Virtual collaboration strategic planning process using balanced scorecard and critical success factors

A Wahyudin1,*, W Widodo2, G T Dwinanda1 and R Megasari1

1Department of Computer Science Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi 229, Bandung 40154, West Java, Indonesia
2Department of Informatic Education, Universitas Negeri Jakarta, Jl. Rawamangun Muka, Jakarta Timur, Indonesia

*away@upi.edu

Abstract. The role of systems and information technology in the enterprise is to supporting operational business processes, decisions making process and implementing strategies for competitive advantage. The information system strategic planning processes required to align between business strategy and information system strategy. This research focuses on virtual collaboration that aims to harmonize business strategies and information systems strategies, especially in determining the implementation hierarchy of the proposed system up to the implementation roadmap. The method used to align business strategy and information system strategy is a combination of the balanced scorecard and critical success factors. The list of information system requirements generated continued as an implementation roadmap and then a multi-criteria decision support system with the fuzzy-ahp algorithm used to help the shortlist process. This result can be an alternative in the preparation of a collaborative implementation roadmap, taking into account the weighting of participants according to their respective perspectives. The next development of this research is building a complete virtual collaborative model in information systems strategic planning.

1. Introduction

In the implementation of information systems and information technology context, strategic information systems planning needed to produce an ideal strategy that can help to achieve the vision, mission, and targets that have been determined more effectively and efficiently in the use of existing resources. Generally, information systems strategic planning is an ongoing activity that carried out continuously that enables enterprise to set priorities in the development of information systems [1].

The process of aligning business strategy with information systems strategy is part of strategic information system planning research to find effectiveness in methods and techniques that can be applied [2]. The alignment process incriminates various parties collaboratively and needs the help of systems and technology to enable them to work simultaneously without having to meet face to face. Modern organizations change orientation in responding to the needs of information systems more quickly, flexibly, collaboratively, and participative among stakeholders [3]. Development of research intended as a fortune-teller between the strategic planning process and the determination of the implementation roadmap so that it can be faster in the process of innovation and discussion at all levels of management. Activities that have so far been paperwork-based are diverted in the development of a computer-supported collaborative planning process, this is based on changes and or
adjustments to business strategies often requiring collaborative knowledge sharing from all management involved [4].

2. Methods
The balanced scorecard is generally used as a tool to measure IT performance management event business strategy but would be good if the information systems strategic planning process uses the same language, planning time can be cut short than having to manage both fields separately [5-7].

In enhancement to the balanced scorecard, Hoshin Kanri facilitated the strategic management process because it provides a systematic framework [8,9] where the refinement process requires top-down initiatives. Research also focuses on the principles of collaborative especially the collaborative partnership approach, where meeting participants considered equal in knowledge and vision so that done collaboratively to align business strategies with information systems. The model proposed in this study combines the balanced scorecard with the critical success factors and information system needs as shown in Figure 1.

![Figure 1. The combine balanced scorecard and SCF.](image)

Related research using the Fuzzy AHP and Balanced Scorecard has also been conducted to evaluate the performance of IT departments in manufacturing companies in Taiwan [10]. The steps for the fuzzy-ahp method [11] are as follows:

- Calculate the fuzzy synthetic extent score

\[
s_i = \sum_{j=1}^{m} M_{ij} l_j \times \left[ \sum_{j=1}^{m} \sum_{i=1}^{n} M_{ij} \right]^{-1}
\]  

\[
With \sum_{j=1}^{m} M_{ij} l_j = (\sum_{j=1}^{m} l_j, \sum_{i=1}^{n} m_{ij}, \sum_{j=1}^{m} u_j)
\]

Where \( M \) = the matrix obtained from weighting, \( l \) = minimum matrix, \( m \) = Medium matrix, \( u \) = maximum matrix. Whereas to obtain the score of \( \left[ \sum_{j=1}^{m} M_{ij} l_j \right]^{-1} \), Summing operation is performed for the whole triangular fuzzy number \( fuzzy M_{ij} l_j \) \((i = 1, 2... m)\) that is,

\[
\sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij} l_j = \left( \sum_{i=1}^{n} \sum_{j=1}^{m} l_{ij}, \sum_{i=1}^{n} \sum_{j=1}^{m} m_{ij}, \sum_{i=1}^{n} \sum_{j=1}^{m} u_{ij} \right)
\]

\[
to \ be \sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij} l_j = \left( \frac{1}{\sum_{i=1}^{n} \sum_{j=1}^{m} u_{ij} \sum_{i=1}^{n} \sum_{j=1}^{m} m_{ij} \sum_{i=1}^{n} \sum_{j=1}^{m} l_{ij}} \right)
\]
- Calculates the probability level ratio for two fuzzy triangular numbers $S_1 = (l_1, m_1, u_1)$ and $S_2 = (l_2, m_2, u_2)$ with the probability level $(S_1 \succeq S_2)$ defined as follows:

$$V(S_1 \succeq S_2) = \begin{cases} 
1, & \text{if } m_1 \geq m_2 \\
0, & \text{if } m_2 \geq u_1 \\
\frac{l_2 - l_1}{(m_1 - u_1) - (m_2 - l_2)}, & \text{otherwise and more}
\end{cases} \tag{5}$$

$V$ = the result of a comparison between two triangular fuzzy numbers. The possible level of fuzzy numbers is defined as follows:

$$d'(A_i) = \min V(S_i \succeq S_k) \quad k = 1, 2, ..., n; \ k \neq i \tag{6}$$

- Calculate weight vectors. Vector weights are defined as follows

$$W' = (d'(A_1), d'(A_2), ..., d'(A_n))^T \tag{7}$$

- Normalize the weight vector. The weight vector which is still in the form of a fuzzy number is then normalized by the equation

$$d(A_i) = \frac{d'(A_i)}{\sum_{i=1}^{n} d'(A_i)} \quad \text{for } i = 1, 2, ..., n \tag{8}$$

Until $W = (d(A_1), d(A_2), ..., d(A_n))^T \tag{9}$

The list of information system requirements that have not been approved does not take into account the weight. Each meeting participant can input the weights of each criterion and sub-criteria individually, then the ranking values for the meeting members are calculated. The system will generate an average ranking of each participant and get a cumulative ranking of criteria and sub-criteria if all meeting participants have entered the criteria and sub-criteria weights.

This system providing analytical features for each participant devoting his analytical ideas in based on background and knowledge and actively participating in conducting analysis based on each viewpoint. The output generated in this application is in the form of an information system implementation roadmap generated by weighting using the fuzzy-ahp method, which each user carries out the weighting, system functional model shown in Figure 2 using use case diagram.

![Figure 2. Software functional model.](image-url)
3. Result and discussion

The limited simulations were carried out by involving four participants in Universitas Pendidikan Indonesia who were experienced in compiling an information system strategic plan as well as decision makers in each unit. The results of this activity depend on the abilities and knowledge possessed by each participant, so that the number of participants will also influence the quantity and complexity of system requirements, through collaborative patterns in this model, participants knowledge will be explored and actively contribute. The results of the analysis activities in Table 1 are examples of the results of customer perspective analysis by participant 1 in the virtual meeting simulation. After getting the data for all perspectives, weighting is done using fuzzy-ahp as in Table 2 and Table 3. Data obtained from the weighting of each participant such as the example shown in Table 2 and Table 3, performed on each participant and perspective. The fuzzy-ahp algorithm process done to determine the hierarchy and information system implementation roadmap, the stages are as follows:

- Calculates the fuzzy synthetic extent. First, calculate \( \sum_{i=1}^{n} \frac{x_{i}}{x_{j}} \) by summing each fuzzy number in each line as in equation (2). In Table 3, the data obtained for weighting criteria by the first user. The results as shown in Table 4. With equation (1) fuzzy synthetic generated as shown in Table 5.
Table 4. Results of criteria weighting scores.

| Criteria                  | Min Amount | Mid Amount | Max Amount |
|---------------------------|------------|------------|------------|
| Finance                   | 5.2500     | 7.3333     | 9.5000     |
| Customer                  | 9.0000     | 12.0000    | 15.0000    |
| Internal Business         | 1.7000     | 1.9167     | 2.3333     |
| Learning and Growth       | 3.4500     | 4.5833     | 5.8333     |

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j$$

$$\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1}$$

| Criteria                  | Min Amount | Mid Amount | Max Amount |
|---------------------------|------------|------------|------------|
| IS 1                      | 0.1607     | 0.2839     | 0.4897     |
| IS 2                      | 0.2755     | 0.4645     | 0.7732     |
| IS 3                      | 0.0520     | 0.0742     | 0.1203     |
| IS 4                      | 0.1056     | 0.1774     | 0.3007     |

Table 5. Fuzzy synthetic extend score.

Table 6. Comparative results of possible levels between fuzzy numbers.

| Criteria          | IS 1   | IS 2   | IS 3   | IS 4   | Min   |
|-------------------|--------|--------|--------|--------|-------|
| IS 1              |        | 0.5425 | 1.0000 | 1.0000 | 0.5425|
| IS 2              | 1.0000 |        | 1.0000 | 1.0000 |       |
| IS 3              | 0.0000 | 0.0000 |        | 0.1244| 0.0000|
| IS 4              | 0.5680 | 0.0806 | 1.0000 |        | 0.0806|

Table 5.

- Calculate the ratio of possible levels between fuzzy numbers. From the fuzzy score obtained in Table 5, a comparison of the possible levels between fuzzy numbers is obtained with equation (5), as shown in Table 6.

- Calculate weight vectors, by taking a minimum value from each, we obtain a weight vector for the criteria filled by the first participant:

$$W'(KU1) = (0.5425, 1.0000, 0.0000, 0.0806)$$

Table 6.

- Normalize the weight vector. The vector is normalized with equation (8) and (9) to become:

$$W(KU1) = (0.3342, 0.6161, 0.0000, 0.0497)$$

With the same calculation, the calculation results are obtained for other sub-criteria by the first participant. From the fuzzy-ahp calculation, all the results obtained by each participant are recalculated to the average in order to determine the information system implementation roadmap. The step is repeated to participants 2, 3 and 4, to get a similar score. The last step is to calculate the average of all the scores obtained to then be sorted ascending.

The sequence of steps above is done based on the combining balanced scorecard model with the critical success factor in Figure 1, while the work to facilitate participant interaction on the system, based on the functional model in Figure 2. These results can be different from other participants and will be better if there are more. The proposed model has successfully produced a list of information system requirements that can be interpreted as the needs of the organization through selected
stakeholder representatives. In Table 7, the result of the calculation of fuzzy-ahp weighting average carried out by 4 users.

| No | Title of IS Need                                      | Score  |
|----|------------------------------------------------------|--------|
| 1  | Bidikmisi Student Fraud Reporting System about Whistle Blowing System | 0.1783 |
| 2  | Scholarship Information System                       | 0.1562 |
| 3  | Registration System Registration Algorithm in the New Student Admissions System | 0.1333 |
| 4  | special PKM page about Research Information Systems  | 0.1030 |
| 5  | Training Centre System                               | 0.0951 |
| 6  | Research information system                          | 0.0488 |
| 7  | Academic Quality Management Information System        | 0.0392 |
| 8  | Infrastructure Management System                     | 0.0376 |
| 9  | Lecturer Profile Information System                  | 0.0369 |
| 10 | Intellectual Property Rights Service System          | 0.0352 |
| 11 | Management Information System for Business Management Institutions | 0.0346 |
| 12 | Lecturer Workload Information System                 | 0.0289 |
| 13 | Whistle Blowing System                               | 0.0222 |
| 14 | Staff information system                             | 0.0216 |
| 15 | Public Service System                                | 0.0158 |
| 16 | Bot System for IT Support                            | 0.0057 |
| 17 | Information System to Evaluate Teaching and Learning Activities | 0.0055 |
| 18 | Budget Management Information System                 | 0.0022 |
| 19 | Student Information System                           | 0.0000 |
| 20 | Graduated Information System                         | 0.0000 |

4. Conclusion
The combination of balanced scorecard with critical success factors can be a powerful model to be used in the process of aligning business strategies and information systems. Critical Success Factors in this research, serve as the point of reference for developing information system needs based on the objective strategy of the balanced scorecard. Therefore, the critical success factor in aligning business strategies and information systems strategy plays an important role in bringing up the list of information system requirements needed. The fuzzy-ahp algorithm is an alternative in determining the information system implementation roadmap. However, the results obtained are still some zero values generated, so it is difficult to determine which list of information system requirements should take precedence because both produce zero values. Building a complete virtual collaborative model in information systems strategic planning in future research.

Acknowledgment
We are very grateful to Department of Computer Science Education, Universitas Pendidikan Indonesia for supporting this research.

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