



Factors Influencing Prioritization of Hospital Services for Outsourcing: A Fuzzy Analytic Hierarchy Process Ranking Model

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Abstract

Background and Objectives: Prioritizing the services to be outsourced is a crucial challenge toward efficient outsourcing of health services. In spite of fruitful efforts in improving the outsourcing process, there still remains room and need for developing more systematic approaches. The present paper introduces a novel multi-criteria decision making model based on the fuzzy analytic hierarchy process to determine and prioritize factors highly affecting outsourcing of services in the hospital setting.

Methods: By reviewing the literature we identified 23 factors affecting selection of services to be outsourced. Out of these factors, the 17 most relevant were selected based on expert opinion, and grouped into 4 high-level domains, namely strategic/management, structural/organizational, supply/environmental, and service characteristics. A hierarchical model of the identified factors was developed and utilized to design dual comparative matrices. The collected data were analyzed and evaluated by a fuzzy hierarchical analysis approach and the weight and relative priority of each factor was determined

Findings: Cost, presence of skilled manpower, and existence of necessary substructures were identified as the highest priority considerations in outsourcing hospital services.

Conclusions: The introduced model may be used as a decision support system to enhance the robustness of prioritization when embarking upon outsourcing in the health care services setting.

Keywords: Hospital services, Outsourcing, Fuzzy Analytic Hierarchy Process (FAHP), Decision support system

Background and Objectives

Hospitals, are the largest and most costly health facilities,¹ and play a significant role in promoting health in the society and in concert with their setting of political, social and cultural milieu they can promote the society's health standards.² Not all tasks performed at a hospital are directly of clinical nature however. One approach to procuring non-clinical services in hospitals is to utilize outside sources.³ But managers embarking on this course have often encountered major impediments and objections. In observing the significance and sensitivity of such decisions, it may help to define the factors that

decision-makers must take into consideration in deciding whether a service can be outsourced or must remain to be fulfilled in-house. In fact, outsourcing itself is not the issue. Rather determining and destining those services to be outsourced is. Therefore, determining the most significant factors which affect this decision and impact level of each factor and prioritization of the task to be outsourced is essential.⁴ Determining these factors and allocating a significance coefficient to each can help managers make more reliable decisions in this regard.

At Hasheminejad Kidney Center, several non-clinical services have been considered for outsourcing over the course of the past 15 years. However, for the most part, our experiments with outsourcing were all based on managers' intuition and demands by the university. Many a time the outsourced units were not satisfied

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with the outcome. Therefore, in refining our approach it became increasingly obvious that we needed an analytical methodology for determining which services to outsource and to analyze the factors affecting the decision. This study represents our experiment in devising a decision support system to help managers by modelling the outsourcing decision process.

In this study in addition to reviewing previous studies, we drew upon expert opinion from the officials most extensively involved in quality improvement, including the chief executive officer, hospital manager and human resource director of the hospital, the deputy for education and research, and heads of department. Since decision criteria do not have the same impact on choosing various services for outsourcing, it is necessary to realistically determine the impact of each criterion through a systematic mathematical method. In this study we chose the analytical hierarchy process (AHP) to determine the weight and influence of each criterion. Although in AHP experts still put their intuition and intellectual capacity to make comparisons, it should be noted that classic analytic hierarchy process may not fully copy the mechanism of human thinking. Introducing fuzzy analysis is more in tone with the often ambiguous familiar human expressions. Thus in this study, we use fuzzy logic to render the impact of each factor.

Methods

Since plenty of factors affect outsourcing and by no means

equally, distinguishing the factors with highest impact from among all the known variables is inevitable. A number of methods and models may be applied to this choice, of which we chose the fuzzy analytic hierarchy process for this application.

Fuzzy Analytic Hierarchy Process

Fuzzy Analytic Hierarchy Process (FAHP) was first mentioned in Van Laarhoven and Pedrycz studies.¹⁴ Afterwards, other researchers have explored several other applications for FAHP in various fields. Here we resort to extension analysis as one of the most common methods of multi-criteria fuzzy analysis based on triangular fuzzy numbers and pairwise comparison; a mathematical modelling described by Chang.¹⁵

Step 1: Drawing the Hierarchy Diagram

In this study, 23 factors presumed to affect outsourcing were initially extracted through review of existing literature on the subject of outsourcing (Table 1). These 23 were subjected to expert opinion from managers and experts, to pick 17 most influential factors relevant to the hospital setting. These 17 extracted factors were grouped into 4 domains: 1-Strategic/ management (S/M), 2-Structural/ organizational (S/O), 3-Service characteristics (SC), 4-Factor associated with the suppliers and environments (S/E), were classified as shown in Figure 1. To prioritize and refine the most impactful factors further, FAHP technique was then applied. Pairwise matrices based on

Table 1. Review of Existing Literature on Factors Affecting Outsourcing

Study	Factors Affecting Outsourcing																								
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	
Yang et al ⁷	*	*	*	*	*		*																		
Almeida ⁶	*					*																			
Yang et al ⁷	*	*			*		*	*																	
Daneshi et al ⁸	*																								
Shirani et al ⁹	*			*	*		*																		
Shahidi et al ¹⁰	*	*				*		*																	
Nahavandi et al ¹¹	*		*	*	*		*		*																
Anvari et al ¹²	*	*	*	*	*	*	*	*	*																
Mo'tadel et al ¹³		*						*	*	*	*	*	*	*	*	*	*								*
Kavosi et al ¹⁴		*										*			*			*	*	*	*	*	*	*	*
Ashrafzadeh ³		*										*			*			*	*	*	*	*	*	*	*
Current research	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

F1, Cost; F2, Concentration on key capabilities; F3, Flexibility in managers; F4, Information security; F5, Management control reduction; F6, Strategic dependency; F7, Quality of the services; F8, Parallelism with the strategies of the organization; F9, Speed; F10, Demand on strategic resources; F11, Extent of Information confidentiality; F12, Complexity of task; F13, Extent of confidence in suppliers; F14, Flexibility in choice; F15, Number of suppliers; F16, Staff expertise; F17, Cost of doing exchanges; F18, Intangibility; F19, Resolution; F20, Heterogeneousness; F21, Uncertain demand; F22, Competitive position; F23, Contact with the end customer; F24, Quality of service.

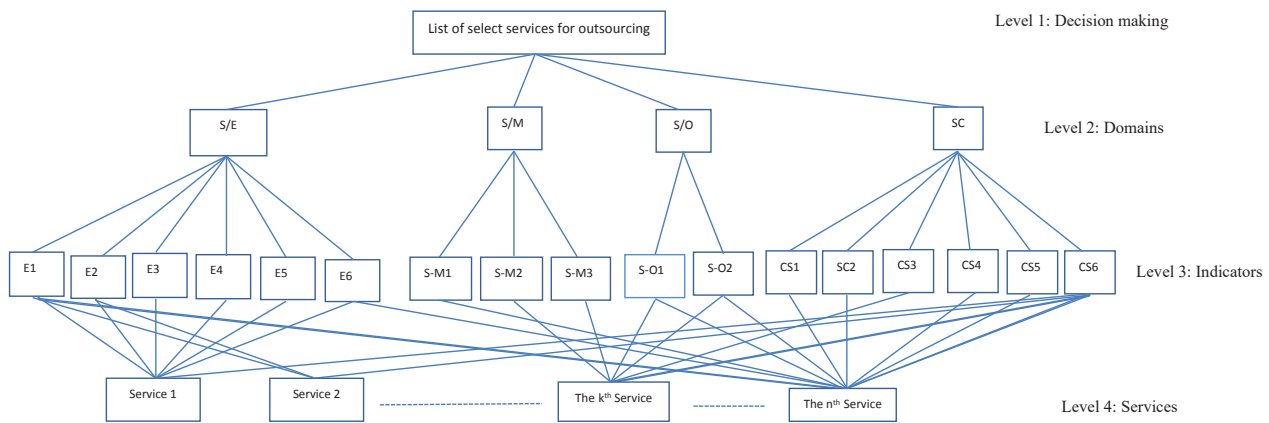


Figure 1. Analytic Hierarchy Process Factors Model Affecting Hospital Services Outsourcing.

AHP model were designed for the factors as described below:

1. Organization’s Strategic/Management Domain (S/M)
 - Sovereign Control (Management) (S-M1)*: Concern that if the organization relegates the service to others, their control over that activity shall diminish.
 - Extent of Demand on the Organization’s Strategic Resources (S-M2)*
 - Costs(S-M3)*: If service outsourcing entails reduction in cost, then that will increase tendency toward outsourcing.
2. Structural/Organizational (S/O)
 - Shortage of skilled workers (S-O1)*: the lack or shortage of skilled workers to carry out activities increases the tendency to outsourcing the service.
 - Existence of the necessary Infrastructures (S-O2)*: If the necessary infrastructures, including physical space, the required technology, etc. for a service in the organization are not enough, the tendency to outsource increases.
3. Characteristics associated with the service (CS):
 - Reduction in the quality of services (CS1)*: If service outsourcing reduces the quality of service to be followed by patient dissatisfaction, the tendency to outsourcing drops.
 - Time Saving in Service Delivery (CS2)*: In case of expedited service delivery, the tendency to outsourcing increases.
 - Independence (CS3)*: Service independence means that the mentioned service activities are independent of other services and activities within the organization, and

the more service is distinct, the more inclination will be to its outsourcing.

- Complexity (CS4)*: The more there is complexity in the service, the less there is tendency for its outsourcing.
 - Contact with the end customer (CS5)*: Tasks directly visible to the patient are less likely to be relegated.
 - Essentiality (importance) (CS6)*: Essentiality means that the mentioned service is in the direction of the strategic and main objective of the organization.
4. Environmental factors associated with suppliers (E)
 - The number of suppliers (alternative suppliers) (E1)*: The larger the number of suppliers, the more bargaining power of the organization expands and tendency to outsourcing increases.
 - Capability and Competency of Suppliers (E2)*: Stronger dependable suppliers will favor outsourcing.
 - Competitive Advantage (E3)*: The higher the competitive advantage of a service for the organization, the less propensity to its outsourcing.
 - Flexibility (E4)*: The purpose of flexibility is that if the company needs are changed, the supplier has the capability to meet the changing needs of the company in a long-term relationship.
 - Information Security (E5)*: There is certainly a substantial risk of jeopardizing the information of the organization in outsourcing.
 - Demand uncertainty (E6)*: Whether the demand extent for the appointed service is decisive and clear or not?

Table 2. Definition of Fuzzy Numbers for Pairwise Comparisons

Fuzzy Number	$\tilde{9}$	$\tilde{7}$	$\tilde{5}$	$\tilde{3}$	$\tilde{1}$	1
Definition	Absolute precedence	Very strong precedence	Strong precedence	Weak precedence	Similar	Identical
Triangular fuzzy scale	(7,9,9)	(5,7,9)	(3,5,7)	(1,3,5)	(1,1,3)	(1,1,1)

Step 2: Definition of fuzzy numbers for pairwise comparisons

Fuzzy numbers that were used in this study are shown in Table 2.

Then pairwise matrices were designed based on the criteria and hierarchical model and presented to 15 experts, and experienced managers of Hasheminejad Kidney Center.

**Step 3: Pairwise Matrix Formation Using Fuzzy Numbers
Step 4: FAHP Calculations**

An analytical model known as the extent analysis method was presented by Chang in 1992 (16). Later in 1996, he further improved his method (15). Chang’s method has been used more than any other for fuzzy hierarchical analysis calculations. The numbers used in this method are fuzzy triangular numbers. To extend AHP technique to the fuzzy space, Chang has used the concept of feasibility degree. The feasibility degree pertains to determining the possibility that one fuzzy number is larger than another one. Before presenting Chang’s proposed algorithm this concept of feasibility or the greater likelihood should be slightly elaborated.

If \tilde{M}_1, \tilde{M}_2 are 2 triangular fuzzy numbers, greatness degree of $\tilde{M}_2 = (l_2, m_2, u_2) \geq (l_1, m_1, u_1)$ is defined using the following equation.

$$\mu(d) = \begin{cases} 1 & m_2 \geq m_1 \\ \frac{u_1 - l_2}{(u_1 - m_1) - (m_2 - l_2)} & \text{otherwise} \\ 0 & l_2 \geq u_2 \end{cases}$$

The compatibility of pairwise comparison matrices in the process of hierarchical analysis is one of the most important subjects that should always be considered in the decision making process. If the incompatibility is less than 0.1, judgments are acceptable. In this study, for considering compatibility of judgments, de-fuzzing the area center before traditional hierarchical analysis relationships has been put to use.

Results and Discussion

In this study, factors affecting service outsourcing in medical care centers were identified and classified in 4 domains and prioritized using fuzzy hierarchical analysis, thus the extent of effect on outsourcing from each of these factors was determined.

Figure 2 shows strategic management factors identified to affect outsourcing and their priority scores determined by FAHP. As seen, costs gained the highest score.

Figure 3 presents the results of prioritization of structural and organizational factors potentially influencing outsourcing process. As can be seen, expert manpower has gained the highest score.

Six factors influencing outsourcing related to the service characteristics were considered by fuzzy hierarchical analysis of which the results indicate that essentiality (importance) of service holds maximum impact on the service appointed for outsourcing. Prioritizing and inclusion of weight casing for the effective factors in this area are shown in Figure 4.

Six factors related to environmental factors or associated with the suppliers were evaluated and it was observed that

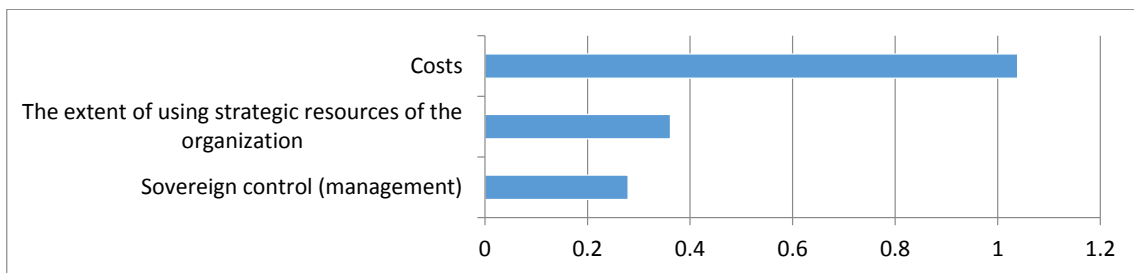


Figure 2. Outcome of Prioritizing Factors Affecting Outsourcing in the Strategic and Management Domain.

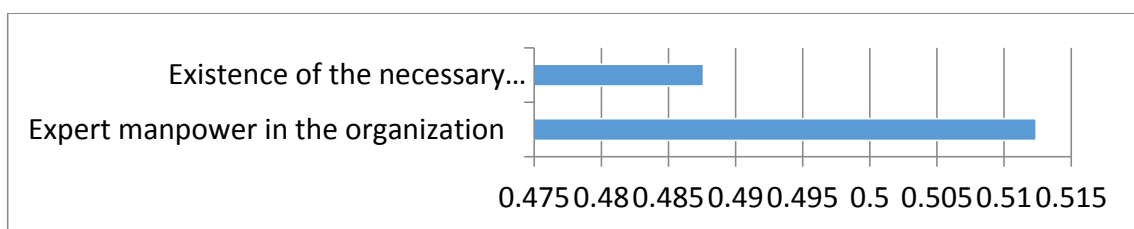


Figure 3. The Outcome of Prioritizing Factors in the Structural/Organizational Domain.

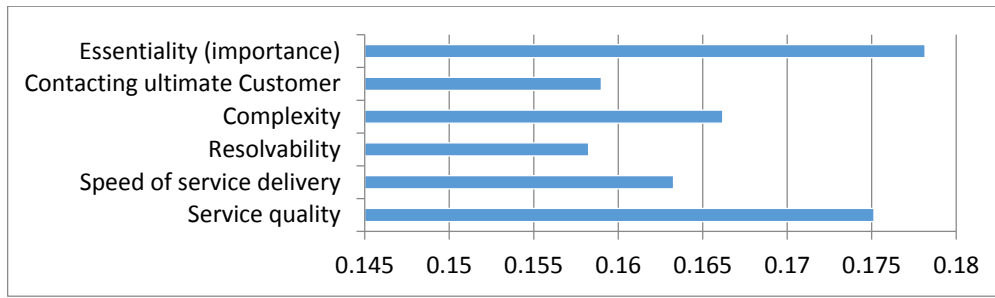


Figure 4. The Outcome of Analysis for Prioritizing Factors Regarding Outsourcing Associated With Service.

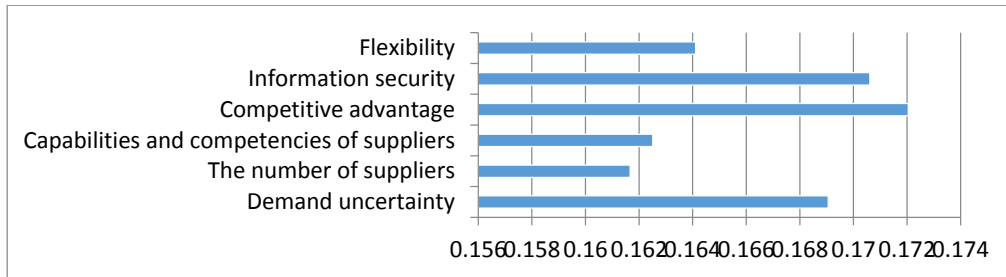


Figure 5. The Outcome of Prioritization of the Elements Affecting Outsourcing Regarding Environmental Factors and Suppliers.

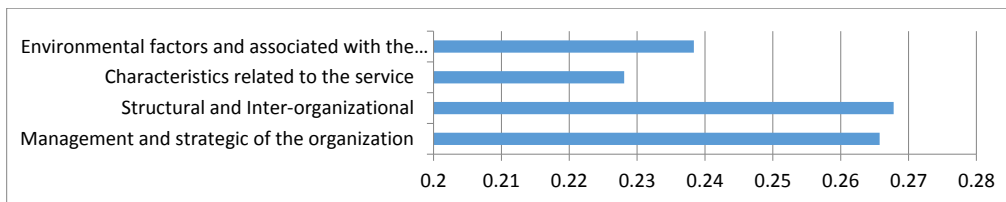


Figure 6. Cross Comparison of the 4 Major Domains of Interest.

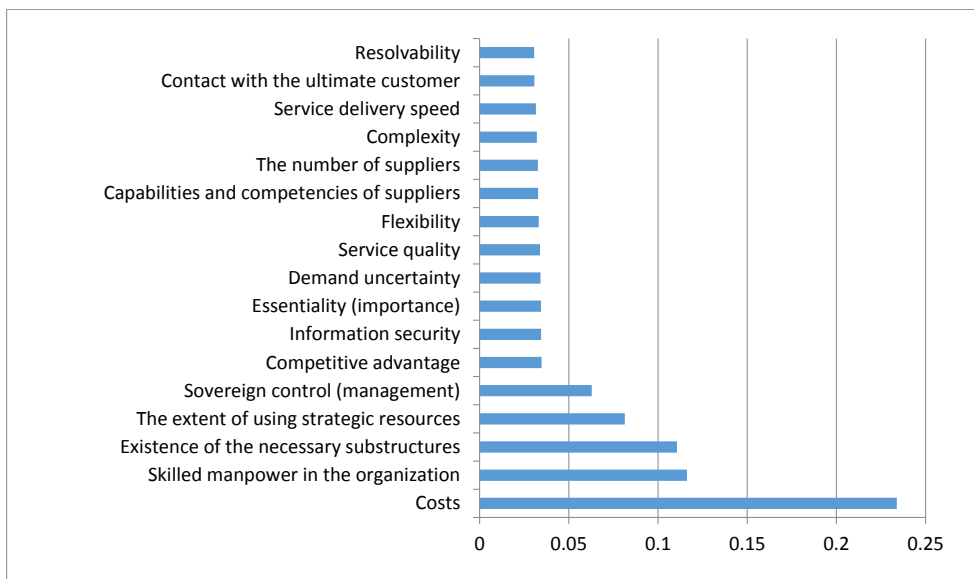


Figure 7. Final Outcome of Prioritizing and Weighting Factors Affecting Service Outsourcing in the Hospital Setting.

the competitive advantage has the maximum impact on outsourcing of the services (Figure 5).

Ultimately, the four domains were cross compared against each other to arrive at the results as shown in the following diagram (Figure 6).

By multiplying each of the effective factors by the weight of each related area, the ultimate weight is achieved and finally the obtained weights are normalized as shown in Figure 7.

As can be seen in Figure 7 above, cost containment, availability of skilled manpower in-house, existence of required substructures in the organization, load on strategic resources and sovereign control possess maximum priority and impact on deciding which services to outsource in the hospital setting. The results gained from this study can be a guide for managers in decision making for outsourcing services in hospitals and similar service organizations.

Previous studies on outsourcing services in hospitals, have ignored the impact of each factor and selection criteria have not been present in all fields (3,5,12-16). This study to our knowledge is the first to include the entire array of criteria thereby covering all aspects known to affect outsourcing. Thus both fiscal and and intra and inter organizational criteria are included in the analysis. On the other hand each of these criteria could not have the same impact on outsourcing services. In this study the fuzzy hierarchical analysis was applied to rank these factors beyond simply being expert based on personal opinion. This method ranks the factors based on paired comparisons (parameters are compared with each other pairwise). In AHP although experts use their competencies and intellectual capabilities to make their own comparisons, it should be noted that the traditional AHP is not capable of simulating human thinking style fully, thus, this study uses the fuzzy logic to determine the weight and impact of each factor.

As shown, the FAHP technique is very convenient and versatile ideally suited for such decision support. Better still as displayed in our paper, is a system of group decision in the fuzzy environment to be included in future researches.

Conclusions

Cost containment, availability of skilled manpower in-house, existence of required substructures in the organization, load on strategic resources and sovereign control possess maximum priority and impact on deciding which services to outsource in the hospital setting. The results gained from this study can be a guide for managers in decision making for outsourcing services in hospitals and similar service organizations using group decision

supported by the fuzzy analytical hierarchical process.

Authors' Contributions

The authors made equal contributions to this study.

Competing Interests

The authors declare no competing interest.

References

1. Beirami HJ, Mosazadeh Y, Janati A. Downsizing hospitals using the mechanisms of integration and outsourcing (response experts and managers of Tabriz University of medical sciences - A quality study. *Teb-E-Nezami*. 2013;15(2):133-1342. [In Persian].
2. Gholamzadehnikjo R. Designing a model of public-private partnership in governmental hospitals. *Tabriz University of Medical Sciences*; 2012. [In Persian].
3. Ashrafzadeh F. Universal model for outsourcing services. *Tadbir*. 2004;147:41-4. [In Persian].
4. Cheshmberah M. Risk management of outsourcing. *Tadbir*. 2008;17(171). [In Persian].
5. van Laarhoven PJM, Pedrycz W. A fuzzy extension of Saaty's priority theory. *Fuzzy Sets Systems*. 1983;11(1):229-241. doi:10.1016/S0165-0114(83)80082-7.
6. Almeida AT. Multicriteria decision model for outsourcing contracts selection based on utility function and ELECTRE method. *Comput Oper Res* 2007;34:3569-3574.
7. Yang D-H, Kim S, Nam C, Min J-W. Developing a decision model for business process outsourcing. *Comput Oper Res*. 2007;34(12):3769-3778. doi:10.1016/j.cor.2006.01.012.
8. Daneshi F, Delavari M, Sfandyari AA. The effects of outsourcing the company's operations and events section of Ahvaz electric power at a lower cost. 13th Conference of the electric power distribution network; Iran, Gilan; 2008. [In Persian].
9. Shirani G, nabizadeh G, Nad-e-Ali A. Outsourcing and distribution companies. 13th Conference of the electric power distribution network; Iran, Gilan; 2009. [In Persian].
10. Shahidi F, Mohammadian A, Yari A. Offer the systematic model to determine the strategic activities is capable to outsourcing. 2nd International Conference on Strategic Management; 2008. [In Persian].
11. Nahavandi N, Yousefi M, Roshani K. Determination the strategy of IT outsourcing with the Analytic Hierarchy approach: A Case Study of Iranian banks. 3rd International Conference on Strategic Management; Tehran, Iran; 2009. [In Persian].
12. Anvari A, Moshtagh H, Zare MR, Zare F. Provide the applicable decision model for a central store for determinin of Reliable outsourcing activity and choice the outsourcing strategy using hierarchical analysis process (AHP), case

- study; the company of distribution empower of Electric Shiraz. The 27th International Conference of the electric power; Tehran, Iran; 2010 [In Persian].
13. Mo'tadel MR, Afshar-Kazemi MA, Dastbaz S. A model for support of outsourcing decision of information technology projects using the method of group decision-making. *Journal of Future Studies Management*. 2011;89:1-14.
 14. Kavosi Z, Sotodehzadewh F, Kharazmi E, Khabiri R, ravangard R, Rahimi H. Check the level of willingness to outsource is based on the characteristics of different units from the perspective of hospital administrators and staff at selected hospitals. *Journal of Hospital*. 2009;11(1):9-18. [in Persian].
 15. Chang DY. Applications of the extent analysis method on fuzzy AHP. *Eur J Oper Res*. 1996;95(3):649-655. doi:10.1016/0377-2217(95)00300-2.
 16. Chang DY. Extent analysis and synthetic decision, optimization techniques and applications. World Scientific. 1992;1:352-355.

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