mathematics

MDPI

Article

Analysis of the Relationship between the Organizational Resilience Factors and Key Performance Indicators' Recovery Time in Uncertain Environments in Industrial Enterprises

Michael Huber [1], Nikola Komatina [1], Vladan Paunović [2] and Snežana Nestić [1,*]

[1] Faculty of Engineering, University of Kragujevac, 34000 Kragujevac, Serbia; michael.huber@kg.ac.rs (M.H.); nkomatina@kg.ac.rs (N.K.)
[2] Faculty of Technical Sciences, University of Kragujevac, 34000 Kragujevac, Serbia; vladan.paunovic@ftn.kg.ac.rs
* Correspondence: s.nestic@kg.ac.rs

Abstract: In terms of uncertain business conditions, the ability of an enterprise to bounce back after severe disruptions, or simply resilience, may be seen as one of the major features needed to sustain successful business operations. This research has the objective of proposing an algorithm for the organizational resilience assessment in industrial companies and conducting an analysis of the relationship between the organizational Resilience Factors and Key Performance Indicators recovery times. As the variables that are an integral part of the research are exposed to a high degree of uncertainty, they are modeled using fuzzy set theory. The methodology used for the research is an enhanced fuzzy Delphi, where the fuzzy geometric mean is employed as an aggregation operator. The relationship between the organizational resilience factors and Key Performance Indicators' recovery time is based on the correlation analysis. The proposed model is based on real data from one complex industrial enterprise. The main finding of the research is that calculations indicate a significant negative correlation between treated variables.

Keywords: organizational resilience; key performance indicators; recovery time; fuzzy delphi; fuzzy sets theory

MSC: 03E72

Citation: Huber, M.; Komatina, N.; Paunović, V.; Nestić, S. Analysis of the Relationship between the Organizational Resilience Factors and Key Performance Indicators' Recovery Time in Uncertain Environments in Industrial Enterprises. *Mathematics* **2023**, *11*, 3075. https://doi.org/10.3390/math11143075

Academic Editor: Georgios Tsekouras

Received: 14 June 2023
Revised: 4 July 2023
Accepted: 8 July 2023
Published: 12 July 2023

1. Introduction

Over the previous decades, resilience-scoped research has been conducted from different perspectives: Resistance and recovery, adaptation, and anticipation [1]. Also, as research interest has grown over the years, there is little consensus about what resilience means or how it is designed [2]. During a period of stable business conditions, organizational performance indices do not have significant oscillations. On the other hand, if severe disruptions occur, a sudden drop in performance might happen [3]. In practice, performances such as quality, cost, productivity, innovativeness, time, etc. need to be managed by companies [4] to make their business activities successful. As performance represents a complex variable, in practice it is measured and managed through Key Performance Indicators (KPIs) [5]. Common sense implies that more resilient organizations will recover their performance faster compared to those that are not so resilient.

It may be assumed that organizational resilience models are complex, which implies that their evaluation cannot be performed directly; assessment models that rely on the judgments of decision-makers could be applied. This assumption is important since many management problems demand this approach to assessment, which induces a certain degree of uncertainty.

The motivation for this research stems from the various uncertainties of the above-mentioned business context. Companies can be affected by various factors such as competition, changes in the market, political instability, and natural disasters. COVID-19 has shown how quickly an uncertain situation can develop and how companies must respond.

Uncertainties for companies have been omnipresent not only since pandemics, unstable geopolitical situations, or endangered supply chains. Entrepreneurial resilience is therefore seen as an important capability for companies to cope with these very changes and crises [6]. In a rapidly changing world, it is thus crucial that companies be resilient as a precondition for success. Therefore, both uncertainty and resilience are closely related concepts that are of significant importance to companies. As organizational resilience models, as well as business processes, are complex in nature, their evaluation cannot be performed directly. This implies that they require evaluation models based on the judgments of decision-makers. This feature is important because, in a variety of management problems, it is not possible to directly measure the variables of interest. This is because those variables are subject to a certain degree of uncertainty. At the same time, it is closer to human thinking to use linguistic variables for assessment. Different mathematical theories support the quantitative description of linguistic expressions [7]. Many mathematical theories support modeling linguistic expressions in a quantitative way. The theory of fuzzy sets [7,8] is used in many research areas to describe uncertainty quantitatively.

The fuzzy Delphi method will be used to assess the organizational resilience of the company. Here, the decision-making method is based on a consensus of expert opinions and uncertain information on a particular topic or issue. The overall objective of this research is the analysis of the dependency between organizational resilience factors (RFs) and KPIs' recovery times. To achieve the defined research goal, organizational resilience should be assessed as well as the recovery time of KPIs in the treated company.

Furthermore, the following chapters are organized as follows: Section 2 provides an overview of the relevant literature. Section 3 presents the proposed model. Section 4 presents the case study in a corporate context, and Section 5 provides a critical discussion and conclusion.

2. Literature Review

The literature supports the use of type one fuzzy sets for modeling existing uncertainties [9,10]. Type one fuzzy sets are used for the research. The features of type one fuzzy sets are the triangular membership function, granulation, and domain. The granulation is often chosen in accordance with the nature of the problem being solved. The domain might be chosen according to the DM assessment or following the literature guidelines [11].

A significant number of scholars support the application of type one fuzzy sets since they provide a solid base for calculations embracing uncertainties with a reasonable number of mathematical operations.

Considering all the issues raised, methods such as Delphi with type one fuzzy sets are used to solve fuzzy group decision-making problems [12,13]. The aggregation of DMs' opinions into unique opinions can be obtained by applying the different aggregation operators [14,15]. Mostly, in the domain of solving real business problems in the presence of uncertainty, fuzzy arithmetic mean [16–19] and fuzzy geometric mean [20–22] are applied.

This section embraces the analysis of the Fuzzy Delphi technique compared with the fuzzy Delphi technique enhanced with type one fuzzy numbers and applied to solving similar problems in management. The comparative analysis is presented in Table 1.

Table 1. Comparative analysis of the proposed Delphi technique with type one fuzzy numbers.

Authors	The Number of DMs	Membership Function Shape/Granulation/ Domain	The Aggregation Operator/Defuzzification Procedure/the Distance between Two Fuzzy Numbers/Checking the Consensus of Decision-Makers Assessments
Chen and Lee [23]	-	TFN/5/[0–1]	the proposed aggregation method/simple gravity method/-/the proposed threshold value [23]
Habibi et al. [12]	-	TFN/5/[0–1] TFN/7/[0–1]	the proposed aggregation procedure/center gravity method/-/the usually used threshold [24]
Liu and Chu [25]	-	TrFN/3/[0–10]	the proposed aggregation procedure/-/-/the proposed procedure by Horng et al. [24]
Kumar et al. [26]	-	TFN/9/[0.1–0.9]	the proposed aggregation procedure [26]/center of gravity method/-/-
Jani et al. [16]	12	TFN/7/[0–1]	fuzzy arithmetic mean/-/Euclidean distance/threshold value defined by Mahmoudi et al. [27]
Singh and Sarkar [28]	15	TFN/5/[0.1–0.9]	the proposed aggregation procedure/center of gravity method/-/the proposed procedure based on a threshold value defined by Kumar et al. [29]
Bui et al. [20]	-	TFN/5/[0–1]	fuzzy geometric mean/method of the maximum possibility/-/the proposed procedure for establishing equilibrium across the fundamental judgments among the expert group [7]
Khan et al. [21]	12	TFN/5/[0–1]	fuzzy geometric mean/center of gravity/-/procedure defined by Horng et al. [24]
Abdollahi et al. [17]	15	TrFN/5/[0–9]	fuzzy arithmetic mean/-/the defuzzification procedure [30]/distance between two consecutive rounds [27]
Tsai et al. [18]	14	TFN/5/[0–1]	fuzzy arithmetic mean/center of gravity method/-/-
Dawood et al. [19]	-	TFN/5/[0–1]	fuzzy arithmetic mean/center of gravity method/Euclidean distance/The consensus must be higher than or equal to 75% to declare an acceptable agreement amongst the experts [31]; defined threshold value; distance between two consecutive rounds [27]
Mabrouk [13]	-	TFN/5/[0–1]	the proposed aggregation model/the proposed defuzzification method/-/defined the filtering threshold for the critical attributes
Aleksić et al. [22]	5	TFN/7/[1–9]	fuzzy geometric mean/-/Hamming distance/combining the Graded Mean Integration Representation and Average Percent of Majority Opinions Cut-off Rate [32]
The proposed model	9	TFN/5/[0–10]	fuzzy square mean/-/Euclidean distance/intraclass correlation coefficient [33]

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and the working hypotheses. The findings and their implications should be discussed in the broadest possible context. Future research directions may also be highlighted.

In the analyzed papers, almost all authors use TFNs to describe the assessment of DMs. Up to now, there is no recommendation in the literature on how to determine the granulation and the domains of the employed fuzzy numbers in the realization of Delphi studies. The number of linguistic variables is most influenced by the complexity of the problem as well as the number of decision-makers included in the Delphi study. Having in mind the stated, it is worth mentioning that most scholars [13,17–21,23,28] employ five linguistic expressions for describing uncertainties in their research.

In the analyzed Delphi studies, the majority of authors [12,13,16–21,23] suggested that the domain should be defined on the set of real lines belonging to the interval [0–1].

In this research, the triangular membership function is used for modeling RF value estimates on sub-processes of the manufacturing process, as in almost all analyzed works. In the literature, many authors suggest that TFNs can capture uncertainties and inaccuracies adequately, and on the other hand, their usage does not require complex computations [7]. The number of pre-defined linguistic terms used to describe the considered uncertainty is five, as in the majority of analyzed papers. The domain of TFNs defined in this research belongs to the interval [0–10], as suggested by Liu and Chu [25].

The aggregation of DMs' assessments into a single assessment is based on the use of different operators. The selection of aggregation methods for DMs' estimates can be acknowledged as a problem in itself.

In this research, the authors suggest a fuzzy quadratic mean operator, which represents the difference between the presented research and papers that can be found in the relevant literature and is presented in Table 1.

The linguistic expression representing the result of the previous round is obtained from the condition of the minimum distance of pre-defined linguistic expressions and TFN, which describe the aggregate value of the DMs' assessment. Euclidean distance is most often used in a variety of research [16,19], as in this one particular study. Some scholars use Hamming distance as well [22].

Checking the consistency of DMs' assessments is based on different procedures [34]. In this research, the procedure for checking if the consensus of DMs' opinions is reached is performed by using an intraclass correlation coefficient [35]. It can be concluded that it is necessary to perform a sensitivity analysis of the results of the consensus check obtained by applying different methods.

3. Methodology

This section proposes the three-stage fuzzy model, which represents the core of this research. Simultaneously, a literature review is provided. In the first stage, the level of RFs is determined at the level of the product delivery process within the analyzed company by applying the proposed fuzzy Delphi technique. The second stage of the proposed model is used to determine the weighted aggregated fuzzy value of RFs at the level of each KPI as well as the scatterplot dependency between RFs and KPIs. The proposed two-stage model is presented in Figure 1.

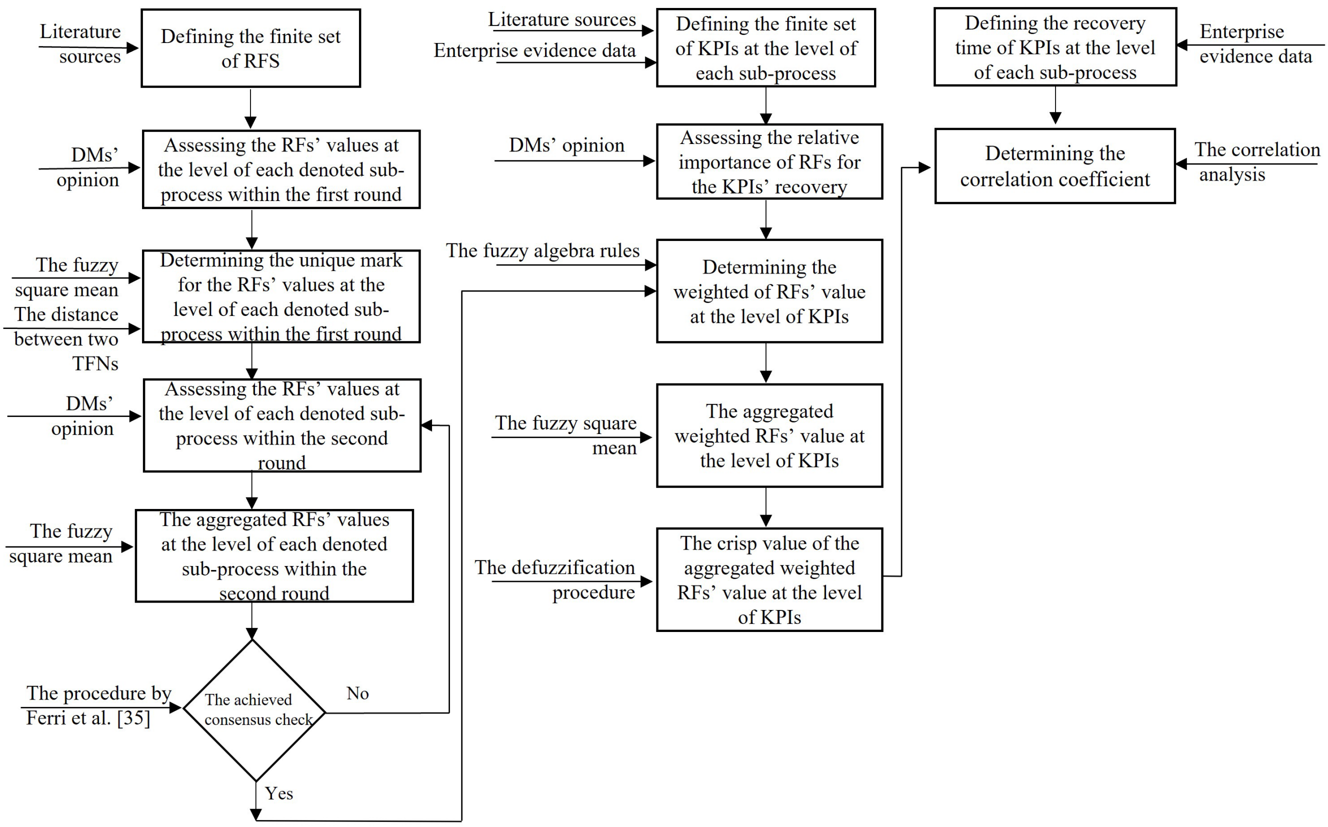

Figure 1. The proposed fuzzy model for assessment and analysis of the relationship between the weighted aggregated RFs' values and KPIs' recovery time.

To execute the proposed research, the following steps should be performed in the corporate context: (1) the definition of a finite set of RFs (see Section 3.1.1); (2) the definition of the main processes (MP) and sub-processes (SP) of the company (see Section 3.1.2); (3) the definition of the KPIs that are managed at the level of identified subprocesses (see Section 3.1.3); (4) the identification of a group of experts who have in-depth knowledge and experience related to enterprise resilience (see Section 3.1.4); (5) the execution of the proposed Delphi method to reach a consensus opinion of the experts related to the RFs' level in the treated company (see Section 3.3); (6) the calculation of the aggregated weighted RFs value at the level of each identified KPI; (7) the assessment of the KPIs' recovery time; (8) The scatter plot analysis of RFs values and KPIs' recovery time values; (9) analysis of the results to identify weaknesses and opportunities for improvement.

3.1. Defining the Finite Set of Input Variables

3.1.1. Defining the Finite Set Resilience Factors

Formally, the list of proposed RFs is represented by a formal set: $\{1, .., j, .., J\}$. The total number of considered RFs is denoted as J. The index of RF is marked as $j, j = 1, .., J$. In this research, the set of RFs is defined according to the referent literature [36]. The considered RFs that are significant for a production company are: management commitment $(j = 1)$, reporting culture $(j = 2)$, learning $(j = 3)$, awareness $(j = 4)$, preparedness $(j = 5)$, flexibility $(j = 6)$, self-organization $(j = 7)$, teamwork $(j = 8)$, redundancy $(j = 9)$, and fault-tolerance $(j = 10)$.

3.1.2. Defining the Finite Set of Business Sub-Processes

The classification of the business process and its' corresponding subprocesses is determined in compliance with the APQC framework [37]. Within this research, a process entitled "Deliver Physical Products" is analyzed. Its' subprocesses can be formally represented by a set of indices: $\{1, .., p, .., P\}$. The finite number of subprocesses is denoted as P, and $p, p = 1, .., P$ represents the index of the subprocess. The sub-processes of Deliver Physical Products are: planning for and aligning supply chain resources $(p = 1)$, procuring materials and services $(p = 2)$, produce/assemble/test product $(p = 3)$, and managing logistics and warehousing $(p = 4)$.

3.1.3. Defining the Managed KPIs

There is no specific recommendation on which KPIs should be managed in different companies, so it is their responsibility to choose adequate KPIs based on their size, business domain, and other features. For this research, the set of KPIs is defined in compliance with the APQC framework to provide generality, and at the same time, it is adjusted to the company that is analyzed to provide expediency.

The set of considered KPIs is presented by a set of indices: $\{1, .., i, .., I\}$. The total number of the considered KPIs is denoted as I. The index of the KPI is marked as $i, i = 1, .., I$. In this research, these KPIs are [37]: Total cost of quality per $100,000 in revenue $(i = 1)$, employee retention rate $(i = 2)$, percentage of sales orders scheduled to customer requests $(i = 3)$, total cost to perform the procurement process group per purchase order $(i = 4)$, average procure-to-pay cycle time in days $(i = 5)$, percentage of unique suppliers who are active suppliers $(i = 6)$, scrap and rework costs as a percentage of cost of goods sold $(i = 7)$, total cost to manufacture per $1000 revenue $(i = 8)$, percentage of defective parts per million $(i = 9)$, average cycle time in calendar days from delivery order to successful completion of delivery and disposal of back-hauled goods $(i = 10)$, perfect order performance $(i = 11)$, percentage of supplier on-time delivery $(i = 12)$.

3.1.4. Defining the Set of DMs' Team

The assessment of the level of each RF, $j, j = 1, .., J$ at the level of each business process should be presented as a fuzzy group decision-making problem. DMs should be aware of the RF level so they can manage and enhance it continuously.

In this research, a set of DMs should be presented by a set of indices: $\{1, .., e, .., E\}$. Ukupan broj DMs are denoted as E. The index of DM is marked as $e, ., e = 1, .., E$.

The DMs team consists of the highest-ranking employees in the company structure, which enables wide insight into the enterprise's functioning and experience in the decision-making process. In the analyzed company, the DMs' team consists of the Chief Executive Officer ($e = 1$), Operations Manager ($e = 2$), Management System Manager ($e = 3$), Global Supply Chain Manager ($e = 4$), Human Resource Manager ($e = 5$), Marketing Manager ($e = 6$), Service and Sale Manager ($e = 7$), Chief Information Officer ($e = 8$), Research and Development Manager ($e = 9$). It should be noted that the DMs' team is responsible for all assessments that are proposed by this research.

3.2. The Selection of Linguistic Variables for the Existing Uncertainties' Description

In this research, existing uncertainties are: (1) the values of RFs at the level of sub-processes of the delivery product business process; and (2) the relative importance of RFs for the KPIs' recovery.

The assessment of RFs' values at a level for each considered sub-process is performed by using five linguistic expressions, which are modeled by TFNs. These linguistic variables and their corresponding TFNs are given:

Very low value ($B1$)—(0, 1.5, 3)
Low value ($B2$)—(1, 2.5, 4)
Medium value ($B3$)—(3, 5, 7)
High value ($B4$)—(6, 7.5, 9)
Very high value ($B5$)—(7, 8.5, 10)

The domains of TFNs that are used for the quantitative description of RFs' level in the analyzed company within the interval [0–10]. The values 0 and 10 denote that RF has the lowest value or the highest value, respectively.

The assessment of the relative importance of RFs for the KPIs' recovery is described by the seven linguistic expressions modeled by TFNs:

Extremely low importance ($A1$)—(0, 0, 2.5)
Low importance ($A2$)—(0.5, 2, 3.5)
Fairly low importance ($A3$)—(1.5, 3.5, 5.5)
Medium importance ($A4$)—(3, 5, 7)
Fairly high importance ($A5$)—(5, 6.5, 8)
High importance ($A6$)—(6.5, 8, 9.5)
Extremely high importance ($A7$)—(7.5, 10, 10)

The domains of these TFNs are defined on a real line belonging to the interval [0–10]. Values 0 and 10 denote that RF has no relative importance for the KPIs' recovery or has extremely high importance, respectively.

3.3. The Assessment of RFs Values' Level by the Proposed Fuzzy Delphi Technique

The Delphi technique is one of the most popular qualitative methods of group decision-making. The simplest explanation of the Delphi technique can be interpreted as the collection and processing of data, which is realized through several rounds.

Within the execution of the technique, one of the most important questions is how to determine the optimal set of DMs. There are no recommendations or guidelines on how to determine the optimal number of DMs. Some scholars [38,39] suggest that there should be between five and ten DMs that provide the assessment. It may be suggested that, through the analysis of the research context, an optimal number of DMs may be determined.

According to best practice, it is assumed that the DMs participating in the Delphi study have a precise perception of the identified problem or that they have in-depth knowledge of the treated area(s). At the same time, the experience level of DMs can vary, and they can be ranked within various levels in the company hierarchy. An important issue during the realization is that the anonymity of DMs must be provided during the execution of the technique so individual biases and personal thoughts do not impact other participants. In this research, the DMs have been selected according to their importance for the company's operations, considering their knowledge and competence.

The Delphi method is realized in several rounds. During the first round, DMs express their assessment regarding the treated problem. The mapping of DMs' assessments into a single assessment can be executed by applying different aggregation operators. The average value of the DMs' assessments is submitted in writing to the DMs again, who should adjust their assessments in the second round according to that value. By applying the different procedures [34], it can be determined if the DMs have reached a consensus. If they are, the average value of the estimates obtained in the second round is accepted as the decision. Otherwise, the described process of data collection and processing is repeated. It should be noticed that the DMs' team is delivering individual assessments to determine the RFs' value. This is because their competence covers several aspects of business activities, and all the uncertainties should be considered.

The questionnaire is adapted taking into account the verified research [22] and it is introduced to each DM with explanations of the different resilience levels within the enterprise. The questionnaire contains guidelines with linguistic expressions defining the level of organizational resilience for each RF as follows:

There are no blueprints or plans for the construction of organizational resilience, there is no awareness of organizational resilience—B1;

There are drafts of activities for securing organizational resilience—B2;

There are clear plans and activities for securing organizational resilience, and the competencies of all employees in the field of organizational resilience management are ensured—B3;

Competencies of all employees in the field of organizational resilience management are ensured, and there is a partially developed awareness of organizational resilience—B4;

All needed competences are ensured, and there is the absolute commitment of management and all employees regarding organizational resilience management—B5.

The proposed fuzzy Delphi technique is realized in the following steps:

Step 1. During the first round, each DM $e, e = 1, \ldots, E$ assesses the level of RFs $j, j = 1, .., J$ at the level of each sub-process $p, p = 1, .., P$ by using one of the five pre-defined linguistic expressions, $\tilde{v}_{jp}^{1e} = \left(l_{jp}^{1e}, m_{jp}^{1e}, u_{jp}^{1e}\right)$.

Step 2. Let us determine the aggregated value of the DMs' assessment in the first round, $\tilde{b}_{jp}^{1}$ by applying the operator of the square mean:

$$\tilde{v}_{jp}^{1} = \left(\sqrt{\frac{1}{E} \cdot \sum_{e=1,..E} \left(l_{jp}^{1e}\right)^2}, \sqrt{\frac{1}{E} \cdot \sum_{e=1,..E} \left(m_{jp}^{1e}\right)^2}, \sqrt{\frac{1}{E} \cdot \sum_{e=1,..E} \left(u_{jp}^{1e}\right)^2}\right) \quad (1)$$

So that:

$$\tilde{v}_{jp}^{1} = \left(l_{jp}^{1}, m_{jp}^{1}, u_{jp}^{1}\right), \quad (2)$$

Step 3. Let us calculate the distance between $\tilde{v}_{jp}^{1}$ and TFNs that correspond to the pre-defined linguistic expressions $Bk, k = 1, .., 5$, $d\left(\tilde{v}_{jp}, Bk\right)$.

Step 4. To each RF $j, j = 1, .., J$ at the level of sub-process, $p = 1, .., P$, should be adjoined one of the pre-defined linguistic expressions $Bk, k = 1, .., K$ according to the expression:

$$\min_{k=1,..,K} d\left(\tilde{v}_{jp}, Bk\right) = B_{jp}^{*}, \quad (3)$$

Step 5. During the second round, DMs adjust their assessment according to the average value of B_{jp}^{*}. Let the DMs' assessments in the second round be denoted as $\tilde{v}_{jp}^{2e}$.

Step 6. Let us check the correlation degree between the DMs assessment in the first, $\tilde{v}_{jp}^{1e}$, and the second round, $\tilde{v}_{jp}^{2e}$. If the degree of correlation is higher than or equal to 0.5, it can be considered that a consensus of DMs has been reached according to the developed procedure [35]. If there is no statistical dependency between DMs' assessments in the first and second rounds, it is necessary to perform the second round of the assessment.

3.4. The Calculation of the Aggregated Weighted RFs Value at the Level of Each Identified KPI

This part of the research contains the steps for determining the relative importance of RFs for the KPIs' recovery that is managed under the business process, which is entitled Deliver Physical Products. The assessment of the relative importance of RFs for the KPIs' recovery is treated as a problem itself, with the assessment in the form of consensus.

The DMs have seven linguistic expressions at their disposal. The guidelines with the linguistic expressions defining the importance of RFs for the treated KPI's recovery time are as follows:

The treated RF has extremely low importance for the treated KPI's recovery time—A1;
The treated RF has low importance for the treated KPI's recovery time—A2;
The treated RF has fairly low importance for the treated KPI's recovery time—A3;
The treated RF has medium importance for the treated KPI's recovery time—A4;
The treated RF has fairly high importance for the treated KPI's recovery time—A5;
The treated RF has high importance for the treated KPI's recovery time—A6;
The treated RF has extremely high importance for the treated KPI's recovery time—A7.

After this, the determination of the weighted *aggregated RFs' value* at the level of each denoted KPI is performed by applying the operator of the fuzzy square mean. The proposed procedure is realized as follows:

Step 1. The assessment of RFs $j, j = 1, .., J$ relative importance of RFs for the KPIs' $i, i = 1, .., I$ recovery time is denoted by TFN $\widetilde{\varphi}_{ji}$.

Step 2. Let us calculate the weighted value of each RF $j, j = 1, .., J$ at the level of each denoted KPI:

$$\widetilde{\theta}_{ji} = \widetilde{v}_{jp} \cdot \widetilde{\varphi}_{ji}, \tag{4}$$

Step 3. Let us determine the weighted aggregated fuzzy value of RFs at the level of each KPI $i, i = 1, .., I$, $\widetilde{\theta}_i$ by applying the operator of the fuzzy geometric mean.

3.5. The Proposed Procedure for Analysis of the Relationship between the Weighted Aggregated RFs' Values and KPIs' Recovery Time

The KPIs for recovery time, t_i, are obtained from the enterprise records. It is worth mentioning that this research does not take into consideration KPI management but rather follows the sudden drop in KPI values. The time needed for the complete recovery of the KPI's values is denoted as the recovery time. It is presented in months.

Here, an assumption is introduced: there is a linear correlation between KPIs' recovery time and the weighted aggregated fuzzy value of RFs at the level of each KPI. This assumption will be checked based on the determination of the coefficient of correlation between the named variables.

The final steps of the research represent the analysis of the relationship between the weighted aggregated RFs' value and KPIs' recovery time. This should be executed as follows:

Step 1. Let us determine the representative scalar TFN $\widetilde{\theta}_i$, Δ_i by applying the simple gravity method.

Step 2. Let us determine the correlation coefficient between the KPIs' recovery time, t_i and the weighted aggregated value of RFs at the level of each considered KPI, Δ_i.

4. A Case Study in a Complex Production Company

The analyzed enterprise follows a decentralized organizational structure. Here, all business units are mapped within a matrix organization, which acts autonomously in the global supply chain of precise industry components. Nevertheless, all organizational units should interact closely with each other without limiting their independence, flexibility, and agility in the market. To meet the challenges mentioned, it is essential for almost all organizational units and employees—regardless of the specific company size, characteristics, form, and maturity—to maintain a management system. The analyzed enterprise has a well-structured business process in compliance with the ISO 9001 and ISO 14001 standards, so it is possible to propose a similar business process framework, such as APQC.

The DMs were engaged in the first round, and after the calculations, which are presented in Section 4.1, they also participated in the second round of the fuzzy Delphi.

4.1. Application of Applying the Proposed Fuzzy Delphi Technique

The defined team of DMs has received an email containing the relevant data for assessing the level of RF values, as explained in Section 3.3. The input data for fuzzy Delphi are assessed values (RFs) at the level of the business process of Delivering Physical Products. This data is presented in Appendix A for round one and in Appendix B for the second round.

The proposed fuzzy Delphi technique is illustrated in the example of determining the value RF $j = 1$ at the level of sub-process alignment of supply chain resources $(p = 1)$.

During the first round, the DMs assessed the values of the treated RF in the following manner:

B5, B4, B4, B4, B4, B4, B4, B4, B3, B2

The aggregated value of the DMs' assessment in the first round, $\tilde{v}{}_{11}^{1}$ is obtained by applying the operator of the fuzzy square mean:

$$\tilde{v}{}_{11}^{1} = \left(\begin{array}{c} \sqrt{\frac{7^2+6^2+6^2+6^2+6^2+6^2+6^2+3^2+1^2}{9}}, \\ \sqrt{\frac{8.5^2+7.5^2+7.5^2+7.5^2+7.5^2+7.5^2+7.5^2+5^2+2.5^2}{9}}, \\ \sqrt{\frac{10^2+9^2+9^2+9^2+9^2+9^2+9^2+7^2+4^2}{9}} \end{array} \right) = (5.53, 7, 8.50)$$

Let us determine the distance of TFN $\tilde{v}_{11}$ from $B1$:

$$d(\tilde{v}{}_{11}^{1}, B1) = \sqrt{\frac{1}{3} \cdot \left((5.53 - 0)^2 + (7 - 1.5)^2 + (8.50 - 3)^2 \right)} = 5.411$$

In a similar manner, the distance of TFN $\tilde{v}_{11}$ from the rest of the pre-defined linguistic expressions is calculated:

$$d(\tilde{v}{}_{11}^{1}, B2) = 4.510$$
$$d(\tilde{v}{}_{11}^{1}, B3) = 2.054$$
$$d(\tilde{v}{}_{11}^{1}, B4) = 0.490$$
$$d(\tilde{v}{}_{11}^{1}, B5) = 4.219$$

Let us determine a linguistic expression that can be used to describe the aggregated value of the DMs' assessment in the first round according to the expression:

$$min(5.411; 4.510; 2.054; 0.490; 4.219) = 0.490 \rightarrow B4$$

The DMs' assessments in the second round are B4, B3, B3, B2, B3, B3, B3, B2, and B2.

The aggregated value of the DMs' assessments in the second round is obtained by using the operator of the fuzzy square mean.

$$\tilde{v}{}_{11}^{2} = (3.06, 4.71, 6.45)$$

The check of the consistency of the DMs' assessment is delivered according to the developed procedure [35].

By using further calculations, the value of the correlation coefficient can be obtained. The value of the correlation coefficient between the assessment of the value RF $j = 1$ in the first round and in the second round is 0.8. The obtained value of the correlation coefficient shows that there is a strong positive relationship between the estimates of DMs in the first and second rounds, so it can be concluded that the obtained value of RF $j = 1$ j in the second round can be considered the final value.

Similarly, the aggregated values of RFs were determined at the level of each sub-process of the considered business process and presented in Appendix B.

Based on the obtained values of the correlation coefficients, it can be concluded that the values of RFs obtained in the second round can be accepted as the final values of RFs at the level of each sub-process.

4.2. The Calculation of the Aggregated Weighted RFs Value at the Level of Each Identified KPI

The assessment of the relative importance of RFs for the KPIs' recovery is performed for each denoted KPI at the level of each treated sub-process (Table 2). The DMs have performed this activity within the scope of the panel discussion that is executed after the second round of fuzzy Delphi. The assessment itself was based on the guidelines explained in Section 3.4. The panel discussion took place at the company headquarters with all DMs that participated in previous activities.

Table 2. The relative importance of RFs for the KPIs' recovery at the level of each treated sub-process.

RFs	*i* = 1	*i*=2	*i* = 3	*i* = 4	*i* = 5	*i* = 6	*i* = 7	*i* = 8	*i* = 9	*i* = 10	*i* = 11	*i* = 12
$j = 1$	A3	A7	A5	A6	A5	A7	A3	A7	A4	A5	A7	A7
$j = 2$	A5	A2	A6	A7	A5	A3	A3	A6	A4	A6	A6	A7
$j = 3$	A5	A6	A5	A5	A2	A2	A6	A5	A4	A4	A6	A5
$j = 4$	A6	A6	A6	A5	A7	A6	A6	A6	A5	A4	A5	A6
$j = 5$	A5	A6	A5	A5	A5	A3	A5	A4	A6	A6	A6	A6
$j = 6$	A4	A2	A4	A6	A6	A3	A4	A5	A2	A4	A4	A5
$j = 7$	A2	A4	A4	A4	A3	A3	A4	A3	A3	A3	A4	A4
$j = 8$	A3	A7	A4	A4	A3	A4	A4	A3	A3	A4	A5	A4
$j = 9$	A5	A2	A2	A3	A2	A1	A6	A5	A5	A5	A4	A3
$j = 10$	A7	A2	A3	A3	A3	A5	A5	A4	A5	A4	A4	A5

Let us determine the aggregate weighted value of the RF (j = 1) at the level of the KPI $(i = 1)$ $\widetilde{z}_{11}$:

$$\widetilde{z}_{11} = \widetilde{v}_{11} \cdot A3 = (3.06, 4.71, 6.45) \cdot (1.5, 3.5, 5.5) = (4.59, 16.49, 35.48)$$

The other aggregated weighted values of RFs are calculated similarly to those presented in Appendix C.

4.3. The Determination of the Relationship between the Weighted Aggregated RFs' Values and KPIs' Recovery Time

The recovery time is taken from the company records, as explained in Section 3.5. The representative scalars of the resilience at the level of KPIs, as well as the recovery time of each KPI, are given in Table 3.

The input data for the correlation analysis are the representative scalars of the total aggregated weighted values of RFs and the recovery time expressed in months. The obtained value of the correlation coefficient is presented as follows (Table 4).

Table 3. The total aggregated weighted crisp values of RFs and KPIs' recovery time in months.

KPIs	z_i	t_i
$i = 1$	31.10	10
$i = 2$	36.76	7
$i = 3$	32.42	5
$i = 4$	37.07	7
$i = 5$	31.50	4
$i = 6$	32.41	6
$i = 7$	27.61	10
$i = 8$	27.81	6
$i = 9$	23.92	7
$i = 10$	22.84	9
$i = 11$	27.09	7
$i = 12$	25.61	8

Table 4. Impact of the aggregated weighted values of RFs on KPIs' recovery time.

	The Weighted Aggregated RFs' Value at the Level of Each KPI	The Recovery Time of Each KPI
The weighted aggregated RFs' value at the level of each KPI	1	
The recovery time of each KPI	−0.73857	1

Based on the obtained value of the correlation coefficient, it can be concluded that there is a statistically significant influence of the values of RFs on the recovery time of KPIs. The value of the coefficient is negative, which indicates that if the value of RFs increases, the recovery time decreases.

5. Discussion and Conclusions

After the execution of the proposed fuzzy Delphi technique, the value of RFs is obtained at the level of each denoted subprocess. In the next step, the relative importance of the RFs for the recovery of each KPI is obtained through a direct assessment. The weighted value of the RFs is obtained through the multiplication of the previously defined variables. The weighted aggregated fuzzy value of each RF is obtained by applying the aggregation operator to the fuzzy square mean. By applying the Simple Gravity Method, the representative scalar of the weighted aggregated fuzzy value of each RF is determined.

The output of the research is the analysis of the relationship between the weighted aggregated value of each RF and the recovery time of each KPI. From the presented calculations considering correlation analysis, it is shown that the introduced assumption of a negative correlation is confirmed. There is a negative statistical dependence between the RFs and the time needed for KPIs' recovery.

Comparing the results with the already presented research, the following may be concluded: The domains where the aggregation of resilience is conducted may be presented as follows: military service [40], social resilience measurement [41], and quantification of operational supply chain resilience [42]. Each of the mentioned papers considers their own set of resilience indicators/factors, so it can be concluded that there is no unique list of RFs. In the mentioned papers, resilience indicators/factors are presented with crisp values compared to the proposed research, which is done by using linguistic variables. It may be concluded that there are different approaches to aggregate resilience indicators/factors. The aggregated value may be determined in an exact manner by applying multi-attribute decision-making techniques, such as the analytical hierarchy process [40], or by applying simple aggregation operators [41,42]. In the presented research, the aggregated value is obtained through the application of the fuzzy Delphi technique and fuzzy square mean operator.

Improving the overall resilience of companies and their decision-makers requires a holistic approach that takes various aspects into account. Based on the case study conducted, the authors of this paper, together with the DMs that provided input data for the case study, derive the following general recommendations for increasing resilience:

(1) Establish strong risk management practices: companies should implement a comprehensive risk management system that identifies potential risks, evaluates them, and takes appropriate measures to address them. Such an approach makes it possible to respond to potential threats at an early stage and minimize damage.
(2) Diversification of business activities: companies should reduce their dependence on individual products, markets, or suppliers. A broader base enables them to respond better to changes in the market and cushion potential risks more effectively.
(3) Promote flexibility and adaptability: companies should develop a corporate culture that promotes flexibility and adaptability. This includes fostering a spirit of innovation, a willingness to change, and the development of agile structures and processes.
(4) Empowering leaders: decision-makers should have a high level of resilience Companies should support their leaders by providing them with the necessary resources, training, and coaching to deal with challenging situations.
(5) Continuous training and learning: companies should ensure that their employees are continuously trained to keep up with changing demands and challenges. This includes both technical and generic competencies, such as problem-solving skills, communication, and teamwork.
(6) Build a strong network: companies should build and maintain relationships with relevant stakeholders, including customers, suppliers, partners, and regulators. A strong network can be invaluable in times of crisis to gain support and find solutions together.
(7) Leverage technology and digital transformation: companies should take advantage of modern technologies to make their processes more efficient and improve their resilience. This can include the use of data analytics, artificial intelligence, and other technologies to identify risks early and make informed decisions.

These recommendations serve as a starting point to improve the resilience of companies and their decision-makers. Companies must consider their challenges and needs and develop tailored solutions accordingly. The other approach that may be combined with the proposed measures may include the ranking of the proposed RFs to identify those ranked last, so the DMs may propose more concrete measures to improve those and sustain the values of those ranked first.

The main contribution of the research may be summarized as follows: There are just a few papers that treat the problem in a similar manner, defining interconnections between RFs and KPIs. All the uncertainties that exist in the model are described by using linguistic variables modeled by fuzzy sets theory. The fuzzy values of RFs at the level of delivery of physical product sub-processes are obtained by using the enhanced fuzzy Delphi method. The weighted aggregated fuzzy value of resilience at the level of a KPI is determined in an exact manner by applying fuzzy algebra rules.

The main constraint of the research is the selection of the DM team, which consists of the top management representatives, considering their knowledge, skills, and experience related to overall business operations, strategy, organizational state, and functioning.

On the other hand, it may be considered that the proposed model is flexible in terms of changing the number of KPIs and RFs. Also, the number of DMs can be changed due to the nature of the treated organization.

Future research should cover the extension of the Delphi method by using some other method for checking the consensus, developing a new method, and comparing the obtained results. For resilience management benchmarking, it can be assumed that this model should be used in some business processes and other branches of industry and the economy. Also, it would be useful to test the proposed model with different types of fuzzy numbers to determine their suitability for embracing the existing uncertainties.

Author Contributions: Conceptualization, M.H. and S.N.; investigation, N.K. and S.N.; methodology, M.H. and V.P., supervision, S.N., validation, M.H., N.K. and V.P.; visualization, M.H. and N.K.; writing—original draft, M.H., S.N., N.K. and V.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. The First Round of the Proposed Fuzzy Delphi

Table A1. The assessment of the DMs in the first round.

Sub-Processes	RFs	e=1	e=2	e=3	e=4	e=5	e=6	e=7	e=8	e=9
$p = 1$	$j = 1$	B5	B5	B5	B5	B5	B5	B5	B4	B3
	$j = 2$	B5	B5	B4	B4	B3	B5	B4	B5	B3
	$j = 3$	B5	B5	B4	B5	B4	B4	B4	B5	B3
	$j = 4$	B5	B4	B5	B5	B4	B3	B2	B3	B3
	$j = 5$	B5	B5	B5	B5	B3	B2	B3	B3	B4
	$j = 6$	B5	B5	B5	B5	B5	B3	B4	B5	B3
	$j = 7$	B4	B5	B3	B5	B4	B3	B2	B5	B5
	$j = 8$	B5	B5	B5	B5	B5	B5	B5	B5	B5
	$j = 9$	B5	B3	B2	B4	B4	B2	B2	B4	B3
	$j = 10$	B5	B5	B5	B4	B4	B5	B5	B5	B5
$p = 2$	$j = 1$	B5	B5	B5	B5	B5	B4	B5	B4	B3
	$j = 2$	B5	B5	B5	B3	B3	B4	B5	B4	B3
	$j = 3$	B5	B5	B4	B4	B4	B4	B4	B5	B3
	$j = 4$	B5	B4	B5	B5	B4	B3	B2	B3	B3
	$j = 5$	B5	B5	B5	B5	B3	B2	B3	B3	B4
	$j = 6$	B5	B5	B5	B5	B5	B3	B3	B5	B3
	$j = 7$	B4	B5	B3	B5	B4	B3	B2	B5	B5
	$j = 8$	B5	B5	B5	B5	B5	B5	B5	B5	B5
	$j = 9$	B5	B3	B3	B4	B4	B2	B2	B4	B3
	$j = 10$	B5	B5	B5	B5	B4	B5	B5	B5	B5
$p = 3$	$j = 1$	B5	B5	B4	B4	B5	B5	B4	B5	B5
	$j = 2$	B5	B4	B2	B4	B3	B4	B3	B3	B3
	$j = 3$	B5	B5	B4	B4	B4	B5	B4	B5	B3
	$j = 4$	B5	B3	B4	B4	B4	B4	B2	B3	B4
	$j = 5$	B5	B5	B4	B4	B4	B2	B2	B2	B3
	$j = 6$	B5	B5	B4	B4	B5	B3	B4	B5	B4
	$j = 7$	B4	B5	B2	B4	B4	B3	B2	B4	B3
	$j = 8$	B5	B5	B5	B5	B5	B5	B5	B5	B5
	$j = 9$	B5	B3	B3	B3	B4	B4	B2	B4	B3
	$j = 10$	B5	B5	B5	B4	B4	B4	B5	B5	B5
$p = 4$	$j = 1$	B5	B4	B4	B3	B5	B5	B3	B3	B5
	$j = 2$	B5	B3	B2	B4	B2	B4	B3	B3	B3
	$j = 3$	B3	B4	B4	B3	B4	B3	B4	B4	B3
	$j = 4$	B4	B3	B2	B3	B4	B4	B2	B4	B4
	$j = 5$	B4	B4	B3	B4	B4	B3	B2	B2	B2
	$j = 6$	B5	B5	B3	B4	B5	B3	B3	B3	B3
	$j = 7$	B3	B3	B2	B4	B4	B2	B2	B4	B4
	$j = 8$	B5	B5	B5	B5	B5	B5	B5	B5	B5
	$j = 9$	B5	B3	B2	B3	B4	B3	B2	B4	B2
	$j = 10$	B4	B3	B5	B3	B3	B4	B5	B4	B4

Table A2. The aggregated values of RFs at the level of sub-process Align supply chain resources ($\boldsymbol{p} = 1$).

RFs	The Aggregated Value in the First Round	The Linguistic Expression
$j = 1$	(5.53,7,8.50)	B4
$j = 2$	(4.70,6.19,7.75)	B4
$j = 3$	(4.48,6.07,7.72)	B3
$j = 4$	(3.97,5.33,6.83)	B3
$j = 5$	(4.33,5.65,7.06)	B3
$j = 6$	(5.30,6.72,8.20)	B4
$j = 7$	(4.27,5.67,7.17)	B3
$j = 8$	(7,8.50,10)	B5
$j = 9$	(2.69,4.06,5.65)	B3
$j = 10$	(5.61,7.15,8.72)	B4

Table A3. The aggregated values of RFs at the level of sub-process Procure materials and services ($\boldsymbol{p} = 2$).

RFs	The Aggregated Value in the First Round	The Linguistic Expression
$j = 1$	(5.53,7,8.50)	B4
$j = 2$	(4.45,5.87,7.37)	B3
$j = 3$	(4.14,5.77,7.48)	B3
$j = 4$	(3.97,5.33,6.81)	B3
$j = 5$	(4.33,5.65,7.06)	B3
$j = 6$	(5.08,6.43,7.84)	B4
$j = 7$	(4.27,5.67,7.17)	B3
$j = 8$	(7,8.5,10)	B5
$j = 9$	(2.71,4.14,5.72)	B3
$j = 10$	(5.99,7.51,9.04)	B4

Table A4. The aggregated values of RFs at the level of sub-process Test product, ($\boldsymbol{p} = 3$).

RFs	The Aggregated Value in the First Round	The Linguistic Expression
$j = 1$	(5.47,7.03,8.63)	B4
$j = 2$	(2.73,4.20,5.78)	B3
$j = 3$	(4.64,6.21,7.85)	B3
$j = 4$	(3.04,4.67,6.39)	B3
$j = 5$	(3.33,4.72,6.25)	B3
$j = 6$	(4.64,6.21,7.85)	B4
$j = 7$	(2.87,4.39,6.03)	B3
$j = 8$	(6.90,8.39,9.89)	B5
$j = 9$	(2.73,4.20,5.78)	B3
$j = 10$	(5.33,6.90,8.51)	B4

Table A5. The aggregated values of RFs at the level of sub-process Manage logistics and warehousing, ($\boldsymbol{p} = 4$).

RFs	The Aggregated Value in the First Round	The Linguistic Expression
$j = 1$	(4.28,5.71,7.23)	B3
$j = 2$	(2.54,3.88,5.39)	B3
$j = 3$	(2.33,4.08,5.86)	B3
$j = 4$	(2.29,3.97,5.73)	B3
$j = 5$	(2.05,3.64,5.32)	B3
$j = 6$	(3.68,5,6.43)	B3
$j = 7$	(2.69,4.09,5.65)	B3
$j = 8$	(6.90,8.39,9.89)	B5
$j = 9$	(2.52,3.83,5.31)	B3
$j = 10$	(3.51,5.07,6.72)	B3

Appendix B. The Second Round of the Proposed Fuzzy Delphi

Table A6. The assessment of the DMs in the second round.

Sub-Processes	RFs	$e = 1$	$e = 2$	$e = 3$	$e = 4$	$e = 5$	$e = 6$	$e = 7$	$e = 8$	$e = 9$
$p = 1$	$j = 1$	B4	B3	B3	B2	B3	B3	B3	B2	B2
	$j = 2$	B4	B4	B3	B3	B2	B3	B3	B4	B2
	$j = 3$	B4	B2	B2	B3	B3	B2	B3	B3	B2
	$j = 4$	B4	B3	B3	B3	B2	B2	B1	B2	B2
	$j = 5$	B4	B5	B3	B3	B2	B1	B2	B2	B2
	$j = 6$	B5	B4	B2	B4	B3	B2	B2	B4	B2
	$j = 7$	B3	B3	B1	B3	B2	B2	B1	B3	B3
	$j = 8$	B5	B5	B4	B4	B5	B5	B5	B5	B3
	$j = 9$	B3	B2	B1	B2	B2	B1	B1	B1	B1
	$j = 10$	B4	B3	B3	B2	B2	B3	B3	B4	B4

Table A6. *Cont.*

Sub-Processes	RFs	e = 1	e = 2	e = 3	e = 4	e = 5	e = 6	e = 7	e = 8	e = 9
$p = 2$	$j = 1$	B5	B4	B4	B4	B3	B4	B4	B4	B3
	$j = 2$	B4	B3	B3	B2	B3	B3	B3	B3	B3
	$j = 3$	B3	B3	B3	B2	B2	B3	B3	B3	B2
	$j = 4$	B4	B3	B3	B3	B2	B2	B1	B2	B2
	$j = 5$	B4	B4	B4	B3	B2	B1	B2	B2	B2
	$j = 6$	B4	B4	B2	B3	B3	B2	B2	B3	B2
	$j = 7$	B3	B3	B1	B3	B2	B2	B1	B3	B3
	$j = 8$	B5	B5	B4	B4	B5	B5	B5	B5	B3
	$j = 9$	B3	B1	B1	B2	B2	B1	B1	B1	B2
	$j = 10$	B4	B3	B3	B2	B2	B3	B3	B3	B3
$p = 3$	$j = 1$	B3	B2	B2	B2	B2	B3	B2	B3	B3
	$j = 2$	B3	B2	B1	B2	B1	B3	B2	B2	B3
	$j = 3$	B3	B3	B2	B2	B2	B2	B3	B4	B2
	$j = 4$	B3	B2	B3	B3	B2	B2	B1	B2	B2
	$j = 5$	B3	B4	B3	B2	B2	B1	B1	B1	B2
	$j = 6$	B4	B3	B3	B3	B4	B2	B2	B3	B3
	$j = 7$	B2	B3	B1	B3	B3	B2	B1	B3	B2
	$j = 8$	B5	B4	B5	B4	B5	B5	B5	B5	B4
	$j = 9$	B3	B1	B1	B1	B2	B2	B1	B2	B2
	$j = 10$	B3	B3	B3	B2	B2	B2	B4	B3	B2
$p = 4$	$j = 1$	B3	B1	B2	B1	B2	B2	B1	B1	B2
	$j = 2$	B3	B1	B1	B2	B1	B2	B1	B1	B1
	$j = 3$	B2	B2	B2	B1	B2	B2	B2	B2	B1
	$j = 4$	B3	B2	B1	B2	B2	B2	B1	B2	B2
	$j = 5$	B3	B2	B1	B3	B2	B2	B1	B1	B1
	$j = 6$	B3	B4	B2	B2	B3	B2	B2	B2	B2
	$j = 7$	B2	B2	B1	B2	B2	B1	B1	B2	B2
	$j = 8$	B5	B5	B4	B4	B5	B5	B5	B5	B5
	$j = 9$	B3	B2	B1	B1	B2	B2	B1	B1	B1
	$j = 10$	B2	B1	B2	B1	B1	B2	B3	B3	B3

Table A7. The aggregated values of RFs at the level of sub-process Align supply chain resource ($\boldsymbol{p} = 1$).

RFs	The Aggregated Value in the Second Round	The Measure of Achieved Consensus
$j = 1$	(3.06,4.71,6.45)	0.8
$j = 2$	(4.03,5.59,7.29)	0.94
$j = 3$	(2.91,4.49,6.16)	0.50
$j = 4$	(2.73,4.20,5.78)	0.90
$j = 5$	(3.45,4.78,6.25)	0.88
$j = 6$	(4.35,5.69,7.12)	0.76
$j = 7$	(2.29,3.97,5.73)	0.91
$j = 8$	(6.45,7.97,9.49)	1
$j = 9$	(1.15,2.47,3.97)	0.79
$j = 10$	(4.03,5.59,7.23)	0.85

Table A8. The aggregated values impact RFs at the level of sub-processes Procure materials and services, ($\boldsymbol{p} = 2$).

RFs	The Aggregated Value in the Second Round	The Measure of Achieved Consensus
$j = 1$	(5.61,7.15,8.72)	0.59
$j = 2$	(3.33,5.14,6.99)	0.61
$j = 3$	(2.69,4.56,6.45)	0.62
$j = 4$	(2.73,4.20,5.78)	0.90
$j = 5$	(3.67,4.96,6.37)	0.92
$j = 6$	(3.38,4.86,6.44)	0.74
$j = 7$	(2.29,3.97,5.73)	0.91
$j = 8$	(6.45,7.97,9.49)	1
$j = 9$	(1.15,2.47,3.97)	0.79
$j = 10$	(3.20,4.93,6.72)	0.71

Table A9. The aggregated values of RFs at the level of sub-process Test product, ($\boldsymbol{p} = 3$).

RFs	The Aggregated Value in the Second Round	The Measure of Achieved Consensus
j = 1	(2.13,3.82,5.54)	0.71
j = 2	(1.18,3.41,5.04)	0.55
j = 3	(2.75,4.25,5.84)	0.56
j = 4	(1.18,3.47,5.12)	0.70
j = 5	(2.52,3.83,5.31)	0.86
j = 6	(3.64,5.27,6.98)	0.78
j = 7	(2.08,3.70,5.40)	0.84
j = 8	(6.68,8.18,9.68)	0.50
j = 9	(1.20,2.56,4.07)	0.88
j = 10	(2.91,4.49,6.16)	0.69

Table A10. The aggregated values of RFs at the level of sub-process Manage logistics and warehousing, ($\boldsymbol{p} = 4$).

RFs	The Aggregated Value in the Second Round	The Measure of Achieved Consensus
j = 1	(1.20,2.56,4.07)	0.68
j = 2	(0.94,2.41,3.90)	0.94
j = 3	(1.60,3.09,4.67)	0.60
j = 4	(1.29,2.73,4.26)	0.58
j = 5	(1.53,2.94,4.50)	0.77
j = 6	(2.58,4,5.53)	0.87
j = 7	(0.82,2.22,3.70)	0.72
j = 8	(6.79,8.29,9.79)	0.66
j = 9	(0.67,2.01,3.48)	0.50
j = 10	(2.05,3.64,5.32)	0.59

Appendix C. The Weighted Aggregated Fuzzy Value of RFs at the Level of KPI

Table A11. The weighted aggregated fuzzy value of RFs at the level of KPI in the scope of sub-process Align supply chain resources ($p = 1$).

RFs	i = 1	i = 2	i = 3
j = 1	(4.59,16.49,35.48)	(22.95,47.10,64.50)	(15.30,30.62,51.60)
j = 2	(20.15,36.34,58.32)	(2.02,11.18,25.52)	(30.23,44.72,69.26)
j = 3	(14.55,29.19,49.28)	(21.83,35.92,58.52)	(14.55,29.19,49.28)
j = 4	(20.48,33.60,54.91)	(20.48,33.60,54.91)	(20.48,33.60,54.91)
j = 5	(17.25,31.07,50)	(25.88,38.24,59.38)	(17.25,31.07,50)
j = 6	(13.05,28.45,49.84)	(2.18,11.38,24.92)	(13.05,28.45,49.84)
j = 7	(1.15,7.94,20.06)	(6.87,19.85,40.11)	(6.87,19.85,40.11)
j = 8	(9.68,27.90,52.20)	(48.38,79.70,94.90)	(19.35,39.85,66.43)
j = 9	(5.75,16.06,31.76)	(0.58,4.94,13.90)	(0.58,4.94,13.90)
j = 10	(30.23,55.90,72.30)	(2.02,11.18,25.31)	(6.05,19.57,39.77)
Weighted aggregated fuzzy value of RFs	(12.90,30.94,49.45)	(22.05,36.40,51.81)	(16.45,30.14,50.68)

Table A12. The weighted aggregated fuzzy value of RFs at the level of KPI in the scope of sub-process procurement materials and services ($p = 2$).

RFs	i = 4	i = 5	i = 6
j = 1	(42.08,57.20,82.84)	(28.05,46.48,69.76)	(42.08,71.50,87.20)
j = 2	(24.98,51.40,69.90)	(16.65,33.41,55.92)	(5,17.99,38.45)
j = 3	(13.45,29.64,51.60)	(1.35,9.12,22.58)	(1.35,9.12,22.58)
j = 4	(13.65,27.30,46.24)	(20.48,42,57.80)	(20.48,33.60,54.91)
j = 5	(18.35,32.24,50.46)	(18.35,32.24,50.46)	(5.51,17.36,35.04)
j = 6	(25.35,38.88,61.18)	(25.35,38.88,61.18)	(5.07,17.01,35.42)
j = 7	(6.87,19.85,40.11)	(3.44,13.90,31.52)	(3.44,13.90,31.52)
j = 8	(19.35,39.85,66.43)	(9.68,27.90,52.20)	(19.35,39.85,66.43)
j = 9	(1.73,8.65,21.84)	(0.58,4.94,13.90)	(0,0,9.93)
j = 10	(4.80,17.26,36.98)	(4.80,17.26,36.98)	(16,32.05,53.76)
Weighted aggregated fuzzy value of RFs	(20.47,35.28,55.46)	(16.10,29.95,48.44)	(17.07,31.70,48.46)

Table A13. The weighted aggregated fuzzy value of RFs at the level of KPI in the scope of the sub-process Test product ($p = 3$).

RFs	$i = 7$	$i = 8$	$i = 9$
$j = 1$	(3.20,13.37,30.47)	(15.98,38.20,55.40)	(6.39,19.10,38.70)
$j = 2$	(1.77,11.94,27.72)	(8.85,27.28,47.88)	(3.54,17.05,35.28)
$j = 3$	(20.63,34,55.48)	(13.75,27.63,46.72)	(8.25,21.25,40.88)
$j = 4$	(8.85,27.76,48.64)	(8.85,27.76,48.64)	(5.90,22.56,40.96)
$j = 5$	(12.60,24.90,42.48)	(7.56,19.15,37.17)	(18.90,30.64,50.45)
$j = 6$	(10.92,26.35,48.86)	(18.20,34.26,55.84)	(1.82,10.54,24.43)
$j = 7$	(6.24,18.50,37.80)	(3.12,12.95,29.70)	(3.12,12.95,29.70)
$j = 8$	(20.04,40.90,67.76)	(10.02,28.63,53.24)	(10.02,28.63,53.24)
$j = 9$	(9,20.48,38.67)	(6,16.64,32.56)	(6,16.64,32.56)
$j = 10$	(14.55,29.19,49.28)	(8.73,22.45,43.12)	(14.55,29.19,49.28)
Weighted aggregated fuzzy value of RFs	(10.53,26.17,46.13)	(11.01,26.54,45.88)	(9.35,21.87,40.54)

Table A14. The weighted aggregated fuzzy value of RFs at the level of a KPI in the scope of a sub-process Manage logistics and warehousing ($p = 4$).

RFs	$i = 10$	$i = 11$	$i = 12$
$j = 1$	(6,16.64,32.58)	(9,25.60,40.70)	(9,25.60,40.70)
$j = 2$	(7.05,19.28,37.05)	(7.05,19.28,37.05)	(7.05,24.10,39)
$j = 3$	(4.80,15.45,32.69)	(12,24.72,44.37)	(8,20.09,37.36)
$j = 4$	(3.87,13.65,29.82)	(6.45,17.75,34.08)	(9.68,21.84,40.47)
$j = 5$	(11.48,23.52,42.75)	(11.48,23.52,42.75)	(11.48,23.52,42.75)
$j = 6$	(7.74,22,38.71)	(7.74,22,38.71)	(12.90,28.60,44.24)
$j = 7$	(1.23,7.77,20.35)	(2.46,11.10,25.90)	(2.46,11.10,25.90)
$j = 8$	(20.37,41.45,68.53)	(33.95,53.98,78.32)	(20.37,41.45,68.53)
$j = 9$	(3.35,13.07,27.84)	(2.01,10.05,24.36)	(1.01,7.04,19.14)
$j = 10$	(6.15,18.35,37.24)	(6.15,18.35,37.24)	(10.25,23.86,42.56)
Weighted aggregated fuzzy value of RFs	(8.84,20.97,38.72)	(13.11,25.41,42.74)	(10.57,24.39,41.88)

References

1. Duchek, S. Organizational Resilience: A Capability-Based Conceptualization. *Bus. Res.* **2020**, *13*, 215–246. [CrossRef]
2. Hepfer, M.; Lawrence, T.B. The Heterogeneity of Organizational Resilience: Exploring Functional, Operational and Strategic Resilience. *Organ. Theory* **2022**, *3*, 26317877221074700. [CrossRef]
3. Beuren, I.M.; dos Santos, V.; Theiss, V. Organizational Resilience, Job Satisfaction and Business Performance. *Int. J. Product. Perform. Manag.* **2021**, *71*, 2262–2279. [CrossRef]
4. Ishaq Bhatti, M.; Awan, H.M.; Razaq, Z. The Key Performance Indicators (KPIs) and Their Impact on Overall Organizational Performance. *Qual. Quant.* **2014**, *48*, 3127–3143. [CrossRef]
5. Závadský, J.; Korenková, V.; Závadská, Z.; Kadárová, J.; Tuček, D. Competences in the Quality Management System Evaluation Based on the Most Worldwide Used Key Performance Indicators. *Calitatea* **2019**, *20*, 29–41.
6. Fatoki, O. The Impact of Entrepreneurial Resilience on the Success of Small and Medium Enterprises in South Africa. *Sustainability* **2018**, *10*, 2527. [CrossRef]
7. Zimmermann, H.-J. *Fuzzy Set Theory—And Its Applications*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2011; ISBN 978-94-010-0646-0.
8. Dubois, D.; Prade, H. Systems of Linear Fuzzy Constraints. *Fuzzy Sets Syst.* **1980**, *3*, 37–48. [CrossRef]
9. Arsovski, S.; Putnik, G.; Arsovski, Z.; Tadic, D.; Aleksic, A.; Djordjevic, A.; Moljevic, S. Modelling and Enhancement of Organizational Resilience Potential in Process Industry SMEs. *Sustainability* **2015**, *7*, 16483–16497. [CrossRef]
10. Akram, M.; Zahid, K.; Deveci, M. Multi-Criteria Group Decision-Making for Optimal Management of Water Supply with Fuzzy ELECTRE-Based Outranking Method. *Appl. Soft Comput.* **2023**, *143*, 110403. [CrossRef]
11. Jin, L. Uncertain Probability, Regular Probability Interval and Relative Proximity. *Fuzzy Sets Syst.* **2023**, *467*, 108579. [CrossRef]
12. Habibi, A.; Jahantigh, F.F.; Sarafrazi, A. Fuzzy Delphi Technique for Forecasting and Screening Items. *Asian J. Res. Bus. Econ. Manag.* **2015**, *5*, 130. [CrossRef]
13. Mabrouk, N. Green Supplier Selection Using Fuzzy Delphi Method for Developing Sustainable Supply Chain. *Decis. Sci. Lett.* **2021**, *10*, 63–70. [CrossRef]
14. Grabisch, M.; Marichal, J.-L.; Mesiar, R.; Pap, E. *Aggregation Functions*; Illustrated Edition; Cambridge University Press: Cambridge, UK, 2009; ISBN 978-0-521-51926-7.
15. Calvo, T.; Mayor, G.; Mesiar, R. *Aggregation Operators: New Trends and Applications*; Studies in Fuzziness and Soft Computing; Physica-Verlag HD: Berlin/Heidelberg, Germany, 2002; Volume 97, ISBN 978-3-662-00319-0.

16. Jani, N.M.; Zakaria, M.H.; Maksom, Z.; Haniff, M.S.M.; Mustapha, R. Validating Antecedents of Customer Engagement in Social Networking Sites Using Fuzzy Delphi Analysis. *Int. J. Adv. Comput. Sci. Appl.* **2018**, *9*, 294–304. [CrossRef]
17. Abdollahi, S.M.; Ranjbarian, B.; Kazemi, A. An Investigation of the Antecedents of Consumers' Confusion in Purchasing an Outbound Package Tour in the City of Isfahan by Fuzzy Delphi Method. *Iran. J. Manag. Stud.* **2020**, *13*, 527–564. [CrossRef]
18. Tsai, H.-C.; Lee, A.-S.; Lee, H.-N.; Chen, C.-N.; Liu, Y.-C. An Application of the Fuzzy Delphi Method and Fuzzy AHP on the Discussion of Training Indicators for the Regional Competition, Taiwan National Skills Competition, in the Trade of Joinery. *Sustainability* **2020**, *12*, 4290. [CrossRef]
19. Dawood, K.A.; Sharif, K.Y.; Ghani, A.A.; Zulzalil, H.; Zaidan, A.A.; Zaidan, B.B. Towards a Unified Criteria Model for Usability Evaluation in the Context of Open Source Software Based on a Fuzzy Delphi Method. *Inf. Softw. Technol.* **2021**, *130*, 106453. [CrossRef]
20. Bui, T.D.; Tsai, F.M.; Tseng, M.-L.; Ali, M.H. Identifying Sustainable Solid Waste Management Barriers in Practice Using the Fuzzy Delphi Method. *Resour. Conserv. Recycl.* **2020**, *154*, 104625. [CrossRef]
21. Khan, S.; Haleem, A.; Khan, M.I. Risk Management in Halal Supply Chain: An Integrated Fuzzy Delphi and DEMATEL Approach. *J. Model. Manag.* **2020**, *16*, 172–214. [CrossRef]
22. Aleksic, A.; Nestic, S.; Tadic, D.; Komatina, N. Determination of Organizational Resilience Level within Business Processes in Production Companies. In Proceedings of the 6th International Scientific Conference COMET-a, Jahorina, Bosnia and Herzegovina, 11–19 November 2022; University of East Sarajevo, Faculty of Mechanical Engineering: Jahorina, Bosnia and Herzegovina, 2022; pp. 750–757.
23. Chen, C.-A.; Lee, S.-R. Developing the Country Brand of Taiwan from the Perspective of Exports. *Asian J. Empir. Res.* **2013**, *3*, 1223–1236.
24. Horng, J.-S.; Chou, S.-F.; Liu, C.-H.; Tsai, C.-Y. Creativity, Aesthetics and Eco-Friendliness: A Physical Dining Environment Design Synthetic Assessment Model of Innovative Restaurants. *Tour. Manag.* **2013**, *36*, 15–25. [CrossRef]
25. Liu, C.-H.S.; Chou, S.-F. Tourism Strategy Development and Facilitation of Integrative Processes among Brand Equity, Marketing and Motivation. *Tour. Manag.* **2016**, *54*, 298–308. [CrossRef]
26. Kumar, A.; Mangla, S.K.; Luthra, S.; Rana, N.P.; Dwivedi, Y.K. Predicting Changing Pattern: Building Model for Consumer Decision Making in Digital Market. *J. Enterp. Inf. Manag.* **2018**, *31*, 674–703. [CrossRef]
27. Mahmoudi, S.; Ranjbarian, B.; Fathi, S. Factors Influencing on Iran's Image as a Tourism Destination. *Int. J. Serv. Oper. Manag.* **2017**, *26*, 186–210. [CrossRef]
28. Singh, P.K.; Sarkar, P. A Framework Based on Fuzzy Delphi and DEMATEL for Sustainable Product Development: A Case of Indian Automotive Industry. *J. Clean. Prod.* **2020**, *246*, 118991. [CrossRef]
29. Kumar, A.; Dash, M.K. Causal Modelling and Analysis Evaluation of Online Reputation Management Using Fuzzy Delphi and DEMATEL. *Int. J. Strateg. Decis. Sci.* **2017**, *8*, 27–45. [CrossRef]
30. Farhadian, T.; Shahgholian, K. A Fuzzy Delphi Method for Identifying Effective Indexes in Absorption Banking Resources in Iran and Pathology He Performance of a Bank with Fan P-Swot (Case Study: Mehr Bank of Iran). *Int. J. Biol. Pharm. Allied Sci.* **2015**, *4*, 557–568.
31. Chu, H.-C.; Hwang, G.-J. A Delphi-Based Approach to Developing Expert Systems with the Cooperation of Multiple Experts. *Expert Syst. Appl.* **2008**, *34*, 2826–2840. [CrossRef]
32. Islam, D.M.; Dinwoodie, J.; Roe, M. Promoting Development Through Multimodal Freight Transport in Bangladesh. *Transp. Rev.* **2006**, *26*, 571–591. [CrossRef]
33. Buck, A.J.; Gross, M.; Hakim, S.; Weinblatt, J. Using the Delphi Process to Analyze Social Policy Implementation: A Post Hoc Case from Vocational Rehabilitation. *Policy Sci.* **1993**, *26*, 271–288. [CrossRef]
34. von der Gracht, H.A. Consensus Measurement in Delphi Studies: Review and Implications for Future Quality Assurance. *Technol. Forecast. Soc. Change* **2012**, *79*, 1525–1536. [CrossRef]
35. Ferri, C.P.; Prince, M.; Brayne, C.; Brodaty, H.; Fratiglioni, L.; Ganguli, M.; Hall, K.; Hasegawa, K.; Hendrie, H.; Huang, Y.; et al. Global Prevalence of Dementia: A Delphi Consensus Study. *Lancet* **2005**, *366*, 2112–2117. [CrossRef] [PubMed]
36. Macuzić, I.; Tadić, D.; Aleksić, A.; Stefanović, M. A Two Step Fuzzy Model for the Assessment and Ranking of Organizational Resilience Factors in the Process Industry. *J. Loss Prev. Process Ind.* **2016**, *40*, 122. [CrossRef]
37. APQC. *Process Classification Framework V6.11*; APQC: Houston, TX, USA, 2015.
38. Somerville, J.A. Effective Use of the Delphi Process in Research: Its Characteristics, Strengths and Limitations. Unpublished Ph.D. Thesis, Oregon State University, Corvallís, OR, USA, 2008.
39. Malone, D.C.; Abarca, J.; Hansten, P.D.; Grizzle, A.J.; Armstrong, E.P.; Van Bergen, R.C.; Duncan-Edgar, B.S.; Solomon, S.L.; Lipton, R.B. Identification of Serious Drug-Drug Interactions: Results of the Partnership to Prevent Drug-Drug Interactions. *J. Am. Pharm. Assoc.* **2004**, *44*, 142–151. [CrossRef]
40. Hodicky, J.; Özkan, G.; Özdemir, H.; Stodola, P.; Drozd, J.; Buck, W. Analytic Hierarchy Process (AHP)-Based Aggregation Mechanism for Resilience Measurement: NATO Aggregated Resilience Decision Support Model. *Entropy* **2020**, *22*, 1037. [CrossRef] [PubMed]

41. Copeland, S.; Comes, T.; Bach, S.; Nagenborg, M.; Schulte, Y.; Doorn, N. Measuring Social Resilience: Trade-Offs, Challenges and Opportunities for Indicator Models in Transforming Societies. *Int. J. Disaster Risk Reduct.* **2020**, *51*, 101799. [CrossRef]
42. Munoz, A.; Dunbar, M. On the Quantification of Operational Supply Chain Resilience. *Int. J. Prod. Res.* **2015**, *53*, 6736–6751. [CrossRef]