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Integration of Balanced Scorecard (BSC), Strategy Map, and Fuzzy Analytic Hierarchy Process (FAHP) for a Sustainability Business Framework: A Case Study of a Spanish Software Factory in the Financial Sector

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Abstract: This paper presents a case study of how a Spanish financial software factory (FSF) has determined the weights of the indicators and objectives included in their strategy map with the aim of ensuring its business sustainability. A strategy map is a graphical representation of the cause-effect relationships between strategic objectives and indicators of a balanced scorecard (BSC). The detailed description of the strategy map development and deployment is not part of the aim of this work as it was described in a former paper. In this study, FAHP, a multicriteria decision-making (MCDM) method using the concepts of fuzzy set theory and hierarchical structure analysis, was used to calculate the weights. The analysis was carried out considering the points of view of different groups of stakeholders (shareholders, top management, middle managers, other employees, customers and some experts in the field of software factories) and the results are presented grouped by role to get a better understanding of the preferences of each kind of stakeholder. The conclusions of this study give a better insight of the corporative sustainability strategies of this kind of firms as well as the different vision of each stakeholder, what could be very valuable to the software factory managers for the decision-making and the strategic management of their organizations.

Keywords: balanced scorecard; strategy map; fuzzy analytic hierarchy process; software factory; software development

1. Introduction

The banking sector is one of the sectors that requires the most amount of software and the development of its business applications represents over 50% of the managed information technology (IT) budget [1], but banks usually pay for the time it takes to produce the software and not the amount produced, a model that in most cases increases the cost of the projects. Financial entities need software development firms to measure the "software production" they are delivering to them. With this information, they can create strategies to transform these software firms into industrialized software manufacturers able to provide software projects related to the efficiency, fast delivery and quality that the financial markets expect today [2]. In addition, since the advent of the Internet and especially since the emergence of smartphones, around the year 2007, banks have tried to relocate in order not to lose their dominant position in the financial sector, although, according to SAP and IBM [3], the traditional banking industry does not keep up very well with today's constantly changing technology landscape.

To solve these challenges, banking requires changes in the software factories that develop its software and systems to increase productivity and reduce costs to be able to face the new challenges in the sector.

Our paper [4] published at the end of 2015 describes the case in which a financial software factory FSF in Spain decided to review the concept of industrialization of software development to implement the principles and elements of the software factory approach [5]. This initial paper suggests a strategic management framework based on the balanced scorecard BSC [6,7] and the strategy map [8,9] to guarantee the business sustainability of FSF. One problem with this initial proposal of BSC framework is that it does not establish the importance weights of the indicators, perspectives and objectives defined in the strategy map of FSF. To know these weights, we have opted for the integration of BSC and strategy map with fuzzy analytic hierarchy process FAHP, a multicriteria decision-making useful method of calculating weights into an evaluation performance system [10] to ensure its sustainability.

The literature does not offer a general conceptual definition of sustainable business models in the context of technological, organizational and social innovation [11], but changes to business models are recognised as a fundamental approach to realise innovations for sustainability [12]. Wirtz's book [13] makes a systematic overview of business model management, and identifies three perspectives related to this model focused on: technology, organizational (deals with the business model as a strategic management tool to improve a company's value chain) and strategy-oriented (adds the element of market competition to the efficiency). The notion of sustainable business models builds on the business model concept and combines it with the important concepts of stakeholder management [14], sustainable value creation [15], and a long-term perspective. Sustainable business model is an emerging topic, but only few tools are currently available to assist companies in sustainable business modelling [16]. The sustainable business model outlined in this paper encourages the operational efficiency, long-term relationship with customers and a focus on their needs, expanding the customer portfolio and employee engagement.

This paper shows a case study in which a Spanish FSF opted to change its management system and establish a new framework based on a weighted strategy map with the aim of ensuring its business sustainability, which is related to achieving a viable sustainable business model over time in terms of productivity and profitability, through appropriate decision-making. In addition, the results will be analysed not only globally, but also by stakeholder roles grouped, which represents a fact to highlight compared to other studies that apply a similar methodology as this study.

The remainder of this paper is organized as follows. Section 2 reviews the literature related to the BSC, the strategy map, FAHP theory and their integration as an evaluation framework. Section 3 describes the research methodology. Section 4 shows the results of the study. Section 5 presents the analysis and discussion of the results. Finally, Section 6 exposes the conclusions, implications, limitations and future research directions related to this paper.

2. Sustainable Evaluation Framework for a FSF Based con BSC, Strategy Map and FAHP

This section includes a review of the literature on the BSC and the strategy map, paying particular attention to their application in a FSF. We then introduce the fuzzy set theory and the FAHP. Finally, and integration of the BSC and the strategy map with FAHP is presented to establish the importance weights for links among indicators and goals included in the strategy map for a sustainable evaluation framework.

2.1. The BSC for a FSF

In today's competitive world, every organization needs a management system that permits an awareness of the performance and productivity with which it is working in order to protect its competitive advantages. The productivity measure in software development is more difficult as is in other industries, due to the intangible nature of software and the difficult to measure output [17]. Nevertheless, it is a necessary management system that can monitor production. The BSC developed by Kaplan and Norton is probably the best–known management tool for companies. In 1992 and the

years that followed, Kaplan and Norton, of Harvard University, presented the BSC [6,7] as a corporate performance tool that allows managers to look at the business from four important perspectives: financial, customer, internal business processes and learning and growth. In the following years, Kaplan and Norton presented new views and ways to improve the initial BSC approach and linked it with measures, objectives and business strategy [18–20]. The BSC is applied by many businesses to assess their performance in diverse aspects of their organization, but it is only a template and must be customized for the specific elements of an organization. Since the BSC was introduced, many authors have proposed some modifications to adapt the initial BSC to other scorecards that were specific for different areas or industrial environments. Studies about the IT BSC [21,22] in the IT sector, the Sustainability BSC (SBSC) [23,24] for sustainable businesses, other studies such as [25,26] that expose the benefits of using the BSC in the financial sector, and finally the specific BSC for a FSF [4,27] are some examples in relation to this study.

Figure 1 shows the BSC for a FSF and includes the chosen key performance indicators (KPIs) with various fields assigned to each: Code, KPI Name, KPI Owner, Frequency Measurement, Value Measurement, Target Tendency and the Upper and Lower Control Limits to manage the stability of processes. This BSC was established by the FSF as a control tool for the top management of the organization according the strategic objectives and the mission and vision of the FSF defined in its strategy map. The KPIs were made in several work sessions with the participation of different roles of employees. Some of the KPIs were simple to create and easy to obtain, but others are difficult to obtain because they are a compendium of different indicators and measures. The top management and consultants review the validity of the KPIs annually, and KPIs are modified or adjusted if it is necessary. The description of the KPIs included in the BSC for a FSF are extensively explained in our prior paper [4].

BALANCED SCORECARD – FINANCIAL SOTWARE FACTORY

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STRATEGIC PERSPECTIVES

	CODE	KPI NAME	KPI OWNER	FREQUENCY MEASUREMENT	VALUE MEASUREMENT	CONTROL LIMITS UPPER|LOWER	TARGET TENDENCY
FINANCIAL	F1	Cost Structure	Management Control	Quarterly	Ratio	Upper|Lower Values	Decrement
	F2	Reduction of Cost	Management Control	Monthly	Percentage	Upper|Lower Values	Increase
	F3	Useful Developments	Production & Man. Control	Quarterly	Ratio	Upper|Lower Values	Increase
CUSTOMER	C1	User Satisfaction	Marketing & Customers	Annual	Aggregate	Upper|Lower Values	Increase
	C2	Cost per Use	Management Control	Quarterly	Numeric Value	Upper|Lower Values	Decrement
	C3	SLA	Production & Man. Control	Monthly	Aggregate	Upper|Lower Values	Increase
INTERNAL BUSINESS PROCESSES	I1	Work Performance	Management Control	Monthly	Percetage	Upper|Lower Values	Increase
	I2	Employee Productivity	Human R. & Man. Control	Monthly	Percentage	Upper|Lower Values	Increase
	I3	Delay	Management Control	Monthly	Numeric Value	Upper|Lower Values	Decrement
	I4	Software Quality	Quality	Biannual	Aggregate	Upper|Lower Values	Increase
	I5	Budgeting Error	Planning & Man. Control	Biannual	Percentage	Upper|Lower Values	Decrement
LEARNING AND GROWTH	L1	Employer Branding	Human Resources	Biannual	Aggregate	Upper|Lower Values	Increase
	L2	Intellectual Capital	Organization &HR&Customers	Annual	Aggregate	Upper|Lower Values	Increase

Figure 1. The balanced scorecard (BSC) for a financial software factory (FSF). Adapted from [4].

2.2. The Strategy Map for a FSF

The main contribution of the BSC framework is that it includes performance measurements and strategic objectives. Kaplan and Norton introduced three principles that link the BSC of an organization to its own strategy: (1) cause–effect relationships; (2) performance drivers; and (3) linkage to financial goals [28]. Strategy maps are built according to the four perspectives of the BSC and they interface between the business strategy and the BSC. Strategy maps provide a visual framework that has been developed by companies in virtually all areas. In relation to this article, it is necessary to highlight the following proposals about the application of the BSC and the strategy maps in the financial sector [28,29], in the software development sector [30,31], in IT departments or companies [22,32,33] and other proposals related to business and corporate sustainability [24,34]. These studies are some examples about the application of strategy maps for linking measurements with business aims.

In software-intensive organizations, such as a software factory, it is necessary to link software measurement goals to higher-level goals. This linkage is important, as it helps to justify software measurement efforts and allows measurement data to contribute to higher-level decisions [30]. Furthermore, linking software activities to an organization's higher-level business goals can improve its performance [35]. Our prior paper [4] implements the business strategy in a FSF by applying the BSC framework, linking the measurement to higher-level goals for the FSF through its strategy map. Figure 2 shows the strategy map for a FSF. At the top of the strategy map are the strategic goals: the mission and vision, the two high-level goals and the six business goals. Under each business goal, a subset of KPIs is situated. This subset includes the KPIs that are directly linked and have an influence on each specific business goal. Every business goal has its own subset of KPIs, and every KPI can influence more than one business goal. This proposal shows the relationships among indicators, perspectives and objectives included in the strategy map, but it does not include weights for each of them.

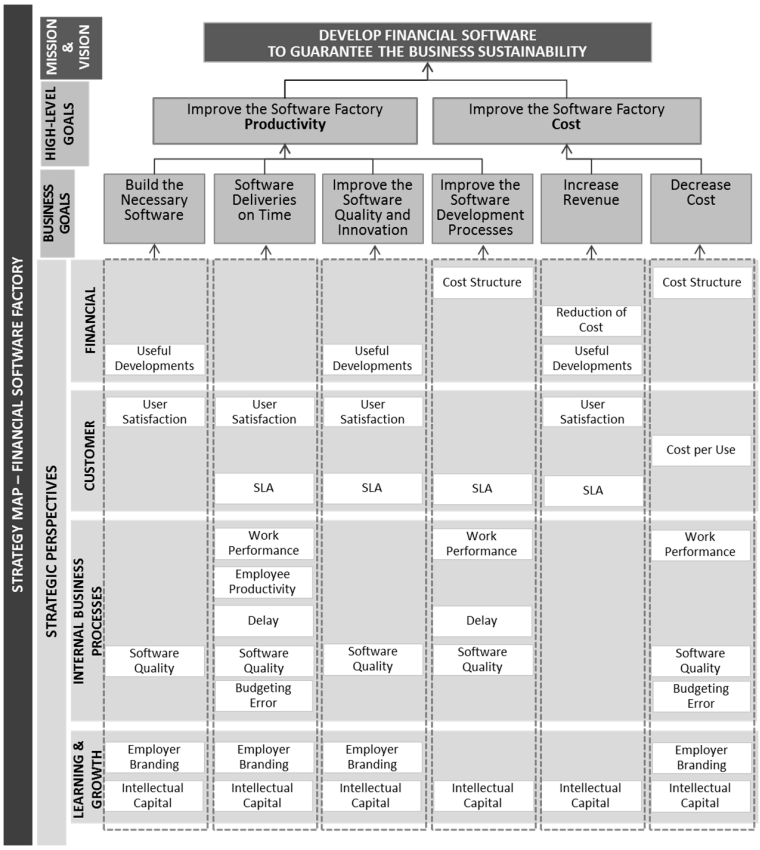

Figure 2. The strategy map for FSF. Adapted from [4].

2.3. Fuzzy Theory and FAHP

In this section, we review some relevant concepts as fuzzy numbers theory and its incorporation into the AHP, calling the resulting theory FAHP, used to determine criteria weights.

2.3.1. Fuzzy Numbers and Linguistic Variables

Evaluating different alternatives is a MCDM problem in the presence of many quantitative and qualitative attributes. The AHP is a method that has been widely used for selecting the best alternative among others [36,37], but fuzzy sets could be incorporated with the AHP, an approach that allows a more accurate description of the decision-making process [38]. Expressions such as "not very clear", "probably so", and "very likely" are used often in daily life and more or less represent some degree of uncertainty of human thought. The fuzzy set theory proposed by Zadeh in 1965 [39], an important concept applied in the scientific environment, has been available to other fields as well. Consequently, fuzzy theory has become a useful tool for automating human activities with uncertainty-based information [38]. Therefore, this research incorporates fuzzy theory into the performance measurement by objectifying the evaluators' subjective judgements. Below, some basic definitions of fuzzy sets, fuzzy numbers, and linguistic variables, mainly from Buckley, Zadeh, and others [40–44], are reviewed, similarly to those presented in other studies [38,45] that combine the FAHP and the BSC framework.

In classical set theory, the truth value of a statement can be given by the membership function as $\mu_A(x)$:

$$\mu_A(x) = \begin{cases} 1 \text{ if } x \in A \\ 0 \text{ if } x \notin A \end{cases} \quad (1)$$

Central to fuzzy set theory is the notion of the fuzzy number. Fuzzy numbers are a fuzzy subset of real numbers and they represent the expansion of the idea of a confidence interval. According to the definition by Dubois and Prade [46], the fuzzy number $\widetilde{A}$ is a fuzzy set and its membership function is $\mu_{\widetilde{A}}(x) : R \to [0,1] \left(0 \leqq \mu_{\widetilde{A}}(\chi) \leqq 1, x \in X\right)$, where x represents the criterion and is described by the following characteristics: (1) $\mu_{\widetilde{A}}(x)$ is a continuous mapping from R (real line) to the closed interval [0, 1]; (2) $\mu_{\widetilde{A}}(x)$ is a convex fuzzy subset; and (3) $\mu_{\widetilde{A}}(x)$ is the normalization of a fuzzy subset, which means that there exists a number x_0 such that $\mu_{\widetilde{A}}(x_0) = 1$.

In applications, it is often convenient to work with triangular fuzzy numbers (TFNs) because of their computational simplicity [47–49], and they are useful in promoting representation and information processing in a fuzzy environment [50]. For instance, the TFN $\widetilde{A} = (l, m, u)$ can be defined as Equation (2) and the TFN membership function is shown in Figure 3:

$$\mu_{\widetilde{A}}(x) = \begin{cases} (x-l)/(m-l) \text{ if } l \leq x \leq m \\ (u-x)/(u-m) \text{ if } m \leq x \leq u \\ 0 \text{ otherwise.} \end{cases} \quad (2)$$

Based on the characteristics of TFNs and the extension definitions proposed by Zadeh [41], given any two positive TFNs $\widetilde{A}_1 = (l_1, m_1, u_1)$ and $\widetilde{A}_2 = (l_2, m_2, u_2)$ and a positive real number r, some algebraic operations of the TFNs $\widetilde{A}_1$ and $\widetilde{A}_2$ can be expressed as follows:

$$\text{Addition of two TFNs } \oplus: \quad \widetilde{A}_1 \oplus \widetilde{A}_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (3)$$

$$\text{Multiplication of two TFNs } \otimes: \quad \widetilde{A}_1 \otimes \widetilde{A}_2 = (l_1\, l_2, m_1\, m_2, u_1\, u_2) \quad (4)$$

$$\text{Multiplication of any real number } r \text{ and a TFN } \otimes: \quad r \otimes \widetilde{A}_1 = (rl_1, rm_1, ru_1) \text{ for } r > 0 \text{ and } l_i > 0,\ m_i > 0,\ u_i > 0 \quad (5)$$

$$\text{Subtraction of two TFNs } \ominus: \quad \widetilde{A}_1 \ominus \widetilde{A}_2 = (l_1 - u_2, m_1 - m_2, u_1 - l_2) \text{ for } l_i > 0,\ m_i > 0,\ u_i > 0 \tag{6}$$

$$\text{Division of two TFNs } \oslash: \quad \widetilde{A}_1 \oslash \widetilde{A}_2 = (l_1/u_2, m_1/m_2, u_1/l_2) \tag{7}$$

$$\text{Reciprocal of a TFN:} \quad \widetilde{A}_1^{-1} = (1/u_1, 1/m_1, 1/l_1) \text{ for } l_i > 0,\ m_i > 0,\ u_i > 0 \tag{8}$$

According to [41], a conventional quantification of reasonable expression in situations that are complex or hard to define is very difficult. In these cases, the notion of a linguistic variable is vital. Linguistic variables are variables whose values are words or sentences in a natural or artificial language. In other words, they are variables with lingual expression as their values [41,51].

This paper uses five basic linguistics terms for comparing the best plan evaluation criteria: "equally important", "weakly important", "essentially important", "very strongly important", and "absolutely important", according to the fundamental scale of Saaty [52]. The membership function of a linguistic term is defined by Mon et al. [53] and displayed in Table 1.

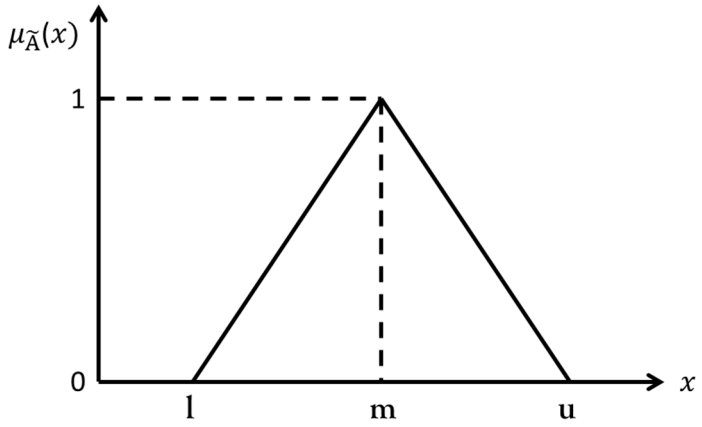

Figure 3. Membership function of the triangular fuzzy number (TFN).

Table 1. Membership function of the linguistic scale.

Fuzzy Number	Linguistic Scale	TFN ($\tilde{a}_{ij}$)	Reciprocal of a TFN ($\tilde{a}_{ij}$)
$\widetilde{1}$	Equally important	(1, 1, 3)	(1/3, 1, 1)
$\widetilde{3}$	Weakly important	(1, 3, 5)	(1/5, 1/3, 1)
$\widetilde{5}$	Essentially important	(3, 5, 7)	(1/7, 1/5, 1/3)
$\widetilde{7}$	Very strongly important	(5, 7, 9)	(1/9, 1/7, 1/5)
$\widetilde{9}$	Absolutely important	(7, 9, 9)	(1/9, 1/9, 1/7)
$\widetilde{2}, \widetilde{4}, \widetilde{6}, \widetilde{8}$	Intermediate value between two adjacent judgements		

The evaluators are asked to conduct their judgements, and each linguistic variable can be indicated by a TFN. An example of membership functions of five levels of linguistic variables is shown in Figure 4.

The use of linguistic variables is applied widely. In this paper, linguistic variables expressed by TFNs are adopted to represent evaluators' subjective measures to determine the degrees of importance among evaluation criteria and also to assess the performance value of alternatives.

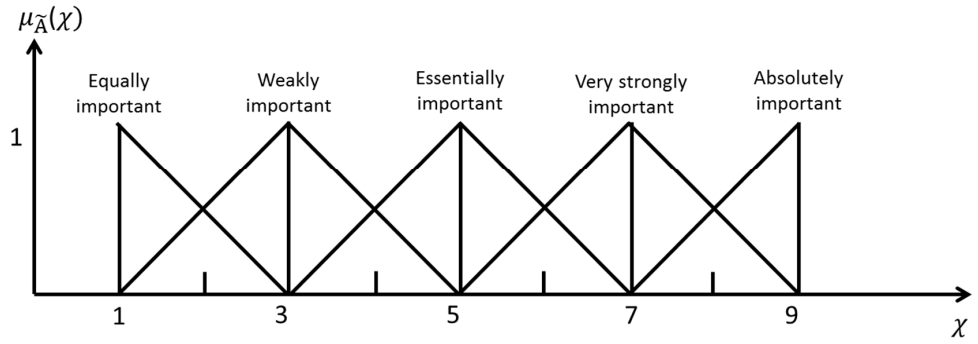

Figure 4. Membership functions of the linguistic variables for criteria comparisons.

2.3.2. FAHP

AHP was developed by Saaty in the 1970s [54–58], initially to solve the scarce resources allocation and planning needs of the military. Since its introduction, the AHP has become one of the most widely used MCDM methods and has been used to solve unstructured problems in different areas of human needs and interests [59]. Finally, the AHP became a useful approach to solve complex decision problems that prioritizes the relative importance of a list of criteria (critical factors and sub-factors) through pairwise comparisons amongst the factors by relevant experts using a nine-point scale. However, due to the vagueness and uncertainty of judgements of the decision-makers, the fuzzy number logic was introduced in the pairwise comparison of the AHP to make up for this deficiency in the conventional AHP [60]. Buckley [40] incorporated fuzzy theory into the AHP, calling the resulting theory FAHP. In 1996, Chang introduced a new approach for handling FAHP with the use of TFNs [61] for pairwise comparisons. FAHP generalizes the calculation of the consistent ratio into a fuzzy matrix.

The procedure of the FAHP for determining the evaluation weights is explained as follows:

- *Step 1: Construct fuzzy pairwise comparison matrices*. Through expert questionnaires, each expert is asked to assign linguistic terms by TFNs (as shown in Table 2 and Figure 4) to the pairwise comparisons among all criteria in the dimensions of a hierarchy system. The result of the comparisons is constructed as fuzzy pairwise comparison matrices ($\widetilde{A}$) as shown in Equation (9).
- *Step 2: Examine the consistency of the fuzzy pairwise comparison matrices*. According to this research [40], it proves that if $A = [a_{ij}]$ is a positive reciprocal matrix then $\widetilde{A} = [\widetilde{a}_{ij}]$ is a fuzzy positive reciprocal matrix. That is, if the result of the comparisons of $A = [a_{ij}]$ is consistent, it implies that the result of the comparisons of $\widetilde{A} = [\widetilde{a}_{ij}]$ is also consistent. Therefore, this research employs this method to validate the questionnaire:

$$\widetilde{A} = \begin{bmatrix} 1 & \widetilde{a}_{12} & \cdots & \widetilde{a}_{1n} \\ \widetilde{a}_{21} & 1 & \cdots & \widetilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \widetilde{a}_{n1} & \widetilde{a}_{n2} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \widetilde{a}_{12} & \cdots & \widetilde{a}_{1n} \\ 1/\widetilde{a}_{12} & 1 & \cdots & \widetilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\widetilde{a}_{1n} & 1/\widetilde{a}_{2n} & \cdots & 1 \end{bmatrix} \quad (9)$$

- *Step 3: Compute the fuzzy geometric mean for each criterion.* The geometric technique is used to calculate the geometric mean ($\widetilde{r}_i$) of the fuzzy comparison values of criterion i to each criterion, as shown in Equation (10), where $\widetilde{a}_{in}$ is a fuzzy value of the pairwise comparison of criterion i to criterion n [40].

$$\widetilde{r}_i = [\widetilde{a}_{i1} \otimes \cdots \otimes \widetilde{a}_{in}]^{1/n} \quad (10)$$

- *Step 4: Compute the fuzzy weights by normalization.* The fuzzy weight of the ith criterion ($\widetilde{w}_i$) can be derived as Equation (11), where $\widetilde{w}_i$ is denoted as $\widetilde{w}_i = (L_{wi}, M_{wi}, U_{wi})$ by a TFN and L_{wi}, M_{wi}, and U_{wi} represent the lower, middle, and upper values of the fuzzy weight of the ith criterion.

$$\widetilde{w}_i = \widetilde{r}_i \otimes (\widetilde{r}_1 \oplus \widetilde{r}_2 \oplus \cdots \oplus \widetilde{r}_n)^{-1} \tag{11}$$

2.3.3. The Synthetic Value of Fuzzy Judgement

Since Bellman and Zadeh [62] proposed the decision-making methods in fuzzy environments in 1970, an increasing number of related models have been applied in various fields, including control engineering, expert systems, artificial intelligence, management science, operations research, and MCDM. The main application to decision-making problems is focused on criteria evaluation or project selection and can assist in selecting the best alternative or ranking the order of projects or alternatives.

Due to the differences in the subjective judgements among the experts about each evaluation criterion, the overall valuation of the fuzzy judgement is employed to synthesize the various experts' opinions in order to achieve a reasonable and objective evaluation. The calculation steps to obtain the synthetic value are as follows:

- *Step 1: Performance evaluation of the alternatives.* Against the evaluation criteria, each linguistic variable can be represented by a TFN. Assume that $\widetilde{E}_{ij}^k$ denotes the fuzzy valuation of performance given by the evaluator k towards alternative i under criterion j, as Equation (12) shows, then:

$$\widetilde{E}_{ij}^k = \left(LE_{ij}^k, ME_{ij}^k, UE_{ij}^k\right) \tag{12}$$

  In this research, $\widetilde{E}_{ij}^k$ represents the average fuzzy judgement values integrated by m evaluators as

$$\widetilde{E}_{ij} = (1/m) \otimes \left(\widetilde{E}_{ij}^1 \oplus \widetilde{E}_{ij}^2 \oplus \cdots \oplus \widetilde{E}_{ij}^m\right) \tag{13}$$

  According to Buckley [40], the three end points of $\widetilde{E}_{ij}$ can be computed as

$$LE_{ij} = \left(\sum_{k=1}^{m} LE_{ij}^k\right)/m,\ ME_{ij} = \left(\sum_{k=1}^{m} ME_{ij}^k\right)/m,\ UE_{ij} = \left(\sum_{k=1}^{m} UK_{ij}^k\right)/m \tag{14}$$

- *Step 2: Fuzzy synthetic judgement.* According to the fuzzy weight, $\widetilde{w}_j$, of each criterion calculated by FAHP, the criteria vector ($\widetilde{w}$) is derived as Equation (15). The fuzzy performance matrix ($\widetilde{E}$), as presented in Equation (16), of all the alternatives can be acquired from the fuzzy performance value of each alternative under n criteria.

$$\widetilde{w} = \left(\widetilde{w}_1, \cdots, \widetilde{w}_j, \cdots \widetilde{w}_n\right)^t, \tag{15}$$

$$\widetilde{E} = \left[\widetilde{e}_{ij}\right] \tag{16}$$

Then, the final fuzzy synthetic decision can be deduced from the criteria weight vector ($\widetilde{w}$) and the fuzzy performance matrix ($\widetilde{E}$), and then the derived result, the final fuzzy synthetic decision matrix ($\widetilde{R}$), is calculated by $\widetilde{R} = \widetilde{E} \leftrightarrow \widetilde{w}$, where the sign $\leftrightarrow$ indicates the computation of the fuzzy number, consisting of both fuzzy addition and fuzzy multiplication. Considering that the computation of fuzzy multiplication is rather complicated, the approximate result of the fuzzy multiplication is used here. For instance, the approximate fuzzy number ($\widetilde{R}_i$) of the fuzzy synthetic decision of the alternative i is denoted as Equation (17), where LR_i, MR_i, and UR_i are the lower, middle, and upper synthetic performance values of alternative i, respectively, and the calculations of each are illustrated as Equation (18).

$$\widetilde{R}_i = (LR_i, MR_i, UR_i) \tag{17}$$

where

$$LR_i = \sum_{j=1}^{n} Lw_j \times LE_{ij},\ MR_i = \sum_{j=1}^{n} Mw_j \times ME_{ij},\ UR_i = \sum_{j=1}^{n} Uw_j \times UE_{ij}. \quad (18)$$

Next, the procedure of defuzzification [51,63] locates the best nonfuzzy performance (BNP) value. There are different methods that can be used in such defuzzified fuzzy ranking, but in this study we used the Center of Area method to find out the BNP because it is simple and practical without the need to bring in the preferences of any evaluators. The BNP value of the fuzzy number $\widetilde{R}_i$ can be found by

$$BNP_i = \frac{[(UR_i - LR_i) + (MR_i - LR_i)]}{3} + LR_i \forall i \quad (19)$$

According to the value of the derived BNP for each alternative, the weight of each of the alternatives and criteria can then proceed.

2.4. Integration of BSC and Strategy Map Framework with FAHP

Although the integration of BSC with MCDM techniques such as AHP or FAHP has usually been adopted as a useful method of calculating weights and can help establish an evaluation performance system, the integration of strategy maps with AHP or FAHP to establish the importance or weights for business strategic objectives has only been used in a few studies. In most cases, it has been used to define the strategy map of a company, but this study integrates the BSC and the strategy map of a FSF with FAHP to assess the impact of each indicators measure changes in the affected business strategies, facilitating to the FSF managers the decision-making based on the improvement of the desired strategy. Wu [28] presents a structural evaluation methodology to link KPIs into a strategy map of the BSC for banking institutions, using MCDM analytical techniques to construct the strategy map for banks. For information services firms, Chen and Wang [64] propose a fuzzy–delphi AHP combined with performance indexes to help firms adjust their business strategies and make better business decisions. Ren et al. [65] present a comprehensive methodology with AHP to translate strategic objectives into performance metrics in supply-chain decision-making, linking the strategy map to low-level metrics with weights. Taticchi et al. [66] present a framework based on business performance measurements and AHP for providing direction and guidance to an organization. It identifies cause–effect relationships in business processes and measures performance and business strategic objectives in a hierarchical strategy branch. Quezada et al. [67] present an application of AHP to support the creation of a strategy map and propose the relationships that are important (with weights for each of them) within the strategy map. With a similar aim, another paper of Quezada and López-Ospina [68] presents a method of designing a strategy map using AHP and linear programming. Lu et al. [69] propose a multicriteria decision analysis to develop effective sustainable development strategies for enhancing competitive advantages. Finally, in the auto industry and dairy companies, respectively, Abdolshah et al. [70] and Sorayaei et al. [71] propose an integrated approach to analyse the strategy map using the BSC and the FAHP, and they determine weights for each strategy and each aspect.

The study presented here proposes an integration of BSC and strategy map with FAHP to determine the relative weights for the KPIs and objectives included in the strategy map to assess the impact of changes in the mission and vision of the organization.

3. Methodology

This section presents the research methods used to conduct the study. We explain the methodology steps and how the necessary data and information to address the research objectives were collected, presented and analysed.

3.1. Methodology Steps

In this research, the BSC and the strategy map for a FSF were taken as the framework for establishing weights for KPIs, perspectives, business goals, and high-level goals. The analytical structure of this research is explained in Figure 5. We first used the BSC and the strategy map for a FSF to study the different KPIs and strategic objectives and then we interviewed several managers in a Spanish FSF. We then got the views of software factory experts and we designed a pairwise comparison questionnaire based on the hierarchical structure of the BSC and the strategy map. Finally, FAHP was applied to obtain the weights of KPIs and objectives included in the strategy map. Afterwards, these weights were treated with the purpose of determining the influence that KPI measures exert on the mission and vision of the organization, depending on the business strategy to be valued.

The steps taken to achieve this purpose are as follows:

1. Analyse the BSC and the strategy map of the FSF.
2. Define the hierarchical framework related to the BSC and strategy map of FSF.
3. Prepare a questionnaire in AHP format to obtain the opinions of experts regarding KPIs, perspectives and goals, under the premise of achieving the mission and vision defined in the strategy map of the organization.
4. Prepare the answers obtained from the experts and give these answers the necessary format for their computer treatment with FAHP software.
5. Calculate the local and overall weights of all the KPIs and perspectives included in the BSC.
6. Calculate the local and global weights of all the objectives included in the strategy map.
7. Based on the relationships between KPIs and goals defined in the strategy map, calculate the relative weight of each indicator according to the business goal that it affects directly. The total weight of the indicators is distributed in proportion to the weight of the affected business goals.
8. Incorporate the calculated weights in the strategy map, which allows the impact of each KPI on the mission and vision of the organization to be known.

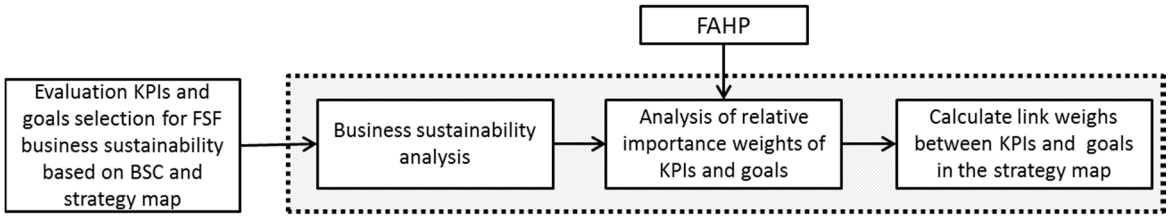

Figure 5. Performance evaluation framework of the research.

3.2. Hierarchical Framework of the BSC and the Strategy Map for Evaluation Criteria in a FSF

The BSC and the strategy map for a FSF have been adopted as hierarchical models in this study. The hierarchical framework of the BSC performance evaluation criteria and sub-criteria (i.e., four perspectives and thirteen KPIs) for a FSF is shown in Figure 6 and uses the four perspectives of the BSC for FSF and the indicators included in each one of them to create the hierarchy. The thirteen KPIs are grouped into the four BSC perspectives: "F: Financial (F1–F3)", "C: Customer (C1–C3)", "I: Internal Business Process (I1–I5)", and "L: Learning and Growth (L1–L2)". On the other hand, the hierarchical framework of the strategy map evaluation criteria and sub-criteria (i.e., six business goals and two high-level goals) for a FSF is shown in Figure 7 and uses the existing relationships between the strategic objectives defined in the strategy map to create the hierarchy. The six business goals are grouped into the two high-level goals: "HLG1: Improve Productivity (BG1–BG4)" and "HLG2: Improve Cost (BG5–BG6)". These hierarchies provide a structure to express the organization's needs [72] and directly support achievement of the mission and vision of the company [24].

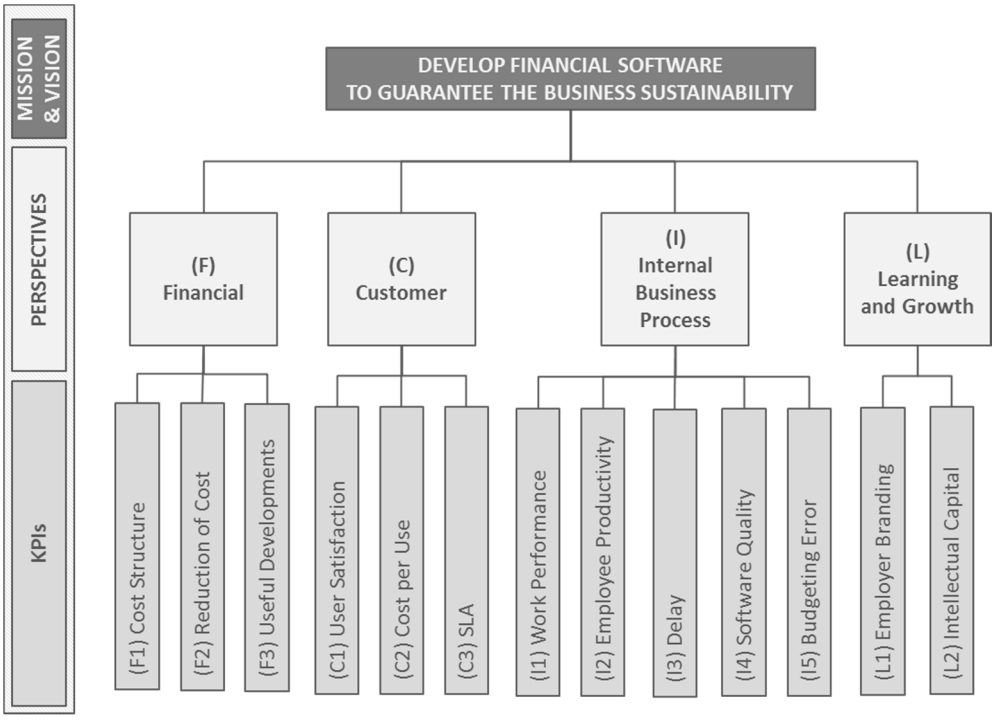

Figure 6. Hierarchical framework of BSC for FSF.

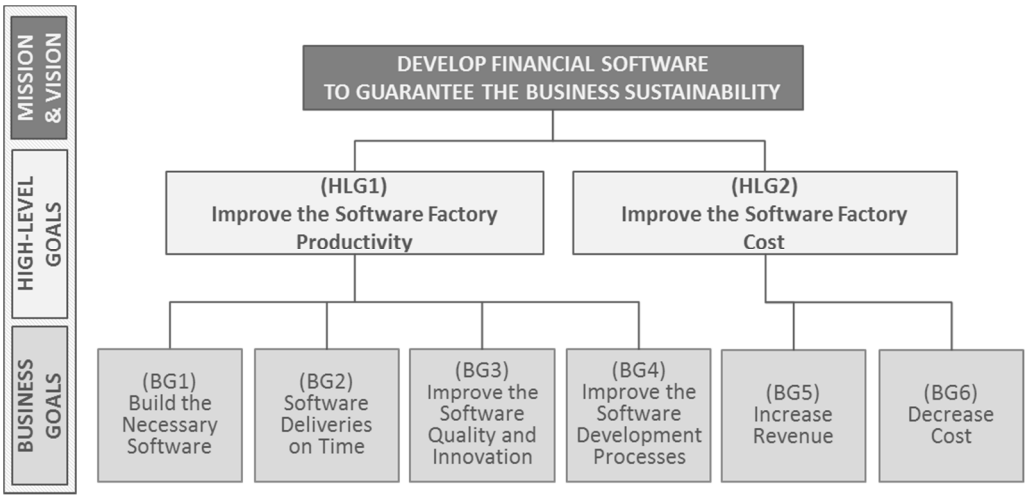

Figure 7. Hierarchical framework of strategy map for FSF.

3.3. Data Collection

Based on the hierarchies shown in Figures 6 and 7, a questionnaire to find out the participants' judgements was designed with a conventional AHP questionnaire format, the five-point linguistic scale shown in Table 1, and pairwise comparison. The questionnaire included the definition and meaning of each criterion or sub-criterion included in every question. After the questionnaire was designed, it was given to some experts, shareholders, and managers of a FSF to test its reliability and validity. Their corrective views were taken into consideration in the final design to avoid potential interpretation errors when the different stakeholders answered the questionnaire. An instruction sheet for completing the questionnaire was created to assist respondents and an example of how the questionnaire should be filled in was given to them. A total of 83 questionnaires were distributed (by email and online form) to stakeholders with different roles related with the FSF. These were grouped, according to the proposal

of roles made by the top management of the FSF and the purpose of consider different types of points of view, into Shareholders, Top management, Middle managers, Other employees, Customers and Experts in the field of software factories. The latter were included to seek their professional opinions and the purpose of weighting criteria under the FSF business sustainability aim. Table 2 shows the different stakeholder roles and their relation with a FSF.

Table 2. Different stakeholder roles and their relation with a FSF.

Stakeholder Roles	Relation with the FSF
Shareholders	The shareholders are the owners of the company. They are usually top management of the financial entities involved in the same financial group.
Top management	Top management are the highest ranking executives responsible for the entire FSF. They translate policy into goals and strategies for the future. Top management make decisions affecting everyone in the software factory.
Middle managers	The middle managers are the employees of the FSF who manage at least one subordinate level of managers, and report to the top management in the organisation to ensure smooth functioning of the software factory.
Other employees	Other employees are the lowest level of managers and the rest of the employees of the software factory, including analysts and developers.
Customers	Customers are the financial entities for which the software factory develops software and offers services to them.
Experts	Experts are a group of managers of other software factories from different sectors, professors and researchers in relation to software factories.

Finally, 61 questionnaires were received (73.5% of questionnaires sent). The questionnaire responses were revised and adapted to the necessary format in order to put this information into the FAHP system (the software used in this study was the FuzzyAHP package of R [73]) generating the pairwise comparison matrixes. The questionnaires that did not pass the consistency test (used to directly estimate the consistency of pairwise comparisons [56]) were revised and the values of the comparison matrix were considered and checked. In those cases in which the adjustments were minor or not significant, the procedure was repeated [74]. The definitive number of valid questionnaires was 44 (72.1% of questionnaires received). Table 3 shows the number and percentage of questionnaires sent, received and validated by stakeholder role. Finally, the FAHP system calculated the comparison weights and generates as output of the FAHP process the result with the weights of the KPIs, perspectives and strategic objectives.

Table 3. Number and percentage of sent, received and valid questionnaires by role.

Stakeholder Roles	Number of Sent Questionnaires	Number of Received Questionnaires		Number of Valid Received Questionnaires	
Shareholders	13	9	69.2%	6	66.7%
Top Management	12	8	66.7%	6	75.0%
Middle Managers	15	13	86.7%	8	61.5%
Other Employees	13	6	46.1%	5	83.3%
Customers	15	14	93.3%	10	71.4%
Experts in Software Factories	15	11	73.3%	9	81.8%
Total	**83**	**61**	73.5%	**44**	72.1%

4. Results: A Case Study for a Spanish FSF

The results of this study are shown in two different ways: first they are shown globally as a main result of this research. Then, the results are shown grouped by stakeholder roles, which allow assessing the different points of view according to the relationship of each role with the software factory.

4.1. Global Results

The intermediate global results of the study are shown in Tables 4 and 5. Table 4 shows the results for the weights of KPIs and perspectives in the BSC ranked by weights. The Customer Perspective, with a priority weight of 0.4254, is the most important perspective. This is followed by the Financial Perspective, with a priority weight of 0.2134. The priority weight of the Learning and Growth Perspective is 0.1808, and the Internal Business Processes Perspective has the lowest priority weight of 0.1804. The priority order of the thirteen KPIs shows that User Satisfaction, with a priority weight of 0.2109, and SLA with 0.1268 (both included in the Customer Perspective), are the most important KPIs among all of those included in the BSC for a FSF. The third most important KPI is Intellectual Capital, with a weight of 0.1053 (included in the Learning and Growth Perspective), followed by Cost Structure, with a weight of 0.0877 (included in the Financial Perspective). The eighth KPI is Software Quality, with a weight of 0.0633 (included in the Internal Business Processes Perspective). Table 5 shows the results for the weights of objectives in the strategy map ranked by weights. The Improve Productivity high-level goal (HLG) is the most important of the two, with a priority weight of 0.7083, and the other HLG, Improve Costs, has a priority weight of 0.2917. The priority order of the six business goals shows that Building the Necessary Software and Software Deliveries on Time are the most important strategies among the business goals.

Table 4. Fuzzy weights of BSC for a FSF sustainable business index by FAHP.

Criteria and Sub-Criteria (Perspectives and KPIs)	Local Weights TFN (*L*, *M*, *U*)	Overall Weights TFN (*L*, *M*, *U*)	BNP [1]	STD BNP [2]	Rank of Weights
(F) Financial	**(0.1148; 0.2035; 0.3518)**		**0.2234**	**0.2134**	**2**
(F1) Cost Structure	(0.2870; 0.4134; 0.5503)	(0.0329; 0.0841; 0.1936)	0.1036	0.0877	4
(F2) Reduction of Cost	(0.1568; 0.2438; 0.3741)	(0.0180; 0.0496; 0.1316)	0.0664	0.0562	9
(F3) Useful Developments	(0.2255; 0.3429; 0.4844)	(0.0259; 0.0698; 0.1704)	0.0887	0.0751	6
(C) Customer	**(0.2957; 0.4586; 0.5817)**		**0.4454**	**0.4254**	**1**
(C1) User Satisfaction	(0.3781; 0.5411; 0.6655)	(0.1118; 0.2481; 0.3871)	0.2490	0.2109	1
(C2) Cost per Use	(0.1090; 0.1712; 0.2881)	(0.0322; 0.0785; 0.1676)	0.0928	0.0786	5
(C3) SLA	(0.1745; 0.2876; 0.4568)	(0.0516; 0.1319; 0.2657)	0.1497	0.1268	2
(I) Internal Business Processes	**(0.1057; 0.1712; 0.2897)**		**0.1889**	**0.1804**	**4**
(I1) Work Performance	(0.1376; 0.2118; 0.3225)	(0.0145; 0.0363; 0.0934)	0.0481	0.0407	10
(I2) Employee Productivity	(0.0955; 0.1516; 0.2431)	(0.0101; 0.0260; 0.0704)	0.0355	0.0301	12
(I3) Delay	(0.0979; 0.1587; 0.2558)	(0.0103; 0.0272; 0.0741)	0.0372	0.0315	11
(I4) Software Quality	(0.2361; 0.3698; 0.5018)	(0.0250; 0.0633; 0.1454)	0.0779	0.0659	8
(I5) Budgeting Error	(0.0675; 0.1082; 0.1944)	(0.0071; 0.0185; 0.0563)	0.0273	0.0231	13
(L) Learning and Growth	**(0.1078; 0.1667; 0.2934)**		**0.1893**	**0.1808**	**3**
(L1) Employer Branding	(0.2644; 0.3708; 0.5154)	(0.0285; 0.0618; 0.1512)	0.0805	0.0682	7
(L2) Intellectual Capital	(0.4846; 0.6292; 0.7356)	(0.0522; 0.1049; 0.2158)	0.1243	0.1053	3

[1] BNP (Best non-fuzzy performance) = $[(U - L) + (M - L)]/3 + L$. [2] STD_BNP: standardised BNP.

Table 5. Fuzzy weights of goals of strategy map for a FSF sustainable business index by FAHP.

Criteria and Sub-Criteria (HLG and Business Goals)	Local Weights TFN (*L*, *M*, *U*)	Overall Weights TFN (*L*, *M*, *U*)	BNP [1]	STD BNP [2]	Rank of Weights
(HLG1) Improve Productivity	**(0.6243; 0.7156; 0.8180)**		**0.7193**	**0.7083**	**1**
(BG1) Build the Necessary SW	(0.1959; 0.2971; 0.4056)	(0.1223; 0.2126; 0.3318)	0.2222	0.2043	1
(BG2) SW Deliveries on Time	(0.1730; 0.2679; 0.3850)	(0.1080; 0.1917; 0.3149)	0.2049	0.1883	2
(BG3) Improve the SW Quality and Innovation	(0.1642; 0.2541; 0.3740)	(0.1025; 0.1818; 0.3059)	0.1967	0.1808	3
(BG4) Improve the SW Development Processes	(0.1197; 0.1810; 0.2881)	(0.0747; 0.1295; 0.2357)	0.1466	0.1348	5
(HLG2) Improve Cost	**(0.2099; 0.2845; 0.3946)**		**0.2963**	**0.2917**	**2**
(BG5) Increase Revenue	(0.4340; 0.5550; 0.6875)	(0.0911; 0.1579; 0.2713)	0.1734	0.1594	4
(BG6) Decrease Cost	(0.3602; 0.4450; 0.5821)	(0.0756; 0.1266; 0.2297)	0.1440	0.1323	6

[1] BNP (Best non-fuzzy performance) = $[(U - L) + (M - L)]/3 + L$. [2] STD_BNP: standardised BNP.

The result of the study is shown in Table 6. This table shows the link weights between KPIs and business goals in the strategy map. The overall weight of each KPI has been distributed in proportion to the weight of the business goals affected by this indicator, thus obtaining both the overall impact on the organization's mission and the particular impact of each KPI according to the different strategies defined by the business goals. Finally, Figure 8 shows the strategy map of a FSF and the calculated link weights between KPIs and strategic goals.

Table 6. Fuzzy weights of links between KPIs and business goals in the strategy map for a FSF.

KPIs and Business Goals	KPI and Business Goal Overall Weights	Link Weights between KPIs and Business Goals
(F1) Cost Structure	**0.0877**	
(BG4) Improve the Software Development Processes	0.1348	0.0443
(BG6) Decrease Cost	0.1323	0.0434
(F2) Reduction of Cost	**0.0562**	
(BG5) Increase Revenue	0.1595	0.0562
(F3) Useful Developments	**0.0751**	
(BG1) Build the Necessary Software	0.2043	0.0282
(BG3) Improve the Software Quality and Innovation	0.1808	0.0249
(BG5) Increase Revenue	0.1595	0.0220
(C1) User Satisfaction	**0.2109**	
(BG1) Build the Necessary Software	0.2043	0.0588
(BG2) Software Deliveries on Time	0.1883	0.0542
(BG3) Improve the Software Quality and Innovation	0.1808	0.0520
(BG5) Increase Revenue	0.1595	0.0459
(C2) Cost per Use	**0.0786**	
(BG6) Decrease Cost	0.1323	0.0786
(C3) Service Level Agreements (SLA)	**0.1268**	
(BG2) Software Deliveries on Time	0.1883	0.0360
(BG3) Improve the Software Quality and Innovation	0.1808	0.0346
(BG4) Improve the Software Development Processes	0.1348	0.0258
(BG5) Increase Revenue	0.1595	0.0305
(I1) Work Performance	**0.0407**	
(BG2) Software Deliveries on Time	0.1883	0.0168
(BG4) Improve the Software Development Processes	0.1348	0.0120
(BG6) Decrease Cost	0.1323	0.0118
(I2) Employee Productivity	**0.0301**	
(BG2) Software Deliveries on Time	0.1883	0.0301
(I3) Delay	**0.0315**	
(BG2) Software Deliveries on Time	0.1883	0.0184
(BG4) Improve the Software Development Processes	0.1348	0.0131
(I4) Software Quality	**0.0659**	
(BG1) Build the Necessary Software	0.2043	0.0160
(BG2) Software Deliveries on Time	0.1883	0.0148
(BG3) Improve the Software Quality and Innovation	0.1808	0.0142
(BG4) Improve the Software Development Processes	0.1348	0.0106
(BG6) Decrease Cost	0.1323	0.0104
(I5) Budgeting Error	**0.0231**	
(BG2) Software Deliveries on Time	0.1883	0.0136
(BG6) Decrease Cost	0.1323	0.0095
(L1) Employer Branding	**0.0682**	
(BG1) Build the Necessary SW	0.2043	0.0197
(BG2) Software Deliveries on Time	0.1883	0.0182
(BG3) Improve the Software Quality and Innovation	0.1808	0.0175
(BG6) Decrease Cost	0.1323	0.0128
(L2) Intellectual Capital	**0.1053**	
(BG1) Build the Necessary Software	0.2042	0.0215
(BG2) Software Deliveries on Time	0.1883	0.0198
(BG3) Improve the Software Quality and Innovation	0.1808	0.0190
(BG4) Improve the Software Development Processes	0.1348	0.0142
(BG5) Increase Revenue	0.1595	0.0168
(BG6) Decrease Cost	0.1323	0.0139

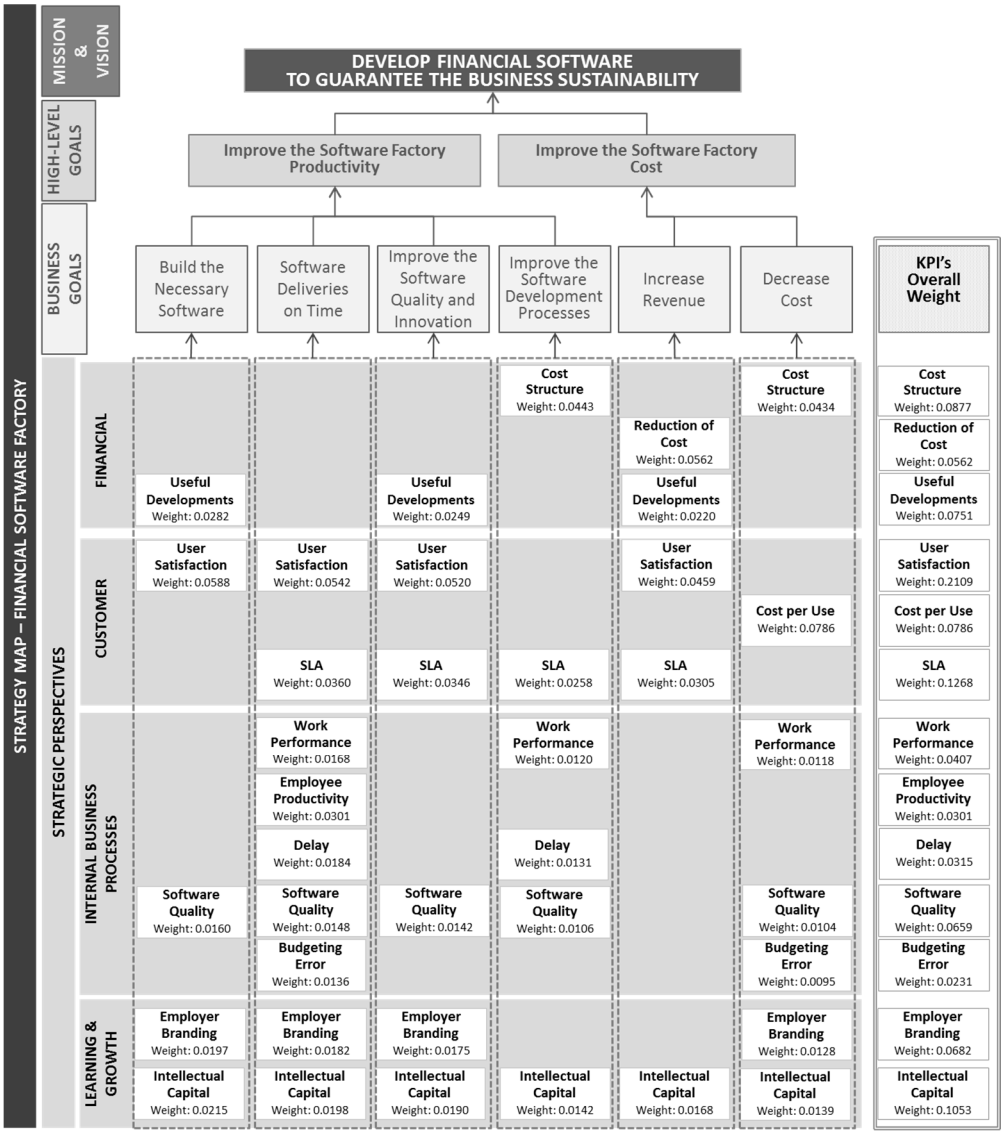

Figure 8. The strategy map of a FSF with weights for links between KPIs and business goals.

4.2. Results Grouped by Stakeholder Roles

Table 7 shows the results about KPIs and perspectives of BSC by stakeholder role. As is shown, the results by role in the FAHP analysis reveal that the Customer Perspective is the primary focus of the BSC, and User Satisfaction is the most important evaluation KPI. The Customer Perspective is the most important by role (Other Employees being the only exception), but User Satisfaction is the best ranking KPI in all cases. The SLA indicator is globally the second most important KPI, and is mostly one of the four most important KPIs for the different roles (Other Employees is again the only exception). The third most important KPI is Intellectual Capital, which is always one of the five most important KPIs for the different roles.

Table 8 shows the results about strategic goals of the strategy map by role. These results grouped by role show that Improve Productivity is the main HLG for all roles, with a weight always higher than 0.6384. Results by role for business goals show that none of them is determinant for all roles.

Table 7. Weights of KPIs and perspectives of BSC for a FSF sustainable business, index by FAHP according to the different stakeholder roles.

Criteria and Sub-Criteria/ Stakeholder Roles	Total/ Global	Share-Holders	Top Management	Middle Managers	Other Employees	Customers	Experts
(F) Financial	**0.2134**	**0.2315**	**0.1733**	**0.2210**	**0.2809**	**0.1597**	**0.2471**
(F1) Cost Structure	0.0877	0.1386	0.0538	0.0916	0.1029	0.0686	0.0858
(F2) Reduction of Cost	0.0562	0.0487	0.0559	0.0655	0.0567	0.0363	0.0759
(F3) Useful Developments	0.0751	0.0414	0.0700	0.0725	0.1202	0.0615	0.0936
(C) Customer	**0.4254**	**0.4810**	**0.4415**	**0.4144**	**0.2780**	**0.4391**	**0.4254**
(C1) User Satisfaction	0.2109	0.1947	0.2009	0.2004	0.1437	0.2155	0.2223
(C2) Cost per Use	0.0786	0.1762	0.0914	0.0455	0.0570	0.0676	0.0801
(C3) SLA	0.1268	0.1037	0.1357	0.1552	0.0726	0.1494	0.1095
(I) Internal Business Processes	**0.1804**	**0.1620**	**0.2398**	**0.2000**	**0.2296**	**0.1635**	**0.1379**
(I1) Work Performance	0.0407	0.0333	0.0447	0.0388	0.0587	0.0392	0.0379
(I2) Employee Productivity	0.0301	0.0252	0.0214	0.0251	0.0416	0.0423	0.0278
(I3) Delay	0.0315	0.0276	0.0541	0.0376	0.0427	0.0230	0.0242
(I4) Software Quality	0.0659	0.0658	0.0977	0.0869	0.0883	0.0580	0.0346
(I5) Budgeting Error	0.0231	0.0273	0.0373	0.0241	0.0210	0.0134	0.0287
(L) Learning and Growth	**0.1808**	**0.1255**	**0.1455**	**0.1647**	**0.2115**	**0.2377**	**0.1896**
(L1) Employer Branding	0.0682	0.0304	0.0543	0.0697	0.0604	0.1200	0.0665
(L2) Intellectual Capital	0.1053	0.0872	0.0829	0.0872	0.1345	0.1053	0.1132

Table 8. Weights of business goals and high-level goals of strategy map for a FSF sustainable business, index by FAHP according to the different stakeholder roles.

Criteria and Sub-Criteria/ Stakeholder Roles	Total/ Global	Share-Holders	Top Management	Middle Managers	Other Employees	Customers	Experts
(HLG1) Improve Productivity	**0.7083**	**0.6384**	**0.7209**	**0.6933**	**0.7906**	**0.7584**	**0.6590**
(BG1) Build the Necessary SW.	0.2043	0.1714	0.1722	0.1494	0.2732	0.2641	0.1886
(BG2) SW Deliveries on Time	0.1883	0.1670	0.2760	0.2295	0.1004	0.1515	0.2079
(BG3) Improve the SW. Q.&I.	0.1808	0.1973	0.1498	0.1706	0.1929	0.2244	0.1355
(BG4) Improve SW. Dev. Proc.	**0.1348**	**0.1027**	**0.1229**	**0.1438**	**0.2241**	**0.1185**	**0.1270**
(HLG2) Improve Cost	0.2917	0.3616	0.2791	0.3067	0.2094	0.2416	0.3410
(BG5) Increase Revenue	0.1594	0.1753	0.1473	0.1872	0.1266	0.1107	0.2052
(BG6) Decrease Cost	0.1323	0.1862	0.1318	0.1194	0.0828	0.1309	0.1358

5. Discussion

As shown in Table 4 and focusing on the BSC, the result of the FAHP analysis reveals that the Customer Perspective is the primary focus of the BSC and User Satisfaction is the most important evaluation KPI. The SLA KPI, also included in the Customer Perspective, is the second most important KPI. This means that the importance given to the Customer Perspective, which is twice as high as that of the next most important perspective, the Financial Perspective, makes clear the relationship and mutual dependence between the FSF and its customers. All of this implies that the main objective of the FSF should be focusing on the continuous improvement of the services offered to its customers to meet the customers' needs in the most efficient way. The third most important KPI is Intellectual Capital, a compendium of human, structural, and relational capital indicators concerning the value of the organization. The importance given to this indicator, included in the Learning and Growth Perspective, is that it provides evidence about the meaning of human factors in software development [75], where human capital plays a very important role [76]. The very nature of this kind of industry, which is absolutely linked to the banking sector, makes Cost Structure, a very important indicator for banks and included in the Financial Perspective of the BSC for an FSF, appear as the fourth most important KPI in this study. The Software Quality KPI is the most important in the Internal Business Processes Perspective. The importance that the software quality has on the user satisfaction [77], the most important KPI, is probably one of the factors that give Software Quality KPI a much greater weight than the other indicators included in the Internal Business Processes Perspective. Furthermore, it is necessary to emphasize the great difference in valuation between the indicators that have the highest weights and those that have the lowest; this difference in valuation reaches a factor of nine in

the most extreme cases, ranging from a weight of 0.2109 for the User Satisfaction KPI to a weight of 0.0231 for the Budgeting Error, which is the KPI with the lowest weight.

As shown in Table 5 and focusing on the strategic goals included in the strategy map, the result of the FAHP analysis reveals that the Improve Productivity HLG is the primary focus of the strategy map and Build the Necessary Software is the most important evaluation business goal. Contrary to what happens with the KPI weights, in the case of the business goals, the difference in weights among them is much less significant, ranging from a weight of 0.2043 for Build the Necessary Software to a weight of 0.1323 for Decrease Cost, which is the business goal with the least weight. The priority order of the six business goals shows that building the necessary software on time and with the expected quality and innovation is directly linked to User Satisfaction (the most important KPI) and these are the most important strategies included in the strategy map of the FSF. Finally, Table 6 shows the link weights assigned to each indicator according to the affected business strategy. These link weights are included in the new proposal of strategy map of a FSF (see Figure 8), which provides a powerful and graphical tool for controlling the company's framework and must allow the correct decision-making in the software development processes in a FSF.

In relation to the result by stakeholder roles, Figures 9 and 10 reveal that the Customer Perspective is the most important by role (Other employees being the only exception), but User Satisfaction is the best ranking KPI in all cases. The SLA indicator (also included in the Customer Perspective) is globally the second most important KPI, and is mostly one of the four most important KPIs for the different roles (Other employees is again the only exception). Intellectual Capital, the third most important KPI, is mostly one of the five most important KPI for the different role. On the other hand, as shown in Figure 11 in relation to the business strategies, there are no significant differences among the results for the different strategies by role, although the Other Employees role assign greater importance to the Improve Productivity HLG than the rest of roles, as also happens with the shareholders with the Improve Cost HLG.

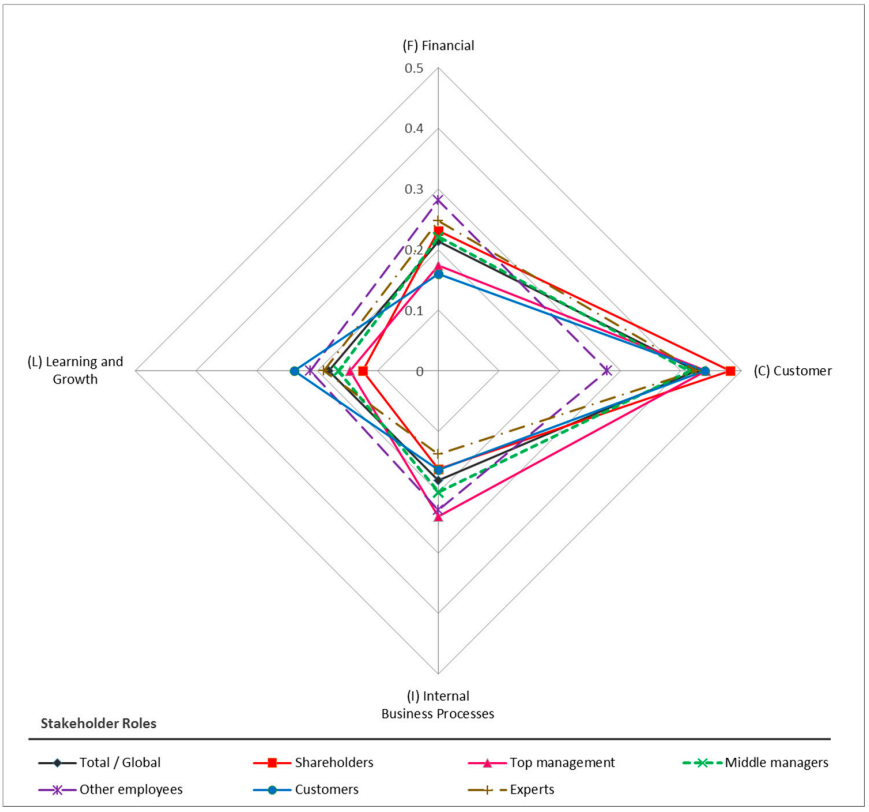

Figure 9. Perspectives weights radar graph for different stakeholder roles.

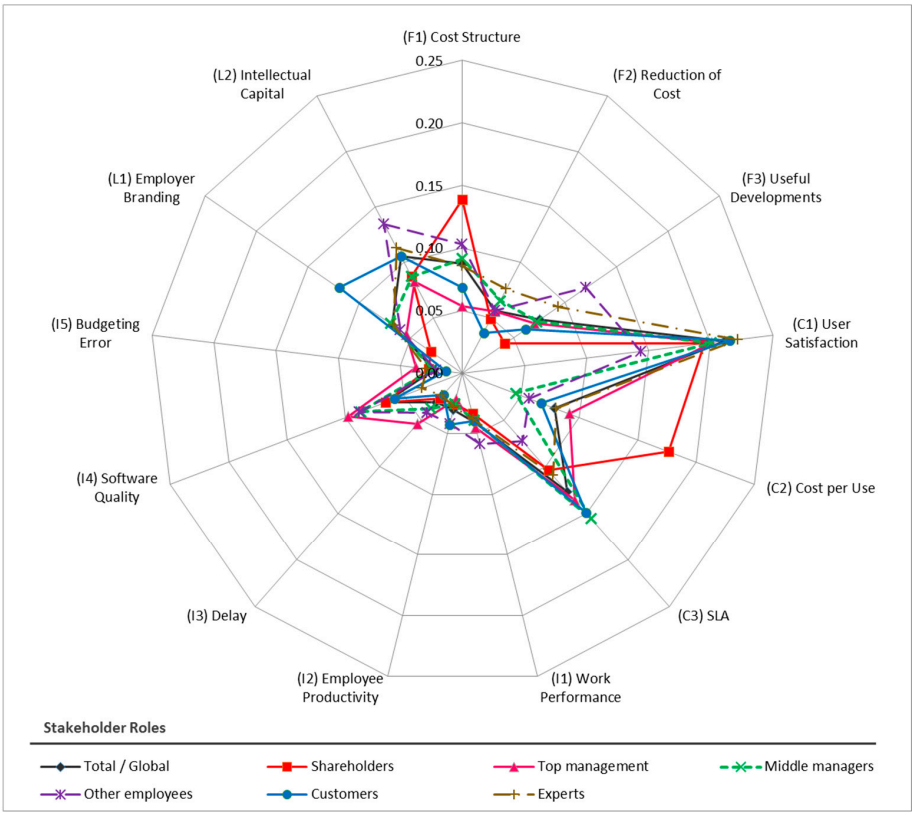

Figure 10. KPIs weights radar graph for different stakeholder roles.

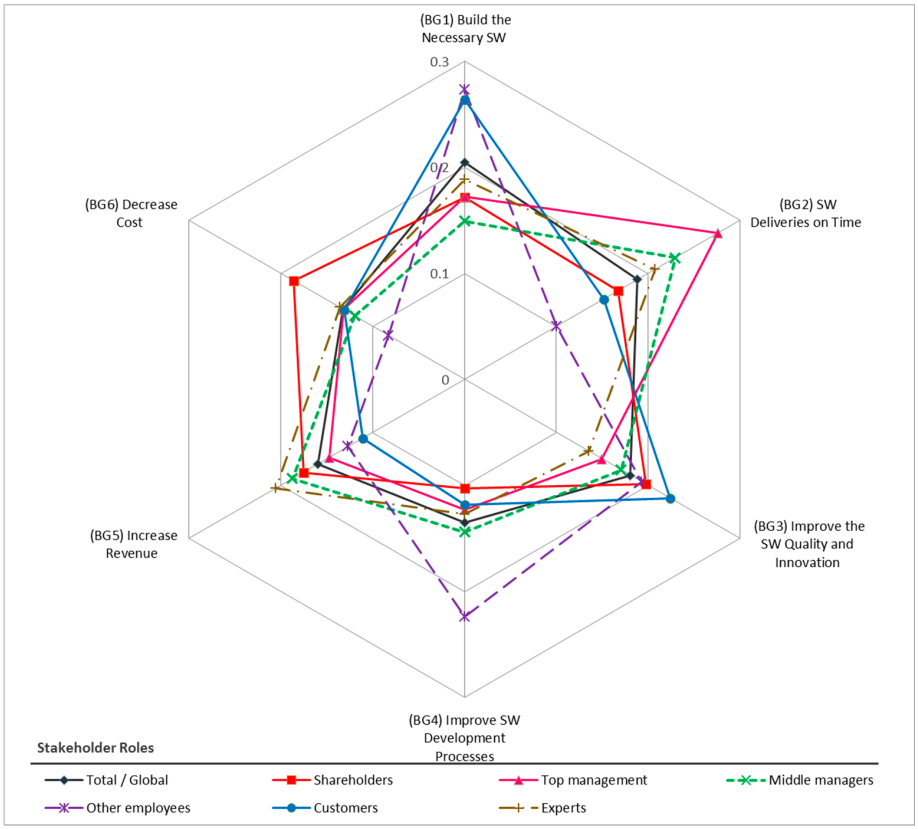

Figure 11. Business goals weights radar graph for different stakeholder roles.

6. Conclusions

The case of how a Spanish FSF involved in a corporate transformation towards sustainability has determined the weights of the KPIs and goals included in their strategy map presented here. The results enable assessing the impact that each KPI included in the BSC has on the different strategic goals defined in the strategy map of the FSF. This knowledge could be the basis for making decisions based on strategic business goals of the organization. The strategy map defines the relationships between indicators and strategic goals to achieve the mission and vision of the organization. Knowing the overall weight that each indicator and goal has in the strategy map and the links between them, it is possible to know the specific effect of each indicator according to each strategic goal. This in turn makes it possible to know the importance of each indicator in the organization's strategy map according to the perspective of the BSC in which it is included and under the influence of each different business strategy defined by the business and high-level goals.

This article shows the case study of a FSF in Spain which refocuses its business model on one based on a new strategy map to achieve the sustainability of its business. In order to know the impact of the decisions in the business sustainability, it was decided to integrate the BSC and the strategy map with FAHP to determine the value that each indicator and objective had in the FSF, according to the opinions of stakeholders and experts of software factories under the premise of achieving the mission of the organization. With the information provided by this new proposal of weighted strategy map, the FSF management can make the most appropriate strategic decisions according to the desired business goal, knowing in advance the relative impact of changes in KPI's measures for the sustainability of the FSF. Banking software faces a constantly changing landscape, so it is necessary that the FSF that develops this software can know in advance the impact of decision-making in order to take the most appropriate decision at any time according to the mission and vision of the company.

The analysis of the results obtained for each kind of stakeholder shows that each stakeholder gives more importance to those indicators or perspectives that, in theory, have a greater relation to its own role. In this sense, as presented in Table 7 and Figures 9 and 10, the shareholders give greater weight to the Financial Perspective. The employees (Top management, Middle managers and Other employees) of the software factory place greater value on the Internal Business Process Perspective. Customers are those that give less importance to the Financial Perspective, but instead they attribute great importance to the assets and image of the company that offers them services. In addition, to confirm this appreciation, User Satisfaction and SLA are the two main indicators for Customers. Furthermore, the role of Other employees differs substantially from the rest of employees, which could indicate the lack of organizational communication, related to the importance of customers for the FSF and satisfying their needs, from higher level of employees to lower levels. The importance given to Intellectual Capital, an indicator that includes human capital value, by the Other employees is the highest of all the stakeholders.

According to the analysis of the results of strategic goals, the different points of view of each kind of stakeholder were presented in Table 8 and Figure 11. The most important differences of points of view are shown for the roles of Shareholders and Other employees. Similar to what happens with the valuation of KPIs and perspectives, the Shareholders is the role who gives the highest value to the business strategies based on improving costs, and Other employees role gives the highest weight to the business strategies related to the improvement of productivity, especially with the improvement of software development processes.

This proposal was applied to the specific case of an FSF, but the methodology proposed in this paper can be applied in other types of organizations that present a framework similar to the one exposed in this paper.

Future research will aim to study the differences in criteria that can represent the different stakeholder roles when they evaluate the strategy map of a FSF, as well as the repercussions of these differences in software development performance.

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Glossary

Abbreviations	Full Forms	Meaning
BSC	Balanced scorecard	The BSC is a performance metric used in strategic planning and management system.
AHP	Analytic hierarchy process	Method used to select the best alternative among others and prioritize their relative importance.
FAHP	Fuzzy analytic hierarchy process	Method that incorporates the fuzzy theory into the AHP.
MCDM	Multicriteria decision-making	MCDM is a subdiscipline of operations research that explicitly evaluates multiple conflicting criteria in decision-making
FSF	Financial software factory	Software factory specializes in software development for the financial sector
KPI	Key performance indicator	Performance measurable value that shows how effectively a company is achieving its business objectives.
TFN	Triangular fuzzy numbers	A type of fuzzy number (fuzzy subset of real numbers which represent the expansion of the idea of a confidence interval) easy to use for its computational simplicity.
BNP	Best nonfuzzy performance	BNP is a real number obtained from the defuzzification of a fuzzy number
HLG	High-level goal	A HLG is a set of business goals that directly supports achievement of the mission and vision of the organization

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