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Enhancing Culinary Operations Through Fuzzy Logic: A Case Study in the Catering Industry

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ABSTRACT

This study aimed to analyze the business impact of the catering sector using the fuzzy logic method. The research was conducted at a catering company in Istanbul, utilizing document review and participant observation methods to evaluate the business impact. The nominal prioritization method was used to identify critical business processes, and a model along with a mathematical formula was developed for calculating the business impact. The Fuzzy Logic Designer Toolbox in MATLAB was utilized for this calculation. The study identified eight critical business processes: (1) material supply, (2) material storage, (3) pre-preparation process, (4) cooking process, (5) portioning, (6) shipping, (7) hygiene and food safety, and (8) customer relationship management. The business impact was assessed using classical and fuzzy logic methods, and the results were compared. The fuzzy logic method provided a more flexible and comprehensive assessment, managing uncertainty and variability more effectively than classical logic. Overall, it proved to be more effective in optimizing business processes, offering a more dynamic and holistic approach to improving and prioritizing these processes.

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Introduction

Nutrition is a basic need, and everyone has the right to be fed healthy and safe foods. To protect public health, individuals need to be fed from the right sources (Walls et. al, 2019). Catering businesses meet this need by providing mass feeding services (Doğan & Ay, 2020). The word *"catering"* means mass catering services, and its origin is based on the word *"cater"* (to provide food and drink). These businesses offer services with pre-agreed menus and prices (Doğan, 2018).

Catering businesses provide food and beverage services and meet the nutritional needs of staff and guests in various facilities. These businesses encompass many different disciplines and offer a wide range of products. Their organizational structure is complex and differs from that of other food companies (Doğan & Tekiner, 2021). Depending on the scope of activity, they can be classified as on-site production or transported food service. Businesses that produce meals on-site prepare meals using the customer's kitchen. Businesses that provide transported food services cook their meals in their central kitchens and deliver them to customers (Doğan, 2022). Today, in developed countries, 70% of the population eats at least one meal a day in institutions that provide mass feeding services (İlbay & Ay, 2021).

Catering businesses carefully organize a series of processes, such as menu planning, purchasing, storage, preparation, cooking, and service (Scanlon, 2012). Menu planning is done carefully according to customer preferences and nutritional requirements. At this stage, catering businesses aim to increase customer satisfaction by offering a variety of food options (Mutlu et. al, 2022). The purchasing process ensures that quality, fresh ingredients are sourced. Catering companies carefully select the suppliers of ingredients and strive to buy the best ingredients at the most affordable prices (Ikinci & Tipi, 2021).

Storage involves keeping purchased materials in appropriate conditions. This stage is acutely important to maintain the freshness of the ingredients and prevent waste. Complying with hygiene standards during storage is one of the basic principles of catering businesses. (Shaikh et. al., 2019). In the preliminary preparation phase, the ingredients are made ready for cooking. This process includes chopping the ingredients, marinating them, and other preparation operations. Pre-preparation speeds up the cooking process and ensures that meals are served to customers in less time (Özçakmak & Gül, 2016).

The cooking phase is one of the most critical processes in catering service. Great attention is paid to cooking techniques to provide customers with delicious and healthy meals. Catering establishments prepare a variety of dishes using different cooking methods (Lobefaro, 2021). Finally, the service phase involves presenting the prepared dishes to customers. Service is of great importance in terms of presenting meals aesthetically and ensuring customer satisfaction (Shadiyev, 2021).

Unlike other sectors, the catering sector includes all the features of both the production and service sectors. Businesses operating in this sector try to keep their service quality at the highest level while managing their production processes effectively. The expectation of providing uninterrupted and adequate quality service to customers is one of the cornerstones of the catering industry (Ying-Yen, 2022). Therefore, catering businesses meticulously plan and implement all processes to ensure customer satisfaction. In this context, catering sector businesses, like other sector companies, strive to continuously improve their production processes within the scope of total quality management. Catering industry production processes contain complex and uncertain variables for many reasons (Khan et. al, 2020). Therefore, fuzzy logic can be used as a useful and alternative tool for improving production processes.

Classical logic is based on the works of Aristotle and is the most basic and widespread type of logic (Duncombe & Dutilh Novaes, 2016). Classical logic is a system of logic that makes a clear distinction within the framework of certain rules and principles as a way of thinking. According to classical logic, propositions are either true (1) or false (0), and there is no third state (intermediate state). While classical logic makes a clear and precise distinction, fuzzy logic can better express uncertainty and ambiguity and is more effective in modeling real-life uncertainties (Nadaban, 2021). Fuzzy logic is a type of logic and a mathematical concept that deals with approximate reasoning rather than being fixed and precise (Doğan, 2024).

Fuzzy logic consists of four main components: fuzzy sets, fuzzy logic operators, fuzzy rules, and fuzzy inference. In traditional set theory, an element either belongs to a set or does not, but in the fuzzy sets approach, elements can have degrees of membership ranging from 0 to 1. Fuzzy logic operators include operations such as *"and," "or,"* and *"not,"* and these operators determine the resulting fuzzy sets by operating on membership values (Peckol, 2021). Fuzzy rules represent expert knowledge through linguistic expressions such as *"if"* and *"then"* and define relationships between input-output variables. The fuzzy inference process consists of three steps: fuzzification, rule evaluation, and defuzzification. Fuzzy logic offers a flexible and intuitive approach to dealing with uncertainty and modeling complex problems (Serrano, 2021).

In kitchens, fuzzy logic can increase efficiency in areas such as cooking processes, determining cooking degrees and times, adjusting ingredient quantities, and personalizing recipes. It ensures that food is consistently cooked to the desired level by controlling uncertain parameters more precisely in cooking processes. Cooking temperatures and times can be flexibly adjusted depending on factors such as the type and thickness of the ingredients. Ingredient quantities in recipes can be adjusted with uncertain and imprecise amounts, and suitable substitute ingredients can be suggested (Doğan, 2024).

Fuzzy logic can also be effective in areas such as menu planning, pricing, and inventory management. It recommends popular and profitable menu items by analyzing factors such as ingredient availability, customer preferences, and seasonal trends (Tom & Annaraud, 2021). Additionally, inventory management minimizes waste and reduces costs by predicting demand. Fuzzy logic can help food and beverage kitchens operate more efficiently, produce better-quality food, and improve the customer experience (Rajaratnam & Sunmola, 2023). Considering that decision-making mechanisms in the catering industry involve uncertainty, fuzzy logic management is likely to contribute to improving these processes.

This study is aimed at determining the business impacts caused by possible business interruptions in the production processes of kitchens operating in the catering sector by using the fuzzy logic method and thus contributing to the improvement of the processes. In this context, it is aimed at managing the uncertainties and variables encountered in catering kitchens more effectively. In an environment full of uncertain parameters and variables, processes such as material supply, storage, preliminary preparation, cooking, portioning, shipment, hygiene, and customer relations will be emphasized. Thus, the efficiency of the kitchens will increase, and customer satisfaction and service quality will also increase. These improvements will increase the competitiveness of catering businesses and enable them to be more successful in the sector.

Materials and Methods

The sample was limited to Istanbul, and after the initial sample was determined using the snowball technique, suggestions for additional samples were requested. In this study, the improvement of kitchen production processes in the catering industry was evaluated using the fuzzy logic method within the context of business impact analysis. Critical business functions, which are key parameters in the business impact analysis of kitchen production processes, were identified along with the potential damages that disruptions in these functions could cause. Subsequently, the production processes of a company that produces an average of 5,000 meals per day, representing the catering industry, were analyzed and compared using both classical logic and fuzzy logic methods.

Population and Sample

The main population of the research consists of catering sector companies and is limited to the Istanbul sample. This means that the identified city is considered a representative sample of the primary population covering the catering industry across Turkey. The research sample was created using the maximum diversity method, and the companies were selected accordingly. Maximum diversity sampling aims to create a relatively small sample and to reflect the diversity of individuals who may be a party to the research in this sample to the maximum extent (Levitt, 2021). The snowball technique, one of the most convenient sampling methods, was used in sample selection, and five companies were contacted via phone call and email. A catering business that agreed to participate in the study was examined on-site (Parker et. al, 2019).

Examining Kitchen Production Processes and Identifying Critical Business Functions

Kitchen production processes were thoroughly examined using the document review method and the participant observation technique, one of the field research methods. The document review method involves the stages of reviewing, recording, and evaluating documents for a specific purpose. The primary advantage of this method is its high reliability, as the text remains unchanged during the data collection process (Morgan, 2022).

The participant observation technique entails the researcher actively participating in the community or group being observed (Hurst, 2023). This approach allows the researcher not only to observe from the outside but also to engage directly with the group. Such direct interaction and observation enhance the reliability of data collection. Additionally, this technique enables the researcher to study participants in their natural environments (Rose & Johnson, 2020). This examination identified critical functions within these processes and the potential business impacts of disruptions to these functions.

To prioritize these critical business functions, we used the nominal prioritization method. This method, often employed to condense a large list of options into key priorities, helped rank the identified business processes based on their criticality. The reliability of the nominal prioritization method has been validated in numerous studies.

Business Impact Analysis

Business impact analysis involves estimating the damage businesses may suffer due to potential interruptions from threats and dangers during critical business processes (Silvius & Schipper, 2014). According to the ISO 22301 Standard, it is the process of analyzing the potential impacts of business interruptions. In essence, business impact analysis aims to identify both the quantitative and qualitative effects of these interruptions on business operations (Wong, & Shi, 2014).

For this study, all critical processes of the business were examined, and business impact analyses were conducted. Business impact analysis forms were prepared and completed in the field. These forms help identify relevant critical activities, assess the effects if these activities are not performed, and determine the time required to resume these critical activities.

Determining Business Impact Analysis with Classical Logic Method

In the evaluation of business impact analysis, an evaluation model that includes the components of business impact was created and is given in Figure 1.

A mathematical formula based on the evaluation of various critical factors and the weighting of these factors has been developed through the business impact analysis model and is given below.

$$\text{Total Impact Score} = \sum_{i=1n}^{n} Wi(Ci(Di + Ii)Ti)$$

$\sum$ Represents the sum of the work functions. W_i is the weight of each work function. C_i is the criticality degree of each work function. D_i is the amount of direct loss that will occur in case of failure of each work function. I_i is the amount of indirect damage that will occur in case of failure of each work function. T_i is the recovery time in case of failure of each work function.

Determining Business Impact Analysis with Fuzzy Logic Method

Fuzzy logic is an approach that helps model uncertainty and uncertain information (Zadeh, 2023). By using fuzzy logic for business impact analysis, it is possible to evaluate critical variables and their effects more flexibly and precisely. Four steps are proposed for the business impact analysis process, namely (1) Determination of input variables, (2) Definition of fuzzy sets, (3) Creation of fuzzy rules, and (4) Fuzzy inference system, and are given in Table 1.

In the evaluation of business impact analysis with the fuzzy logic method, the Fuzzy Logic Designer Toolbox of MATLAB (R2024a Update 3) was used due to the availability of ready libraries among programming languages and ease of operation (Kaviranjanii & Rangasamy, 2024). The Mamdani method was used in the fuzzy inference and defuzzification process in the MATLAB Fuzzy Logic Designer Toolbox. The output in the Mamdani method is a fuzzy result set (Kubat, 2016). The study does not require ethics committee approval.

Figure 1. Business impact analysis evaluation model

Table 1. Stages of business impact analysis with fuzzy logic method

S	BIAS	Definition
1	Determination of input variables	Critical variables to be used in business impact analysis for the fuzzy logic model are determined.
2	Defining fuzzy sets	Membership functions are created for each variable.
3	Generating fuzzy rules	Business impact analysis is performed using fuzzy rules.
4	Fuzzy inference system	Using the fuzzy logic system, input variables are evaluated and results are obtained. • Fuzzification • Rule evaluation • Includes the steps of clarification.

S: Steps; BIAS: Business Impact Analysis Stages

Result and Discussion

The company's documents were reviewed, and field research was conducted over three months, from March to June 2024. Using business impact analysis forms, all production processes were listed, sub-processes were defined, and their criticality was assessed. Seven main processes and fourteen sub-processes were identified. Experts were asked to rank these processes based on their criticality levels, highlighting the most critical ones.

The numerical values for the parameters used in the business impact analysis were determined according to specific scales or evaluation criteria. Total impact scores were calculated using mathematical methods. Additionally, a business impact analysis was performed using a fuzzy logic model, with the results evaluated through the MATLAB Fuzzy Logic Designer Toolbox. The outcomes were compared between classical logic and fuzzy logic methods. The detailed findings and evaluations of the study are presented under specific headings.

Determination of Kitchen Production Processes and Critical Business Functions

Business impact analysis forms were used to identify kitchen production processes and critical functions. All business functions within the production processes were listed in the analysis forms, and the sub-processes of each function were defined and assessed for their criticality. The goal of determining the criticality of each business function was to decide if it should be categorized as a critical business function. Detailed information on the general kitchen production processes and their criticalities, following a thorough examination of the business processes, is presented in Table 2.

Table 2. Stages, definition and criticality of business functions

	SBP	Sub-stage	Definition	Criticality status
1	Planning and Preparation	Menu Planning	Determining menus, selecting ingredients, and creating recipes.	Seasonal availability of ingredients, compliance with customer preferences, and adherence to dietary requirements.
		Material Supply	Purchasing necessary ingredients and stock management.	Ingredient quality and freshness, supply chain issues, and inventory costs.
2	Preparation and Pre-Processing	Material purchasing and control	Receiving ingredients, checking their quality, and storing them.	Delivery timing, ingredient quality control, and management of storage areas.
		Material Storage	Proper storage of ingredients (especially for products requiring a cold chain).	Storage conditions, inventory management, spoilage, and waste.
3	Portioning and Shipment	Pre-Preparation Process	Preliminary operations such as washing, chopping, etc. of ingredients.	Workforce efficiency, management of preparation time, and maintenance of food safety standards.
		In-Kitchen Logistics	Transporting ingredients within the kitchen and distributing them to workstations.	Time management, organization of workstations, and material losses.
4	Customer Relations and Improvement	Cooking Process	Cooking meals according to recipes.	Cooking time and temperature control, adherence to recipes, and avoiding over- or under-cooking.
		Assembling	The assembling of different ingredients and preparing them for presentation.	Timing, aesthetic presentation, and correct proportions of ingredients.
5	Incoming Controls and Storage	Portioning	The placing of meals appropriately in gastronomy tubs and thermoboxes.	Selection of appropriate gastronomy tubs and boxes, packaging speed and efficiency, and maintenance of food temperature.
		Shipment	Delivering meals to customers on time.	Shipping logistics, traffic, and accurate time management.
6	Cooking and Processing	Quality Control	Checking the compliance of products with quality standards.	Ensuring process consistency, meeting quality standards, and gathering customer feedback.
		Hygiene and Food Safety	Ensuring sanitation and food safety.	Monitoring hygiene practices, employee training, and mitigating cross-contamination risks.
7	Quality Control and Hygiene	Customer Relationship	Obtaining and analyzing customer feedback.	Collecting and evaluating feedback to eliminate dissatisfaction.
		Continuous Improvement	Determining and improving deficiencies in processes.	Increasing productivity, optimizing processes, and enhancing employee motivation and training.

SBP: Stage of the business process

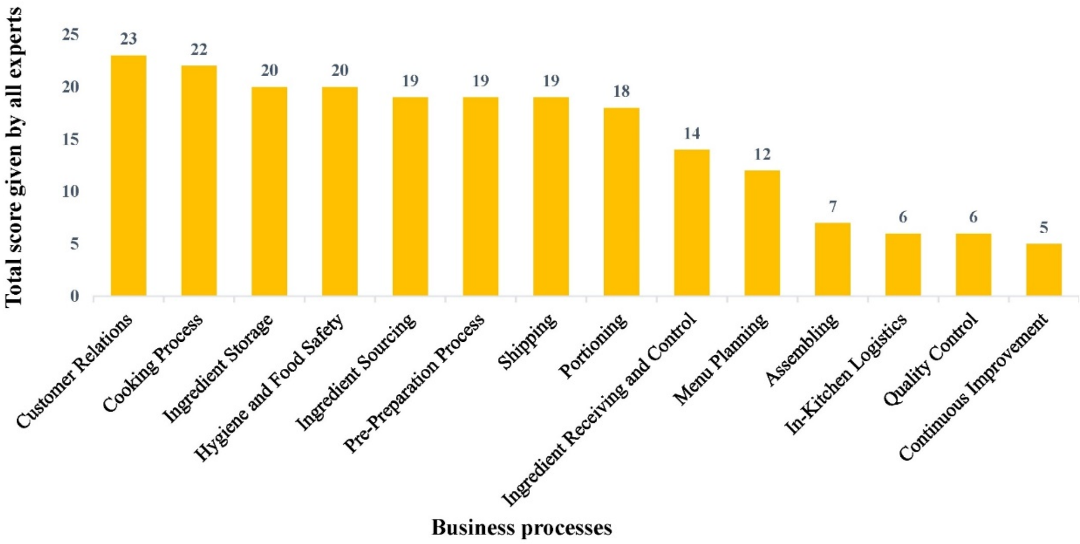

Figure 2. Prioritization findings of business processes in terms of their criticality.

Fourteen business processes were evaluated according to their priority scores, and it was decided to include (1) material supply, (2) material storage, (3) pre-preparation process, (4) cooking process, (5) portioning, (6) shipping, (7) hygiene and food safety, and (8) customer relations processes within the scope of critical business processes.

Table 3. Parameters and evaluation scales used in business impact analysis

P	Definition	Value Range	How was it determined?
C	It expresses how critical the business function is to the business.	It takes a value between 0 and 1. 0 means the lowest criticality, and 1 means the highest criticality.	Determined using expert opinions, business experience, and historical data. For example, a vital business function may receive a value between 0.9 and 1, while a less critical function may be evaluated between 0.1 and 0.3.
D	A direct financial loss will occur in the event of a disruption of the business function.	It is a positive number (for example, 5000 or 100000₺). It is determined using real financial data.	Estimated using financial reports, historical cost analysis, and accounting records.
I	Indirect losses that will occur in the event of a disruption of the business function (e.g., loss of customers, loss of reputation).	It is a positive number (for example, 5000 or 10000₺). It is determined using real financial data and estimates.	Indirect losses are estimated using the business's experience and expert opinions.
T	Time required for recovery in case of disruption of the business function.	It is a positive number (for example, 1 hour or 5 hours).	Determined using operational data and historical recovery periods.
W	It expresses the relative importance of the business function to the business.	It takes a value between 0 and 1. 0 means the lowest importance, and 1 means the highest importance.	Determined using the relative importance level determined by business managers and experts.

P: Parameter; C: Criticality Degree (C); D: Direct Loss (D); I: Indirect Loss (I); T: Recovery Time (T); W: Weight (W)

The business impact analysis forms completed during the field and document research were evaluated, identifying seven processes and fourteen sub-processes. Their criticality was then assessed. This list was presented to five experts, who were asked to rank the business functions based on their criticality. Each expert evaluated the criticality level of the fourteen stages on a scale from 0 to 5, assigning more points to more urgent critical situations. They were also allowed to assign equal points to stages if necessary. The results are presented in Figure 2.

The numerical values of the parameters used in the business impact analysis were determined within the framework of a certain scale or evaluation criteria. Table 3 explains what each parameter means, in which ranges it can take values, and how these values were decided.

Mathematical calculations were made using the total impact formula (TIS) we developed to perform the business impact analysis, and the result is below.

$$\text{TIS} = \sum_{i=1}^{8} Wi \cdot (Ci \cdot (Di + Ii) \cdot ti) = 136.29$$

In addition, the weight (W), criticality degree (C), direct loss (1000₺), indirect loss (1000₺), total loss (1000₺), recovery time (h), and impact scores determined for each critical function are given in Table 4.

Table 4. Impact scores of critical business functions

CBF	Definition	CD	DL	IL	TL	RT	W	IS
Material Supply	Purchasing necessary ingredients and stock management.	0.9	8	4	12	2	1	17.28
Material Storage	Proper storage of ingredients (especially for products requiring a cold chain).	0.6	4	2	6	1	1	2.70
Pre-Preparation Process	Preliminary operations such as washing. chopping. etc. of ingredients.	0.7	4	3.2	7.2	1	1	4.54
Cooking Process	Cooking meals according to recipes.	0.8	16	8	24	2	1	38.88
Portioning	The placing of meals appropriately in gastronomy tubs and thermoboxes.	0.5	0.2	0.1	0.28	0.5	1	0.09
Shipping	Delivering meals to customers on time.	0.9	2	2	4	1	1	2.88
Hygiene and Food Safety	Ensuring sanitation and food safety.	0.7	0.8	1.2	2	0.5	1	0.81
Customer Relationship	Obtaining and analyzing customer feedback.	0.9	4	20	24	4	1	69.12
Total Impact Score								136.29

CBF: Critical Business Function; CD: Criticality Degree (C); DL: Direct Loss (1000₺); IL: Indirect Loss (1000₺); TL: Total Loss (1000₺); RT: Recovery Time (h); E: Weight (W), IS: Impact Score

Table 5. Input variables and membership functions of critical business functions

Critical Business Function No.	Input Variables	Defining Fuzzy Sets Membership Function
1	Material Supply	Low, Medium, High
2	Material Storage	Low, Medium, High
3	Pre-Preparation Process	Low, Medium, High
4	Cooking Process	Low, Medium, High
5	Portioning	Low, Medium, High
6	Shipping	Low, Medium, High
7	Hygiene and Food Safety	Low, Medium, High
8	Customer Relationship	Low, Medium, High

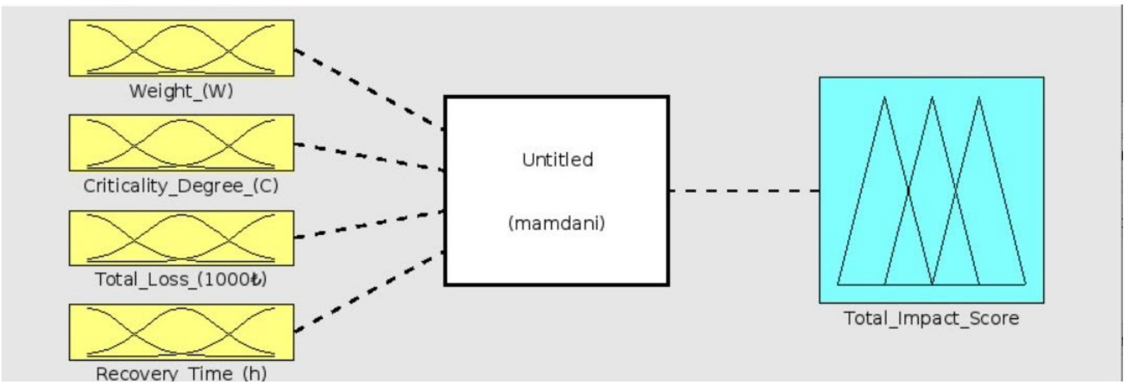

Figure 3. Created fuzzy inference system

Determining Business Impact Analysis with Fuzzy Logic Method

In determining the business impact using fuzzy logic, the critical business function parameters developed with the classical logic method and the business impact scores calculated using mathematical formulas were considered. Next, the fuzzy sets were defined, and the membership functions were determined, as shown in Table 5.

Rules were created using the MATLAB Fuzzy Logic Designer Toolbox based on the variables of the formula we developed for the business impact analysis: weight (W), criticality (C), direct damage (1000₺), and recovery time (h).

In summary, the fuzzy logic process includes fuzzification, rule evaluation, and defuzzification steps. Finally, the data was evaluated using the MATLAB program using the following steps:

MATLAB Fuzzy Logic Designer Toolbox Steps

- *Creating FIS:* A Mamdani-type fuzzy inference system (FIS) has been created, and the input and output variables have been defined and are given in Figure 3.
- *Membership Functions:* Membership functions for input variables are defined in Figure 4, and the output variable is given in Figure 5.
- *Adding Rules:* The determined rules have been added to the system and are given in Figure 6.
- *Setting Input Values:* The data set given in Table 4 was entered for each business function.
- *Running the Inference***:** By running the fuzzy logic model, the job impact values were calculated by the program and are shown in Figures 7 and 8.

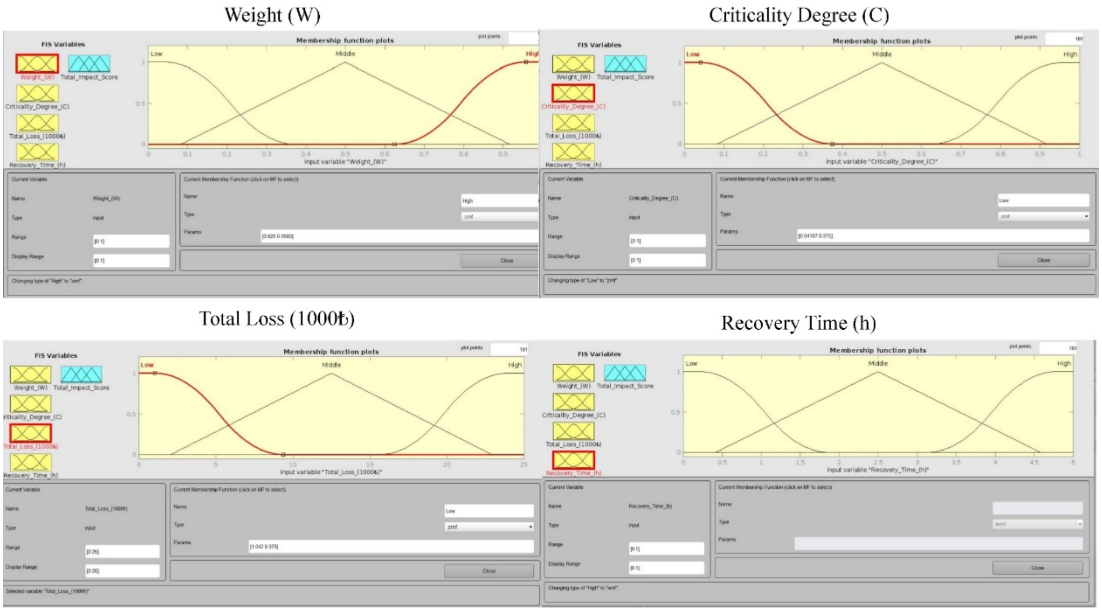

Figure 4. Membership functions for input variables

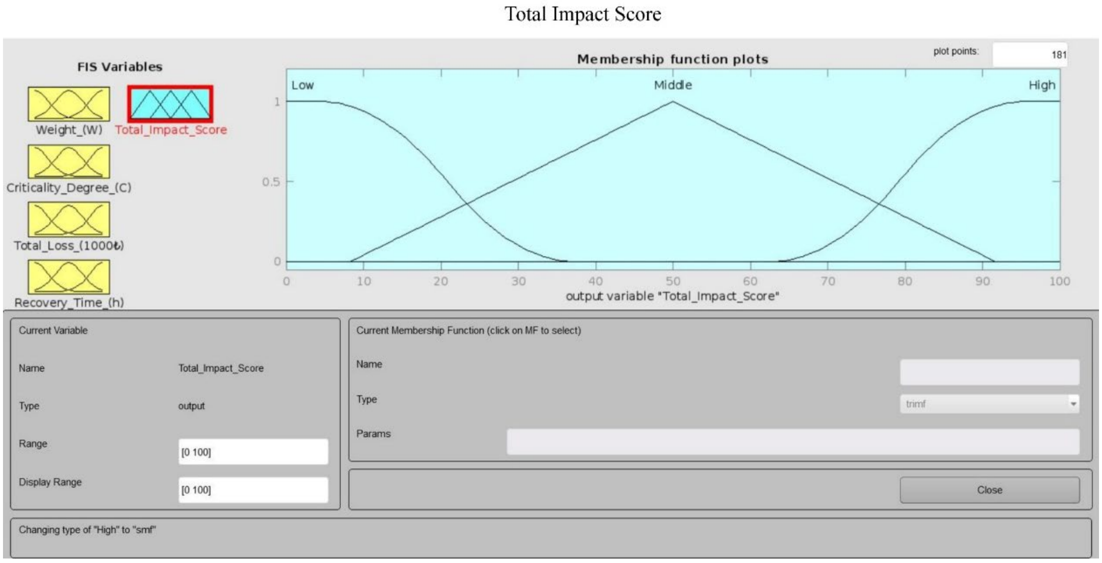

Figure 5. Membership functions for the output variable.

Table 6. Comparison of the priority order of critical business processes in terms of classical and fuzzy logic methods

n	CBF	BLM	WS	OS	BFM	WS	OS
8	Customer Relationship	69.12	50.71	1	92.70	18.67	1
4	Cooking Process	38.88	28.53	2	92.70	18.67	2
1	Material Supply	17.28	12.68	3	55.40	11.16	3
3	Pre-Preparation Process	4.54	3.33	4	51.50	10.37	5
6	Shipping	2.88	2.11	5	54.20	10.92	4
2	Material Storage	2.7	1.98	6	50.00	10.07	6
7	Hygiene and Food Safety	0.81	0.59	7	50.00	10.07	7
5	Portioning	0.09	0.07	8	50.00	10.07	8
	Total Impact Score	136.30	100.00	Total Impact Score	496.50	100.00	

CBF: Critical Business Function; BLM: Business impact score calculated by classical logic method; WS: Weighted percentage (%) of business impact score; OS: Order of priority of business impact scores; BFM: Business impact score calculated by fuzzy logic method

The comparison of the results of the results of the business impact analysis obtained through classical logic and fuzzy logic is given in Table 6.

Table 6 compares the prioritization of critical business processes using classical logic and fuzzy logic methods. Business impact scores were calculated with both approaches, and the resulting priority orders were analyzed.

In the classical logic evaluation, the “customer relationship” function received the highest business impact score, placing it at the top of the list. This was followed by the “cooking process” and “material supply” processes. Lower scores were assigned to other processes, establishing their respective priority orders.

In contrast, the fuzzy logic analysis also placed “customer relationship” and “cooking process” in the top two positions. However, in this method, some processes received higher scores than they did under classical logic, resulting in a shift in their priority ranking. Notably, the “pre-preparation process” and “shipping” processes scored higher in the fuzzy logic method and moved up in the rankings.

Rajaratnam & Sunmola (2023) evaluated the effectiveness of the supply chain application in the airline catering sector using fuzzy logic. Similar to our study, they proposed a model for the effectiveness of supply chain applications in the airline catering sector using fuzzy logic. While the related study proposed a model for the effectiveness of only one part of the sector, our study covers all business processes.

These differences underscore the fuzzy logic method's ability to better handle uncertainty and variability. By assessing the impact levels of processes more flexibly, this method provided a more nuanced and comprehensive prioritization than classical logic. As a result, fuzzy logic appears to be more effective in optimizing and prioritizing business processes.

The business impact scores and their percentage weighted ratios calculated with the classical logic method have a more limited range (highest 50,71%, lowest 00,7%) and offer a clearer ranking. However, the scores calculated with the fuzzy logic method have a much wider range (highest 18.67%, lowest 10.07%) and provide a more flexible assessment. This shows that the fuzzy logic method can take into account a wider range of uncertainty and variability.

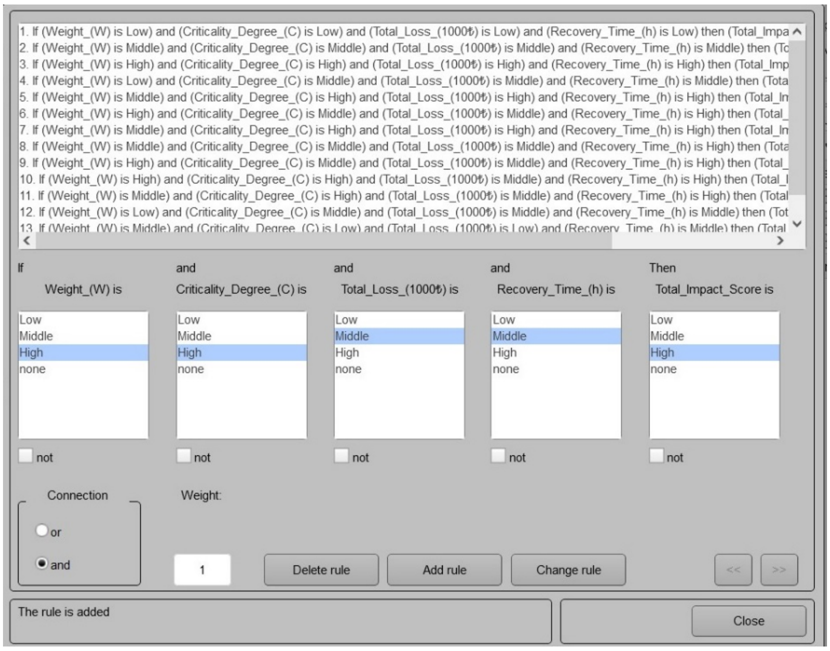

Figure 6. Fuzzy logic rules

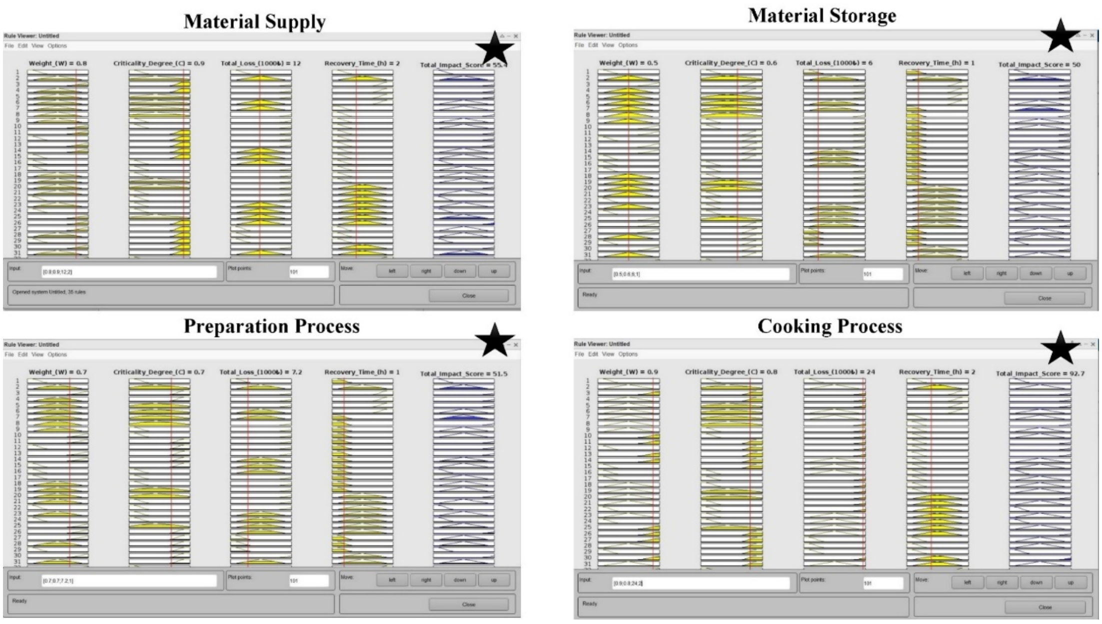

Figure 7. Business impact values of the parameters of material supply, material storage, pre-preparation process, and cooking process from critical business processes.

Figure 8. Business impact values of critical business processes such as portioning, shipping, hygiene and food safety, and customer relations parameters.

Bingöl et al. (2022) conducted a study to increase the effectiveness of using robots in restaurants, hotels, and catering businesses. In the study, they used the fuzzy logic method to classify plates with known dimensions. When they examined the fuzzy logic results, they determined that the plate type selection was successful and the prediction rate was close to one hundred percent accurate. Similarly, our study showed that the fuzzy logic method can account for a wider range of uncertainty and variability. Therefore, it was seen that fuzzy logic can better manage uncertainty and variability and that business processes are better optimized and successful due to more flexible decisions.

In the classical logic method, the percentage ratios of the business impact scores show a very sharp and distinct distribution, indicating that the classical logic method offers a more rigid and limited perspective when determining critical business functions. Kahraman et al. (2004) used the fuzzy logic method to develop an analytical tool for selecting the best catering companies that provide a high level of customer satisfaction. For this purpose, they interviewed three catering companies and identified the criteria that customers use to choose these services. Initially, the companies were compared using the Analytical Hierarchy Process (AHP), and then the fuzzy logic hierarchy was applied for comparison. Their findings indicated that fuzzy logic produced better and more successful results.

Similarly, in our study, the fuzzy logic method outperformed the classical logic method, offering a more dynamic and holistic approach to optimizing business processes. The study's findings demonstrate that the fuzzy logic method was more effective in achieving successful outcomes. In the fuzzy logic method, the percentage-weighted ratios are distributed more evenly. For example, functions such as “pre-preparation process” and “shipping” are ranked higher because they are evaluated at higher rates compared to classical logic. This shows that fuzzy logic can better manage uncertainty and variability and determine the order of importance of business processes more flexibly.

The fuzzy logic method can be more effective in improving and prioritizing business processes compared to the classical logic method. While classical logic provides more precise and rigid results, the fuzzy logic method offers a more comprehensive assessment by handling variability and uncertainty more flexibly. This better reflects the complexity and uncertainty of business processes in the real world. These findings show that the fuzzy logic method offers a more dynamic and holistic approach to business processes so that businesses can make more flexible decisions while optimizing their processes.

Çakır & Ulukan (2021) proposed a new fuzzy control system for evaluating in-flight catering customer satisfaction. The implementation and design of the control system were simulated multiple times, and the results were assessed through graphical and visual analysis. In our study, we propose a similar system to enhance the business processes of catering enterprises. Our findings indicate that this system when evaluated using the fuzzy logic method, proved to be more functional and effective.

Conclusion

Catering businesses are essential for providing large-scale nutritional services, and they must expertly manage every step of the process, from menu planning and purchasing to storage, preparation, cooking, and service. The fuzzy logic method serves as an effective tool for managing and improving uncertainties in these processes. Additionally, applying fuzzy logic enhances the efficiency of catering kitchens, boosts customer satisfaction, and improves service quality. These advancements increase the competitiveness of catering businesses and enable them to achieve greater success in the industry.

This study focuses on improving the business impact analysis of kitchen production processes in the catering sector using the fuzzy logic method. Conducted on a catering company in Istanbul, the research compares classical logic and fuzzy logic methods. The goal was to identify critical functions and assess the potential impact on the business if these functions were disrupted. Kitchen production processes were analyzed through document reviews and participant observation methods, identifying critical functions and potential business risks.

The business's essential functions were ranked using the nominal prioritization method. During the business impact analysis, critical processes were evaluated, and the potential impacts of business interruptions were analyzed. In addition to the classical logic method, the fuzzy logic method was employed to model uncertainty and manage ambiguous information. MATLAB's Fuzzy Logic Designer Toolbox facilitated this analysis, enabling a more flexible and precise evaluation of critical variables and their impacts.

Field studies and document reviews were conducted from March to June 2024 to identify critical processes. Seven main processes and fourteen sub-processes were defined, and experts assessed their criticality levels. The business impact analysis results were then calculated using both classical logic and fuzzy logic methods, and the scores were compared. The fuzzy logic method offered a more flexible and comprehensive assessment, managing uncertainty and variability more effectively than classical logic. It proved to be more effective in optimizing business processes, especially in situations involving high levels of uncertainty. The findings indicate that the fuzzy logic method provides a more dynamic and holistic approach to improving and prioritizing business processes.

Declarations

Consent for Publication
The author has read and approved the content of this manuscript for publication.

Competing Interests
The author declares that there are no competing interests.

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Authors' Contributions
There is only one author.

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