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Achieving strategic excellence: Integrating balanced scorecard and IVHF-DEMATEL for strategic management of a medical device SME

Zeynep Tuğçe Kalender[a,b*], Özalp Vayvay[c] and Büşra Çırpan[d]

[a]*Faculty of Mechanical Engineering, Department of Enterprise Management and Economics Czech Technical University in Prague, Prague, Czech Republic*
[b]*Faculty of Engineering, Department of Industrial Engineering, Marmara University, Istanbul, Turkey*
[c]*Faculty of Engineering and Natural Sciences, Department of Industrial Engineering, Istanbul Health and Technology University, Istanbul, Turkey*
[d]*Institute of Social Science Production Management and Marketing Master Program, Marmara University, Istanbul, Turkey*

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A B S T R A C T

Nowadays, strategic planning and the establishment of long-term objectives are pivotal for companies from diverse economies based on geographical location, demographic distribution, financial challenges, and distinct customer portfolios. Defining strategic goals is vital more than ever however requires acceptance, adoption, and execution by the entire workforce. In this sense, this paper presents an integrated methodology that combines the Balanced Scorecard and the Interval-Valued Hesitant Fuzzy DEMATEL approaches to enhance strategic management in a Medical Device SME located in Istanbul-Turkey. The proposed approach aims to provide a holistic perspective on organizational performance and facilitate decision-making processes for sustainable growth and competitive advantage.

1. Introduction

The ever-changing nature of today's business ecosystem has prompted companies to explore diverse managerial approaches and methodologies in order to thrive in a competitive landscape. The transition from the industrial age to the information age has brought about a fundamental shift in the importance of intangible assets compared to tangible assets in the businesses. However, studies showed that the lack of alignment in management objectives, hinder the conversion of business strategies into tangible outcomes and prevent a clear understanding of how to achieve business objectives. From a broader perspective, businesses commonly encounter two challenges, namely, the failures of enterprises in strategic applications and the inadequacy of traditional performance methods employed for performance evaluation (Kaplan and Norton, 1999). However, it is a well-known fact that the measurement of an organization's success is primarily based on the identification and implementation of relevant, widely accepted, and goal-oriented strategies. It is crucial that these strategies are applicable and comprehensible to all units within the organization. Only after the accurate determination and effective implementation of these strategies, the measurement of success can be applied.

In 1987, Johnson and Kaplan emphasized the limited impact of short-term financial metrics, highlighting that they were losing their significance due to rapid technological changes, shorter product life cycles, and innovations in production processes. They proposed selecting non-financial indicators that are based on the organization’s strategy and encompass not only accounting but also other departments such as production, marketing, and research and development, for a more effective performance measurement. Today, organizations need to collect, process, store and disseminate increasing

* Corresponding author.
E-mail address: zeyneptugce.kalender@fs.cvut.cz (Z. T. Kalender)

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amounts of intellectual and financial capital into knowledge (Yaralı and Ergun, 2021). Therefore, when evaluating companies, it is necessary to measure not only tangible factors such as financial indicators, but also with intangible indicators. In this regard, the Balanced Scorecard (BSC), initially developed by Norton and Kaplan in 1992, has become essential in evaluating companies. Basically, the BSC, which is one of the major strategic management models for modern enterprises (Gumbus, and Lussier, 2006), demonstrates its effectiveness in precisely establishing targets and measuring non-financial objectives across four distinct perspectives within an organizational framework (Aryanezhad et al., 2011; Messeghem et al., 2018). It recognizes the need to measure not only financial indicators but also non-financial indicators to enable an accurate assessment of the company. By encompassing both financial and non-financial indicators, the BSC incorporates concepts that goes beyond traditional balance sheets or income-expense statements. Making company strategies operationally manageable, BSC enables the company to implement its strategies. At the same time, it provides not only measuring the targets set in the past as a performance measurement, but also shaping the future of the company.
This study presented an application of a BSC model into a medical device company. The selected company faces the notable challenge of balancing competitiveness and profitability, while also integrating non-financial indicators into their business operations. To address this challenge, the company started to undertake strategy development efforts by implementing the BSC model. Initially the vision and strategies of the company are determined, then main targets are created within the organization, therefore financial and non-financial goals are set by planning and setting goals. This shared vision is presented with strategic feedback and learning. After the overall target plan is created, determined targets are prioritized with interval valued hesitant fuzzy the Decision-Making Trial and Evaluation Laboratory (IVHF-DEMATEL) methodology.

The main reason of proposing an integrated approach with emerging BSC and IVHF-DEMATEL is because to increase both flexibility and applicability in strategic management. Asan et al. (2018) stated that IVHF-DEMATEL model is very successful in dealing both hesitancy in each expert's individual assessment and, also hesitancy in the assessment among multiple experts. Especially, in practical cases where experts are struggling to define their evaluations as precise value, it is believed that using this approach provide valuable insights to companies. By employing the proposed approach outlined in this study, organizations can develop an improvement plan considering the priority of determined targets. The main aim is to provide a comprehensive and holistic perspective on organizational performance and facilitate decision-making processes for sustainable growth and competitive advantage. In the following parts, firstly a brief review of the literature is presented then, in the methodology part of the study, steps of the BSC application and the IVHF-DEMATEL model that is used to determine priority of targets is presented. Details of the case study is provided step by step with final results and discussions.

2. Literature Review

In the current market landscape, characterized by the significant impact of information on companies' success, relying on a single performance indicator is insufficient to capture the complex nature of organizational performance. Due to the presence of multiple and often conflicting demands from various stakeholders, a company's performance objectives become inherently multidimensional (Kalender & Vayvay, 2016). On the other hand, traditional performance evaluation systems commonly overemphasis financial parameters while neglecting other perspectives. In order to achieve organizational goals financial metrics provide beneficial feedback about the past however, they offer limited insights into performance and long-term success. In the current age of information, to survive among rivals, unique customer relationships, efficient internal processes, organizational learning, and growth, is also needed. The basic elements and current performance should be reviewed and necessary revisions should be made in the light of leading indicators that will increase future performance.

The BSC aims to find solutions to the problems faced by enterprises in the field of performance evaluation by presenting a table in which the vision, mission and strategy of the enterprise are transformed into performance criteria, including non-financial criteria (Kaplan and Norton, 1992). Kocel (2005) defined BSC as a method of controlling whether the strategies achieve the expected results by monitoring the variables that relate to the goals and represent these relationship. In general, it is the combination of four different performance targets; financial, customer, internal business and innovation and learning perspectives as presented in Figure 1. The implementation of the balanced scorecard enables the systematic presentation of cause-and-effect relationships in terms of how the determined business strategies will be effectively implemented, how employee competencies will be enhanced, how new business processes will be developed, how customer loyalty will be fostered, and how all these factors will ultimately lead to superior financial performance (Unler, 2010).

The key differentiating factor of the BSC is its ability to create a balance between financial and non-financial metrics, providing managers with the opportunity to measure and track not only the financial results considered as output or lagging indicators but also the non-financial factors identified as input or leading indicators that contribute to those results. In a way, the balanced scorecard integrates the financial metrics of past performance with the input metrics of future performance. The goals and metrics established in the scorecard are derived from the organization's vision and strategy.
In the initial articles where the BSC approach was first published, Kaplan and Norton provided limited information on the process of selecting performance indicators, emphasizing the centrality of vision and strategy in the design philosophy of the balanced scorecard (Lawrie and Cobbold, 2004). However, realizing this limitation in practical applications, in 1996, Kaplan and Norton emphasized the concept of strategic objectives and published their study "The Balanced Scorecard: Translating Strategy into Action". According to the new concept, strategic objectives for each perspective and

corresponding performance indicators were to be determined. Accordingly, organizations were required to select and track performance indicators aligned with strategic objectives, rather than focusing solely on measurable indicators. Kaplan and Norton referred to these changes in the balanced scorecard as a transformation from performance measurement system to strategic management system. Therefore the model is revised and developed in line with the findings that are obtained as a result of further articles and sectoral applications (Yaralı and Ergun, 2021). In 2000, four years later, a new book "The Strategy-Focused Organization" which examines the five key components of BSC was published. Following ten years, with the books "Strategy Maps" (2004), "Alignment" (2006) and "The Execution Premium" (2008) more detailed information was served about strategy focused organizations. In literature, after the spread of the basic model to the business world, several theorists suggested revisions about Kaplan and Norton's work and modified the design of the model via changing the existing dimensions or adding more (Letza, 1996; Epstein and Wisner, 2001; Speckbacher et al., 2003; Kalender and Vayvay, 2016; Kevianpour, 2022).

Today, BSC is accepted as one of the main management (Gumbus, and Lussier,2006) approaches since the model can be applied regardless of the sector, size, culture, and type etc. of the company and makes companies successful in transforming organizational strategies into actions (Edwards, 2001; Eskafi et al., 2015; Quezada et al., 2022, 2023). Although BSC can be applied across businesses, the model needs to be customized to meet the expectations of different markets since each organization has different strategies and environments (Coşkun, 2007; Keivanpour, 2022).

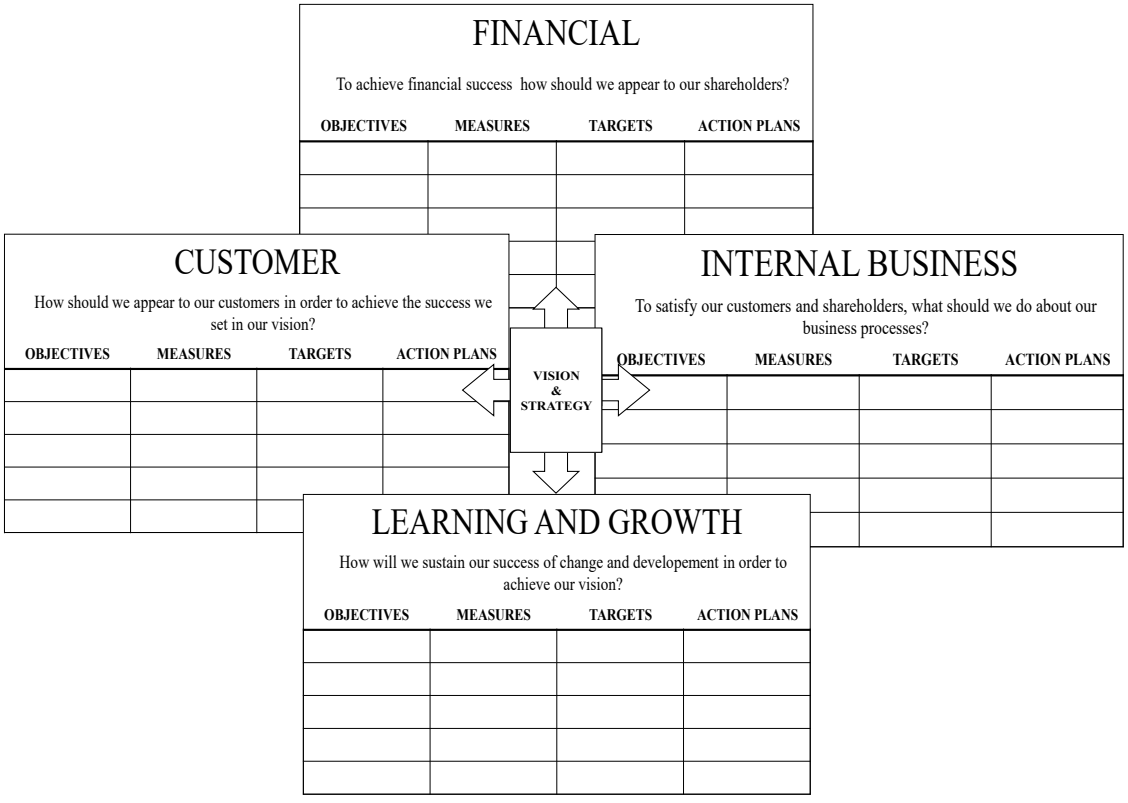


Fig. 1. General framework of BSC

From a healthcare sector point of view, organizations need to utilize the most effective performance management systems that align with their mission and vision in order to achieve their strategic objectives since health systems involve advanced technology and high costs. In literature there are many studies showing the implementation of the BSC model in different areas (Zelman et al., 2003). Inamdar and Kaplan (2002) identified some common factors based on the feedback of nine healthcare organizations in the early stages of BSC implementation. According to their study, BSC provided an evaluation of the organization's readiness and thus encouraged an open environment for learning and feedback. McDonald (2012) stated that regarding both for-profit and not-for-profit healthcare organizations that are using BSC for management decisions, improve the healthcare projects, to create financial solutions and for performance measurement. Literature showed that in the examples where BSC is applied to health institutions, researchers make some minor modifications, such as changing the customer dimension title to patient dimension (Pineno, 2002).

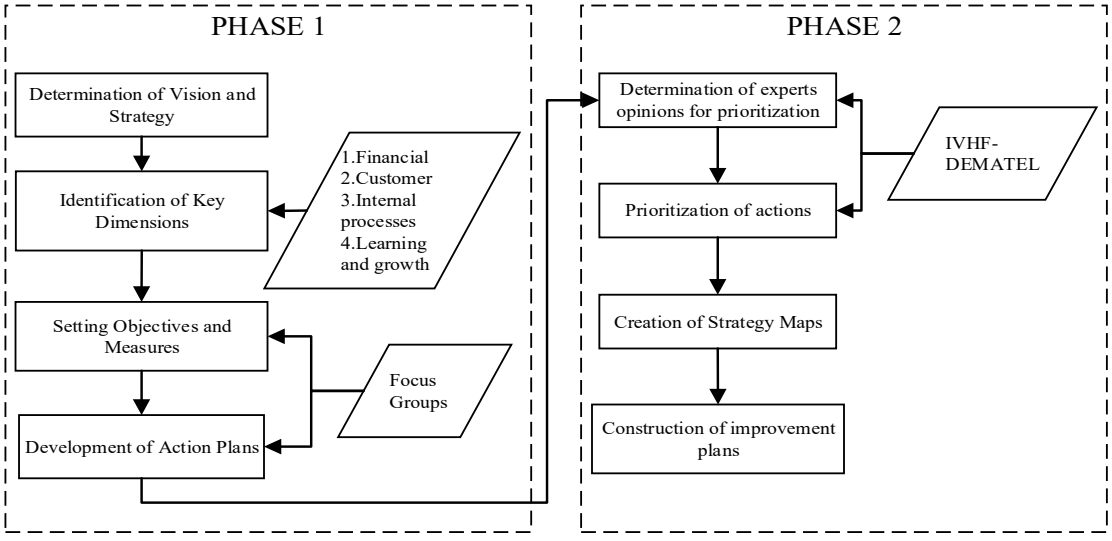
As companies in global competition shape themselves according to knowledge-based competition, their ability to manage their physical assets has become more decisive. With the BSC, companies can develop the skills necessary for their financial growth and also possess intangible assets. It should be noted that BSC is more than a stand-alone performance measurement tool. In other words, BSC is developed not to replace financial measurements, but rather to complement them. The model

provides a complete framework for planning and executing a strategy. In order for the strategies to be carried out effectively, the key performance measures of the perspectives at different levels must be in communication and connectedness.

3. Methodology

In recent years, the business ecosystem for companies has undergone significant changes, and stability has been replaced by continuous volatility. In such an uncertain environment, achieving a sustained competitive advantage has become extremely challenging so businesses require better guidelines that indicate their future positions. In the healthcare sector, with the emergence of strategic management and a value-based healthcare approach, efforts to maximize value for patients by achieving the best outcomes at the lowest cost are gaining increasing importance. These efforts are being adapted to the healthcare industry through activities such as setting strategies and objectives, uncovering existing potential, analysing stakeholders, calculating tangible indicators like productivity, profitability, and performance, and utilizing financial reporting and key ratios. In parallel with the increasing competition in healthcare institutions, the manner in which services are delivered has begun to change. Within this transformation, measuring performance and shaping processes based on the outcomes to be achieved have become crucial.

In this study, the selected company also faces the notable challenge of balancing competitiveness and profitability, while also integrating non-financial indicators into their business operations. To address this challenge, the company started to undertake strategy development efforts by implementing the BSC model. However, an integrated approach with emerging BSC and IVHF-DEMATEL is proposed to the company to increase both flexibility and applicability in strategic management. In this sense, within this study steps that are presented in Fig. 2 are followed. Therefore, initially detailed evaluations are made under four different perspectives of BSC as finance, customer, internal processes, and learning and growth and analysis are presented separately. After the overall target plan is created, determined objectives in the plan are prioritized with IVHF-AHP methodology. Thus, an improvement plan considering the weights of determined objectives are achieved and these roadmap is presented.



Figu. 2. Steps of the proposed model

Steps of the BSC

The BSC process is more than just a tactical or operational measurement system. Innovative organizations utilize the balanced scorecard as a strategic management tool to execute their strategies over the long term. The stages of this fundamental management process can be outlined as presented in Fig. 3. It's important to note that the specific steps may vary depending on the organization's context and requirements, but these general steps provide a framework for implementing the BSC effectively.

IVHF-DEMATEL

In practical applications involving expert opinions for consensus creation and subsequent evaluations, there is a high level of hesitation and/or uncertainty in the opinions of decision makers (DMs). This uncertainty can be caused due to many reasons such as time pressure, lack of information, and evaluation deficiencies. As a result, conventional methods may fall short in effectively dealing with uncertainty and ambiguity in problems. In the decision analysis literature, to overcome these challenges, fuzzy logic methods have been developed (Zadeh, 1996) and over time, several versions such as intuitive fuzzy sets (Atanassov, 1986), neutrophic fuzzy sets (Smarandache, 2003) and hesitant fuzzy sets (Torra, 2010) have been suggested to better handle the uncertainty of DMs.

In literature, hesitant fuzzy (HF) sets are used with several extensions of traditional fuzzy sets such as interval valued fuzzy sets, intuitionistic fuzzy sets and etc. (Asan, et al., 2018). However, in real life cases DMs often rely on interval values since these intervals provide flexibility and applicability (Tsai et al., 2022). In other terms, instead of providing a single membership degree, DMs can provide a range of possible values within an interval thus complex and uncertain information is represented more accurately.

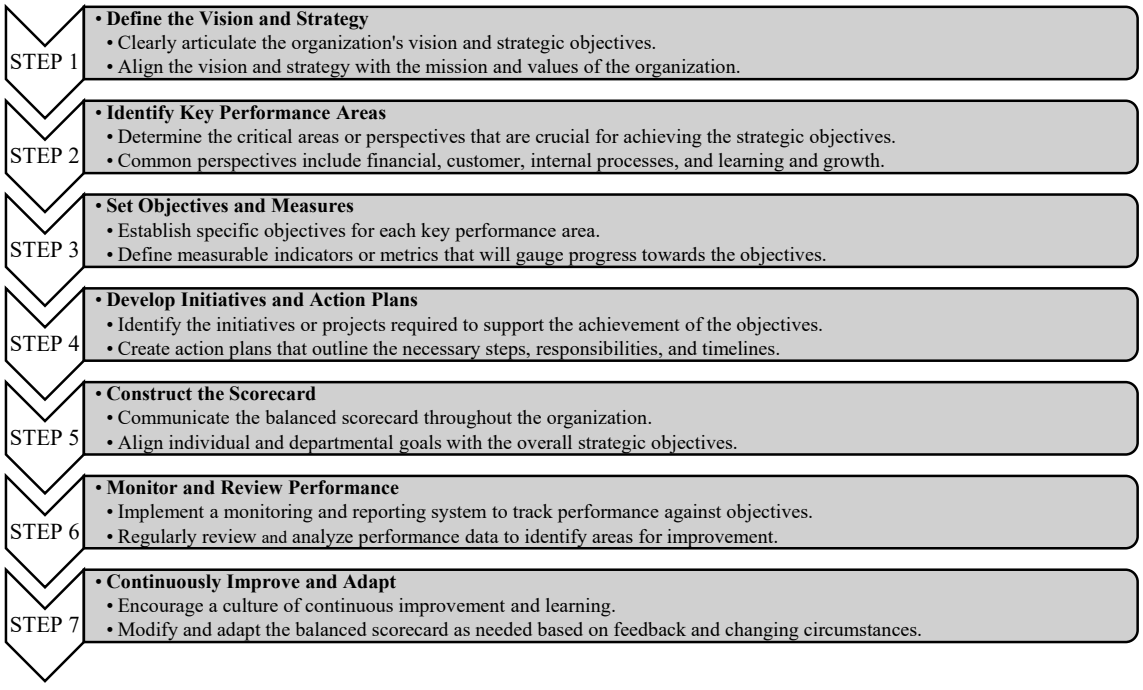


Fig. 3. Steps of the BSC model

In the interval valued hesitant fuzzy (IVHF) sets each element is associated with an interval that represents the possible values of its membership and non-membership degrees with upper and lower limits simultaneously. Let X be a reference set and an IVHF set $\tilde{A}$ on X is defined as $\tilde{A} = \{\langle x_i, \tilde{h}_{\tilde{A}}(x_i)\rangle | \, x_i \in \mathrm{X}, \mathrm{i} = 0, 1, 2, \ldots \mathrm{n}\}$ where $\tilde{h}_{\tilde{A}}(x_i) : \mathrm{X} \rightarrow \mathrm{D}[0,1]$ represents the possible interval-valued membership degrees of the element $| \, x_i \in \mathrm{X}$ to the set $\tilde{A}$. Here, $\mathrm{D}[0,1]$ denotes the set of all closed subintervals. In this regard, an IVHF element is defined as $\tilde{h}_{\tilde{A}}(x_i) = \left\{\{\tilde{\gamma}\} \middle| \tilde{\gamma} \in \tilde{h}_{\tilde{A}}(x_i)\right\}$ where $\tilde{\gamma} = [\, \tilde{\gamma}^L, \tilde{\gamma}^U \,]$ is an interval number by representing the lower and upper limits of $\tilde{\gamma}$ respectively. Therefore, the basic arithmetic operations were defined as follows. Let $\tilde{h}_1 = \left[\tilde{\gamma}^L{}_1, \tilde{\gamma}^U{}_1\right]$ and $\tilde{h}_2 = \left[\tilde{\gamma}^L{}_2, \tilde{\gamma}^U{}_2\right]$ be two IVHF sets then,

$$\tilde{h}_1 \cup \tilde{h}_2 = \left\{\left[max\left(\tilde{\gamma}^L{}_1, \tilde{\gamma}^L{}_2\right), max\left(\tilde{\gamma}^U{}_1, \tilde{\gamma}^U{}_2\right)\right]\right\} \quad (1)$$

$$\tilde{h}_1 \cap \tilde{h}_2 = \left\{\left[min\left(\tilde{\gamma}^L{}_1, \tilde{\gamma}^L{}_2\right), min\left(\tilde{\gamma}^U{}_1, \tilde{\gamma}^U{}_2\right)\right]\right\} \quad (2)$$

$$\tilde{h}_1 + \tilde{h}_2 = \left\{\left[\tilde{\gamma}^L{}_1 + \tilde{\gamma}^L{}_2 - \tilde{\gamma}^L{}_1\tilde{\gamma}^L{}_2, \quad \tilde{\gamma}^U{}_1 + \tilde{\gamma}^U{}_2 - \tilde{\gamma}^U{}_1\tilde{\gamma}^U{}_2 \,\right]\right\} \quad (3)$$

$$\tilde{h}_1 \times \tilde{h}_2 = \left\{\left[\tilde{\gamma}^L{}_1\tilde{\gamma}^L{}_2, \quad \tilde{\gamma}^U{}_1\tilde{\gamma}^U{}_2\right]\right\} \quad (4)$$

$$\lambda \times \tilde{h} = \left\{\left[1 - (1 - \tilde{\gamma}^L)^{\lambda}, 1 - (1 - \tilde{\gamma}^U)^{\lambda}\right]\right\} where \ \lambda > 0 \quad (5)$$

$$\tilde{h}^{\lambda} = \left\{\left[\, (\tilde{\gamma}^L)^{\lambda}, \quad (\tilde{\gamma}^U)^{\lambda} \,\right]\right\} \ where \ \lambda > 0 \quad (6)$$

In addition to basic arithmetic operations, IVHF weighted averaging (IVHFWA) operator is denoted as follows when $w = (w_1, w_2, \ldots, w_n)$ and $w_i \in [0,1], \sum_{j=1}^{n} w_j = 1$,

$$IVHFWA\left(\tilde{h}_1, \ldots, \tilde{h}_n\right) = w_1\tilde{h}_1 + \cdots + w_n\tilde{h}_n = \left\{\left[1 - \prod_{j=1}^{n}\left(1 - \tilde{\gamma}^L{}_j\right)^{w_j}, 1 - \prod_{j=1}^{n}\left(1 - \tilde{\gamma}^U{}_j\right)^{w_j}\right]\right\} \quad (7)$$

The DEMATEL model, which was first introduced in the 1970s, is one of the commonly used methods to analyse and visualize the structure of complex systems (Najmi and Makui, 2010; Tsai et al., 2022; Quezeda et al., 2023). One of the major advantages of the model is its simple structure in which interactions of elements with each other is also included in the analysis (Yasmin et al., 2020; Ocampo et al., 2020). In other words, casual relationships and interdependencies between variables can be analysed. In 2020, Gül presented an extensive literature search on the use of DEMATEL and the study revealed that the model is one of the most frequently used MCDM techniques.

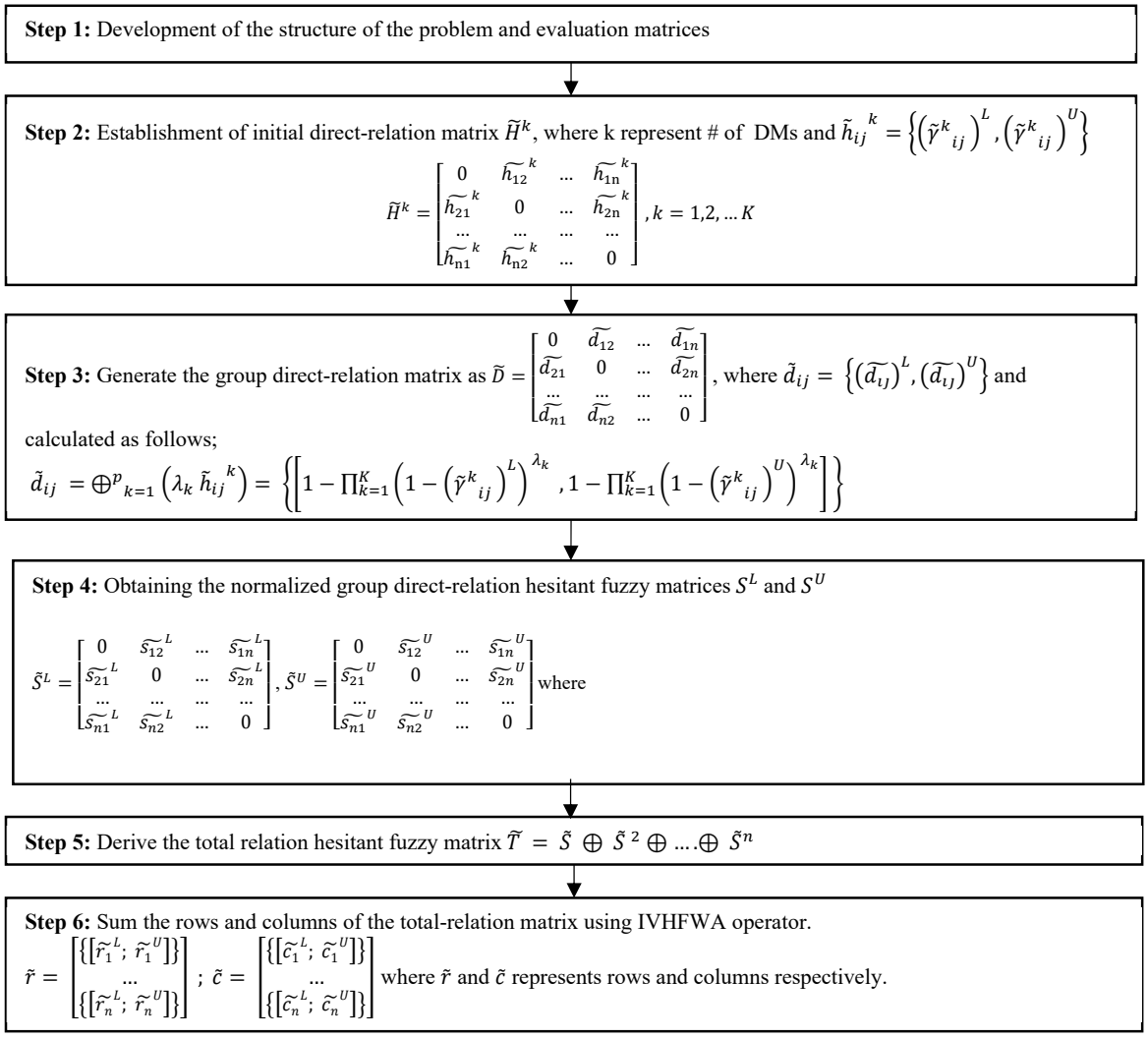


Fig. 4. Steps of IVHF-DEMATEL methodology

On the other hand, the IVHF sets address the uncertainty caused by DMs doubts in terms of assignment of membership degrees during evaluations (Asan et al., 2018). From this point of view, it provides an advantage in dealing with strategic decisions in which multiple experts are required to participate in assessments. For this reason, within the scope of this study, the DEMATEL method with IVHFs extension is preferred to determine the priority of the determined BSC objectives. The application steps of the method are presented in Fig. 4.

4. Case Study

XSM Company is a medical device company that has been operating as a regional dealer in Istanbul since 2017. As of 2021, the company supplies medical devices to some private and public hospitals in Istanbul. Mainly working in gastroenterology and urology, the company supplies products to general surgery, bariatric surgery, pediatric surgery and interventional radiology departments. However, companies not only sold products directly to the hospitals but also to other companies that have direct connections with hospitals, and in some cases to pharmacies in order to deliver the products directly to the end users. Therefore, customers of the XSM Company can be listed as hospitals, user physicians and nurses, companies, pharmacies and in some cases purchasing departments of hospitals. Product promotions are carried out to these units by the marketing and sales teams. The main reason why XSM Company also wanted to implement the BSC application was to determine performance criteria within their growing organizations, and to know that each member of the team would progress in line with these goals. In this regard, following questions are asked to managers to define mission and strategy as an initial step of the proposed approach.

1. Direction of the company: What is the future trajectory of the company? Where is it heading in terms of market positioning, product development, and growth strategies?

2. Managerial Perspective on the Management Model: Does the company have a well-defined management model that outlines the necessary processes, responsibilities, and activities to achieve its objectives? Are all crucial tasks and functions adequately addressed and executed?
3. Prioritization and Focus: How can the company effectively prioritize and focus its capabilities to align with its long-term improvements while also addressing short-term plan pressures? What strategies and techniques can be employed to strike a balance between these two competing priorities?
4. Balancing Long-Term Improvements and Short-Term Plan Pressures: How can the company strike a balance between the need for long-term improvements, such as innovation and strategic investments, and the short-term pressures to meet financial targets and deliver immediate results?
5. Rapid Change and Flexibility: In the face of rapidly changing market dynamics and evolving customer needs, how can the company embrace the need for rapid change and flexibility? How can it integrate new knowledge into the strategic decision-making process and effectively implement operational revisions to stay ahead of the competition?

After the mission, vision and strategy of the XSM Company is reviewed in the light of this framework, key dimensions in other terms main perspectives of BSC are determined. Detailed evaluations under these four perspectives were carried out in the form of focus group interviews with 6 employees and 2 managers of the company. In this sense, two focus groups, consisting of 3 employees and 1 manager, were created homogeneously. All perspectives were asked of all participants. The criteria were determined after the analysis provided for each group, and the final answers were shared. In the following part(s), detailed evaluations under four different perspectives as finance, customer, internal processes, and learning and growth analysis is presented separately. Then, an overall target plan and related actions are presented. After the overall target plan is created, determined objectives are prioritized with IVSF-AHP methodology. Thus, an improvement plan considering the weights of determined objectives are achieved and strategy maps are created.

4.1 Analysis of the Company from BSC perspectives

4.1.1 Financial Perspective

Initially, each focus group evaluated the current conditions of the sector and the company itself in terms of financial aspects. It is well-known fact that among the various sectors, today the medical device sector stands out as having the most challenging financial conditions because of payment periods. In general, the invoices of the products sold by the company to the hospitals vary between 90 days and 3 years.

During discussions, selected company stated that, payment terms of private hospitals vary in proportion to the size of the hospitals, their brand values, the type and quality of their transactions. Therefore, currently, private hospital payments in Istanbul vary between 90 days and 1 year. On the other hand, public hospitals invoice the transactions made using the products they bought from the companies and the costs of these products to the Social Security Institution (SGK), and receive the transaction fee within 60 days. However, the costs of the products invoiced to SGK are not always paid at 100%. Since 201 the medical device industry has been controlled by the Turkish Medicines and Medical Devices Agency (TITCK), under the leadership of the Ministry of Health. According to the determined directives and regulations, hospitals cannot invoice the SSI for prices above the ceiling prices (SUT Prices) determined for products. Since distributor companies import their products and manufacturers import their raw materials from abroad, the costs of the products increase in direct proportion to the exchange rates. However, since TITCK does not update the prices at the same rate, hospitals cannot collect all the costs of these products from SGK, although they supply products far above the price of SUT. In order for the hospitals not to go bankrupt, additional fees are demanded from the patients in various ways.

Another financial aspect is about the connection of the selected company and the main distributors or manufacturers to which it supplies products. Main distributors or manufacturers prefer to work with local dealers and collect their payments in a shorter time by targeting smaller profitability, instead of working with hospitals with long payment term options. Results of focus group discussions showed that from financial perspective view of point, collections, increasing income and stretching payment plans are emphasized in both groups. After the interviews were completed, the final opinions of the groups were collected, and then both groups were brought together and the opinions were combined. In this step, the final list which is presented in Table 1 obtained as a result of the combined opinions was approved by all participants.

Hospitals, clinics, user physicians/surgeons, nurses, pharmacies and other medical device companies are evaluated as customers. The employees working in the purchasing units of the hospitals are in charge of providing the most affordable product in the desired time period, with the product information they receive from the clinics. Depending on what process and for what purpose medical devices are used, product promotions are made by focusing on physicians or nurses. While the control and decision is made by the doctor for the products to be used in the body, the responsible nurses of the relevant clinics are mostly concerned with the products outside the body and used as ancillary. Some products are sold to patients from medical companies and pharmacies located across the hospitals. In order to determine these types of products and to determine which products are preferred, the sales and marketing teams meet in coordination with both the relevant clinics

and the employees of this company and the pharmacy.

Table 1

Aggregated results for financial perspective

	OBJECTIVES	MEASURES	TARGETS
FINANCIAL PERSPECTIVE	Increase in payment collection	Payment Collection Speed	Speeding up the collection of payments
		Duration of payment periods (Days Sales Outstanding)	Shortening the payment periods
	Increase in income	Sales Growth	Increasing sales growth
		Cash Flow Forecast Accuracy	Efficient cash management
		Cash to Cash Cycle Time	
		# of different currency ratios	Using currency advantages
	Flexible payments	Duration of purchasing periods (Days Payable Outstanding)	Longer purchasing payment terms

Customers Perspective

Apart from all these, the company is also the customer of the main distributors. One of the most important parts of the work being done is to establish a balance between price and customer satisfaction between these manufacturer(s)/distributor(s) and its own customer(s). Since there are so many companies in the sector, the competition is extremely intense. Therefore, it is not enough just to have a price advantage, or even to have a good product compared to other brands. At the same time, it is essential to have good bilateral dialogues with customers and to fulfil all requests at the desired time. In this sense, increasing of customer loyalty and satisfaction was put in the spotlight during the evaluations, and objectives are created as presented in Table 2.

Table 2

Aggregated results for customer perspective

	OBJECTIVES	MEASURES	TARGETS
CUSTOMER PERSPECTIVE	Customer Loyalty	Customer Retention Rate	Measure, monitor and increase the loyalty of the customers
		Repeat Purchase Rate	
		Customer Churn Rate	
		Customer Engagement	Stronger loyalty and interest of the existing customers
	Customer Satisfaction	Customer Satisfaction Score	Improving Customer Satisfaction and commitment to continuous satisfaction
		Customer Complaint Resolution Time	

Internal Processes Perspective

The company keeps stocks in high quantities especially due to the products it provides to gastroenterology clinics. The vast majority of medical devices have different sizes and dimensions in order to increase suitability for patients. This is one of the reasons to increase the stock and production costs. The dimensions of the products to be attached to the patient during the procedure or to be used during the application are mostly determined during the examination and visit which is 1 day before the procedure. For this reason, companies should procure the product to be in the hospital before the operation time, as soon as they learn which size will be appropriate. In some cases, keeping stocks of all products is advantageous when it is considered the economic uncertainties. However, if the products are high-tech products with high unit costs, this is a financial burden for the company. In addition, hospitals prefer companies to leave on consignment instead of stocking all the sizes of the products they may need. In this case, in order to fulfil the demands of the clinics, the XSM Company takes stock and leaves consignment products to the hospital. It is a fact that this was done not only to one hospital, but also to more than one hospital in different districts throughout Istanbul.

The biggest organizational skill of the company is to leave the products purchased from the main distributor on consignment to hospitals, where it will not know exactly when they will be used, with a much shorter term than the promise it will receive from the hospital, and to replace each missing product with a new one the next day. At the same time, it undertakes not only the supply of its own products, but also the organization of the shipment of the products it buys.

Considering the current circumstances of the market, one of the major topics which is discussed by focus groups during BSC analysis is the importance of time management for internal processes. Groups evaluated the topic from both the operation and logistics side. In this sense, targets and indicators for measurement are determined considering the better time management objective as presented in Table 3.

Table 3
Aggregated results for internal processes perspective

	OBJECTIVES	MEASURES	TARGETS
INTERNAL PROCESSES PERSPECTIVE	Time Management	On-time delivery	Increasing the products transportation
		Backorder rate	
		Order-processing time	Faster product deliveries
		Pick, Pack, and Ship Time	
		Cycle time	Speeding up the routine works
		Lead time	
		Time Spent on Non-Value-Added Activities	
		Time to Resolve Internal Issues	

Learning and Growth Perspective

From the learning and growth perspective, the biggest success of the company is that it can clearly identify its needs, is aware of the process and is open to development. In the analysis of current circumstances during BSC evaluations, several topics are discussed by determined focus groups. It should be noted that this perspective was the one with the longest time spent in discussions. In general, the following issues are highlighted. In Table 4, summarized information based on these issues is provided.

The XSM Company and its employees should be able to consider stock control and financial burden by ordering the right product at the right time, in the right quantities, during the sales process that starts with product supply. In this regard, the company has been subject to the Product Tracking System (UTS) since 2017. This system monitors the process from production to the application of the products to the patient, by tracking them on the basis of code and lot number. However, the company has to employ personnel with the capacity to perform UTS operations in the product supply section. The continuous and active use of this system is very important for the growth of the company.

Table 4: Aggregated results for learning and growth perspective

	OBJECTIVES	MEASURES	TARGETS
LEARNING AND GROWTH PERSPECTIVE	Employee training	Training hours per employee	Employee development and the commitment to continuous learning
		Training ROI	Increasing the effective usage of UTS system
		Sales Performance Improvement	Improvement in sales performance metrics
	Employee expertise	Skills and Competencies Development	Increasing sectoral expertise
		Knowledge Transfer	
		Employee Competency Assessment	
	Career path planning	Employee Feedback on Career Pathing	Effective career path programs and identification of improvement areas
		Employee Satisfaction with Career Development	
		Career Development Participation	
		Career Development Plan Completion	

Target Plan and Actions of the Company

Apart from the competence of the office personnel, the sales and delivery personnel must also be competent. All employees undergo a detailed training on products during the orientation process. This ensures that they are ready for any questions and problems that may arise regarding the product. It is very important to find competent personnel for the company's reputation. The firm's product line should be expandable and renewable. In case of a continuous problem that may arise in the product, the company should provide alternative products to its customers. Apart from this, hospital employees who have determined that the less products to be used in a transaction are procured from fewer companies, the less problems they encounter. Therefore, the company should be open to developments and be able to meet its product needs.

All road maps determined after the common opinions of the participants took their place in the table, taking into account the current realities of the sector and the social and economic situation of the country. According to completed analyses in each perspective, results are aggregated in Table 5 in which planned actions are also presented. During the analysis ,which is carried under 4 perspectives, 9 major objectives are defined. In line with these objectives, 17 targets are planned and 31 indicators for measurement are determined. In general, the following insights are emphasized during evaluations.

- Financial Perspective: In general, these objectives are designed to support the overall financial health and success of the business. Based on the evaluations in XSM Company focus group study three major objectives are determined as increase in payment collections, increasing income and stretching payment plans.
- Customers Perspective: Loyalty and customer satisfaction are determined as the two most important factors during the analyses. It is also emphasized that loyal customers provided up to the period of the interviews are important both for the introduction of new products and for acquiring new customers with references.
- Internal processes perspective: A speed-oriented target plan has been drawn up for the improvement of internal processes. In this sense, time management is considered the primary objective but several indicators are determined to achieve the planned targets.
- Learning and growth perspective: During the analysis, it is seen that the learning and growth perspective helped executives understand that plans for departmentalization and company growth could allow employees to set themselves targets for higher positions in the long run. Managers, on the other hand, stated that they agreed that the importance of education and specialization is better understood. In this sense, three major objectives are determined for the learning and growth of the company.

For each target determined during the focus group studies, action plans are developed. In this stage, focused groups are merged and plans are developed with all participants. Upon the request of the managers, the condition of agreement of all the participants was taken in order to determine the targets and actions. There is 100% participation and approval of the participants in the final targets and actions to be taken.

Table 5
Final structure of the BSC and actions plans

FINANCIAL PERSPECTIVE

To achieve financial success how should we appear to our shareholders?

OBJECTIVES	MEASURES	TARGETS	ACTION PLANS
Increase in payment collection	Payment Collection Speed	Speeding up the collection of payments	One more employee can be tasked for collection.
	Duration of payment periods (Days Sales Outstanding)	Shortening the payment periods	New agreements can be offered to the hospital finance departments
Increase in income	Sales Growth	Increasing sales growth	New centers can be add to the portfolio
	Cash Flow Forecast Accuracy	Efficient cash management	Different investment assessment may be suitable for the company
	Cash to Cash Cycle Time		
	# of different currency ratios	Using currency advantages	Cash management can evaluate different currencies
Flexible payments	Duration of purchasing periods (Days Payable Outstanding)	Longer purchasing payment terms	Main distributors can apply longer or flexible the payment terms

CUSTOMERS PERSPECTIVE

How should we appear to our customers in order to achieve the success we set in our vision?

OBJECTIVES	MEASURES	TARGETS	ACTION PLANS
Customer Loyalty	Customer Retention Rate	Measure, monitor and increase the loyalty of the customers	Implementation of customer survey is planned to collect the opinions and monitor the current loyalty level.
	Repeat Purchase Rate		
	Customer Churn Rate		
	Customer Engagement	Stronger loyalty and interest of the existing customers	Brand management actions are planned for improvement of existing customers' loyalty
Customer Satisfaction	Customer Satisfaction Score	Improving Customer Satisfaction and commitment to continuous satisfaction	Surveys to determine the satisfaction score and net promoter score are planned to see current level of satisfaction.
	Customer Complaint Resolution Time		

INTERNAL PROCESSES PERSPECTIVE

How will we sustain our success of change and development in order to achieve our vision?

OBJECTIVES	MEASURES	TARGETS	ACTION PLANS
Time Management	On-time delivery	Increasing the products transportation	Coordination plans are developed between sales and logistics departments for product orders.
	Backorder rate		
	Order-processing time	Faster product deliveries	Consideration of current districts of the deliveries is planned thus new districts can be evaluated.
	Pick, Pack, and Ship Time		
	Cycle time	Speeding up the routine works	Process management initiatives are planned for continuing daily works to monitor existing status and increase efficiency.
	Lead time		
	Time Spent on Non-Value-Added Activities		
	Time to Resolve Internal Issues		

LEARNING AND GROWTH PERSPECTIVE

To satisfy our customers and shareholders, what should we do about our business processes?

OBJECTIVES	MEASURES	TARGETS	ACTION PLANS
Employee training	Training hours per employee	Employee development and the commitment to continuous learning	Regular trainings about existing products are planned for all the employee.
	Training ROI	Increasing the effective usage of UTS system	The training of the employees regarding the UTS system integrated in the company and planned as a must for new employees.
	Sales Performance Improvement	Improvement in sales performance metrics	Special sales trainings are planned for sales team so that that can increase the performance.
Employee expertise	Skills and Competencies Development	Increasing sectoral expertise	For sales and marketing teams sectoral expert plans are developed.
	Knowledge Transfer		
	Employee Competency Assessment		
Career path planning	Employee Feedback on Career Pathing	Effective career path and identification of improvement areas	A career planning system is planned to develop for both the new employees (for which it can be presented in the first orientation) and existing teams (for which improvement paths can be presented with regular one-to-one meetings.)
	Employee Satisfaction with Career Development		
	Career Development Participation		
	Career Development Plan Completion		

Prioritization of targets

In the second phase of this proposed approach, predetermined targets are prioritized using IVHF-DEMATEL methodology in order to develop an improvement plan for the selected medical device company. In this regard, steps of the IVHF-DEMATEL which is presented in Figure 4 is followed as presented below.

Step 1: In general in the first step details of the selected problem are presented and the main structure of the model is developed. In this case study, factors that are going to be prioritized with IVHF-DEMATEL are defined in the conducted BSC procedure by focus group studies. In this regard, targets in the general action plan are listed and codes are generated for each factor to better present the results.

- Financial Perspective:
    - F1: Speeding up the collection of payments
    - F2: Shortening the payment periods
    - F3: Increasing sales growth
    - F4: Efficient cash management
    - F5: Using currency advantages
    - F6: Longer purchasing payment terms
- Customers Perspective
    - C1: Measure, monitor and increase the loyalty of the customers
    - C2: Stronger loyalty and interest of the existing customers
    - C3: Improving Customer Satisfaction and commitment to continuous satisfaction
- Internal processes perspective
    - IP1: Increasing the products transportation
    - IP2: Faster product deliveries
    - IP3: Speeding up the routine works
- Learning and growth perspective
    - LG1: Employee development and the commitment to continuous learning
    - LG2: Increasing the effective usage of UTS system
    - LG3: Improvement in sales performance metrics
    - LG4: Increasing sectoral expertise
    - LG5: Effective career path and identification of improvement areas

Using the listed targets 17 X 17 dimensional evaluation matrix is generated to collect data from DMs. In total, 3 DMs was interviewed to give their IVHF assessments for pairwise comparison. An in-depth interview was adopted to obtain the experts' opinions by paper questionnaire. In detail, during the analysis, evaluations are collected from 2 top level managers and 1 executive manager. Based on their expertise level, DMs are weighted as $\{0.3; 0.3; 0.4\}$ respectively.

Step 2: The assessments of the DMs were obtained in the form of linguistic terms then predefined scale which is presented in Table 6 is used for further analysis. Thus initial direct –relation matrices $\widetilde{H}^k$ are created for individual DMs as stated in the step 2 of Fig. 4. In here, k is represented the related DM.

Table 6
Evaluation scale for IVHF

Linguistic Terms		**Lower Value ($\widetilde{\gamma}^L$)**	**Upper Value ($\widetilde{\gamma}^U$)**
No influence	NI	0	0
Very low influence	VL	0.05	0.15
Low influence	LI	0.25	0.35
Medium influence	MI	0.45	0.55
High influence	HI	0.65	0.75
Very high influence	VH	0.85	0.95
Complete influence	CI	1	1

Step 3: After the assessments of individual DMs were obtained and restructured using IVHF and matrix forms, the group direct-relation matrix $\widetilde{D}$ is developed as presented in Table 7.

Table 7
The group direct-relation matrix

	F1		F2		F3		F4		F5		F6		C1		C2		C3	
	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U
F1	0	0	0.05	0.15	0.65	0.75	0.05	0.15	0	0	0	0	0	0	0	0	0	0
F2	0.85	0.95	0	0	1	1	0.65	0.75	0.05	0.15	0	0	0	0	0	0	0	0
F3	0	0	0	0	0	0	1	1	0.65	0.75	0.02	0.05	0	0	0	0	0	0
F4	0	0	0	0	0.05	0.15	0	0	0.05	0.15	0.02	0.05	0	0	0	0	0	0
F5	0	0	0	0	0	0	0.73	0.85	0	0	0	0	0	0	0	0	0	0
F6	0	0	0	0	0.45	0.55	1	1	0.45	0.55	0	0	0	0	0	0	0	0
C1	0.45	0.55	0.65	0.75	1	1	0.65	0.75	0	0	0.65	0.75	0	0	1	1	1	1
C2	0.45	0.55	0.65	0.75	1	1	0.65	0.75	0	0	0.65	0.75	1	1	0	0	1	1
C3	0.45	0.55	0.65	0.75	1	1	0.65	0.75	0	0	0.65	0.75	1	1	1	1	0	0
IP1	0.45	0.55	0.65	0.75	1	1	0.65	0.75	0.05	0.15	0.05	0.15	0.45	0.55	1	1	1	1
IP2	0.65	0.75	0.65	0.75	1	1	1	1	0.05	0.15	0.45	0.55	0.45	0.55	1	1	1	1
IP3	0.45	0.55	0.25	0.35	1	1	0.65	0.75	0	0	0	0	0.25	0.35	0.25	0.35	0.25	0.35
LG1	0.65	0.75	0.05	0.15	0.45	0.55	0.45	0.55	0.45	0.55	0	0	0.05	0.15	0.05	0.15	0.05	0.15
LG2	0.65	0.75	0.05	0.15	0.65	0.75	0.65	0.75	0.45	0.55	0	0	0.45	0.55	0.45	0.55	0.45	0.55
LG3	0.05	0.15	0.05	0.15	1	1	1	1	0.65	0.75	0.05	0.15	0.05	0.15	0.05	0.15	0.05	0.15
LG4	0.45	0.55	0.25	0.35	1	1	1	1	1	1	0	0	1	1	1	1	1	1
LG5	0.12	0.2	0	0	0.28	0.36	0.28	0.36	0	0	0	0	0.08	0.12	0.08	0.12	0.08	0.12

	IP1		IP2		IP3		LG1		LG2		LG3		LG4		LG5	
	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U
F1	0.45	0.55	0.05	0.15	0	0	0	0	0	0	0.65	0.75	0	0	0.45	0.55
F2	0.65	0.75	0.45	0.55	0	0	0	0	0	0	0.65	0.62	0	0	0.45	0.55
F3	0.45	0.55	0.05	0.15	0	0	0	0	0	0	0.65	0.75	0	0	0.45	0.55
F4	0.05	0.15	0.05	0.15	0.16	0.21	0	0	0	0	0.65	0.75	0	0	0.05	0.15
F5	0	0	0.02	0.05	0	0	0	0	0	0	0	0	0	0	0	0
F6	0.05	0.15	0.05	0.15	0	0	0	0	0	0	0	0	0	0	0.05	0.15
C1	0	0	0	0	0	0	0	0	0	0	0.73	0.85	0.05	0.15	0.45	0.55
C2	0	0	0	0	0	0	0	0	0	0	0.73	0.85	0.05	0.15	0.45	0.55
C3	0	0	0	0	0	0	0	0	0	0	0.73	0.85	0.05	0.15	0.45	0.55
IP1	0	0	1	1	0	0	0	0	0	0	0.65	0.75	0	0	0.45	0.55
IP2	1	1	0	0	0	0	0	0	0	0	0.65	0.75	0	0	0.45	0.55
IP3	0.45	0.55	0.45	0.55	0	0	0.43	0.59	0.43	0.59	1	1	0.65	0.75	0.45	0.55
LG1	0.65	0.75	0.65	0.75	0.65	0.75	0	0	1	1	1	1	1	1	1	1
LG2	1	1	1	1	1	1	0.65	0.75	0	0	0.65	0.75	1	1	1	1
LG3	0.25	0.35	0.25	0.35	0.25	0.35	0.65	0.75	0.45	0.55	0	0	0.65	0.75	1	1
LG4	0.65	0.75	0.65	0.75	0.65	0.75	0.85	0.95	0.45	0.55	0.85	0.95	0	0	1	1
LG5	0.05	0.15	0.05	0.15	0.45	0.55	1	1	0.85	0.95	0.85	0.95	1	1	0	0

Step 4: Obtained results are normalized by dividing each element of $\widetilde{D}$ with the maximum value of the sum of rows. In the analysis, summing only the upper limit values in each row is sufficient since the sum of upper limits will always be greater than the sum of lower limit. In this sense, the max. of row totals is calculated as $d = \max\{3.05; 5.32; \ldots; 7.34; \ldots; 12.6; \ldots; 6.04\} = 12.6$. Then, the normalized group direct-relation IVHF matrix split into two separate hesitant fuzzy matrices S^L and S^U.

Step 5: To derive total relation hesitant fuzzy matrix $\widetilde{T}$, firstly matrices S^L and S^U are raised to their successive powers, separately, until obtain zero matrices. In the analysis, both S^L and S^U matrices are achieved zero matrix form in their 10th power. Then, as presented in Step 4 of Figure 4, these matrices are summed using the equation 3 and 4. Thus, total relation hesitant fuzzy matrix for lower and upper values are determined as T^L and T^U. As a last step, these separate matrices are combined and final $\widetilde{T}$ is derived and presented in Table 8.

Table 8
Total relation hesitant fuzzy matrix

	F1		F2		F3		F4		F5		F6	
	L	U	L	U	L	U	L	U	L	U	L	U
F1	0.0000	0.0000	0.0040	0.0120	0.0542	0.0631	0.0040	0.0120	0.0000	0.0000	0.0000	0.0000
F2	0.0720	0.0811	0.0000	0.0000	0.0857	0.0857	0.0542	0.0631	0.0040	0.0120	0.0000	0.0000
F3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0857	0.0857	0.0542	0.0631	0.0012	0.0038
F4	0.0000	0.0000	0.0000	0.0000	0.0040	0.0120	0.0000	0.0000	0.0040	0.0120	0.0012	0.0038
F5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0612	0.0716	0.0000	0.0000	0.0000	0.0000
F6	0.0000	0.0000	0.0000	0.0000	0.0370	0.0456	0.0857	0.0857	0.0370	0.0456	0.0000	0.0000
C1	0.0370	0.0456	0.0542	0.0631	0.0857	0.0857	0.0542	0.0631	0.0000	0.0000	0.0542	0.0631
C2	0.0370	0.0456	0.0542	0.0631	0.0857	0.0857	0.0542	0.0631	0.0000	0.0000	0.0542	0.0631
C3	0.0370	0.0456	0.0542	0.0631	0.0857	0.0857	0.0542	0.0631	0.0000	0.0000	0.0542	0.0631
IP1	0.0370	0.0456	0.0542	0.0631	0.0857	0.0857	0.0542	0.0631	0.0040	0.0120	0.0040	0.0120
IP2	0.0542	0.0631	0.0542	0.0631	0.0857	0.0857	0.0857	0.0857	0.0040	0.0120	0.0370	0.0456
IP3	0.0370	0.0456	0.0202	0.0285	0.0857	0.0857	0.0542	0.0631	0.0000	0.0000	0.0000	0.0000
LG1	0.0542	0.0631	0.0040	0.0120	0.0370	0.0456	0.0370	0.0456	0.0370	0.0456	0.0000	0.0000
LG2	0.0542	0.0631	0.0040	0.0120	0.0542	0.0631	0.0542	0.0631	0.0370	0.0456	0.0000	0.0000
LG3	0.0040	0.0120	0.0040	0.0120	0.0857	0.0857	0.0857	0.0857	0.0542	0.0631	0.0040	0.0120
LG4	0.0370	0.0456	0.0202	0.0285	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857	0.0000	0.0000
LG5	0.0098	0.0160	0.0000	0.0000	0.0225	0.0295	0.0225	0.0295	0.0000	0.0000	0.0000	0.0000

	C1		C2		C3		IP1		IP2		IP3	
	L	U	L	U	L	U	L	U	L	U	L	U
F1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0370	0.0456	0.0040	0.0120	0.0000	0.0000
F2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0542	0.0631	0.0370	0.0456	0.0000	0.0000
F3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0370	0.0456	0.0040	0.0120	0.0000	0.0000
F4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040	0.0120	0.0040	0.0120	0.0132	0.0172
F5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0038	0.0000	0.0000
F6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040	0.0120	0.0040	0.0120	0.0000	0.0000
C1	0.0000	0.0000	0.0857	0.0857	0.0857	0.0857	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C2	0.0857	0.0857	0.0000	0.0000	0.0857	0.0857	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C3	0.0857	0.0857	0.0857	0.0857	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
IP1	0.0370	0.0456	0.0857	0.0857	0.0857	0.0857	0.0000	0.0000	0.0857	0.0857	0.0000	0.0000
IP2	0.0370	0.0456	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857	0.0000	0.0000	0.0000	0.0000
IP3	0.0202	0.0285	0.0202	0.0285	0.0202	0.0285	0.0370	0.0456	0.0370	0.0456	0.0000	0.0000
LG1	0.0040	0.0120	0.0040	0.0120	0.0040	0.0120	0.0542	0.0631	0.0542	0.0631	0.0542	0.0631
LG2	0.0370	0.0456	0.0370	0.0456	0.0370	0.0456	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857
LG3	0.0040	0.0120	0.0040	0.0120	0.0040	0.0120	0.0202	0.0285	0.0202	0.0285	0.0202	0.0285
LG4	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857	0.0542	0.0631	0.0542	0.0631	0.0542	0.0631
LG5	0.0066	0.0097	0.0066	0.0097	0.0066	0.0097	0.0040	0.0120	0.0040	0.0120	0.0370	0.0456

	LG1		LG2		LG3		LG4		LG5	
	L	U	L	U	L	U	L	U	L	U
F1	0.0000	0.0000	0.0000	0.0000	0.0542	0.0631	0.0000	0.0000	0.0370	0.0456
F2	0.0000	0.0000	0.0000	0.0000	0.0542	0.0517	0.0000	0.0000	0.0370	0.0456
F3	0.0000	0.0000	0.0000	0.0000	0.0542	0.0631	0.0000	0.0000	0.0370	0.0456
F4	0.0000	0.0000	0.0000	0.0000	0.0542	0.0631	0.0000	0.0000	0.0040	0.0120
F5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040	0.0120
C1	0.0000	0.0000	0.0000	0.0000	0.0612	0.0716	0.0040	0.0120	0.0370	0.0456
C2	0.0000	0.0000	0.0000	0.0000	0.0612	0.0716	0.0040	0.0120	0.0370	0.0456
C3	0.0000	0.0000	0.0000	0.0000	0.0612	0.0716	0.0040	0.0120	0.0370	0.0456
IP1	0.0000	0.0000	0.0000	0.0000	0.0542	0.0631	0.0000	0.0000	0.0370	0.0456
IP2	0.0000	0.0000	0.0000	0.0000	0.0542	0.0631	0.0000	0.0000	0.0370	0.0456
IP3	0.0356	0.0493	0.0356	0.0493	0.0857	0.0857	0.0542	0.0631	0.0370	0.0456
LG1	0.0000	0.0000	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857	0.0857
LG2	0.0542	0.0631	0.0000	0.0000	0.0542	0.0631	0.0857	0.0857	0.0857	0.0857
LG3	0.0542	0.0631	0.0370	0.0456	0.0000	0.0000	0.0542	0.0631	0.0857	0.0857
LG4	0.0720	0.0811	0.0370	0.0456	0.0720	0.0811	0.0000	0.0000	0.0857	0.0857
LG5	0.0857	0.0857	0.0720	0.0811	0.0720	0.0811	0.0857	0.0857	0.0000	0.0000

Step 6: As a final step, using the equation 3, the sum of rows indicating the sum of influence exerted from factor to the other factors and sum of columns indicating the sum of influence that factor receives from the other factors are obtained. The resulting vectors $\tilde{r}$ and $\tilde{c}$ are given in Table 9. In general the final step of the traditional DEMATEL methodology is determination of the final ranking based on the $\tilde{r}$ and $\tilde{c}$ scores. The causal diagram is drawn by using the prominence and relation values. However in this analysis, all calculations are made by using IVHF operators without defuzzifying and converting to crisp values to avoid information loss. Thus the influence-dependence chart is used as an equivalent presentation that made in traditional DEMATEL (Asan et. Al, 2018). Finally, $\tilde{r}$ and $\tilde{c}$ scores are used to calculate cut-off points in the horizontal and vertical axes therefore a better prioritization is achieved for the selected company.

Table 9
Influence matrices

	R		C	
	Lower Value ($\tilde{\gamma}^L$)	**Upper Value ($\tilde{\gamma}^U$)**	**Lower Value ($\tilde{\gamma}^L$)**	**Upper Value ($\tilde{\gamma}^U$)**
F1	0.18038	0.22887	0.38248	0.44455
F2	0.33700	0.37053	0.28518	0.35087
F3	0.24549	0.28036	0.63930	0.65754
F4	0.08629	0.13660	0.61931	0.65589
F5	0.06230	0.07515	0.28118	0.33515
F6	0.16215	0.19681	0.19380	0.23958
C1	0.43925	0.47470	0.34084	0.37594
C2	0.43925	0.47470	0.40578	0.42728
C3	0.43925	0.47470	0.40578	0.42728
IP1	0.47617	0.51216	0.38855	0.43995
IP2	0.51913	0.54851	0.33479	0.39104
IP3	0.44885	0.50973	0.23855	0.26858
LG1	0.50853	0.55387	0.26810	0.29877
LG2	0.58580	0.62171	0.24115	0.27231
LG3	0.42819	0.48846	0.59681	0.63765
LG4	0.64637	0.67164	0.32442	0.35293
LG5	0.36209	0.40809	0.50610	0.55161

5. Results and Discussions

The influence-dependence chart (Godet, 1994) is a two dimensional chart in which horizontal axis represents the $\tilde{c}$ scores (sum of columns) and the vertical axis represents the $\tilde{r}$ scores (sum of rows). The chart is a beneficial tool used in strategic analysis to assess the level of dependence of factors on one another within a system or a specific issue. It helps identify key actors, relationships, and dependencies in a given situation. The chart typically consists of four regions representing influential, critical, dependent and excluded factors. Each factor is positioned on this chart and the role of the factors can be monitored based on the region that they belong to. In the determination of the regions cut-off points should be calculated. The cut-off points for the horizontal axis is calculated with $\{[\tilde{c}^L{}_{avg}, \tilde{c}^U{}_{avg}\ ]\} = \left\{\left[\frac{1}{n} \oplus \left(\oplus^n{}_{i=1}\ \tilde{c}^L{}_i\right), \frac{1}{n} \oplus \left(\oplus^n{}_{i=1}\ \tilde{c}^u{}_i\right)\right]\right\}$ whereas the cut-off points for the vertical axis is calculated with $\{[\tilde{r}^L{}_{avg}, \tilde{r}^U{}_{avg}\ ]\} = \left\{\left[\frac{1}{n} \oplus \left(\oplus^n{}_{i=1}\ \tilde{r}^L{}_i\right), \frac{1}{n} \oplus \left(\oplus^n{}_{i=1}\ r^u{}_i\right)\right]\right\}$.

In this study, cut-off points are calculated as $\{[\tilde{c}^L{}_{avg}, \tilde{c}^U{}_{avg}]\} = \{[\tilde{r}^L{}_{avg}, \tilde{r}^U{}_{avg}]\} = \{[0.396; 0.436]\}$. To obtain a better interpretation of the results, the influence-dependence chart is created by using the cut-off points as presented in Fig. 5.

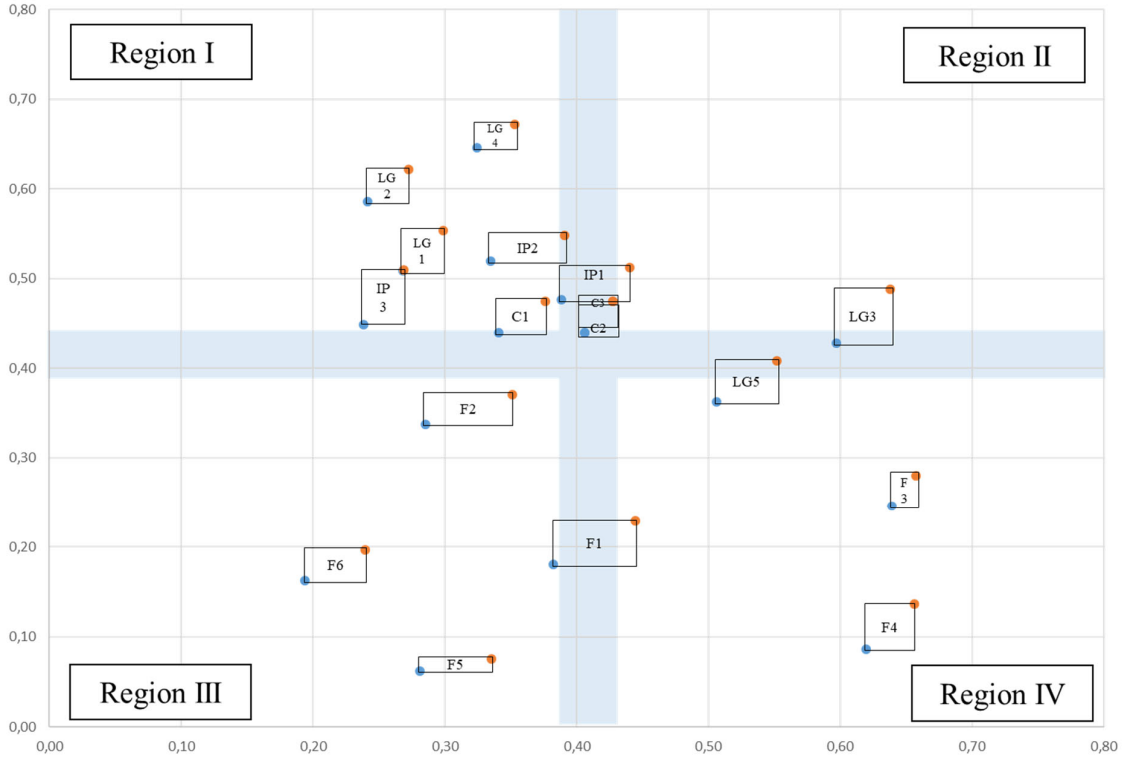


Fig. 5. The influence-dependence chart with cut-off points

Asan et al. (2018) suggested that comparisons based on the influence-dependence chart can include three major dimensions.

1. Distance: This indicator describes the difference between factors. Relatively larger distances indicate that these factors are different in terms of their roles and importance in the system. It is possible to see some overlapping factors. Such cases pointed out that these factors are not clearly different from each other.
2. Size: In the influence-dependence chart factors are represented with rectangles which are generated based on their upper and lower limits. The size of the rectangular represents the hesitancy with the relevant factor and the larger size indicates higher hesitancy.
3. Position: In the chart, the vertical axis, the scores (sum of rows), corresponds to the individual role of a factor in relation to the system where higher values indicate higher influence of the relevant factor on others. Besides, the horizontal axis, scores (sum of columns), gives the degree of dependence where higher values indicate that the relevant factors are highly dependent on other factors. According to this logic, four quadrants are determined as Region I: Dependent region; Region II: Critical region; Region III: Excluded region and Region IV: Influential region. Therefore, the position of the factor gives insights about the role of the factor.

In this study, an influence-dependence chart based on the conducted analysis provides new perspectives to the managers of XSM Company in prioritization of their strategies. According to Fig. 5, achieved results are discussed in the following parts.

5.1 Analysis based on distance

The results show that, in general, the distance between financial targets and the others are relatively larger. In other words, the role of these targets are very different in terms of their importance in the system. Considering the details of the targets, this is an expected result. On the other hand, it is seen that targets of other dimensions, namely, customers, internal processes and learning and growth are very close. From Figure 5, it can be seen that factors C2 (Stronger loyalty and interest of the existing customers) and C3 (Improving Customer Satisfaction and commitment to continuous satisfaction) are overlapping. This means that there is no clear cut difference between these factors. Since both of these factors aim to increase customer loyalty and satisfaction this result is meaningful. Also, a small portion of IP1 (Increasing the products transportation) is overlapping with C2 and C3. It is seen that when the target IP1 is achieved or improvement made in the related area it will directly affect customer satisfaction. Therefore, overlapping these factors is reasonable since their individual role aims to achieve the same goal.

5.2 Analysis based on size

As it is stated before, size of the rectangular of the factor represents the hesitancy degree of DMs about the related target. Final results showed that, F1 (Speeding up the collection of payments) is proportionally larger than the other factors. It means that DMs have higher hesitancy about the evaluations of this factor. This is quite an expected result since improvement in the related target depends on many factors. The XSM Company can plan significant improvements in the related issue and in the internal processes it possibly gives advantageous results however, in some point, collection of the payments depends on the processes of the customers as well. Even though companies evaluate this factor as a highly prioritized one in some cases, managers can be face to face with some regulatory barriers.

Following the F1, it is seen that the size of other factors are considerably similar to each other. However, F3 (Increasing sales growth), F5 (Using currency advantages) and LG4 (Increasing sectoral expertise) can be evaluated as small sized ones in comparison with others. This situation can be caused in terms of definitions. In detail, the mentioned small sized factors are very clear and understandable for evaluations. These definition related issues can be considered as a limitation of the study.

5.3 Analysis based on positions

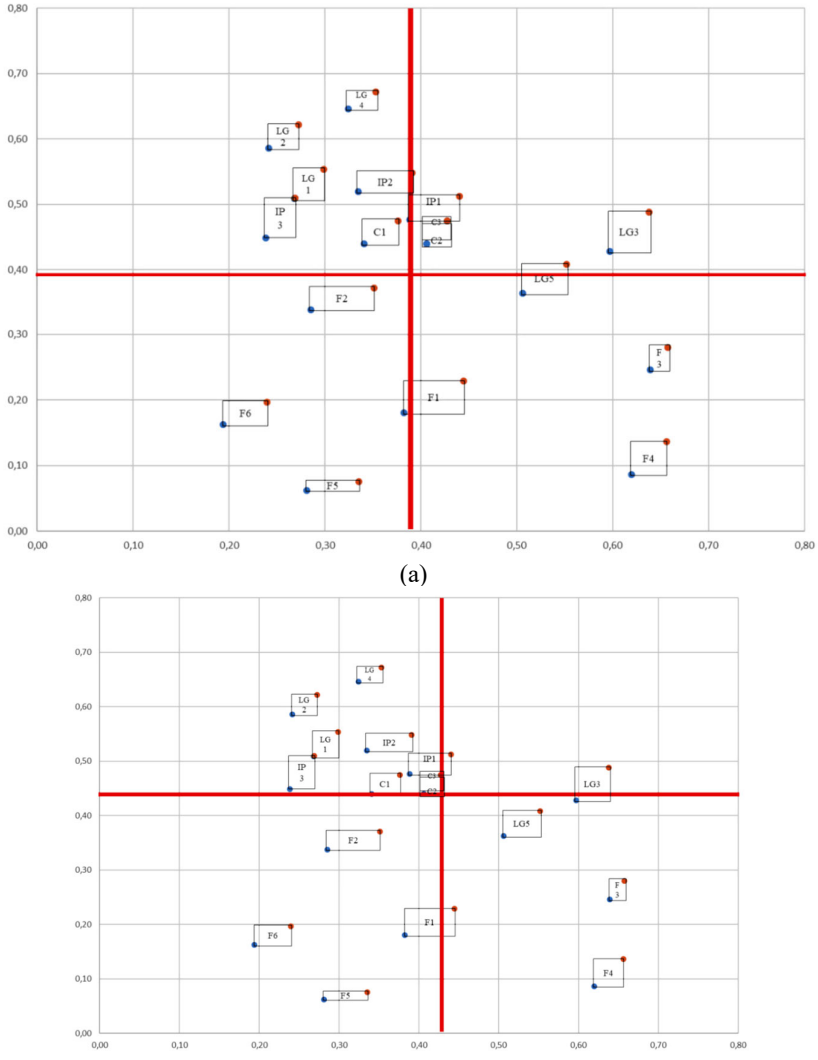
In the influence-dependence chart, each region identifies important insights in order to determine improvement plans. For this reason, initially each region is examined separately then further detailed analysis is provided as follows.

- Region I: Dependent region: Factors in this region have strong dependence however weak influence to the system. In other words, these factors are affected by other factors. According to the Fig. 5, LG1 (Employee development and the commitment to continuous learning), LG2 (Increasing the effective usage of UTS system), LG4 (Increasing sectoral expertise), IP2 (Faster product deliveries), IP3 (Speeding up the routine works) and C1 (Measure, monitor and increase the loyalty of the customers) are included in this region.
- Region II: Critical region: This region involves strongly dependent and influential factors that impact both themselves and affect others. In some studies the factors included in this region are considered unstable therefore it is indicated that these factors should be carefully followed. Based on Fig. 5, a considerably high proportion of LG3 (Improvement in sales performance metrics) is included in the region. For that reason, it is suggested to the managers to follow the impact

of this target regularly. As a planned target improvement in sales performance metrics is strategically very critical and affects other targets in the improvement plan. Additionally, optimistic and pessimistic examinations should be carried out to decide about the factors IP1 (Increasing the products transportation), C2 (Stronger loyalty and interest of the existing customers) and C3 (Improving Customer Satisfaction and commitment to continuous satisfaction).

- Region III: Excluded region: The factors included in this region are considered as weak influential and dependent ones. It is not wrong to say that factors in this region do not have significant impact or links to the system. In this study, F2 (Shortening the payment periods), F5 (Using currency advantages), and F6 (Longer purchasing payment terms) fully included in this region. Considering the details of these targets, it is obvious that XSM Company cannot make improvements in these factors alone. In other words, strategic improvements depend on the agreements between shareholders, regulations, and some external factors.
- Region IV: Influential region: This region involves factors having strong influence but weak dependence thus these factors are critical and should be prioritized. In line with this information, F3 (Increasing sales growth) and F4 (Efficient cash management) should be prioritized in strategic maps since these factors are fully included in this region. However, F1 (Speeding up the collection of payments) and LG5 (Effective career path and identification of improvement areas) are partially included in this group. Therefore a further analysis in which optimistic and pessimistic views are examined should be carried out.

It is seen from the analysis, hesitancy in DMs assessments makes the factors belong to more than one region. In such cases, optimistic and pessimistic views of the influence-dependence chart should be examined. In optimistic view analysis, lower bounds of cut-off points are considered whereas in pessimistic view analysis upper bounds are taken into consideration. In this study, to better understand the results for F1, C2, C3 and IP1 both views are examined as presented in Fig. 6(a) and Fig. 6(b).



(a)

(b)

Fig. 6. Optimistic (a) and pessimistic (b) views of the influence-dependence chart

In the optimistic view analysis, F1 belongs to region III which makes this factor highly important for strategic management of the company. Considering the details of target F1, it is more meaningful to place this factor in the influential area since it has a direct contribution in the growth of the company. Another point that should be taken into consideration is the positions of IP1, C2 and C3. In the optimistic view analysis these factors are in the critical region. It means that these factors affect both themselves and others. Considering the importance of customer loyalty and satisfaction in todays' business environment, optimistic view analysis gives reasonable results. Finally, for LG5, in the optimistic analysis view, related factors partially included both influential and critical regions. It is not wrong to say that depending on the situation this factor can be considered differently.

From a pessimistic analysis point of view, F1 moves to the excluded region and IP1, C2 and C3 moves to the dependent region. Based on the knowledge of the authors, change in F1 position is not a reasonable result since this factor is always considered very critical in every focus group study. However, position changes for IP1, C2 and C3 can be acceptable.

6. Conclusion

In today's business environment where competition conditions are increasingly challenging, the identification of correct strategies and their effective implementation are vital for businesses. Intellectual capital, such as employees' knowledge level, customer and supplier relationships, and innovation culture play a crucial role in value creation in today's economy. By utilizing the tangible and intangible assets of businesses in a balanced manner, it is possible to achieve strategic objectives. In this context, the BSC provides business managers with the necessary tools to reach future competitive success.

The BSC as a strategic management tool helps organizations effectively address the expectations of various stakeholders, including shareholders, customers, and employees. It serves as a means to translate strategies into actionable plans. The fundamental concept behind this model is its ability to manage intangible or qualitative assets, which play a crucial role in a competitive environment. The BSC offers mechanisms to concentrate on attaining strategic objectives in the future, while also providing metrics to assess the effectiveness and efficiency of past measures. It is a well-known fact that merely reporting performance is not sufficient; each performance metric should have a target, and individuals responsible for each performance metric should be identified to monitor improvements in performance. However, in such a complex and dynamic business environment it is not always possible to define strategies and improvement plans without hesitancy or an uncertainty in the roadmaps. Especially, companies that face the challenge of balancing competitiveness and profitability at the same time, strategic evaluations for target prioritization become more difficult. For this reason, the main reason for proposing an integrated approach with emerging BSC and IVHF-DEMATEL is to increase both flexibility and applicability in strategic management.

In the presented case study, after financial and non-financial goals are set by BSC, determined targets are evaluated using IVHF-DEMATEL methodology. Instead of using a traditional strategic maps BSC model, a four quadrant influence-dependence chart is developed to develop strategically critical insights. Based on the analysis, F3 (Increasing sales growth) and F4 (Efficient cash management), F1 (Speeding up the collection of payments) and LG5 (Effective career path and identification of improvement areas) are prioritized in strategic maps. As a second level, LG3 (Improvement in sales performance metrics) is evaluated as strategically critical. Additionally, IP1 (Increasing the products transportation), C2 (Stronger loyalty and interest of the existing customers) and C3 (Improving Customer Satisfaction and commitment to continuous satisfaction) are also considered critical since they are affecting both themselves and other factors. In the third level, LG1 (Employee development and the commitment to continuous learning), LG2 (Increasing the effective usage of UTS system), LG4 (Increasing sectoral expertise), IP2 (Faster product deliveries), IP3 (Speeding up the routine works) and C1 (Measure, monitor and increase the loyalty of the customers) are included. Finally, F2 (Shortening the payment periods), F5 (Using currency advantages), and F6 (Longer purchasing payment terms) fully included in excluded regions.

By employing the proposed approach outlined in this study, organizations can develop an improvement plan considering the priority of determined targets. Especially, in practical cases where experts are struggling to define their evaluations as precise value, it is believed that using this approach provides valuable insights to companies. Due to the limited resources, the number of determined targets and the definitions of them can be considered as limitations in this study. In future research, the same approach can be applied in multiple companies in the same sector and a more comprehensive result can be achieved by comparisons.

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