December 2006

Where to Outsource: Using a Hybrid Multi-criteria Decision Aid Method for Selecting an Offshore Outsourcing Location

Huifen Li
Dalian University of Technology

Jianjun Wang
Dalian University of Technology

Deli Yang
Dalian University of Technology

Where to Outsource: Using a Hybrid Multi-criteria Decision Aid Method for Selecting an Offshore Outsourcing Location

Huifen Li [1,2]
1. Dalian University of Technology
Dalian, 116024, China;
2. NEUSOFT Institute of Information
Dalian, 116023, China
lihuifen@neusoft.edu.cn

Jianjun Wang
Dalian University of Technology
Dalian, 116024, China
wmeagle717@163.com

Deli Yang
Dalian University of Technology
Dalian, 116024, China
somdyang@dlut.edu.cn

ABSTRACT

As the offshoring becomes more widespread, business practitioners outsource their activities to overseas countries. Although there is a wealth of academic literature examining outsourcing and offshoring, there is little literature that addresses the current outsourcing decision most firms facing, which is where to outsource. Given multi-attribute nature of offshore location selection, this paper argues that five factors should be considered for decisions, and proposes the use of analytic hierarchy process (AHP) and PROMETHEE as aids in making offshore location selection decisions. AHP is used to analyze the structure of the location selection problem and determine weights of the criteria, and PROMETHEE method is used for final ranking, together with changing weights for a sensitivity analysis. It shows by means of an application that the hybrid method is very well suited as a decision-making tool for the offshore location selection decision. Finally, potential issues for future research are presented.

Keywords

Offshoring, location decision, multi-criteria decision, AHP, PROMETHEE, sensitivity analysis

INTRODUCTION

Despite the ongoing debate over its business benefits and risks, offshoring has become so pervasive that business practitioners cannot ignore it, and has witnessed brisk growth in recent years. Improved information technology and the globalization of labor markets have facilitated the growth of offshoring, with the market for offshoring services estimated to be ＄241 billion in 2004 and also 9% growth expected through 2006 (EDS, 2003). For many developing countries, work received from US, Japanese firms serves as an engine that encourages expansion into new industries and fuels local economic growth.

More and more business practitioners recognize that offshoring is one of the many tools in their toolkit to design and manage their business and potentially has a place in most strategic plans. While there is also a wealth of academic literature examining outsourcing and offshoring, how to outsource overseas is a current research focus. During this hot research field, vendor selection and relationship management have received much attention (Aubert et al. 1999, Chaudhury et al. 1995, Kern & Willcocks 2002, Kishore 2003, Klepper 1995, Lee and Kim 1999, Willcocks & Kern 1998), whereas little academic literature can be searched that mainly addresses the current offshoring decision most firms facing: where to outsource. In addition, there is a dearth of literature that addresses offshore outsourcing location decision making process in a quantitative way.

In this paper, we focus on where to outsource decision. It will apply APH and PROMETHEE to the research topic in an effort to demonstrate one quantitative method to this complex decision. After a review of both outsourcing decision-making and AHP, PROMETHEE literature, it argues five factors proposed as the principal criteria for offshore location decision, then a description of proposed methodology is followed by an application.

LITERATURE REVIEW

Outsourcing & Offshoring

Outsourcing is defined as when an organization uses an external company to carry out activities previously carried out within the organization.(Bailey, Masson & Raeside, 2002). Firms have always looked to find the best skills to perform business functions; depending on the specific function the best skill for the job may not be found in the firm. Offshoring is "the practice among US, European & Japanese companies of migrating business processes overseas to India, China, the Philippines, Mexico, and elsewhere to lower costs without significantly sacrificing quality." (Venkatraman, 2004). Enabled by a global economy and competition for low-cost expertise, a wide array of jobs is being outsourced outside the US. The later emergence of global capital markets pressed this trend further; now, with global skills married to global infrastructure, offshoring is readily accessible and manageable for most firms. Even small start-up firms "go global" in order to leverage cost effectiveness with regional functional competence.

Much of the academic literature of the last decade on outsourcing/offshoring considers information technology functions. This does not limit the literature's applicability to other functions that can be offshored-cost, capability, management control, and other decision criteria considered in these articles are equally applicable to other service or manufacture operations.

Outsourcing Decision Models

There have already been some researchers in the field of outsourcing decision. Lacity, Willcocks and Feeny(1996) argued that deciding the outsourcing of IS activities just by strategic or commodities is fallacious and senior executives might mistakenly classify all IS activities as commodities. Therefore, they presented a 2×2 decision matrix guiding the selection of outsourcing candidates based on the business, economic, and technical factors.

Yang and Huang develop an application of the Analytic Hierarchy Process to support the outsourcing decision based on five factors: management, strategy, economics, technology, and quality (Yang & Huang, 2000). This model addresses the question of whether to outsource, it does not consider where to outsource.

Where to Offshore

There is a paucity of academic literature that addresses the specific "where to outsource" decision; in particular the author was not able to find any quantified decision-support models that address the offshore location.

In evaluating offshore location for US-based firms, countries where English fluency is common and political risk is low should be given priority as should countries that have recognized superior skills in certain functional areas (King, 2005). Vestring et al make the argument that the country choice when offshoring should be portfolio-tized, as "every country presents a different mix of strengths and weaknesses" (Vestring, Rouse, & Reinert, 2005). Factors to consider include costs, regulatory environment, domestic markets, engineering talent, political stability, currency fluctuations, facility costs, infrastructure, and language skills.

The AHP Method

The AHP, developed by Saaty (1980), is a technique for considering data or information about a decision in a systematic manner (Schniederjans and Garvin, 1997). 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.

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.

Priority setting

The relative "priority" given to each element in the hierarchy is determined by comparing pair-wise 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)

Let $C = \{C_j \mid j = 1, 2, \ldots, n\}$ be the set of criteria. The result of the pair-wise 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).

$$A = (a_{ij}), (i, j = 1, \ldots, n) \tag{1}$$

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

$$Aw = \lambda_{\max} w \tag{2}$$

In case the pair-wise 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 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 (Macharis et al, 1997).

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

Table1. Scale of Relative Importance

Consistency Check

A measure of consistency of the given pair-wise 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).

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

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.

$$\text{CR=CI/RI} \tag{4}$$

The PROMETHEE Method

The PROMETHEE method is a multi-criteria decision making method developed by Brans et al (Brans, Vincke, 1986). It is a ranking method quite simple in conception and application compared to other methods for multi-criteria analysis. It is well adapted to problems where a finite number of alternative actions are to be ranked considering several, sometimes conflicting, criteria (Goumas and Lygerou, 2000).

The PROMETHEE method is appropriate to treat the multi-criteria problem of the following type:

$$\max\{ f_1(a), \ldots, f_n(a) | a \in A\} \tag{5}$$

where A is a finite set of possible alternatives, and f_j are n criteria to be maximized. For each alternative, $f_j(a)$ is an evaluation of this alternative. When we compare two alternatives $a, b \in A$ we must be able to express the result of these comparisons in terms of preference. We, therefore, consider a preference function P.

Let

$$P(a,b) = F(d) = F[f(a) - f(b)] \tag{6}$$

$$0 \le P(a,b) \le 1 \tag{7}$$

be the preference function associated to the criteria, where $F(d)$ is a monotonically increasing function of the observed deviation (d) between $f(a)$ and $f(b)$. In order to facilitate the selection of specific preference function, six basic types of this preference function are proposed to decision maker, in each case no more than two parameters (thresholds q, p or s) have to be fixed (Brans and Vincke, 1985).

Indifference threshold q: the largest deviation to consider as negligible on that criterion. It is a small value with respect to the scale of measurement.

Preference threshold p: the smallest deviation to consider decisive in the preference of one alternative over another. It is a large value with respect to the scale of measurement.

Gaussian threshold s: it is only used with the Gaussian preference function. It is usually fixed as an intermediate value between an indifference and a preference threshold.

PROMETHEE permits the computation of the following quantities for alternatives a and b:

$$\begin{cases} \pi(a,b) = \dfrac{\sum_{j=1}^{n} w_j P_j(a,b)}{\sum_{j=1}^{n} w_j}, \\ \phi^+(a) = \sum_{b \in A} \pi(a,b), \\ \phi^-(a) = \sum_{b \in A} \pi(b,a), \\ \phi(a) = \phi^+(a) - \phi^-(a). \end{cases} \tag{8}$$

where w_j are weights associated with criteria.

For each alternative a, belonging to the set A of alternatives, $\pi(a,b)$ is an overall preference index of a over b. The leaving flow $\phi^+(a)$ is the measure of the outranking character of a (how a dominates all the other alternatives of A). Symmetrically, the entering flow $\phi^-(a)$ gives the outranked character of a (how a is dominated by all the other alternatives of A). $\phi(a)$ represents a value function, whereby a higher value reflects a higher attractiveness of alternative a. We call $\phi(a)$ the net flow of alternative a. All the alternatives can be completely ranked (PROMETHEEII) by net flow.

The geometrical analysis for interactive aid (GAIA) plane displays graphically the relative position of the alternatives in terms of contributions to the various criteria (Brans and Vincke, 1985).

PERFORMANCE CRITERIA

When evaluating country location for offshored work, a number of criteria could be considered. There have been a lot of attempts to find out all factors of offshoring location 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 is provided in Table 2.

AN APPLICATION

Based on offshoring decision problem presented in section 1, an example is used to illustrate how the combined AHP and PROMETHEE model support decision maker on the offshoring decision-making.

The Problem Faced

Assume that an American company wants to outsource parts of its IT functions to oversea countries; they think about the factors of offshoring and want to know how to decide which country should be selected.

Infrastructure(C1)	IT infrastructure quality IT infrastructure costs Geographic distance
Country risk(C2)	Economic risk Political risk
Government policy(C3)	Tax rate Investment incentives
Human capital(C4)	Workforce size & availability Technical and language skills Compensation levels Cultural distance
Cost(C5)	Set up cost, monitoring/coordinating cost Switching cost Labor cost Trend in labor cost

Table2. Offshoring Decision Categories[a]

[a](Ngwenyama, Bryson, 1999; Vestring et al., 2005, Venkatraman, 2004; Graf & Mudambi, 2005; Weill,Subramani, Broadbent, 2002; Manrai, Lascu 1996; Mudambi, 1995; Richardson & Marshall, 1999).

Problem Hierarchy and Criteria Weights

The candidate countries for offshoring are India (P1), Mexico (P2), China (P3), Philippines(P4), Malaysia (P5). To facilitate the use of AHP, the problem can be decomposed into a multi-level hierarchy showing the overall goal of the decision process, each decision criterion to be used, and the decision alternatives to be considered as candidates for selection. For this problem the hierarchy is illustrated in Fig. 1. The overall goal is to select the optimal offshore location.

Following the computing method described in AHP, experts began to compare the factors. After that, they got the square matrix as shown in Table 3.

After computing,

$\mathrm{RI}=1.12$,

$\mathrm{CR}=0.0249<0.1$,

$w = (0.136, 0.087, 0.250, 0.128, 0.399)$.

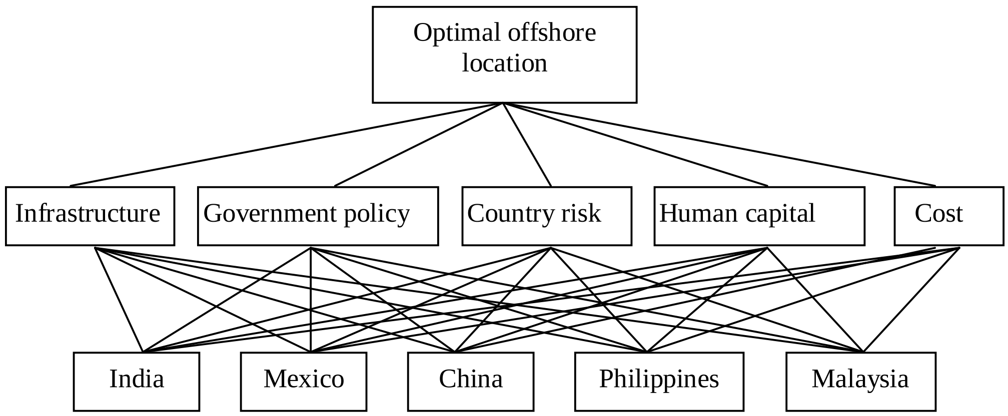

Figure1. Problem Hierarchy

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

Table3 The Square Matrix

The Problem Faced Evaluation and Analysis

The evaluations of these 5 alternatives according to the previously stated criteria, i.e. evaluation matrix, are displayed in Table 4. According to the factors, a qualitative impact value was 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, such as ranking from 1 to 5, that is used for the calculations.).

Criteria	C1	C2	C3	C4	C5
Max/Min	Max	Max	Min	Max	Min
Weight	0.136	0.087	0.250	0.128	0.399
P1	1	4	1	5	1
P2	3	2	3	3	4
P3	3	3	2	4	1
P4	2	4	4	1	2
P5	4	2	2	2	3

Table4. Evaluation Matrix

Before using the PROMETHEE method to rank the candidate systems, for each criterion, a specific Preference Function (PF), with its thresholds is defined (see Table 5).

Criteria	PF	Thresholds		
		q	*p*	*s*
C1	Level	1	2	
C2	Level	1	2	
C3	Level	1	2	
C4	U-shape	2		
C5	V-shape		2	

Table 5. Preference Functions

The problem was completely prepared for implementation of PROMETHEE II, performing the comparison with the weights gotten by the AHP method leads to the final values of leaving, entering and net flows and the complete ranking of alternatives in Table6 and in Figure 2.

The priorities for the five offshore locations are in the following order: India (P1), China (P3), Philippines (P4), Malaysia (P5), and Mexico (P2).

The decision problem can be represented in the GAIA plane (see Figure3, where candidate systems are represented by points and criteria by vectors); in this way conflicting criteria may appear clearly. Criteria vectors expressing similar preferences on the data are oriented in the same direction, while conflicting criteria are pointing in opposite directions. The length of each vector is a measure of its power in candidate systems' differentiation. We observe that cost (C5) has a high differentiation power and expresses independent preferences, different from those expressed by most of all other criteria. Two clusters of conflicting criteria (C1 and C2, C5 expressing opposite preferences) are clearly represented. It is also possible to appreciate clearly the quality of the candidate systems with respect to the different criteria. P1 and P3 are particularly good on C4 and C5. P2 and P5 are good on C1.

Alternative	Φ^+	Φ^-	Φ
P1	0.4289	0.0680	0.3609
P2	0.0170	0.4021	-0.3851
P3	0.3296	0.0000	0.3296
P4	0.1714	0.3058	-0.1344
P5	0.1321	0.3031	-0.1710

Table 6. PROMETHEE Flows

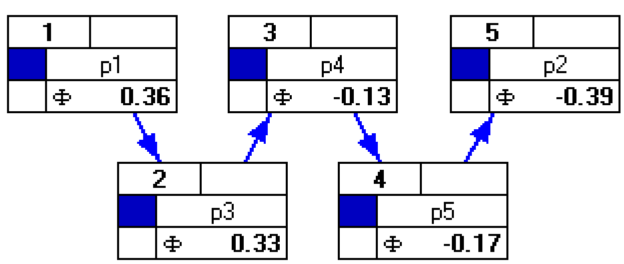

Figure2. PROMETHEE II Complete Ranking

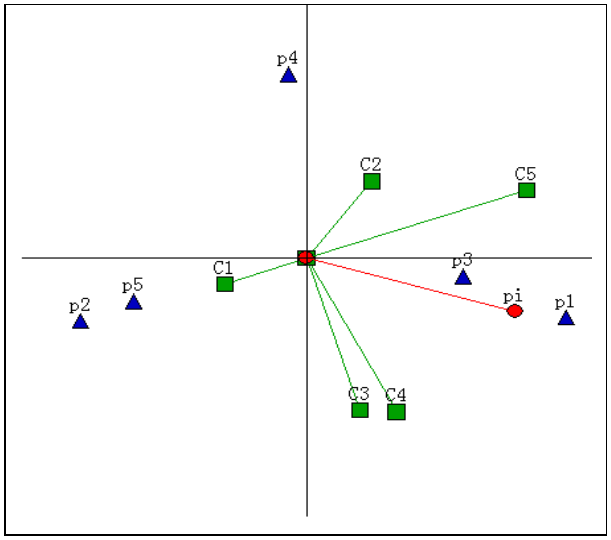

Figure3. GAIA Analysis

Vector pi ("decision axis") represents the direction of the compromise deriving from the weights assignment; the decision-maker is invited to appreciate the candidate systems located in that direction. According to the weights associated with the criteria, pi is oriented in the direction of in the direction of P1 (this is consistent with PROMETHEE II complete ranking).

The Problem Faced Sensitivity Analysis

When the weights of the criteria are modified, we have to analyze the impact on the results by a sensitivity analysis. Table 7 gives for each criterion the limits within weights' values which can vary without changing the PROMETHEE II complete ranking. From the result of sensitivity analysis, it is clear that Infrastructure (C1) and Country risk (C3) have the greatest impact on the complete ranking.

Criteria	Weight	Interval	
		Min	Max
C1	0.136	0.0000	0.1860
C2	0.087	0.0137	1.0000
C3	0.250	0.1250	0.3086
C4	0.128	0.0030	0.2745
C5	0.399	0.3404	1.0000

Table 7. Stability Intervals

CONCLUSION AND FUTURE RESEARCH

This research described herein presents a proposal for applying a decision model to support the offshoring decision-making; this model uses two multiple criteria decision aid techniques (AHP and PROMETHEE II), with more dimensions (infrastructure, country risk, government policy, value of human capital and cost) and a sensitivity analysis approach. We have tried to explain how the hybrid method, in this case, AHP/PROMETHEE II, provides powerful tools to rank candidate information systems and to analyze the relations between criteria. Our approach allows to deal with offshore location selection involving several conflicting performance criteria (qualitative as well quantitative). The proposed decision model can help practitioners choose and analyze factors and attributes easily. Because it is a quantitative process, the practitioners can make better decisions and obtain better results from offshoring.

Although the multi-criteria analysis provides a powerful tool and apparatus to answer the offshore location selection question, it is obvious that there are possibilities to use these two methods of multi-criteria analysis (AHP and PROMETHEE II) to resolve other questions, such as vendor selection, investment project selection, etc.

One possible limitation of the model concerns the multi-attribute weighting method. Weights determined by the AHP method are considered as complete subjective weights. The data envelopment analysis (DEA) method is partially based on strict optimization by linear programming, and it can be considered as an objective one. Some studies (e.g. Entani, Ichihashi, Tanaka, 2004) showed that weights could be determined by the DEA method. Weights combined objectivity with subjectivity might be much better than these just with subjectivity. This is one of directions in our future research.

REFERENCES

1. EDS, (December 17, 2003). Broad business process outsourcing portfolio helps financial services, consumer and retail industries clients integrate, streamline repeatable processes. EDS News Release (Accessed online at http://www.eds.com/news).
2. Aubert, B. A., Dussault, S., Patry, M. and Rivard, S. (1999). Managing the Risk of IT Outsourcing, *Proceedings of the 32nd Annual Hawaii International Conference on System Sciences*.
3. Chaudhury, A., Nam, K. and Rao, H. R. (1995). Management of Information Systems Outsourcing: A Bidding Perspective, *Journal of Management Information Systems*, 12, 2,131-159.
4. Kern, T., and L. Willcocks (2002). Exploring Relationships in Information Technology Outsourcing: The Interaction Approach, *European Journal of Information Systems*, 11, 3-19.
5. Kishore, R., H.R. Rao, K. Nam, S. Rajagopalan, and A. Chaudhury (2003). A Relationship Perspective on IT Outsourcing, *Communications of the ACM*, 46, 12, 87-92.
6. Klepper, R. (1995). The Management of Partnering Development in IS Outsourcing, *Journal of Information Technology*, 10, 249-258.
7. Lee, J.-N. and Kim, Y.-G. (1999). Effect of Partnership Quality on IS Outsourcing Success: Conceptual Framework and Empirical Validation, *Journal of Management Information Systems*, 15, 4, 29-61.
8. Willcocks, L. P. and Kern, T. (1998). IT Outsourcing as Strategic Partnering: The Case of the UK Inland Revenue, *European Journal of Information Systems*, 7, 1, 29-45.
9. Bailey, W., Masson, R., Raeside, R. (2002) Outsourcing in Edinburgh and the Lothians, *European Journal of Purchasing & Supply Management*, 8, 83-95.
10. Venkatraman, N.V. (2004) Offshoring without Guilt, *Sloan Management Review*, 45, 3, 14-16.
11. Lacity, M.C., Willcocks, L.P., Feeny, D.F. (1996) The value of IT sourcing, *Sloan Management Review*, 37, 3, 13-25.
12. Yang, C., Huang, J. (2000) A decision model for IS outsourcing, *International Journal of Information Management*, 20, 3, 225-239.
13. King, W.R. (2005) Outsourcing becomes more complex, *Information Systems Management*, 22, 2, 89-90.
14. Vestring, T., Rouse, T., Reinert, U. (2005) Hedge your offshoring bets, *Sloan Management Review*, 46, 3, 27-29.
15. Saaty, T.L. (1980) The analytic hierarchy process, McGraw-Hill, New York.
16. Schniederjans, M.J., Garvin, T. (1997) Using the analytic hierarchy process and multi-objective programming for the selection of cost drivers in activity-based costing, *European Journal of Operational Research*, 100, 72-80.
17. Brans, J.P., Vincke, P.h., Mareschal, B. (1986) How to select and how to rank projects: The PROMETHEE method, *European Journal of Operational Research*,24, 228-238.
18. Goumas, M., Lygerou, V. (2000) An extension of the PROMETHEE method for decision making in fuzzy environment: Ranking of alternative energy exploitation, *European Journal of Operational Research*, 123, 606-613.
19. Brans, J.P., Vincke, P.H. (1985) A preference ranking organization method, *Management Science*, 6,31, 647-656.
20. Ngwenyama, O.K., Bryson, N. (1999) Making the information systems outsourcing decision: A transaction cost approach to analyzing outsourcing decision problems, *European Journal of Operational Research*, 115, 351-367.
21. Graf, M., Mudambi, S.M. (2005) The outsourcing of IT-enabled business processes: A conceptual model of the location decision, *Journal of International Management*, 11, 253-268.
22. Weill, P.,Subramani, M., Broadbent, M.. (2002) Building IT infrastructures for strategic agility, *Sloan Management Review*, 44, 1, 57-65.
23. Manrai, L.A., Manrai, A.K., Lascu, D.N. (1996) Eastern Europe's transition to a market economy: an analysis of economic and political risk, *Journal of Euro-Marketing*, 5, 1, 29-36.
24. Mudambi, R. (1995) The MNE investment location decision: some empirical evidence, *Managerial and Decision Economics*, 16, 3, 249-257.
25. Richardson, R., Marshall, J.N. (1999) Teleservices, call centres and urban and regional development, *The Services Industry Journal*, 19, 1, 96-116.
26. Entani, T., Ichihashi, H., Tanaka, H. (2004) Evaluation method based on interval AHP and DEA, *Central European Journal of Operation Research* , 12, 25-34.