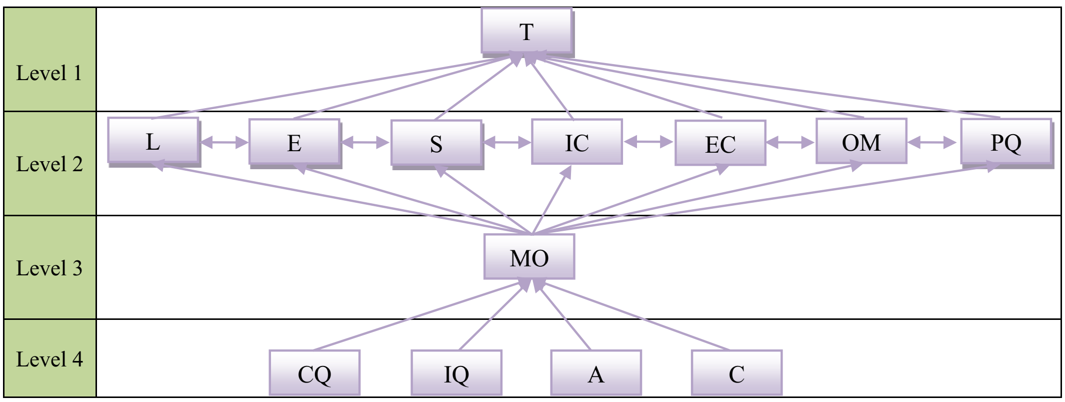

Fig. 2. ISM base model for the service capabilities criteria.

According to finally reachability matrix, the level partition is presented in Table 6, and based on the above figure, the driving and dependence digraph in reachability matrix is achieved. To get the driver power of the criteria, number "1" was added in the row for each criterion. Also, to get the dependence power of the criteria, the number "1" was added in the column for each criterion. The results can be seen in Table 7.

Although Fig. 3 shows the hierarchy and the relationships between the criteria, it does not indicate the extent of the influence that one criterion has on another. The overall direct and indirect relationships were analyzed by Matriced' Impacts Croise´s Multiplication Applique´e a UN Classement (MICMAC) method. The MICMAC root is based on the multiplication properties of the matrices. The main objective of the MICMAC analysis is to appraise the driving power and dependence of criteria of service capabilities. In MICMAC analysis, criteria can be classified into four clusters of linkage, autonomous, independent, and dependent criteria. Figure 3 illustrates MICMAC analysis for criteria of service capabilities in SEs.

The criteria were classified into four clusters. The first cluster or the so-called "autonomous criteria" contain the criteria that have weak driving power and dependence. According to the answers from the experts, none of the criteria was classified in this cluster, which means that none of the criteria was relatively disconnected from the system. The second cluster or the so-called "dependent criteria" contain the criteria that have weak driving power but strong dependence. Criterion (T) is classified in this cluster. The third cluster or the so-called "linkage criteria" contain the criteria that have strong driving power and dependence. Criteria (L), (E), (S), (IC), (EC), (OM), and (PQ) are classified in this cluster, which means that these criteria are unstable, and in fact, any action

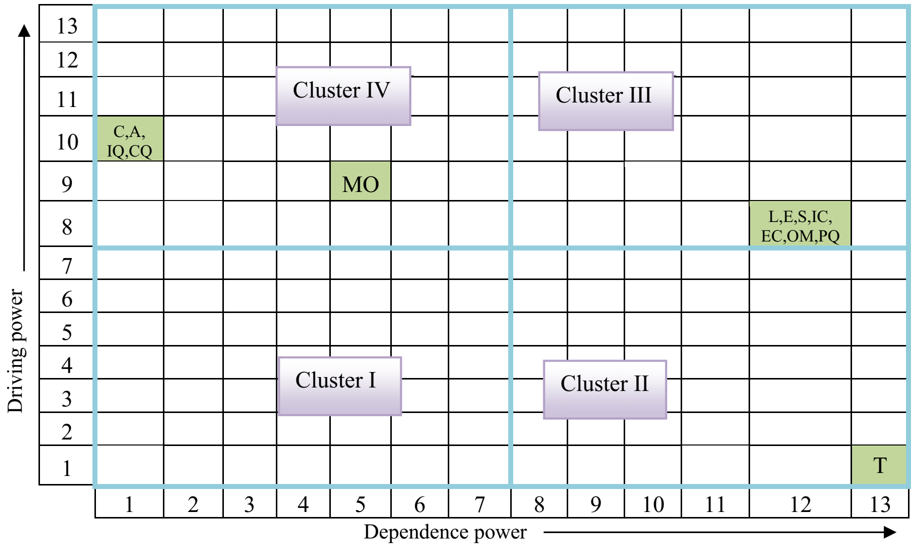

Fig. 3. Clustering service capabilities criteria.

Criteria	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
Driving power	8	8	8	1	10	8	10	8	8	9	8	10	10
Dependence power	12	12	12	13	1	12	1	12	12	5	12	1	1

Table 7. Driving power and dependence of criteria.

on these criteria will have an effect on others and also a feedback on themselves. The fourth cluster or the so-called "independent criteria" contain the criteria with strong driving power and weak dependence. Criteria (C), (A), (IQ), (CQ) and (MO) are classified in this cluster, which means that these are of key criteria which are at the lowest level of the diagram.

The fuzzy DEMATEL method

DEMATEL is applied as a structural model which is able to extract the relations between complex criteria. In other words, DEMATEL demonstrates the interrelations among complex criteria[40]. This method can also specify the importance of the criteria under consideration and the extent that a given factor influences others[41]. It is based on digraphs, i.e. directed graphs and functions according to two cause and effect groups. The DEMATEL method is an appropriate approach for evaluating problems and making decisions[42]. However, because of the uncertain or vague environment, decision making is often unclear and hard to assess by exact numerical values, resulting in the need for fuzzy logic in the DEMATEL[26]. In fuzzy MCDM methods, DEMATEL is more efficient in solving a system with uncertain relationships between criteria and maximizing the accuracy of the linguistic terms[43]. Table 8 demonstrates the fuzzy DEMATEL method used in many fields.

To implement fuzzy DEMATEL technique, specifying and analyzing interdependencies among these criteria and their strengths must be based on the following process which is adopted from previous studies[26,48–52].

Step1: Design the fuzzy linguistic scale.

Given the fact that DEMATEL method is used by experts whose views are often vague and presented as linguistic terms, it is better to integrate and deal with the ambiguities of human appraisements in the form of fuzzy numbers by adopting fuzzy linguistic scale. Fuzzy DEMATEL method enables scholars to make better decisions in an environment of incomplete information specified by experts' linguistic terms[53]. Table 9 demonstrates the fuzzy linguistic scale.

Using pair-wise comparison questionnaires, 10 experts were asked to determine the severity and strengths of the impact of the relationships identified in the interpretive structural modeling technique with the fuzzy linguistic scale.

Step2: Establish fuzzy direct-relation matrix.

The fuzzy direct-relation matrix, which is the matrix of experts' opinions, is demonstrated by a triangular fuzzy number, expressed as symbol ã, and given by Eq. (3):

$$\tilde{A} = \begin{bmatrix} 0 & \cdots & \tilde{a}1n \\ \vdots & \ddots & \vdots \\ \tilde{a}n1 & \cdots & 0 \end{bmatrix} \tag{3}$$

Research study	Criteria	Applied fields
44	Security and technology, Economy, Comfort and aesthetic, Maintenance	The truck selection problem is modeled and solved by using an integrated novel approach which combines fuzzy DEMATEL method and fuzzy hierarchical TOPSIS method
45	Quality, Cost, Time, Flexibility	Investigation of a novel hybrid MCDM approach to evaluate green suppliers for the need of improving GSCM initiatives
46	Financial, Customer, Internal process, Learning and growth	The DEMATEL method gathers collective knowledge to acquire the causal relationships between strategic criteria also especially practical and effective for visualizing the structure of intricate causal relationships with matrices or digraphs
47	Diabetes mellitus, Parathyroid function disorder, Anemia, Hypertension, …, Malignancy	The Fuzzy DEMATEL method to decrease the complexity of the relationships among many diseases in internal medicine

Table 8. A review of fuzzy DEMATEL in previous studies.

Linguistic terms	Abbreviations	Influence score	Triangular fuzzy numbers
No influence	NO	0	(0, 0, 0.25)
Very low influence	VL	1	(0, 0.25, 0.50)
Low influence	L	2	(0.25, 0.50, 0.75)
High influence	H	3	(0.50, 0.75, 1)
Very high influence	VH	4	(0.75, 1, 1)

Table 9. The fuzzy linguistic scale for pair-wise comparison.

Where $\tilde{a} = (l_{ij}, m_{ij}, u_{ij})$ and the triangular fuzzy number of the criteria a_{ij} (i = 1, 2… n) in the direct relationship matrix is (0, 0, 0). The result of the matrix of experts' opinions can be seen in Table 10.

Step3: Defuzzify into the crisp values for the initial approximate direct-relation matrix (F).

The defuzzification procedure is the method of converting a set of fuzzy numbers to crisp values prioritization target. In the current study, the mean value method is used, which not only is simple but also uses the entire membership information. This method is expressed by the following equation[54].

According to Eq. (4), the initial direct-relation matrix (**F**) is demonstrated in Table 11.

$$S\ (\tilde{a}_{ij})\ = \frac{1}{2}\left[\left(aij^{M} - \int_{aij^{L}}^{aij^{M}} f_{\tilde{a}ij\ (x)}\right) + \left(aij^{M} + \int_{aij^{M}}^{aij^{U}} f_{\tilde{a}ij\ (x)}\right)\right] = \frac{aij^{L} + 2\ aij^{M} + aij^{U}}{4} \tag{4}$$

Step4: Average the appraisement.

The study attained the average appraisement of initial direct-relation matrixes F from the total amount of all initial direct-relation matrixes **F** divided by 10 (the number of the experts).

Step5: Establish the generalized direct-relation matrix **(S)**.

The study attained the generalized direct-relation matrix **(S)** through the following Eqs. (5, 6):

$$K = \frac{1}{max \sum_{j=1}^{n} aij} \tag{5}$$

$$\mathrm{S} = \ \mathrm{K} \times \mathrm{F} \tag{6}$$

Here, max is the sum of rows, and the sum of columns the initial direct-relation matrix **(F)** is equal to 7.45, thus

$$\mathrm{K} = \frac{1}{7.45} = \ 0.134.$$

According to Eq. (6), the generalized direct-relation matrix **(S)** is demonstrated in Table 12.

Step6: Establish the total-relation matrix **(M)**.

The study attained the total-relation matrix **(M)** through the following Eq. (7).

$$\mathrm{M}\ = \mathrm{S}\ (\mathrm{I} - \mathrm{S})^{-1} \tag{7}$$

Where I, is the square matrix (n×n) with ones on its diagonal.

According to Eq. (7), the total-relation matrix **(M)** is demonstrated in Table 13.

Step7: Obtain the final value and analyze the casual diagram.

	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
	0.00	0.50	2.00	0.25	1.00	0.75	0.25	1.00	2.00	2.00	0.00	0.00	3.25
(L)	0.00	2.00	4.50	1.50	3.00	2.50	1.50	2.75	4.50	4.50	0.00	0.75	5.75
	0.00	4.50	7.00	4.00	5.50	5.00	4.00	5.25	7.00	7.00	0.25	3.25	8.25
	2.25	0.00	5.50	0.00	0.00	0.00	0.00	0.00	2.00	2.25	0.00	0.00	2.00
(E)	4.75	0.00	8.00	0.00	0.75	0.00	1.00	1.25	4.50	4.75	0.75	1.50	4.50
	7.25	0.00	9.50	0.25	3.25	0.25	3.50	3.75	7.00	7.25	3.25	4.00	7.00
	2.75	0.75	0.00	0.00	0.75	1.00	0.25	0.25	1.00	3.00	0.00	0.00	4.00
(S)	5.25	2.50	0.00	1.25	2.50	2.75	1.50	1.00	2.75	5.50	0.00	0.50	6.50
	7.75	5.00	0.00	3.75	5.00	5.25	4.00	3.50	5.25	8.00	0.25	3.00	8.50
	0.25	0.00	4.75	0.00	0.00	4.75	1.50	0.00	0.00	4.00	0.00	0.50	2.50
(T)	1.50	0.00	7.00	0.00	0.50	7.25	4.00	0.00	0.75	6.50	0.50	1.75	5.00
	4.00	0.25	8.75	0.00	3.00	9.50	6.50	0.25	3.25	8.75	3.00	4.25	7.50
	0.25	0.00	3.00	0.75	0.00	4.25	0.00	0.25	0.75	0.50	0.00	0.00	2.25
(C)	1.50	0.00	5.50	2.50	0.00	6.75	0.50	1.50	2.50	2.00	1.75	0.00	4.75
	4.00	0.25	8.00	5.00	0.00	9.00	3.00	4.00	5.00	4.50	4.25	0.25	7.25
	0.00	0.00	1.00	0.00	2.50	0.00	0.75	0.00	0.75	3.50	0.00	0.00	3.75
(IC)	1.25	0.00	3.00	0.00	5.00	0.00	2.50	0.00	2.75	6.00	0.50	0.00	6.25
	3.75	0.25	5.50	0.25	7.50	0.00	5.00	0.25	5.25	8.50	3.00	0.25	8.75
	0.00	1.00	4.75	3.75	0.00	0.00	0.00	0.00	0.00	4.00	1.00	0.00	3.00
(A)	1.25	2.75	7.25	6.25	0.75	1.50	0.00	0.00	0.00	6.50	2.75	0.50	5.50
	3.75	5.25	9.50	8.75	3.25	4.00	0.00	0.25	0.25	8.75	5.25	3.00	8.00
	2.75	0.25	3.50	0.00	0.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	3.75
(EC)	5.25	1.50	6.00	0.00	0.00	0.00	0.50	0.00	6.50	6.50	0.00	0.00	6.25
	7.75	4.00	8.50	0.25	0.25	0.25	3.00	0.00	8.75	8.75	0.25	0.25	8.75
	0.25	0.00	4.75	0.00	0.00	0.00	0.75	3.75	0.00	3.75	0.25	0.00	3.00
(OM)	1.50	0.00	7.00	0.00	0.75	0.00	2.50	6.25	0.00	6.25	1.50	0.00	5.50
	4.00	0.25	8.75	0.25	3.25	0.25	5.00	8.75	0.00	8.75	4.00	0.25	8.00
	0.25	0.00	4.75	0.00	0.00	0.00	0.00	0.25	4.00	0.00	0.00	0.00	4.75
(MO)	1.50	1.25	7.25	0.00	0.00	0.00	0.00	1.50	6.50	0.00	0.00	0.00	7.25
	4.00	3.75	9.50	0.25	0.25	0.25	0.25	4.00	8.75	0.00	0.25	0.25	9.50
	0.00	0.00	3.75	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	3.00
(PQ)	1.25	0.00	6.25	0.75	0.00	0.00	0.50	0.75	2.00	2.00	0.00	0.00	5.50
	3.75	0.25	8.75	3.25	0.25	0.25	3.00	3.25	4.50	4.50	0.00	0.25	8.00
	0.25	0.00	4.75	0.00	3.50	0.75	0.00	0.75	4.75	4.75	0.00	0.00	4.00
(IQ)	1.50	0.00	7.25	0.00	6.00	2.75	0.00	2.75	7.25	7.25	0.50	0.00	6.50
	4.00	0.25	9.50	0.25	8.50	5.25	0.25	5.25	9.50	9.50	3.00	0.00	8.50
	2.75	0.75	3.50	0.00	0.75	0.00	0.00	1.00	4.00	0.00	0.00	0.00	0.00
(CQ)	5.25	2.50	6.00	0.50	2.75	0.00	0.00	2.75	6.50	0.50	0.50	0.00	0.00
	7.75	5.00	8.50	3.00	5.25	0.25	0.25	5.25	8.75	3.00	3.00	0.25	0.00

Table 10. The triangular fuzzy numbers matrix (Ã).

According to the total-relation matrix **(M)**, the sum of the rows and the sum of the columns were denoted as **Di** and **Rj**, respectively, i.e. (8, 9):

$$D = [d_j]_{1\times n} = \left(\sum_{i=1}^{n} mij\right)_{1\times n} \quad (8)$$

$$R = [r_i]_{n\times 1} = \left(\sum_{i=1}^{n} mij\right)_{n\times 1} \quad (9)$$

Where **Di** shows the dispatched influence, and **Rj** shows the received influence.

Causal diagram can be obtained by the horizontal axis (**D + R**) named "Prominence", which is the degree of the central role (i.e. expresses how important the criterion is, whereas the vertical axis (**D - R**) named "Relation"is the degree of the relation(i.e. may divide the criteria into the cause and effect clusters).In previous studies, the final value that is the result of the intensity of prominence and relation of the has not been presented;

	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
(L)	0	0.475	0.525	0.181	0.181	0.156	0.156	0.525	0.181	0.181	0.156	0.181	0.525
(E)	0.225	0	0.269	0.006	0.006	0.006	0.294	0.181	0.006	0.156	0.006	0.006	0.269
(S)	0.450	0.775	0	0.688	0.550	0.313	0.719	0.600	0.688	0.719	0.625	0.719	0.600
(T)	0.181	0.006	0.156	0	0.269	0.006	0.625	0.006	0.006	0.006	0.119	0.006	0.100
(C)	0.313	0.119	0.269	0.100	0	0.500	0.119	0.006	0.119	0.006	0.006	0.600	0.288
(IC)	0.269	0.006	0.294	0.719	0.669	0	0.175	0.006	0.006	0.006	0.006	0.288	0.006
(A)	0.181	0.138	0.181	0.400	0.100	0.269	0	0.100	0.269	0.006	0.100	0.006	0.006
(EC)	0.294	0.156	0.144	0.006	0.181	0.006	0.006	0	0.625	0.181	0.119	0.288	0.294
(OM)	0.450	0.450	0.294	0.119	0.269	0.288	0.006	0.644	0	0.644	0.225	0.719	0.644
(MO)	0.450	0.475	0.550	0.644	0.225	0.600	0.644	0.644	0.625	0	0.225	0.719	0.100
(PQ)	0.006	0.119	0.006	0.100	0.194	0.100	0.294	0.006	0.181	0.006	0	0.100	0.100
(IQ)	0.119	0.175	0.100	0.206	0.006	0.006	0.100	0.006	0.006	0.006	0.006	0	0.006
(CQ)	0.575	0.450	0.638	0.500	0.475	0.625	0.550	0.625	0.550	0.719	0.550	0.638	0

Table 11. The initial direct-relation matrix (F).

	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
(L)	0	0.064	0.070	0.024	0.024	0.021	0.021	0.070	0.024	0.024	0.021	0.024	0.070
(E)	0.030	0	0.036	0.001	0.001	0.001	0.039	0.024	0.001	0.021	0.001	0.001	0.036
(S)	0.060	0.104	0	0.092	0.074	0.042	0.096	0.081	0.092	0.096	0.084	0.096	0.081
(T)	0.024	0.001	0.021	0	0.036	0.001	0.084	0.001	0.001	0.001	0.016	0.001	0.013
(C)	0.042	0.016	0.036	0.013	0	0.067	0.016	0.001	0.016	0.001	0.001	0.081	0.039
(IC)	0.036	0.001	0.039	0.096	0.090	0	0.023	0.001	0.001	0.001	0.001	0.039	0.001
(A)	0.024	0.018	0.024	0.054	0.013	0.036	0	0.013	0.036	0.001	0.013	0.001	0.001
(EC)	0.039	0.021	0.019	0.001	0.024	0.001	0.001	0	0.084	0.024	0.016	0.039	0.039
(OM)	0.060	0.060	0.039	0.016	0.036	0.039	0.001	0.086	0	0.086	0.030	0.096	0.086
(MO)	0.060	0.064	0.074	0.086	0.030	0.081	0.086	0.086	0.084	00	0.030	0.096	0.013
(PQ)	0.001	0.016	0.001	0.013	0.026	0.013	0.039	0.001	0.024	0.001	0	0.013	0.013
(IQ)	0.016	0.023	0.013	0.028	0.001	0.001	0.013	0.001	0.001	0.001	0.001	0	0.001
(CQ)	0.077	0.060	0.086	0.067	0.064	0.084	0.074	0.084	0.074	0.096	0.074	0.086	0

Table 12. The generalized direct-relation matrix (S).

	(L)	(E)	(S)	(T)	(C)	(IC)	(A)	(EC)	(OM)	(MO)	(PQ)	(IQ)	(CQ)
(L)	0.035	0.096	0.100	0.058	0.053	0.047	0.057	0.102	0.059	0.054	0.044	0.065	0.098
(E)	0.046	0.017	0.051	0.019	0.015	0.015	0.056	0.042	0.019	0.035	0.013	0.020	0.049
(S)	0.119	0.157	0.061	0.149	0.121	0.090	0.156	0.135	0.144	0.137	0.116	0.164	0.128
(T)	0.035	0.013	0.032	0.014	0.045	0.013	0.094	0.011	0.013	0.009	0.023	0.014	0.023
(C)	0.062	0.036	0.056	0.039	0.021	0.081	0.037	0.020	0.032	0.017	0.014	0.103	0.054
(IC)	0.053	0.017	0.056	0.112	0.104	0.015	0.046	0.014	0.014	0.011	0.011	0.059	0.017
(A)	0.039	0.032	0.038	0.067	0.028	0.045	0.016	0.027	0.047	0.012	0.022	0.018	0.015
(EC)	0.063	0.046	0.043	0.022	0.043	0.021	0.022	0.028	0.103	0.047	0.031	0.070	0.062
(OM)	0.103	0.102	0.083	0.061	0.072	0.073	0.046	0.128	0.044	0.118	0.057	0.147	0.119
(MO)	0.105	0.106	0.115	0.132	0.071	0.110	0.130	0.126	0.122	0.035	0.057	0.146	0.056
(PQ)	0.011	0.024	0.010	0.023	0.033	0.022	0.047	0.009	0.031	0.008	0.005	0.024	0.021
(IQ)	0.021	0.029	0.019	0.033	0.006	0.004	0.021	0.006	0.006	0.005	0.005	0.005	0.006
(CQ)	0.132	0.115	0.138	0.127	0.113	0.127	0.132	0.136	0.126	0.135	0.106	0.153	0.050

Table 13. The total-relation matrix (**M**).

	R_j	D_i	$R+D$	R-D	OWj	SWj	Ranking
(L)	0.824	0.869	1.693	-0.045	2.942	0.082	5
(E)	0.789	0.397	1.186	0.392	0.942	0.026	10
(S)	0.802	1.676	2.478	-0.874	8.306	0.231	1
(T)	0.855	0.340	1.195	0.515	0.813	0.023	11
(C)	0.725	0.573	1.298	0.152	1.488	0.041	7
(IC)	0.664	0.531	1.195	0.134	1.268	0.035	8
(A)	0.860	0.406	1.266	0.454	1.028	0.029	9
(EC)	0.784	0.601	1.385	0.184	1.663	0.046	6
(OM)	0.759	1.154	1.913	-0.394	4.413	0.123	4
(MO)	0.624	1.312	1.936	-0.688	5.080	0.141	3
(PQ)	0.506	0.267	0.773	0.239	0.413	0.012	12
(IQ)	0.987	0.165	1.152	0.821	0.381	0.011	13
(CQ)	0.699	1.590	2.288	-0.891	7.274	0.202	2

Table 14. The values of calculated weights.

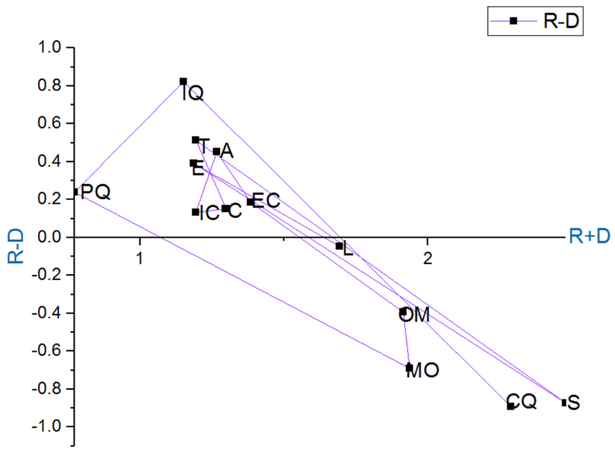

Fig. 4. The causal relations map of criteria.

therefore, to calculate the final weights (values), this research proposes a new view which is in accordance with the following Eq. (10):

$$OW_j = |(Ij - Pj) \times Ij| \tag{10}$$

Where $I_j = r\,i + d\,j$ and $P_j = r\,i - d\,j$.

By normalizing the Eq. (10), the final weights can be obtained as follows (11):

$$SWj = \frac{OWj}{\sum_{j=1}^{m} OWj} \tag{11}$$

Where $0 \leq SWj \leq 1$ and $\sum_{j=1}^{m} SWj = 1$

Table 14 demonstrates the values of the prominence and relation and the final weights.

As shown in Table 14, criterion of (S) is of the greatest importance, whilst criterion of (IQ) is of the lowest importance.

The causal diagram of the criteria could be plotted by mapping the values of prominence and relation as shown in Fig. 4.

According to the causal diagram of criteria, it can be deduced that criteria of (IQ), (T), (A), (E), (PQ), (EC), (C), and (IC) are above the horizontal axis and influence the dispatching evaluation criteria. In other words, these criteria are classified into the cause cluster and affect others ($(R - D) > 0$).Whereas, criteria of (L), (OM), (MO), (CQ), and (S) are below the horizontal axis, are classified in to the effect cluster, and are influenced by others ($(R - D) < 0$). Given the views of the experts, worth cues are obtained for making fundamental decisions. SEs must control and consider cause cluster criteria in order to achieve an ideal level of performance in terms of the effect cluster criteria. Criterion of (IQ) has the highest relation and the most important criterion for the service capabilities. Whilst, criteria of (CQ) and (S) have the lowest relation and are the most easily improved of the effect cluster criteria. In addition, criterion of (S) that moves to the right of the causal relations in the criteria map is more important than other criteria, and its (R + D) value is higher than other criteria.

Results and discussions

This look at hired a hybrid method combining interpretive structural modeling (ISM) and fuzzy choice-making trial and assessment laboratory (fuzzy DEMATEL) to map and analyze carrier abilities in small enterprises (SEs). The results offer an established knowledge of the interrelationships among thirteen provider capability criteria, their hierarchical levels, and their causal dynamics. This segment summarizes the important thing findings, compares and contrasts them with previous research, discusses their implications for SEs and the wider literature on provider capabilities and barriers and similarly tips.

Summary of findings

The ISM evaluation revealed a four-level hierarchy of carrier capability criteria, as shown in Fig. 2; Table 6. At the base (Level 4), criteria including corporate quality (CQ), interactive quality (IQ), activities (A), and centralization (C) showcase excessive using electricity and low dependence, indicating their foundational function in shaping different abilities. These standards impact better-level standards, together with market orientation (MO) at stage 3 and leadership (L), entrepreneurship (E), strategy (S), internal communication (IC), external communication (EC), operational marketing (OM), and physical quality (PQ) at level 2. Task design (T) occupies the top level (Level 1), with the highest dependence power (13) and lowest riding power (1), suggesting its miles closely stimulated via other standards (Table 7). The MICMAC evaluation (Fig. 3) labeled standards into 4 clusters: no independent standards, task design (T) as a structured criterion, leadership (L), entrepreneurship (E), strategy (S), internal communication (IC), external communication (EC), operational marketing (OM), and physical quality (PQ) as linkage standards, and centralization (C), activities (A), interactive great (IQ), corporate quality (CQ), and market orientation (MO) as impartial criteria.

The fuzzy DEMATEL analysis quantified the interdependencies and strengths of these criteria, as shown in Tables 10, 11, 12, 13 and 14; Fig. 4. The criterion "analysis and formulation of the strategy" (S) emerged as the most significant, with the highest prominence (R + D = 2.478) and a weight of 0.231, indicating its central role in service capability dynamics (Table 14). Conversely, interactive quality (IQ) had the lowest weight (0.011) and highest relation (R-D = 0.821), classifying it as a cause criterion. The causal diagram (Fig. 4) divided criteria into cause (IQ, T, A, E, PQ, EC, C, IC) and effect (L, OM, MO, CQ, S) clusters, highlighting that cause criteria drive improvements in effect criteria. Notably, strategy (S) and corporate quality (CQ) were the most easily improved effect criteria due to their negative R-D values (-0.874 and − 0.891, respectively).

Comparison with prior research

The findings of this take a look at each align with and diverge from prior research on carrier skills, imparting new insights into their structure and dynamics inside SEs. Consistent with the useful resource-based view (RBV), our results strengthen the importance of managerial abilities, specifically strategy (S), as a linchpin for organizational overall performance. Barney[55] and Cruz-Ros and Gonzalez-Cruz[6] argue that managerial skills indirectly enhance firm overall performance by using developing other purposeful capabilities, which include advertising and service first-rate. Our finding that strategy (S) has the very best prominence and weight aligns with this, as it impacts a couple of standards (e.g., OM, MO, PQ) throughout the ISM hierarchy and fuzzy DEMATEL causal diagram. However, unlike prior studies that regularly study competencies in massive companies or together with performance results[7–9], our consciousness on SEs and remoted carrier capabilities famous that method is not best a driver but additionally a rather structured criterion (effect cluster), suggesting a remarks loop precise to useful resource-constrained settings.

The foundational function of corporate quality (CQ), interactive quality (IQ), activities (A), and centralization (C) at level 4 of the ISM hierarchy echoes findings via Kang and James[21] and Cruz-Ros and Gonzalez-Cruz[6], who emphasize the importance of service first-class and organizational tactics in shaping consumer perceptions and operational performance. However, our take a look at extends this by quantifying their driving electricity (e.g., CQ and IQ with riding electricity of 10, Table 7) and classifying them as unbiased standards, highlighting their strategic importance in SEs wherein useful resource obstacles make bigger their impact. In evaluation, Skaggs and Galli-Debicella[11] awareness on combinations of capabilities without isolating their hierarchical relationships, whereas our ISM model affords a clear structural map.

The classification of task design (T) as a based criterion with minimum riding energy contrasts with Wu[15], who emphasize operational capabilities as principal to provider transport. This divergence may also replicate the SE context, in which challenge design is greater reactive to strategic and organizational inputs in preference to a primary motive force. In addition, the fuzzy DEMATEL analysis's identification of cause (e.g., IQ, T, A) and impact (e.g., S, CQ) clusters adds nuance to prior research[1,6], which regularly treat skills as uniformly interdependent. Our finding that interactive quality (IQ) is a primary reason criterion aligns with Hartline and Ferrell[21], who spotlight patron-worker interactions as vital to provider excellent, however our take a look at quantifies it's have an effect on (R-D = 0.821) and positions it as a leverage point for SEs.

Methodologically, our use of hybrid ISM and fuzzy DEMATEL distinguishes this study from prior work. Whilst research like Kannan et al.[25] and Lin et al.,[26] practice ISM or fuzzy DEMATEL in different domain names, their utility to carrier abilities is novel. Our creation of a new weighting method in fuzzy DEMATEL (Eqs. 10 and 11) addresses a gap referred to by Zhou et al.,[51], who call for improved techniques to quantify criterion significance in MCDM frameworks. This methodological contribution complements the precision of our findings in comparison to in advance qualitative or unmarried-technique research[6,20].

Implications

The findings of this observe, utilizing a hybrid ISM and fuzzy DEMATEL technique to map and analyze provider skills in small enterprises (SEs), offer sizeable implications for each practice and principle. These implications provide actionable insights for SE managers and contribute to the academic discourse on carrier functionality management.

Managerial implications

The structured model developed through ISM and fuzzy DEMATEL provides SE managers with a clear framework to prioritize and manage service capabilities. First, the identification of "analysis and formulation of the strategy" (S) as the most critical criterion (with a fuzzy DEMATEL weight of 0.231) underscores the need for SEs to invest in strategic planning to integrate resources and capabilities effectively. Managers can use this insight to align service delivery with long-term organizational goals, enhancing competitive positioning. Second, the classification of criteria into cause (e.g., interactive quality, task design) and effect (e.g., strategy, corporate quality) clusters enables managers to focus on controlling cause criteria to improve outcomes in effect criteria. For instance, enhancing interactive quality (IQ) can positively influence strategic outcomes. Third, the hierarchical model from ISM highlights foundational criteria such as corporate quality (CQ), interactive quality (IQ), activities (A), and centralization (C), suggesting that SEs should strengthen these areas to build robust service capabilities. Fourth, the study's findings can guide SEs in benchmarking their service capabilities against competitors, fostering continuous improvement in service delivery. Finally, the practical insights from this study empower SE managers to develop targeted interventions, such as training programs for managerial capabilities or process standardization, to enhance overall performance.

Theoretical implications

This have a look at advances the theoretical understanding of service abilities in the resource-based view (RBV) framework. First, by keeping apart service abilities in SEs and studying their interrelationships, the examiner addresses a gap inside the literature, which regularly focuses on big firms or performance-related competencies[6,7]. The hybrid ISM-fuzzy DEMATEL approach, informed by TISM[23] and gray-DEMATEL[22], introduces a singular methodological framework. The brand new fuzzy DEMATEL weighting technique complements MCDM precision, building on[24]. The findings offer a basis for exploring AI-pushed carrier competencies, as counseled via[24], in numerous contexts. The proposed technique for calculating weights in fuzzy DEMATEL (Eqs. 10 and 11) offers a brand-new angle on quantifying criterion significance, enriching multi-criteria decision-making (MCDM) literature. Third, the identification of thirteen criteria and their hierarchical and causal relationships affords a complete framework that destiny studies can construct upon to discover carrier abilities in different contexts, together with small and medium enterprises (SMEs) or exceptional industries. Subsequently, the take a look art's findings on the prominence of managerial abilities (e.g., strategy) align with previous RBV propositions[6] and [55], reinforcing the indirect role of managerial skills in enhancing practical skills like advertising and service high-quality.

Limitations and further recommendations

Despite its contributions, the examiner has barriers. The model is predicated on 13 criteria derived from the literature, which may not capture all provider functionality components in SEs. The findings are context-precise to SEs, and specific consequences may also emerge in small and medium enterprises (SMEs) or other industries. The version has not been statistically validated, proscribing its generalizability. Destiny studies may want to employ structural equation modeling (SEM) to validate the version statistically or observe the ISM-fuzzy DEMATEL framework to other contexts, along with SMEs or service industries. Additionally, integrating other multi-criteria decision-making (MCDM) strategies, which includes fuzzy analytic network process (ANP), should decorate the robustness of the findings.

Data availability

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

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