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Prototype system for pursuing firm's core capability

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Abstract Core capabilities are critical abilities that enhance and sustain an organization's competitive advantage in extremely competitive environments. In today's complex and dynamic business environment, companies are often prevented from effectively and efficiently evaluating relevant factors necessary for developing their core capability strategic systems. These systems, with inherent human decision-making processes, should be fully considered when creating a method for determining a firm's suitable or required core capabilities. It is helpful to implement IT-based group decision support systems (GDSS) with soft computing algorithms to assist managers in determining the appropriate core capabilities for the firm. Therefore, this study develops a holistic group decision support system in which similarity measures, fuzzy set theory, and fuzzy mathematics programming are implemented to facilitate managers in making decisions. Through evaluations done in actual cases, we have found that this system creates a flexible and user-friendly environment that aids top management and other relevant staff members in evaluating all relevant factors related to core capabilities.

Keywords Core capability · Synergy analysis · Value chain · Similarity measure · Fuzzy mathematics programming

1 Introduction

Core capabilities are critical abilities that allow organizations to sustain competitive long-run advantages. The de-

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velopment process that firms use to determine appropriate core capabilities has had a large impact on business performance (e.g., Pierce 2009; Sahlman and Haapasalo 2009; Sommer 2009). A capability is a strategically essential asset that plays a critical role in realizing the business objectives of a firm with the potential to create a competitive advantage (Barney 1991; Grant 1991). Therefore, a firm's top management invariably pursues core capabilities that should attain competitive advantage in the strategic planning process.

How a firm leverages its resources depends on how the firm's capabilities will exploit its resources (Javidan 1998). Capability is the ability to make use of resources to perform some task or activity and should be treated independently from resources (Amit and Schoemaker 1993; Hafeez et al. 2002). Additionally, capabilities are a set of differentiated skills that are deeply embedded in the organizational routines, practices, and complementary assets of a firm. They also provide the basis for the firm's capacities in a particular business (Nanda 1996; Teece and Pisano 1997).

There are several studies that link some form of the core capabilities concept with a firm's success. Successful firms build successful strategies around the notion of core capabilities (Morone 1993; Teece and Pisano 1997). Thus, developing core capabilities is an important strategic issue for firms since they play a key role in the firm's survival and growth. In addition, Walsh et al. (1996) have shown that there is a strong empirical link between core competence and long-term firm success in a single industry. Firms should be sufficiently agile so that they can develop the core capabilities necessary to strengthen and leverage their resources in order to improve performance (Zhuang and Lederer 2006). A firm's core capabilities are also able to add stakeholder value. Nonetheless, not every firm can make the best use of its resources due to weaknesses in its capabilities, even if it does have an excellent level of resources. This is especially true with the challenges of today's highly dynamic business environment. Firms now have to allocate their resources optimally, often rethinking their criteria for formulating strategies to handle problems. Thus, firms that used to focus on developing core capabilities are now confronted with the challenge of identifying, developing, protecting, and deploying resources in ways that create sustainable competitive advantage (Amit and Schoemaker 1993; Ethiraj et al. 2005). Firms are able to pursue strategic positions that allow them to utilize resources excellently. Hence, the first step in developing a firm's strategy is to identify their core capabilities.

However, there are firms that still lack the accord necessary for developing core capabilities due to the inherent complexity of the contexts and the dynamic environments with which they are confronted. Information technology (IT) is necessary to find more efficient ways of leveraging IT in order to further support firms in selecting core capability development strategies. This is particularly true in dynamic environments consisting of dynamic markets, complex organizational structures, and chaotic technological innovations. In these types of environments, information technology has become one of the critical tools for firms in taking competitive positions (Sabherwal and Sabherwal 2005; Mitchell and Zmud 2006; Smith and Sharif 2007). In addition, Andreu and Ciborra (1996) research shows that IT can contribute to core capability formation for firms and becomes an active tool for attaining competitive advantage. Thus, IT is a facilitator for enhancing dynamic capabilities (Sher and Lee 2004; Ettlie and Pavlou 2006).

Firms are usually confronted with a lack of appropriate tools to facilitate the process of determining the necessary core capabilities. There have been a number of studies proposing a holistic and completely integrated methodology (i.e. quantitative methodologies and supporting tools) that would help managers decide what core capabilities should be developed for individual firms. This may be an adequate solution for a firm using a decision support system (DSS) with an interactive, flexible, and adaptable computer-based information system that is inherently useful for improving decision-making for unstructured management problems. In addition, the use of group support systems improves decision quality, depth of analysis, equality of participation, and satisfaction over manual methods (Fjermestad 2004). It is more effective to use a group support system for communicating unshared requirements compared to face-to-face methods (Shirani 2006). The advantage of DSS is to utilize data effectively and provide an easy-to-use interface that incorporates the decision-maker's own insights (Turban 1995). DSS has been explored in several fields; namely, research and development project selection (Tian et al. 2005), portfolio selection (Lin and Hsieh 2004; Lin et al. 2005), collective memory utilization (Haseman et al. 2005), journal evaluation (Turban et al. 2004), family financial planning (Gao et al. 2007), schedule optimization (Yang 2008), and vehicle routing (Mendoza et al. 2009). However, few studies have discussed the application of DSS to the selection of core capabilities in facilitating top management in the strategic formulation process.

Given the importance of capabilities for a firm's strategy development, it is extremely important that user-friendly, efficient, and effective tools be created that allow firms to further explore and develop core capabilities. The goal of this paper is to provide an integrated and user-friendly system that will select the appropriate core capabilities for a firm by using existing decision algorithms (i.e. soft computing algorithms) and IT software systems. The integrated framework is built by taking advantage of the characteristics of some existing methods, including similarity measures, fuzzy set theory, and fuzzy mathematics programming. Furthermore, based on Turban's key concepts of DSS (Turban

1995), a system for core capability selection is developed in this study to help managers systematically and scientifically make their decisions.

The remainder of the paper is divided into the following sections. Section 2 introduces research background, including value chain, synergy analysis, gap analysis, distance and cosine similarity measures, fuzzy numbers and linguistic variables, and fuzzy mathematics programming. Section 3 designs and develops a group decision support system (GDSS) for the selection of core capabilities. In Section 4, case studies are presented to illustrate the proposed integrated approach. Finally, Section 5 concludes this study and discusses future extensions of this research.

2 Research background

In this section, the research background including such topics as value chain, synergy analysis, gap analysis, and algorithms was introduced.

2.1 Value chain

The value chain is adopted to emphasize the value-added activities in an organization's processes (Porter 1985). The value chain provides information on how the activities of a firm interact and suggests ways to analyze the firm's sources of competitive advantage. The advantage of the value chain is systematically viewing a firm's operational activities and its application in industries. However, current literature lacks a systematic view of a firm's operational activities when discussing core capability. It is therefore useful to examine the available and relevant capabilities of activities in the value chain when determining a firm's core capabilities. Hence, in the GDSS framework, the value chain is introduced to map the core capabilities of each activity.

2.2 Synergy analysis

The concept of synergy, proposed for evaluating the coherence of a firm, was an extension of the principle of manufacturing economies of scale. This principle is in response to the broader concept of economies of overhead, which resulted from the mutual sharing of overhead among functional areas of a firm's business units in the 1960s (Sherman and Rupert 2006). Tanriverdi and Venkatraman (2005) examined corporate performance effects of cross-business knowledge synergies in multi-business firms and synergies that arose from the complementary nature of product, customer, and managerial knowledge relatedness, which significantly improved both market-based and accounting-based performance for multi-business corporations. As a result, the effects of synergy can be investigated when firms use complementary resources and capabilities.

Organizational capabilities are the resources an organization has attained. The work achieved through resource utilization is regarded as the expression of organizational capabilities (Grant 1991). In addition, resource sharing may increase power and leverage in accessing and managing the drivers of cost and uniqueness within each business unit (Porter 1985; Markides and Williamson 1996). Resources must be effectively integrated and managed in order to reach synergy and provide an opportunity for the firm to create competitive advantages that can be sustained indefinitely. Hence, capability and resource redeployment are typified by the specific manner in which these scarce, valuable, and inimitable resources are combined (Li and Greenwood 2004).

According to the concept of synergy, a common capability thread is a capability factor that is common to two or more strategic business units (SBUs) or departments. Additionally, a common capability thread represents a set of complimentary capabilities (Ansoff and McDonnell 1990). Firms can attain benefits from the effects of synergy by investing in such a common capability thread.

However, sharing resources among business units also inevitably leads to additional costs. For example, excessive sharing of capabilities with other SBU managers can curtail the degree of freedom required by a manager in order to respond quickly, decisively, and effectively to the demands of the environment (Gruca et al. 1997). These costs may be small, or they may be so large that they surpass the benefits that come from sharing resources. Thus, Ansoff and McDonnell (1990) proposed synergy choice process counting for returns on investment (ROI) to consider the effect of synergy that can assist managers in deciding which capabilities should be developed.

To identify those synergy opportunities worth pursuing, managers must identify the anticipated benefits and weigh them against any coordination and compromise costs in order to arrive at the notional net synergy (Osegowitsch 2001). In this study, the investment cost, expected revenue of capabilities, and the importance ratings for each candidate's common capability thread will be assessed. The importance ratings will be used to represent the effects of synergy among capabilities in a common capability thread.

2.3 Gap analysis

Gap analysis is a process of identifying the differences between two objects by using qualitative and/or quantitative methods that can vary in complexity and sophistication from simple averages or histograms to more complex regressions. Data collection for gap analysis is done for a number of reasons, such as monitoring, data analysis, or prediction in areas such as quality (Chen and Chang 2005), marketing (Chen et al. 2005) and strategic management (Rho et al. 2001). Some studies have proposed the concept of a "knowledge gap" to describe the differences between the knowledge an organization needs to support its strategic goals and the knowledge the organization currently possesses (Lin and Tseng 2005). In this study, in determining which core capability the firm should pursue, managers should also consider the core capability gap between the level of core capability the firm will possess after developing the selected core capability, and the level of core capability the firm should possess. The level of core capability that the firm will possess after developing the selected core capability is determined by the firm's existing core capability. The level of core capability the firm should possess refers to the level necessary for a firm to survive in an industry. This level is constantly changing and is influenced by the external environment. The smaller the capability gap, the more likely the core capability enables a firm to distinguish itself, adapt, grow and achieve competitive advantage.

2.4 Algorithms

In this subsection, the distance and Cosine similarity measures, fuzzy mathematics programming, and solution procedure for solving the MOLP model were surveyed to introduce the algorithms.

2.4.1 Distance and cosine similarity measures

The similarity measure is a measure used to compare two objects and determine how they are related on observed topics. Recently, there have been several studies exploring similarity measures, in which the distance between intuitionistic fuzzy sets (Liu 2005; Wang and Xin 2005), nonlinear similarity measures Li and Ouyang (2006) and concept similarity (Guzman-Arenas and Olivares-Ceja 2006) is measured and examined.

Distance-based similarity can be measured in a number of different ways, including Euclidean Distance, Mahalanobis Distance, City Block Distance, and Minkovski Distance. In this study, Euclidean Distance is used as follows:

$$D_{\mathrm{x\,y}} = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \quad (1)$$

where n is the number of core capabilities for each candidate's common capability thread and presents the dimensionality of a capability vector space. x is an observed point, and y is a reference point in the capability vector space. In this study, we also applied the angle-based similarity measure. By its mathematical definition, the Cosine similarity measure (Chung and Lee 2004) is an angle-based or direction-based similarity measure. Direction is a fundamental characteristic in a vector space. In the Cosine measure, it is the direction of the two vectors that is used to judge the relevance between them. The Cosine similarity used in the study is as follows:

$$\cos(\vec{x}, \vec{y}) = \left(\sum_{i=1}^{n} x_i, y_i\right) \Big/ \left(\sqrt{\sum_{i=1}^{n} (x_i)^2}\sqrt{\sum_{i=1}^{n} (y_i)^2}\right) \quad (2)$$

where n is also the number of capabilities for each candidate's common capability thread and presents the dimensionality of a capability vector space. The cosine function is used to measure the similarity between the observed vector $\vec{x}$ and the reference vector $\vec{y}$ in a capability vector space. The value of the cosine function is always between −1 and 1. The value of 1 indicates that the vectors being compared point to the same direction, and the value of −1 indicates that the vectors point to the opposite direction. The more the comparing vectors tend to go in opposite directions, the less relevant or similar they are.

In the proposed system, we apply Euclidean Distance and Cosine Similarity to compare the level of core capabilities that a firm must possess for each candidate's common capability thread by using spatial distance and relative direction.

2.4.2 Fuzzy mathematics programming

In 1978, Zimmermann first introduced fuzzy set theory into a multi-objective linear programming (MOLP) problem. In relation to fuzzy programming, MOLP problems can be solved as easily as LP problems by maximizing the overall satisfactory level of compromise between objectives. The problem of determining which core capability should be developed in firms can be seen as a multi-objective decision-making problem. This involves finding the proper core capability in which gaps between the chances that they should and they would be developed if they are selected are identified. Besides, the core capability also satisfies the fact that they would have maximizing synergies on selected core capability. In this study, capability gaps are assessed by the similarity analysis, and the synergy effects are assessed by the synergy analysis. Thus, a MOLP model is constructed to simultaneously satisfy both objectives.

The MOLP model used in the proposed GDSS includes the following notations:

- r_j Unity if the jth candidate common capability thread is selected; otherwise it is 0
- n The number of capability for the jth candidate common capability thread
- m The number of candidate common capability thread
- x_{ij} The ith capability of jth observed candidate common capability thread

y_{ij} The ith capability of jth reference candidate common capability thread
R_j Return on investment for the jth candidate common capability thread
C_j Investment cost of the jth candidate common capability thread
B The total budget of the firm for selecting the candidate common capability thread
Z_1 Cosine similarity function
Z_2 Euclidean Distance similarity function
Z_3 Return on investment function

The MOLP model can then be stated as follows:

$$\text{Maximize} \quad Z_1 = \sum_{j=1}^{m} r_j \cos\left(\vec{x}_j, \vec{y}_j\right) \tag{3}$$

$$\text{Minimize} \quad Z_2 = \sum_{j=1}^{m} r_j D_{x_j y_j} \tag{4}$$

$$\text{Maximize} \quad Z_3 = \sum_{j=1}^{m} r_j R_j \tag{5}$$

$$\text{Subject to} \quad \cos\left(\vec{x}_j, \vec{y}_j\right)$$

$$= \left(\sum_{i=1}^{n} x_{ij}, y_{ij}\right) \Big/ \left(\sqrt{\sum_{i=1}^{n} \left(x_{ij}\right)^2} \sqrt{\sum_{i=1}^{n} \left(y_{ij}\right)^2}\right) \tag{6}$$

$$D_{x_j y_j} = \sqrt{\sum_{i=1}^{n} \left(x_{ij} - y_{ij}\right)^2} \tag{7}$$

$$\sum_{i=1}^{m} r_j C_j \geq B \tag{8}$$

$$r_j = 0, 1 \tag{9}$$

The objective function, Eq. 3, is to maximize the cosine coefficient. The objective function, Eq. 4, is to minimize the total Euclidean distance. Both Eqs. 3 and 4 are used to obtain the common capability thread with the highest value of similarity analysis. The objective function, Eq. 5, is to maximize the return on investment, which is used to obtain the common capability thread with the highest value of synergy analysis. Meanwhile, constraint Eq. 8 guarantees that the investment cost of the selected candidate common capability thread will not exceed the total budget of the firm. Finally, constraint Eq. 9 specifies the integrality restriction on the values of the decision variables r_j.

2.4.3 Solution procedure for solving the MOLP model

The solution procedure for solving the proposed MOLP model can be stated as follows:

Step 1: Construct the payoff table of the positive-ideal solution, as shown in Table 1. In Table 1, for the objective function Z_1, x_1^* is the feasible and optimal solution, and U_1 and L_1 are the upper and lower bounds of the solution set. For the objective function Z_2, x_2^* is the feasible and optimal solution, and U_2 and L_2 are the upper and lower bounds of the solution set. And x_3^* is the feasible and optimal solution, and U_3 and L_3 are the upper and lower bounds of the solution set for the objective function Z_3.

Step 2: Construct the membership functions $\mu_1(x)$, $\mu_2(x)$, and $\mu_3(x)$ for the three objective functions Z_1, Z_2, and Z_3 respectively by

$$\mu_1(x) = \begin{cases} 0 & \text{if} \quad Z_1 \leq L_1, \\ \frac{Z_1 - L_1}{U_1 - L_1} & \text{if} \quad L_1 < Z_1 < U_1, \\ 1 & \text{if} \quad Z_1 \geq U_1, \end{cases} \tag{10}$$

$$\mu_2(x) = \begin{cases} 1 & \text{if} \quad Z_2 \leq L_2, \\ 1 - \frac{Z_2 - L_2}{U_2 - L_2} & \text{if} \quad L_2 < Z_2 < U_2, \\ 0 & \text{if} \quad Z_2 \geq U_2, \end{cases} \tag{11}$$

$$\mu_3(x) = \begin{cases} 0 & \text{if} \quad Z_3 \leq L_3, \\ \frac{Z_3 - L_3}{U_3 - L_3} & \text{if} \quad L_3 < Z_3 < U_3, \\ 1 & \text{if} \quad Z_3 \geq U_3, \end{cases} \tag{12}$$

Step 3: Obtain the single-objective LP model by aggregating $\mu_1(x)$, $\mu_2(x)$, and $\mu_3(x)$ using the augmented max-min operator as

$$\text{Maximize} \quad \alpha + \frac{\delta(\mu_1(x) + \mu_2(x) + \mu_3(x))}{3} \tag{13}$$

$$\text{Subject to} \quad \alpha \leq \mu_1(x), \quad x \in X, \tag{14}$$

$$\alpha \leq \mu_2(x), \quad x \in X, \tag{15}$$

$$\alpha \leq \mu_3(x), \quad x \in X, \tag{16}$$

Objective function (3)–(5),
Constraints (6)–(9),

Table 1 Payoff table of positive-ideal solution

	Z_1	Z_2	Z_3	x
Max Z_1	$Z_1(x_1^*)$	$Z_2(x_1^*)$	$Z_3(x_1^*)$	x_1^*
Min Z_2	$Z_1(x_2^*)$	$Z_2(x_2^*)$	$Z_3(x_2^*)$	x_2^*
Max Z_3	$Z_1(x_3^*)$	$Z_2(x_3^*)$	$Z_3(x_3^*)$	x_3^*
	$U_1 = Z_1(x_1^*)$	$U_2 = Max\{Z_2(x_1^*), Z_2(x_3^*)\}$	$U_3 = Z_3(x_3^*)$	
	$L_1 = Min\{Z_1(x_2^*), Z_1(x_3^*)\}$	$L_2 = Z_2(x_2^*)$	$L_3 = Min\{Z_3(x_1^*), Z_3(x_2^*)\}$	

χ represents the feasible space, and α is the overall satisfactory level of compromise (to be maximized) and δ is a small positive number. A non-dominated solution is always generated when α is maximized. This is because the averaging operator used in the objective function (13) for $\mu_1(x)$, $\mu_2(x)$, and $\mu_3(x)$ is completely compensatory. Then, solve the above single-objective LP model.

3 Conceptual framework

The purpose of this study is to design and develop a GDSS to assist top management in identifying core capabilities that should be developed. A GDSS is proposed to facilitate a firms' identification of core capabilities (see Fig. 1).

Conceptually, our approach for core capabilities selection in the GDSS consists of the following processes: (i) identification of core capabilities which are determined via an electronic focus group, (ii) calculation of the ROI for each candidate's common capability thread to be developed in the SBU through the use of fuzzy sets and synergy analysis, (iii) establishment of the gap between the level of the capabilities the firm must possess for each candidate's common capability thread through the use of distance and cosine similarity measures, and (iv) establishment of a prioritized list of each candidate's common capability thread to be developed in the SBU through the use of fuzzy mathematics programming. This technique takes existing ideas and integrates them into a four-model decision process that can be easily and efficiently implemented by decision makers. Figure 2 presents the implementation procedures of the proposed framework.

3.1 System model procedure

In this section, the interactions between the actors, models, modules, and algorithms are discussed in detail. The following are the implementation procedures for each model.

1. The process enacted by Model I

   Model I is used to identify core capabilities which should be developed by the firm.

   Step 1: The GDSS facilitator uses Porter's value chain to map the core capabilities for each activity in the value chain and stores the results for different capabilities such as IT capability, technical capability, quality management, and integrated ERP. According to every SBU's internal and external business environment, electronic focus group facilitators conduct an interactive discussion and then, through the voting in every SBU, the facilitators discover the potential core capabilities and thus, decide which core capability is worthwhile of developing.

   Step 2: The GDSS facilitator inputs the results of the interactive discussion with the experts. The results are then reported back to the actors through the Reporting Module.

2. The process enacted by Model II

   Model II is used to calculate the ROI of common capability threads that should be developed in each SBU from an internal perspective.

   Step 1: The GDSS facilitator inputs the fuzzy linguistic variables obtained from top management.

   Step 2: According to internal operational performance, each top management representative gives his/her preferences for investment cost, expected revenue, and also the importance rating for each common capability thread. The importance rating represents the effects of synergy among capabilities on the expected revenues and investment cost in a common capability thread.

   Step 3: Top management confirms the results.

3. The process enacted by Model III

   From an external perspective, model III is used to identify the gap within the boundaries of the core capabilities. It is also used to determine what common capability threads should be developed.

   Step 1: Top management evaluates what the capabilities should and might be for common capability threads to be developed.

   Step 2: The GDSS facilitator begins similarity analysis to process the preference scores offered by top management and calculate Euclidean distance

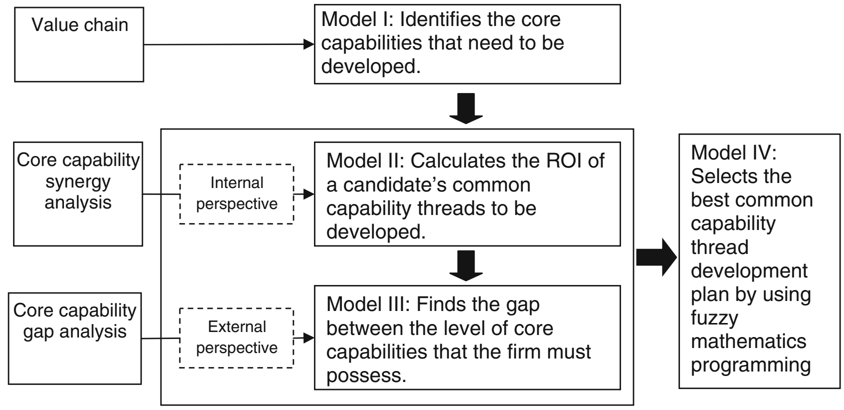

Fig. 1 A conceptual framework of this research

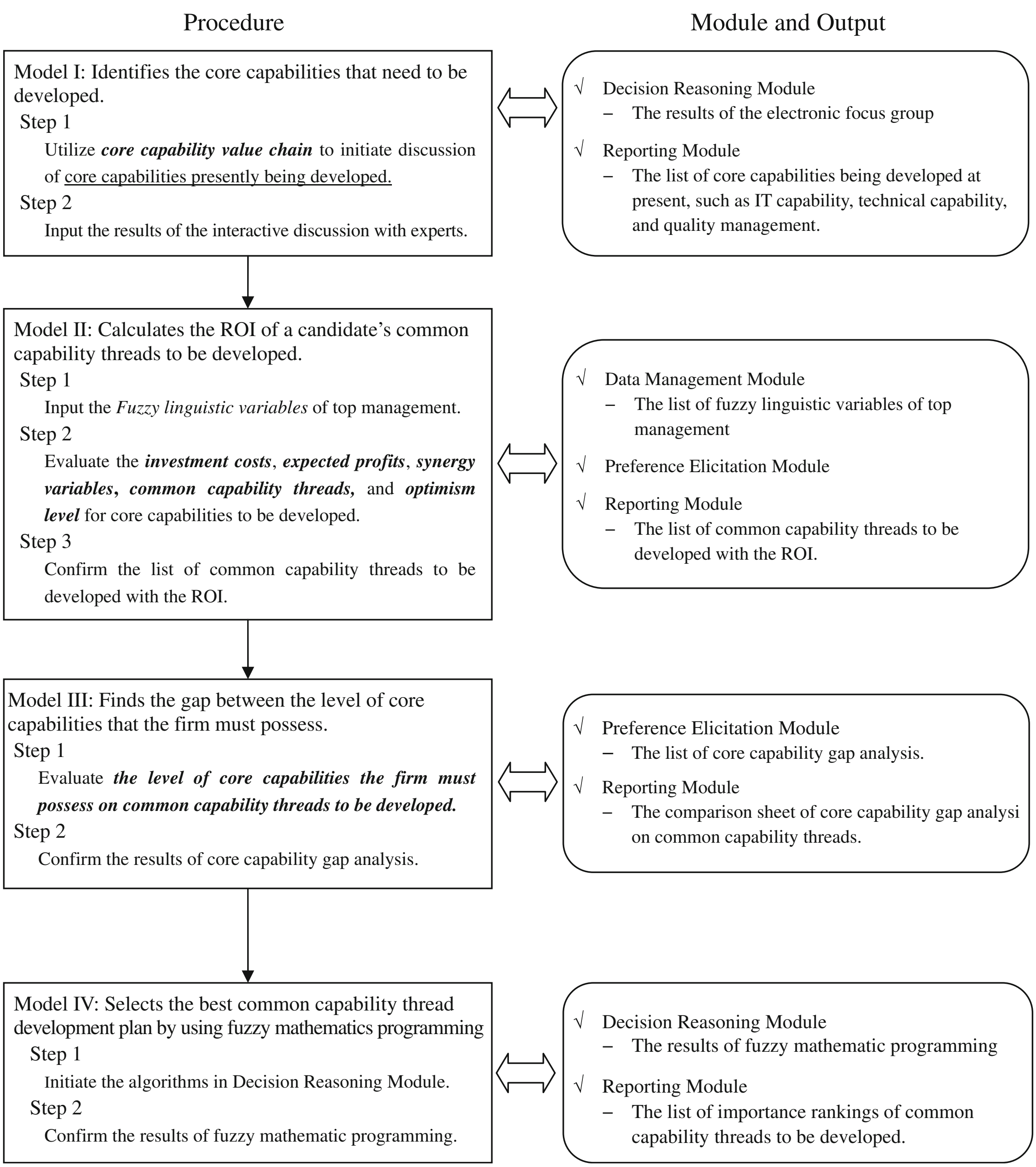

Fig. 2 The four-model process of the proposed framework

and Cosine similarity to represent the level of gap between the level of capabilities that the firm will and should possess for each common capability thread. The GDSS facilitator confirms the results.

4. The process enacted by Model IV

   Model IV is used to determine the importance ranking for common capability threads to be developed for each SBU unit.

   Step 1: The GDSS facilitator begins the fuzzy mathematics programming algorithm to calculate the importance rankings of common capability threads to be developed.

   Step 2: The GDSS facilitator confirms the results. These recommendations combined with the results of similarity analysis and synergy analysis from the internal and external perspectives are made.

3.2 Prototype system construction, test and evaluation

The prototype was run through the Windows XP™ platform. Tomcat was used as the Web server to accept the JSP request forms that were sent from client browsers. Internet Explorer 6.0 was selected as the Web browser for the client computers. Macromedia Dreamweaver™ was selected as the HTML editor for the Web site and page design. The main body of the GDSS was written by JSP language. In the GDSS, JavaScript embedded in JSP code was mainly responsible for the HTML format and data validation, and pull-down menus were used in the interface design. Once the system is built, it is necessary to test and evaluate the performance and usability of the prototype. The proposed integrated approach has been discussed with Executive Master of Business Administration (EMBA) students at National Cheng Kung University in Taiwan. These students come from various industries and are usually executives, senior managers, department managers, or other types of managers. We first selected 50 students randomly to inquire if they were willing to operate and evaluate this system, and 10 students were willing to participate in the project. Next, we presented the fundamental conceptual framework and system architecture and then detailed the procedural flows to demonstrate how it functions. Finally, the participants were required to input data and execute the system based on a certain scenario. These participants agreed that the system was an effective assessment tool that could assist them in identifying what core capabilities should be developed. However, they criticized the contents of the menus (i.e. the contents of menus for alternative strategies and domains of value chain activities) as too rough to represent practical situations. Based on these comments, we expanded the menu contents and created a new function that allowed users to select or add items to the menus. The improved flexibility of the system thus allows the users to obtain a more customized solution that matches the specialty of the firms.

4 Case study

In this section, a case study was conducted to demonstrate the application of the system in practice. To evaluate the applicability of the proposed approach, we simulated the system based on the resources that are accessible to the case company.

4.1 Case 1

This case company, established in 1972 as a textile business, has expanded into banking, construction, food, and electronics industries. The company has 1,600 employees in the textile industry and its business volume is around 6 billion NTD per year.

Due to the recent financial decline, orders of the company have dropped dramatically. This case company, combined with some difficulties in the operation of the whole corporation, has hit the bottleneck in its textile industrial development. The problem lies in the failure to integrate the operations of its subsidiaries to create synergy, and in the inability to find the gap between its core strategies both in the present and in the future. Therefore, this case firm wants to find the core capabilities that each SBU can employ to create competitive advantage, promote corporate performance, generate synergy within the enterprise, and measure the outside gap of the core capability. However, the traditional decision-making model in the company has been redundant and inefficient. Consequently, the company wants to make decisions in a much more efficient way and discover the core capability that can improve its competitiveness.

The evaluation team included the case firm's five representatives from the executive office, SBU 1: Filament, SBU 2: Yarn Dye, SBU 3: Piece Dye, and the MIS department. The representative from the MIS department acted as the GDSS facilitator.

The company's decision-making team spent 13 days to find out the core capabilities that the company should develop through the system in this study. Each SBU should develop its common capability threads with the combination of similarity analysis and synergy analysis from the internal and external perspectives. The final suggestion by the system on the common capability is shown in Table 2. According to the company's decision-making team, the average time for making decisions is approximately 28 days and the team often faces inconsistent situations in making decisions. However, through the operation in the system of this study, we can effectively shorten the decision-making time and successfully resolve inconsistent situations in making decisions. Moreover, if the company adopts the system in this study, it will better understand and value the internal and external analysis in the enterprise strategy analysis, and will know how to apply the internal and external analysis to discover the real core capability suited to the company.

4.2 Case 2

The case company is a business administration consultancy company. Each year, more than 350 enterprises are consulted and up to 60,000 people are trained. The company hires nearly 500 employees and its annual revenue exceeds 1 billion NTD. Since the company is the largest management consultancy institute in Taiwan, it hopes to maintain its current advantages. However, a great deal of prejudice exists among all levels of departments, leading to the failure to achieve the benefit of the synergy. Therefore, executives in this company actively want to find the core capabilities that each SBU can employ to promote corporate performance and achieve the synergy within the enterprise.

The evaluation team included the case firm's seven representatives from the executive office, SBU 1: Manufacturing Business Division, SBU 2: Service Business Division, SBU 3: Innovation Business Division, SBU 4: Planning and Training Division, SBU 5: Technology Service & Project Integration Business Division, and the MIS department. The representative from the MIS department acted as the GDSS facilitator.

The company's decision-making team spent 16 days in finding the core capabilities that the company should develop through the system in this study. According to the company's decision-making team, the average time for making decisions is approximately 35 days. However, through the operation in the system of this study, we can effectively shorten the decision-making time. In addition, the advice generated by this system can effectively reflect the situation in the company because this system integrates the opinions of all levels of departments, and through the internal perspective of the synergy and external perspective of the core capability gaps, and finally through the optimized computing of the computer systems. Thus, we can objectively and effectively generate the core capability that the enterprise should develop. Moreover, the case company cannot only focus on the internal synergy, but it can also simultaneously pay attention to external strategy analysis.

4.3 Case 3

The case company is a steel corporation with annual revenue of approximately 200 billion NTD. Currently, in addition to its core business of steel, the company includes a wide range of businesses such as construction, industrial materials, logistics, and investment service. However, the corporation is subjected to the influence of the external environment of enterprises. For example, the fluctuation of raw material price often influences the company's revenue. Therefore, the case firm highly values the changes in the external environment. It hopes to integrate its groups in all fields and analyze the enterprise's external core capability gap to locate the core capabilities that each SBU should develop in order to maintain its advantages.

The evaluation team included the case firm's seven representatives from the executive office, SBU 1: Steel Core Business Group, SBU 2: Construction Business Group, SBU 3: Industrial Material Group, SBU 4: Logistic Business Group, SBU 5: Investment Service Group, and the MIS department. The representative from the MIS department acted as the GDSS facilitator.

The company's decision-making team spent 21 days in finding the core capabilities that the company should develop through the system in this study. According to the company's decision-making team, the average time for making decisions is approximately 48 days. However, through the operation in the system of this study, we can effectively shorten the decision-making time. Inconsistent situations in making decisions can be successfully resolved through the assistance of the system in this study. Furthermore, the advice generated by this system can effectively reflect the current situation in the company because this system integrates different opinions from all levels of departments, and through the internal perspective of the synergy and external perspective of the core capability gap, and finally through the optimized computing of the computer system, we can generate the real core capability that the enterprise should develop. Moreover, the case company cannot only focus on the external core capability gap, but it should also simultaneously pay attention to internal synergy analysis.

4.4 Discussion of case study

In Table 3, we summarized the reason that the case company needs for developing core capability, the focus of the case company's current strategy, and the achievements by using the proposed GDSS.

In these cases, the companies all suffered problems in business operating, which was the reason that they needed to develop core capability. They can reallocate the budget for strengthening the capabilities they needed in different SBUs to effectively resolve the inconsistent situation in making decisions among all levels of departments by using the proposed GDSS, which integrates the opinions of managers via electronic focus group facilitators. In order to do so, it is able to connect to internet to use the proposed GDSS, and thus the decision-making time can be reduced by half and the situations in the companies can be reflected effectively. The above demonstration shows that this system can help a manager select and rank the priorities of common capability threads in a more timely fashion. Table 4 shows the main differences between the proposed approach and the traditional business meeting through the quantitative and qualitative comparisons.

Table 2 The result of the fuzzy mathematics programming algorithm

SBU	Common capability thread	Core capabilities	Ranking
SBU1	Common capability thread 2	Technical capability, quality management, and SCM capability	1
	Common capability thread 1	SCM capability, and IT capability	2
SBU2	Common capability thread 5	R&D capability, integrated ERP, and IT capability	1
	Common capability thread 3	R&D capability, and SCM capability	2
	Common capability thread 4	SCM capability, and integrated ERP	3
SBU3	Common capability thread 6	Technical capability, quality management, and operational capability	1
	Common capability thread 7	Operational capability, and IT capability	2

5 Conclusion

A semi-structured interview with the participants of the case firm was used to obtain their comments on the usability of the proposed GDSS. A structured questionnaire included such items as user-friendliness, practicability, reasonableness, objectivity, effectiveness, and usability of the system. These items are consistent with the evaluation of GDSS in prior research (Klapka and Pinos 2002; Lin and Hsieh 2004). Descriptive statistics revealed that a majority of the participants agreed that the proposed GDSS was conformable to the aforementioned criteria at a high level. In addition, the results of open-ended items are summarized as follows:

(i) It is a flexible, expandable, and easy-to-use core capabilities ranking tool.
(ii) Its computer-aided evaluation environment can reduce meeting time and offer the evaluators more convenience and flexibility in working location and time.
(iii) The system is supported by several sound mathematical theories and provides users with an easy-to-understand procedure and interface.

GDSS has been implemented and the results of the system evaluation show that GDSS can be applied effectively for the identification of a firms core capabilities. The computations involved in the MOLP model are tedious if performed manually. However, when using GDSS, it is an easy

Table 3 The case companies' current strategy and the achievements by using the proposed GDSS

The industry of the case company	The reason of the case company needs to develop core capability	The focus of the case company's current strategy	The achievements by using the proposed GDSS
Traditional industry (case 1)	(1) Orders of the company have drastically declined. (2) Development of its business has hit the bottleneck. (3) The inability to integrate the operation of its subsidiaries to create synergy. (4) Failure to locate the core strategy gap in the enterprise.	Internal and external analysis	(1) Decision-making time reduced from 28 days to 13 days. (2) Effectively resolve the inconsistent situation in making decisions among all levels of departments. (3) Knowing how to apply the perspective of internal and external analysis to discover the real core capability suited to the company.
Service (case 2)	(1) Maintain its current advantages. (2) A great deal of prejudice exits among all levels of departments. (3) Failure to achieve the benefit of the synergy.	Internal analysis	(1) Decision-making time reduced from 35 days to 16 days. (2) Effectively reflect the situation in the company. (3) Integrating opinions from all levels of departments. (4) The case company recognizes the significance of external strategy analysis.
Manufacturing (case 3)	(1) Subjective to the influence of external environment of enterprises (2) Hoping to integrate the company's groups in all fields.	External analysis	(1) Decision-making time reduced from 48 days to 21 days. (2) Successfully resolve the inconsistent situation in making decisions. (3) The case company recognizes the significance of internal strategy analysis.

Table 4 Main differences between the proposed model and traditional business meeting

	Quantitative		Qualitative	
	Decision-making time	Intuition	Geographical limitations	Consensus
Proposed model	Case 1: 13 days Case 2: 16 days Case 3: 21 days (i.e. faster than half of traditional business meeting)	Can be evaluated quantitatively using fuzzy linguistic variables	No	High
Traditional business meeting	Case 1: 28 days Case 2: 35 days Case 3: 48 days	Cannot be measured	Yes	Low

task and the time for core capability analysis can be significantly reduced. The benefits of using the system are briefly stated as follows:

- Core capabilities to be developed are identified through the mapping of value chain activities. Top management can be informed and assisted in the recognition of the assessment items associated with core capability development.
- The system provides an effective, systematic, and more natural way of identification through the use of the proposed MOLP model. Top management can simply use the evaluation checklist and linguistic terms to evaluate common capability threads.
- A list of prioritized common capability threads associated with strategic development will be produced. Therefore, the most proper common capability thread will be addressed first.

The development of a firm's core capabilities usually takes place in a complex, uncertain, and dynamic business environment. Researchers have suggested that more extensive strategic information systems planning in an uncertain environment would be more successful, because it would help managers understand the impact of the environment and better respond to it (Sabherwal and King 1992; Newkirk and Lederer 2006). Few studies provide the model-developing nature oriented support for managers in solving such decision-making problems. Hence, this paper presents an integrated system with a Web-based GDSS to deal with the problem. Feedback and comments collected from the pretest were used to provide a more customized solution to match the specialty of each firm. Simulation and evaluation were conducted in a field study in order to identify whether or not the GDSS achieved its designed purpose, and the results were satisfactory. The results of the evaluation strongly support the viability of this study's approach in assisting top management to select the firm's development strategy for core capabilities.

Although it is a flexible and expandable system that offers several advantages through a complete procedure for top management to determine a firm's core capability development strategy by appropriately combining both strategic planning and information technology, the experiment was only conducted in a single firm. Hence, the evaluation results may be difficult to generalize. However, this study provides a useful reference to explore the possible usage of DSS in tackling the problem of selecting core capabilities or other similar problems which require holistic processes for combining the inputs of many decision makers with different backgrounds and/or different geographic work locations and handling complicated and heterogeneous information.

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