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A Decision Model for Information Systems Outsourcing: Using a Multicriteria Method

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ABSTRACT

An ever-increasing trend in today's firms is to exploit outsourcing for those information systems (IS) functions deemed to be outside the company's core competence. Given the multi-attribute nature of IS outsourcing decision, this paper argues that five factors, including, strategy, economics, risk, environment and quality, should be considered for IS outsourcing decisions, and proposes the use of analytic hierarchy process (AHP) and improved ELECTREIII as aids in making IS outsourcing decisions. The AHP is used to analyze the structure of the outsourcing problem and determine weights of the criteria, and the improved ELECTREIII method is used for final ranking. It shows by means of an application that the hybrid method is very well suited as a decision-making tool for the IS outsourcing decision. Finally, potential issues for future research are presented.

Keywords: *Information systems outsourcing, Multiple criteria analysis, AHP, ELECTREIII*

1. Introduction

Information systems (IS) outsourcing can be defined as "a significant contribution by external vendors in the physical and/or human resources associated with the entire or specific components of the IS infrastructure in the user organization"[1]. IS outsourcing is a growing phenomenon in a wide variety of industries. According to the Gartner Group, overall spending in information technology (IT) outsourcing reached $ 177 billion in 2003, and it is predicted to rise to $ 236 billion in 2007(Oh, 2005). Yet in many cases, outsourced IS projects have failed. For example, in one study, IS managers reported only a 33% satisfaction with outsourced IS services, as compared with a satisfaction rate of 70%-80% for outsourced non-IS services [2]. Wrong IS outsourcing decision is one of critical reasons which cause the high IS outsourcing failure [3]. Therefore, the scientific IS outsourcing decision process is very important to increase the success rate of outsourcing. The problem of how to scientifically make the IS outsourcing decisions tends to be an important issue facing organizations in today's rapidly changing business environment [4].

Business practitioners recognize that IS outsourcing is one of the many tools in their toolkit to design and manage their business and potentially has a place in most strategic plans. Although there is a wealth of academic literature examining outsourcing, it generally addresses the decision whether or not to outsource: the go/no go choice. There is little academic literature that address the IS outsourcing decision in a quantitative way. This paper will apply a hybrid of analytic hierarchy process (AHP) and improved ELECTRE III methods to the "IS outsourcing decision" in an effort to demonstrate one quantitative approach to this complex decision.

The remainder of this paper is organized into five sections. Section 2 presents a brief literature review of the existing decision models related to the IS outsourcing decision. Section 3 will briefly describe the two proposed methodologies. In section 4 we argue five factors proposed as the principal criteria for outsourcing decision. In Section 5 a description of proposed methodology is followed by an application. In Section 6, we present our conclusions and future research.

2. Literature Review

A number of decision frameworks appear in academic literature to support the outsourcing decision-making process. Lacity, Willcocks and Feeny (1996) argued that deciding the outsourcing of IT activities just by strategic or commodities was fallacious and senior executives might mistakenly classify all IS activities as commodities. Therefore, they presented a 2x2 decision matrix guiding the selection of outsourcing candidates based on the business, economic, and technical factors[5].

Venkatraman (1997) viewed information technology as a portfolio of IS elements that were cost centers, service centers, investment centers and profit centers (which are collectively referred to as an IS "value centers"). His focus on "four independent sources of value from IS resource" is useful for identifying IS elements that might be considered for outsourcing [6].

Yang and Huang (2000) argued that five factors, including management, strategy, economics, technology and quality, should be considered for outsourcing decision, then they used the analytic hierarchy process (AHP) method to help users in structuring the outsourcing problems[7].

Roy and Aubert (2002) presented an IT outsourcing decision model based on the resource theory[8]. Hsu *et al* (2004) analyzed the IS outsourcing decision problems by case-based reasoning (CBR) method[9]. Aubert *et al* [2004] proposed an IT outsourcing decision model relied on transaction costs and incomplete contracts theories[10].

According to the above-mentioned literature, researchers put so many outsourcing decision strategies and determinants to practitioners, but current practice remains in the stage of conceptual discussion as to how to outsource the IS activities. Furthermore, only the AHP method offers a quantitative magnitude for judgment among these strategies and determinants. But AHP approach has the disadvantage that the number of pairwise comparisons to be made, may become very large (more specifically: n(n-1)/2). Another critical disadvantage of the AHP method is that compensation between good scores on some criteria and bad scores on other criteria can occur. Other strategies or determinants, for instance, decision matrix, transaction cost or CBR method, are too narrow to help the practitioners determine if their systems could be outsourced or to examine the priorities among many potential IS outsourcing projects. Ineffective outsourcing activities, derived from improper strategy or method, would lead to loss core competencies and capabilities, exposure to unexpected risk and business failures.

Facing the problem of how to decide the priority of those IS which have been decided to outsource, we propose a hybrid multi-criteria decision method for the IS outsourcing decision making. We shall use the AHP method to analyze the structure of the outsourcing problem and determine the weights of criteria, and use the improved ELECTRE III method for final ranking. The purpose of this work is to offer a quantitative decision model that can help practitioners set priority and reap the most benefits from outsourcing.

3. The AHP and Electre III Method

3.1. The AHP Method

The AHP, developed by Saaty (1980)[11], is a technique for considering data or information about a decision in a systematic manner [12]. The AHP mainly addresses how to solve decision problems with uncertainty and with multiple criteria characteristics. It is based on three principles: first, constructing the hierarchy; second, priority setting, and third, logical consistency.

3.1.1. Construction the hierarchy

A complex decision problem, centered round measuring contributions to an over objective or focus, is structured and decomposed into sub-problems (sub-objectives, criteria, alternatives, etc), within hierarchy.

3.1.2. Priority setting

The relative "priority" given to each element in the hierarchy is determined by comparing pairwise the contribution of each element at a lower level in terms of the criteria (or elements) with a causal relationship exists. In AHP multiple paired comparisons are based on a standardized comparison scale of nine levels (see Table 1, Saaty 1980).

Table 1. Scale of Relative Importance

Intensity of importance	Definition
1	Equal importance
2	Weak
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong or demonstrated importance
8	Very, very strong
9	Extreme importance

Let $C = \{C_j | j = 1, 2, \cdots, n\}$ be the set of criteria. The result of the pairwise comparison on n criteria can be summarized in a $(n \times n)$ evaluation matrix A in which every element a_{ij} is the quotient of weights of the criteria, as shown in (1).

$$A = (a_{ij}), (i, j = 1, \cdots, n) \qquad (1)$$

The relative priorities are given by the right eigenvector (w) corresponding to the largest eigenvector (λ_{max}), as shown in (2).

$$Aw = \lambda_{max} w \qquad (2)$$

In case the pairwise comparisons are completely consistent, the matrix A has rank 1 and $\lambda_{max} = n$. In that case, weights can be obtained by normalizing any of the rows or columns of matrix A.

The procedure described above is repeated for all subsystems in the hierarchy. In order to synthesize the various priority vectors, these vectors are weighted with the global priority of the parent criteria and synthesized. This process starts at the top of the hierarchy. As a result, the overall relative priority to be given to the lowest level elements is obtained. These overall, relative priorities indicate the degree to which the alternatives contribute to the focus. These priorities represent a synthesis of the local priorities, and reflect an evaluation process that permits to integrate the perspectives of the various stakeholders involved [13].

3.1.3. Consistency check

A measure of consistency of the given pairwise comparison is needed. The consistency is defined by the relation between the entries of A: $a_{ij} \cdot a_{jk} = a_{ik}$. The "consistency index" (CI) is given by (3).

$$CI = (\lambda_{max} - n)/(n-1) \qquad (3)$$

The final consistency ratio (CR), on the basis of which one can conclude whether the evaluations are sufficiently consistent, is calculated as the ratio of the consistency index (CI) and the random consistency index (RI), as indicated in (4). The number 0.1 is the accepted upper limit for CR. If the final consistency ratio exceeds the number, the evaluation procedure has to be repeated to improve consistency. The measurement of consistency can be used to evaluate the consistency of decision makers as well as the consistency of all the hierarchy.

$$CR=CI/RI \qquad (4)$$

3.2. The ELECTRE III Method

3.2.1. The normal ELECTRE III method

ELECTREIII method is a non-compensatory, MCDM technique. It uses various mathematical functions to indicate the degree of dominance of one alternative or group of alternatives over the remaining ones. It also facilitates comparisons between alternative schemes by assigning weights to decision criteria. The outranking relationships between alternatives are constructed and exploited eventually.

A discrete multiple criteria decision making problem is usually formulated by a set of alternatives $X=\{x_1,x_2,\cdots,x_n\}$, a set of criteria $C=\{c_1,c_2,\cdots,c_m\}$ and a set of functions $G=\{g_1,g_2,\cdots,g_m\}$. The real-valued functions defined on the set X so that $g_l(x_j)$ represents the performance of the alternative x_j on the criterion c_l. Without loss of generality we assume that all the objective functions are to be maximized.

A *pseudo-criterion* is a preference model including three different thresholds: a preference threshold $p_l(g_l(x_j))$, an indifference threshold $q_l(g_l(x_j))$ and a veto threshold $v_l(g_l(x_j))$ for each criterion $C=\{c_1,c_2,\cdots,c_m\}$. These thresholds may be constants, linear or affine functions of $g_l(x_j)$ in the form [14].

$$p_l(g_l(x_j)) = \alpha_{p,l} + \beta_{p,l}g_l(x_j)$$

and $q_l(g_l(x_j)) = \alpha_{q,l} + \beta_{q,l}g_l(x_j)$

For every criterion c_l, the preference and indifference threshold model is as follows. x_i is preferred to x_j if

$$g_l(x_i) \succ g_l(x_j) + p_l(g_l(x_j))$$

x_i is weakly preferred to x_j if

$$g_l(x_j)+q_l(g_l(x_j)) \prec g_l(x_i) \le g_l(x_j)+p_l(g_l(x_j)), \text{ and } x_i \text{ is}$$

indifferent to x_j if

$$g_l(x_j) + q_l(g_l(x_j)) \ge g_l(x_i) \text{ and}$$
$$g_l(x_i) + q_l(g_l(x_i)) \ge g_l(x_j)$$

Where $p_l(g_l(x_j))$ and $q_l(g_l(x_j))$ are preference and indifference thresholds, respectively and $p_l(g_l(x_j)) \succ q_l(g_l(x_j)) \succ 0$. Weak preference is supposed to describe the decision maker's hesitation between indifference and preference.

In ELECTRE III method, one considers an outranking degree $S(x_i, x_j)$ describing the outranking credibility of x_i over x_j taking its values between 0 and 1. The value of $S(x_i, x_j)$ is defined based on so-called concordance and discordance indices. A concordance index $C(x_i, x_j)$ is computed for each pair of alternatives (x_i, x_j) by

$$C(x_i, x_j) = \frac{1}{w}\sum_{l=1}^{m} w_l c_l(x_i, x_j) \qquad (5)$$

Where $w_l(l=1,\cdots,m)$ is the weight of each criterion, and

$$w = \sum_{l=1}^{m} w_l \qquad (6)$$

$$c_l(x_i,x_j) = \begin{cases} 1 & g_l(x_i)+q_l(g_l(x_i)) \ge g_l(x_j) \\ 0 & g_l(x_i)+p_l(g_l(x_i)) \le g_l(x_j) \\ \dfrac{p_l(g_l(x_i))+g_l(x_i)-g_l(x_j)}{p_l(g_l(x_i))-q_l(g_l(x_i))} & \text{otherwise} \end{cases} \qquad (7)$$

A discordance index $d_l(x_i, x_j)$ is defined for each criterion c_l by

$$d_l(x_i,x_j) = \begin{cases} 1 & g_l(x_i)+v_l(g_l(x_i)) \le g_l(x_j) \\ 0 & g_l(x_i)+p_l(g_l(x_i)) \ge g_l(x_j) \\ \dfrac{g_l(x_j)-g_l(x_i)-p_l(g_l(x_i))}{v_l(g_l(x_i))-p_l(g_l(x_i))} & \text{otherwise} \end{cases} \qquad (8)$$

where $p_l(g_l(x_i))$ is the preference threshold value and $v_l(g_l(x_i))$ is the veto threshold value of each c_l and $v_l(g_l(x_i)) \succ p_l(g_l(x_i))$.

Finally, the degree of outranking is defined by

$$S(x_i, x_j) = \begin{cases} C(x_i, x_j) & d_l(x_i, x_j) \le C(x_i, x_j) \quad \forall l \\ C(x_i, x_j) \bullet \displaystyle\prod_{l \in J(x_i, x_j)} \frac{1 - d_l(x_i, x_j)}{1 - C(x_i, x_j)} & J(x_i, x_j) \end{cases}$$

(9)

where $J(x_i, x_j)$ is the set of criteria for which $d_l(x_i, x_j) \succ C(x_i, x_j)$. The complete set of outranking degree is assembled as shown in the following credibility matrix S.

$$S = \begin{bmatrix} S(x_1, x_1) & S(x_1, x_2) & \cdots & S(x_1, x_n) \\ S(x_2, x_1) & S(x_2, x_2) & \cdots & S(x_2, x_n) \\ \vdots & \vdots & \vdots & \vdots \\ S(x_n, x_1) & S(x_n, x_2) & \cdots & S(x_n, x_n) \end{bmatrix}$$

(10)

The ranking of the decision alternatives in ELECTRE III is carried out by a distillation procedure, where the alternatives are ranked based on their qualification from the best to the worst (descending distillation process) and from the worst to the best (ascending distillation process).The final partial order of the alternatives is built based on these two complete orders. The descending distillation process is as follows.

Let $\lambda = \max_{x_i, x_j \in X} S(x_i, x_j)$. Determine a "credibility value" such that only values of $S(x_i, x_j)$ that are sufficiently close to λ are considered; that is, $\lambda - s(\lambda)$. Thus if $\lambda = 1$, let $s(\lambda) = 0.15$. Define the matrix T as:

$$T(x_i, x_j) = \begin{cases} 1 & \text{if } S(x_i, x_j) \succ \lambda - s(\lambda) \\ 0 & \text{otherwise} \end{cases}$$

(11)

Further, define the qualification of each alternative $- Q(x_i) -$ as the number of alternatives that are outranked by x_i minus the number of alternatives which outrank x_i. $Q(x_i)$ is simply the row minus the column sum of the matrix T. The set of alternatives having the largest qualification is the first distillate of D_1. If D_1 contains only one alternative, repeat the previous procedure with $X \setminus D_1$.Otherwise, apply the same procedure inside D_1. If distillate D_2 contains only one alternative, the procedure is started in $D_1 \setminus D_2$ (unless the set is empty); otherwise it is applied within D_2, and so on until D_1 is used up. The procedure is then repeated starting with $X \setminus D_1$. The outcome is the first preorder.

The ascending distillation is carried out in a similar fashion except that alternatives with the smallest (rather than the largest) qualification are retained first.

3.2.2. An improved ranking method for ELECTRE III
The normal ranking of ELECTRE III requires an additional threshold to be introduced. The weakness of this handing is that the ranking of the alternatives depends on the size of this threshold for which there exists no "correct" value. Additionally, the final ranking is not complete.

Aiming at the ranking problems in ELECTRE III, we present a new ranking method by introducing three definitions — concordance credibility degree, discordance credibility degree and net credibility degree, into ELECTRE III method.

Definitions
The concordance credibility degree is defined by

$$\Phi^+(x_i) = \sum_{x_j \in X} S(x_i, x_j), \quad \forall x_i \in X$$

(12)

The concordance credibility degree is the measure of the outranking character of x_i (how x_i dominates all the other alternatives of X)

The discordance credibility degree is defined by

$$\Phi^-(x_i) = \sum_{x_j \in X} S(x_j, x_i), \quad \forall x_i \in X$$

(13)

The discordance credibility degree gives the outranked character of x_i (how x_i is dominated by all the other alternatives of X)

The net credibility degree is defined by

$$\Phi(x_i) = \Phi^+(x_i) - \Phi^-(x_i), \quad \forall x_i \in X$$

(14)

The net credibility degree represents a value function, where a higher value reflects a higher attractiveness of alternative x_i.

Final ranking
All the alternatives can be completely ranked by the net credibility degree.

An application
This application is based on a real-life case study where the ELECTRE III method was use to help choose route for Dublin port motorway [15].

The first credibility matrix in [15] is as follows:

$$S_1 = \begin{bmatrix} & B2/B3 & B4 & B6 & B5/7it & B5/7bt & B5/7ht & B8 \\ B2/B3 & - & 0.625 & 0.75 & 0.875 & 0.875 & 0.875 & 0.875 \\ B4 & 0.875 & - & 1 & 1 & 1 & 0.875 & 0.875 \\ B6 & 0.875 & 1 & - & 1 & 1 & 0.875 & 0.875 \\ B5/7it & 0.875 & 0.875 & 0.875 & - & 0.875 & 0.875 & 0.875 \\ B5/7bt & 0.875 & 1 & 1 & 1 & - & 0.875 & 0.875 \\ B5/7ht & 0.75 & 0.875 & 0.875 & 0.875 & 0.875 & - & 1 \\ B8 & 0.688 & 0 & 0 & 0 & 0 & 0 & - \end{bmatrix}$$

The final ranking based on the normal method is as follows [15]:

$$\{B4, B6, B5/7bt\} \to \{B2/B3, B5/7hb\} \to \{B5/7it, B8\}$$

With S_1 and (12)-(14) leads to the final values of concordance credibility degree, discordance credibility degree and net credibility degree of alternatives in Table 2.

Table 2. Degrees of alternatives (S_1)

	Φ^+	Φ^-	Φ
B2/B3	4.875	4.938	-0.063
B4	5.625	4.375	1.25
B6	5.625	4.5	1.125
B5/7it	5.25	4.75	0.5
B5/7bt	5.625	4.625	1
B5/7ht	5.25	4.375	0.875
B8	0.688	5.375	-4.687

The final ranking based on the new method is as follows:

$$B4 \to B6 \to B5/7bt \to B5/7ht \to B5/7it$$
$$B5/7it \to B2/B3 \to B8$$

The second credibility matrix in [15] is as follows:

$$S_2 = \begin{bmatrix} & B2/B3 & B4 & B6 & B5/7it & B5/7bt & B5/7ht & B8 \\ B2/B3 & - & 0.45 & 0.61 & 0.81 & 0.81 & & \\ B4 & 0.93 & - & 1 & 1 & 1 & 0.93 & 0.93 \\ B6 & 0.93 & 1 & - & 1 & 1 & 0.93 & 0.93 \\ B5/7it & 0.93 & 0.97 & 0.97 & - & 0.97 & 0.93 & 0.93 \\ B5/7bt & 0.93 & 1 & 1 & 1 & - & 0.93 & 0.93 \\ B5/7ht & 0.75 & 0.82 & 0.82 & 0.82 & 0.82 & - & 1 \\ B8 & 0.69 & 0 & 0 & 0 & 0 & 0 & - \end{bmatrix}$$

The final ranking based on the normal method is as follows [15]:

$$\{B4, B6, B5/7it, B5/7bt\} \to B5/7ht \to B2/B3 \to B8$$

With S_2 and (12)-(14) leads to the final values of concordance credibility degree, discordance credibility degree and net credibility degree of alternatives in Table 3.

The final ranking based on the new method is as follows:

$$B4 \to B6 \to B5/7bt \to B5/7it \to B5/7ht$$
$$B5/7ht \to B2/B3 \to B8$$

From above comparison, the final ranking based on the new method is complete ranking, while the normal is partial ranking.

Table 3. Degrees of alternatives (S_2)

	Φ^+	Φ^-	Φ
B2/B3	4.29	5.16	-0.87
B4	5.79	4.24	1.55
B6	5.79	4.4	1.39
B5/7it	5.7	4.63	1.07
B5/7bt	5.79	4.6	1.19
B5/7ht	5.03	4.53	0.5
B8	0.69	5.52	-4.83

The normal ranking method of ELECTRE III suffers from the complicated ranking process, which requires an additional threshold to be introduced. The weakness of this handing is that the ranking of the alternatives depends on the size of this threshold for which there exists no "correct" value. Additionally, the normal ranking method also suffers from incomplete ranking result. Aiming at the ranking problems in ELECTRE III, the present research develops a new ranking method. Compare to the normal ranking method, the new ranking method is simple and ranking result is complete.

4. Performance Criteria

There have been a lot of attempts to find out all factors of outsourcing decision, but the problem has not been theoretically solved. The choice of factors has been selected in agreement with a group of experts and managers. Another group might have selected a somewhat different set of factors. Firms should select all factors which can affect organizations benefit as possible as they can. A careful examination of factors used before concludes that five dimensions, strategy, economics, risk, environment and quality, should be included.

4.1. Strategy

For strategy, firms need to focus on their core activities and outsource noncore activities. IS outsourcing allows management to focus available IS talent on important and strategic IT applications rather than the mundane and routine activities. The internal operations and outsourced operations should then work in unions striving to optimize flexibility and responsiveness to customer and internal needs, and minimize unnecessary paperwork and bureaucracy. In addition, the firms can make strategic alliance with vendors to make up the shortage of resources; resources include new technologies and professional workers. From strategic alliances, the firm even can develop and market new products. Other strategic consideration includes sharing risks and accelerating the time of product to market [5][7][16][17][18][19].

4.2. Economics

For economics, the major consideration of a firm is to reduce costs of information systems. Because the vendors have a better management skill as well as higher productivity per employee, the costs can be reduced. Meanwhile, Because of the scale of economics vendors have invested in the hardware, software and human resources, the cost can be reduced. Another consideration of economics is financial flexibility. Because of outsourcing, the facilities and employee would be transferred to the vendor side, which transform fixed costs into variable costs, resulting in increasing financial flexibility [7][9][20][21].

4.3. Risk

For risk, it is rare to experience opportunities in organizational life where the managerial actions taken to produce benefits are not associated with potential risks either. This is most certainly the case with IS outsourcing. The most prominent risks in outsourcing are information security concerns and loss of management control. Khalfan [2004] noted theses two factors were coupled with hidden costs in outsourcing [22].

If a labor union exists, a firm should first explore its negative effect before deciding to outsource, since outsourcing is accompanied with some possibility of layoffs. Companies often have to deal with low employee morale as a result of outsourcing, and low employee morale in turn affects productivity. It has been noted that often a large proportion of IT staff are laid off as a consequence of an outsourcing contract. This can cause a lot of disturbance in the client company.

Other risks that have to be dealt with include: loss of core competence, loss of internal technical knowledge, loss of flexibility, damaging the firm's innovative capability, increasing information services management complexity, etc [23][24]. As being the factors with benefits, these risks factors should not be ignored in outsourcing activities [25] [26].

4.4. Environment

Quinn and Hilmer [1994] indicated that environment factors such as market maturity, market depth, and the number of suppliers influences the level of outsourcing [16]. There are times when contestability explains market maturity; a contestable market means that while only a few firms can immediately provide the service now, many other firms are intending to provide the service if the price paid by the firm exceeds the average cost of vendors. In addition, the decision to outsource may be induced by imitative behavior among firms [27]. For example, Kodak's outsourcing decision made many other firms begin to consider IS outsourcing as a viable alternative [28].

4.5. Quality

For quality, because vendors may have access to more technological environments, have more qualified or more motivated personnel, provide a greater breadth of services, and simply be more committed than internal staff to making the alliance with the customer work well, outsourcing can improve the quality and services of the internal IS department. Therefore, good quality of service and good relationship are the significant success factors of outsourcing [7] [25[29].

5. An Application

Based on IS outsourcing decision problem presented in Section 1, an example is used to illustrate how the combined AHP and improved ELECTREIII model support decision maker on the IS outsourcing decision making.

5.1. The Problem Faced

A bookstore wants to outsource parts of IT functions, they think about the management and cost issues and want to know how to decide which systems should be outsourced first.

The candidate systems for outsourcing are facilities management (P1), development of internet homepage (P2), maintenance of the customer relationship management information system (P3), development of the supplier relationship management information system (P4), development and maintenance of the online transaction processing system (P5).

The leader of the task force is the vice president, while members include IS department manager, a senior engineer, business department manager, finance department manager, planning department manager and five professional consultants. The vice president convened a meeting to discuss this problem. After some discussion, they employ the hybrid of AHP and ELECTRE III methods in the decision process.
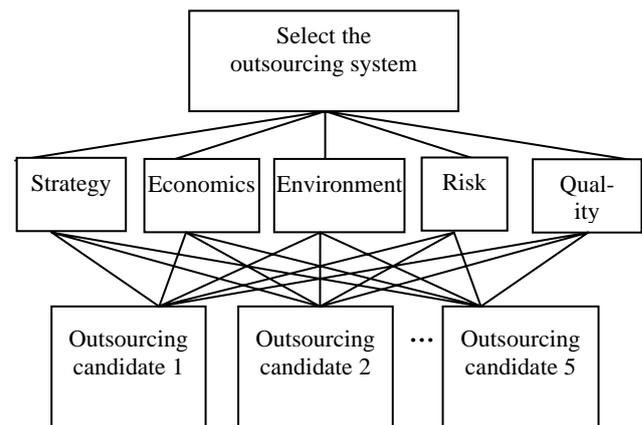
Figure 1. The Hierarchy Structure of the Problem

5.2. Structure of the Problem

After some debate, according to the AHP method, the

task force depicts a hierarchy structure as shown in Figure 1.

5.3. Determination of the Weights

Following the computing method described in the AHP, experts began to compare the factors of the structure. After that, they got the square matrix as shown in Table 4.

Table 4. The Square Matrix.
(C1- Strategy; C2- Economics; C3- Environment;C4- Risk;C5- Quality)

	C1	C2	C3	C4	C5
C1	1	3	4	2	4
C2	1/3	1	1	1/3	1
C3	1/4	1	1	1/3	1
C4	1/2	3	3	1	3
C5	1/4	1	1	1/3	1

According to (1)-(4), we got

$\lambda_{max} = 5.0394$

$RI = 1.12$

$CR = 0.0088 < 0.1$

$w = (0.41, 0.11, 0.10, 0.28, 0.10)$

5.4. Evaluation of Alternatives

All outsourcing candidates were evaluated by experts. According to the criteria of strategy, environment, risk and quality, a qualitative impact value is used, expressed on a qualitative scale (judgment on a series of ordered semantic values; each semantic value included in the set {very weak, weak, common, good, very good} is associated with a numerical value {1, 3, 5, 7, 9}, that is used for the calculations.). The economics indicator is evaluated by the following formula:

Saving costs / Costs of in house development and maintenance (%). A 5×5 matrix was produced, as shown in table 5.

Table 5. Evaluation Matrix (C1- Strategy; C2- Economics; C3- Environment;C4- Risk;C5- Quality)

Criteria	C1	C2	C3	C4	C5
Max/Min	Max	Max	Max	Min	Max
Weight	0.41	0.11	0.10	0.28	0.10
P1	9	15	9	1	9
P2	7	12	7	3	7
P3	3	8	3	7	3
P4	7	15	5	5	7
P5	7	10	7	7	5

5.5. Final Ranking

Before using the ELECTRE III method to calculate the indices, for each criterion's thresholds is defined (see table 6).

Table 6. The Thresholds of Each Criterion

	q	p	v
Strategy	2	3	8
Economics	2	4	8
Environment	2	3	4
Risk	2	3	7
Quality	2	3	6

According to (5)-(9), we get the outranking degree matrix S :

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 0.94 & 1 & 1 & 0.94 & 1 \\ 0 & 0 & 1 & 0.15 & 0 \\ 0 & 1 & 1 & 1 & 1 \\ 0.26 & 0.72 & 1 & 0.89 & 1 \end{bmatrix}$$

According to (12)-(14), we got the values of leaving, entering and net flows and the complete ranking of alternatives in table 7 and in figure 2.
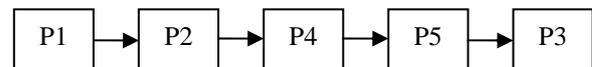
Figure 2. Final Ranking

The priorities for outsourcing the five IS are in the following order: facilities management (P1), development of internet homepage (P2), development of the supplier relationship management information system (P4), development and maintenance of the online transaction processing system (P5), maintenance of the customer relationship management information system (P3). If the bookstore want to outsource two IS activities first, we know that the facilities management and development of internet homepage would be outsourced.

Table 7. Values of Leaving, Entering and Net Flows

	Φ^+	Φ^-	Φ
P1	4	1.20	2.80
P2	3.88	2.72	1.16
P3	0.15	4	-3.85
P4	3	2.98	-0.02
P5	2.87	3	-0.13

6. Conclusions and Future Researches

IS outsourcing is emerging as a flexible and powerful

management approach chosen by managers to achieve a wide range of tactical and strategic goals. Outsourcing firms benefit from cost savings, strategic fitness, improved management effectiveness, technology upgrade, and the service quality of IS. Moreover, one needs an operational decision model that can offer systematic steps and quantitative results to increase the precision of decision-making.

This study suggests a decision model for IS outsourcing adoption for management, and shows how it may be applied in a real decision process for IS outsourcing. This research also argues that firms need to consider more dimensions, including economics, strategy, risk, environment and quality factors. Meanwhile, we offer a decision model, which developed by AHP and improved ELECTRE III methods, to help the practitioners make better decisions. Our approach allows to deal with IS outsourcing project selection involving several conflicting performance criteria (qualitative as well quantitative). The proposed decision model can help practitioners analyze factors and attributes easily. Because it is a quantitative process, the practitioners can make better decisions and obtain better results from outsourcing.

While it has successfully developed the decision model for IS outsourcing, and with most research efforts, this study is not without limitations. First, the case study just based on a small firm. Second, the AHP and ELECTRE III methods also have their own limitations; such as, in order to get more professional results, the use of more advance form of AHP method would be desirable. In addition, the determinants in the decision model are not complete. Further studies need to include additional possible factors through a more extensive literature review and empirically investigation.

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