ORIGINAL ARTICLES

Designing a maintenance outsourcing decision making model Using Gray Relational Analysis (the Electric company as case study)

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ABSTRACT

Organizations around the world are looking for new approaches to maintain or develop competitive advantage. Outsourcing can be such an approach and one of the strategies that can lead to greater competitiveness. maintain and develop core competences as a way of providing barriers to protect against present and future competitors; make full use of external capabilities, innovation and investment; and finally, provide better service, quality and cost to the customer. In this study we determined variables and factors involved in maintenance outsourcing decision making and developed a generic model for the maintenance outsourcing process in base on BSC strategic model. then the proposed model has been tested in a electric company by the use of gray theory in order to determine that the organization do complete outsourcing, outsourcing with non-decisions or don't do the outsourcing

Key words: Outsourcing, maintenance outsourcing, gray relation analysis, balance score card.

Introduction

Organizations around the world are looking for new approaches to maintain or develop competitive advantage. Outsourcing can be such an approach and one of the strategies that can lead to greater competitiveness (Embleton & Wright, 1998).

Outsourcing focuses on two strategic ways of developing a competitive advantage: first, concentrating the organization's resources and investments on what it does best – called core competences; and second, outsourcing all other activities for which the company has neither a strategic need nor a special capability. Outsourcing allows companies to maximize the return on their internal resources and it can be an effective way to reduce costs, free-up capital and improve quality and service (Campbell, 1995).

The advantages in outsourcing can be operational, strategic, or both (Rajabzadeh & Anvary Rostamy, 2008). Outsourcing can be defined as a "managed process of transferring activities to be performed by others" (Bertolini *et al*., 2004).

It denotes the shift that occurs when a business entity takes work traditionally performed internally and contracts with an external provider for the provision of that work (EIU/AA, 1995).

According to Quinn (1992) and Sharpe (1997), outsourcing is a form of predetermined external provision with another enterprise for the delivery of goods and/or services that could previously have been offered in-house (Quinn, 1992), (Sharpe, 1997).

The outsourcing process is including of:

(1) Does outsourcing make sense?
(2) Are your objectives achievable?
(3) Is the organization ready?
(4) What are the outsourcing alternatives?
(5) How is the request for the outsourcing proposal structured?
(6) What are the negotiating tactics? (Campbell, 1995).

Prior to starting the outsourcing program the company should objectively evaluate its actual situation with respect to some critical issues. Doing so, a significant picture of the overall ability to manage the outsourcing program could be drawn and, at the same time, the company's readiness to outsource maintenance activities could be somehow quantified (Rajabzadeh & Anvary Rostamy, 2008). A company's readiness can be assessed based on a number of factors (Campbell, 1995).

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Maintain and develop core competences as a way of providing barriers to protect against present and future competitors; make full use of external capabilities, innovation and investment; and finally, provide better service, quality and cost to the customer (Bertolini *et al.*, 2004).

Where capacity and precision of equipment are critical, companies have begun to look at outsourcing their maintenance activities. Some companies, outsourced all its equipment maintenance, achieving a more effective use of the maintenance budget and a reduction of downtime, thus increasing overall efficiency (Sleigh, 1989).

Overview:

Kant Rao and Richard R. Young (1994) examined the attitudes of shippers and service providers towards outsourcing of logistics functions performed within large multinational, manufacturing companies engaged in global trade. Based on case studies, they presented a conceptual model indicating the factors which influence outsourcing or single sourcing decisions (Rao &Young, 1994).

Lieb's (1992) survey indicated that about one-third of large manufacturing companies in the US use third-party logistics services and over 60 per cent of these firms have utilized these services for more than five years. The three most widely outsourced services were warehousing, shipment consolidation, and selected logistics information systems. All three activities are important in the context of international logistics as well and their study indicates that, due to its critical role, information systems can also influence the outsourcing decision itself (Lieb, 1992).

Hassanain and Al-Saadi (2005) provided a framework for outsourcing asset management services especially for municipal organizations. Their framework consists of five sequential processes that a number of supporting activities have been defined for each of them. Moreover, they have proposed some main advantage and disadvantages for outsourcing and provided some key strategies for achieving a successful outsourcing in municipal infrastructure (Hassanain & Al-Saadi, 2005).

John D. Campbell (1995) determined The six-step approach that provides a framework to outsource in a systematic way, addressing the key issues around objectives, readiness, alternatives, proposals and negotiations. This six steps are as follow:

1.Is outsourcing a viable alternative to self provision?
2. Are the objectives achievable through outsourcing?
3. Is the organization ready to use outsourcing?
4.Evaluate outsourcing alternatives by function.
5.Request for proposal to outsourcing supplier.
6.vendor selection and agreement negotiation.

Also he assess that Although not without some risk, those organizations that have embraced outsourcing maintenance activities in a strategic manner have been able to focus their efforts more at providing higher value to their customers (Campbell, 1995).

Kant Rao and Richard R. Young (1994) examined the attitudes of shippers and service providers towards outsourcing of logistics functions performed within large multinational, manufacturing companies engaged in global trade. Based on case studies they presented a conceptual model that indicating the factors which influence outsourcing or single sourcing decisions. This factor determined as follow:

- Centrality
- Information technology
- Cost and service
- Risk and control
- Market relations

The research also suggests that the above factors are influenced by drivers: sets of variables from a firm's operating profile. The key drivers are:

- network complexity;
- process complexity;
- product complexity (Rao &Young, 1994).

Bertolini & *et al*. (2004) experience dealing with the analysis of maintenance outsourcing by means of multi-criteria decision methods (MCDM) is reported. In their paper the proposed methodology has been tested on an industrial case study dealing with an important Italian brickwork. This application shows how the AHP is able to support the choice of the correct level of the maintenance activities outsourcing. In particular, the hierarchic decisional structure developed represents an instrument able to give a well balanced synthesis of several different factors that must be taken into account during this type of decision problem.

This factors are consist of:

- increase labor productivity;
- reduce maintenance costs;
- focus in-house personnel on "core" activities;

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- reduce management effort;
- obtain specialist skills not available in-house;
- level fluctuations in workload;
- increase access to specialist equipment;
- improve equipment uptime/performance;
- reduce risk;
- improve labor productivity;
- improve work quality;
- reduce influence of trade unions;
- improve environmental performance; and
- keep pace with rapidly changing technology (Bertolini *et al*., 2004)

Ali Rajabzadeh & *et al*. determine the effective factors involved in out sourcing process and their priorities that was conducted in the Ministry of Economic Affairs and Finance of Iran.. The purpose of this paper is to describe the outsourcing process in the public sector. The aim is to develop a generic conceptual model for the outsourcing process in public sectors by conducting binominal and Friedman tests. The model consists of the following steps and components:

- considering the organization's basic activities,
- evaluation of organizations' existing potentials and analyzing organizational processes,

studying general outsourcing patterns,

- implementing and monitoring outsourcing process in terms of some critical success factors,
- evaluation of outsourcing process of the organization and identifying feedbacks.

They Found the main components and influence factors involving in the process of outsourcing in public sectors that are as follow:

- Cost reduction
- Improvement of organization focus
- Obtaining world class capabilities
- Resource savings
- Take advantage of reengineering benefits
- Risk sharing
- Increasing service flexibility
- Response to the variety of customers' demands
- Better customization
- Better management of organization's functions
- On time performance
- Quality of services and products
- Accuracy in budgeting
- Responsibility and accountability
- Employees' motivation (Rajabzadeh &Anvary Rostamy, 2008).

In this study we are determining variables and factors involved in maintenance outsourcing decision making and developing a generic model for the maintenance outsourcing process in basedon BSC strategic modelbecause that BSC make a performance measurement framework that provides an integrated look at the business performance of a company by a set of both financial and non-financial measures, seems to be a good solution. thenby the use of gray theory we determine that the organization do complete outsourcing ,outsourcing with non-decisions or don't do the outsourcing.

The balanced score card (BSC):

In the attempt to solve the problem by supplementing financial measures with additional measures that can help evaluate the long term performance of a firm, Kaplan and Norton introduced the BSC, a performance measurement framework that provides an integrated look at the business performance of a company by a set of measures, which includes both financial and non-financial metrics (Kaplan & Norton, 1996a)

The name of BSC is with the intent to keep score of a set of measures that maintain a balance ''between short- and long-term objectives, between financial and non-financial measures, between lagging and leading indicators, and between internal and external performance perspectives. Of the BSC's four performance perspectives, one is a traditional financial performance group of items, and the other three involve non-financial performance measurement indexes: customer ,internal business process, and learning and growth (Kaplan & Norton, 1996a).

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Gray system theory:

The information that is either incomplete or undetermined is called Gray (chang *et al.*, 2003). The Gray system provides multidisciplinary approaches for analysis and abstract modeling of system for which the information is limited, incomplete and characterized by random uncertainty (Liu & Lin, 1998).

In order to pursue the grey system theory we use gray number that is kind of the interval number and the procedures are summarized as follows (Slavek & Jovic, 2012).

Step 1. Form a committee of decision-maker and identify attribute weights of suppliers. Assume that a decision group has K persons, then the attribute weight of attribute aj can be calculated as:

$$\otimes Wj = \frac{1}{k}[\otimes Wj1 + \otimes Wj2 + \cdots + \otimes Wjk] \tag{1}$$

Step 2.Using linguistic variables for the ratings to make attribute rating value. Then the rating value can be calculated as:

$$\otimes Vj = \frac{1}{k}[\otimes Vj1 + \otimes Vj2 + \cdots + \otimes Vjk] \tag{2}$$

Step 3.Establishment of grey-decision table. The attribute values of $\otimes vij$ are linguistic variables based on grey number

Step 4.Normalization grey-decision table. For benefit attribute, $\otimes v*ij$ is expressed as:

$$\otimes^* Vij = [\frac{\underline{v_{ij}}}{v_{jmax}}, \frac{\overline{v_{ij}}}{v_{jmax}}] \tag{3}$$

For cost attribute, $\otimes v*ij$ is expressed as:

$$\otimes^* Vij = [\frac{v_{jmin}}{\overline{v_{ij}}}, \frac{v_{jmin}}{\underline{v_{ij}}}] \tag{4}$$

Step 5.Establishment of weighted normalized grey-decision table that $\otimes Wj * \otimes Vj$ is shown as below:

$$\otimes_1 * \otimes_2 = [\min(ac, ad, bc, bd), \max(ac, ad, bc, bd)] \tag{5}$$

Step 6. Selection ideal suppliers by grey-based rough set lower approximation.

Step 7. Calculation of grey relational grade (GRG) between comparative sequences:

$$i(k) = \frac{\Delta max - \Delta oi(k)}{\Delta max - \Delta min} \tag{6}$$

$$\Delta max = \max_i \max_k \Delta_i(k)$$
$$\Delta min = \min_i \min_k \Delta_i(k)$$

$$ri = \frac{1}{n}\sum_{k=1}^{n} \xi i(k) \qquad\qquad i = 1,2,\dots,m.$$

Methodology:

In this study we are determining variables and factors involved in maintenance outsourcing process and developing a generic model for the maintenance outsourcing process in based on BSC strategic model. then by the use of gray theory we determine that the organization do complete outsourcing ,outsourcing with non-decisions or don't do the outsourcing.

A company's readiness for maintenance outsourcing can be assessed based on a number of factors. These factors are gathered by Library study and opinion of experts in this field. The result can be listed in this way, that control to access rights objectives:

- Control and monitoring: control over supplier, supply chain, risk and outputs (Campbell,1995), (Zhu *et al.*, 2001).
- Obtain access to new technology: Outsourcing may provide the organization with greater developing new technologies (Emond,1994), (Campbell, 1995)
- Higher productivity: . Higher productivity can often be achieved from vendors employers. These employees can see opportunities for promotion into management as their jobs are part of the core business of that outsourcing organization (Bertolini *et al.*, 2004), (Fill &Visser, 2000).
- Speed on new problem: Unlike in-house experts, outside sources do not require extended time to come up to speed on a new concept. They are hired because they already possess knowledge and experience. External resources have skills which some companies find difficult to develop themselves internally (Campbell,1995), (Fill &Visser, 2000), (Bertolini *et al.*, 2004).

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- Improvement of Working relationships: The communication among skilled people in different departments may initially be undermined by outsourcing as traditional lines of communication are redrawn. Further, the potential for cross-skilling can be reduced, with a potential loss of flexibility (Bertolini *et al.*, 2004), (Rao &Young, 1994), (Campbell, 1995).
- Information Confidentiality: A subcontractor, after building up expertise with the organization's support, may attempt to provide their knowledge to competitors. Clearly, the company must ensure the contractor's reputation is solid (Campbell, 1995), (Bertolini *et al.*, 2004).
- More focus on core business: focus in-house personnel on "core" activities (Rao &Young,1994), (Bertolini *et al.*, 2004), (Rajabzadeh & Anvary Rostamy, 2008), (Fill &Visser, 2000).
- Consolidationsin workload (Rao & Young, 1994), (Bertolini *et al.*, 2004).
- Improvement of equipment performance (Beaumont & Sohal, 2004), (Blumberg, 1998)
- Increasing service flexibility (McIvor, 2000), (Rajabzadeh & Anvary Rostamy, 2008), (Beaumont & Sohal, 2004), (Gavin & Matherly, 1997), (Webb & Laborde, 2005)
- reduce maintenance time (Bertolini *et al.*, 2004)
- Improvement in quality of service and productions: Contractors may have superior quality practices than internal suppliers (Campbell, 1995), (Rao & Young, 1994), (Bertolini *et al.*, 2004), (Rajabzadeh & Anvary Rostamy, 2008), (Elmuti & Kathawala, 2000).
- Consistent service (Rao &Young, 1994).
- Images of organization (Bertolini *et al.*, 2004).
- Response to the variety of customer's demands (Rajabzadeh & Anvary Rostamy, 2008), (Webb & Laborde, 2005).
- achieve new ideas: The organization is not limited to its own capabilities; it can tap into a stream of new ideas and improvement potentials it could not possibly generate itself (Campbell, 1995).
- obtain specialist: Each supplier can have more personnel depth and sophisticated technical knowledge about its specific area and also support more specialized capabilities (Campbell, 1995), (Bertolini *et al.*, 2004), (Rajabzadeh & Anvary Rostamy, 2008).
- Update knowledge and skills: Permanent staff are exposed to outside specialists and thus have an opportunity to upgrade their skills. In the long term,this knowledge transfer will improve the quality of work performed by the permanent staff. (Bertolini *et al.*, 2004), (Campbell, 1995).
- Belonging to the organization: problems among personnel, since they lose their functions (Campbell, 1995), (Bertolini *et al.*, 2004), (Rajabzadeh & Anvary Rostamy, 2008), (Beaumont & Sohal, 2004).
- cost reduction: Contractors may have more specialized equipment for performing theservice. This may allow the contractor to provide better quality and service at a lower price (Bertolini *et al.*, 2004), (Gottschalk & Solli-Saether, 2005), (Jiang & Qureshi, 2006)
- Risk reduction: About risk liability and control (Gottschalk & Solli-Saether, 2005), (Embleton & Wright, 1998).
- Cost/service tradeoffs (Rao &Young, 1994).
- Increase revenue (Bertolini *et al.*, 2004), (Fill &Visser, 2000), (Blumberg, 1998)
- Optimum use of resource (Elmuti & Kathawala, 2000), (Gottschalk & Solli-Saether, 2005).
- Increase return on assets (Blumberg,1998), (Fill &Visser, 2000).

For using maintenance outsourcing in the BSC model, first The four perspectives of BSC are explained briefly as follows:
- Financial: This perspective typically contains the traditional financial performance measures, which are usually related to profitability. The measurement criteria are usually profit, cash flow, ROI, return on invested capital (ROIC), and economic value added (EVA).
- Customer: Customers are the source of business profits; hence, satisfying customer needs is the objective pursued by companies. In this perspective, management determines the expected target customers and market segments for operational units and monitors the performance of operational units in these target segments.
- Internal business process: The objective of this perspective is to satisfy shareholders and customers by excelling at some business processes that have the greatest impact. In determining the objectives and measures, the first step should be corporate value-chain analysis. An old operating process should be adjusted to realize the financial and customer dimension objectives. A complete internal business-process value chain that can meet current and future needs should then be constructed. A common enterprise internal value chain consists of three main business processes: innovation, operation and after-sale services.

Learning and growth: The primary objective of this perspective is to provide the infrastructure for achieving the objectives of the other three perspectives and for creating long-term growth and improvement through people, systems and organizational procedures. The criteria include turnover rate of workers, expenditures on new technologies, expenses on training, and lead time for introducing innovation to a market (Lee, 2008).

In order to classify the effective outsourcing factors in the BSC model30 questionnaire is developed. This questionnaire contains the effective factors on maintenance outsourcing. The statistical population of this

research includes all managers and experts who were familiar to outsourcing. Accordingly from 30 distributed questionnaires, 25 of them are returned. In this research, we used of judgmental sampling method. The result is as follows:

Table 1: Effective outsourcing factors in the BSC model.

The main criterion	Sub-criteria
process	Control and monitoring
	Obtain access to new technology
	Higher productivity
	Speed on new problem
	Improvement of Working relationships
	Information Confidentiality
	More focus on core business
	Consolidations in workload
	Improvement of equipment performance
	Increasing service flexibility
	reduce maintenance time
Customer & market	Improvement in quality of service and productions
	Consistent service
	Improvement in images of organization
	Response to the variety of customer's demands
Learning and growth	achieve new ideas
	obtain specialist
	Update knowledge and skills
	Belonging to the organization
Financial	cost reduction
	Risk reduction
	Cost/service tradeoffs
	Increase revenue
	Optimum use of resource
	Increase return on assets

Now in the purpose of determined the readiness of organization in the different industry, we should defined the weight of effective factors then rating them in the specified industry with the gray relation analyze method to ranking the level of company readiness for complete outsourcing, activity outsourcing or non-outsourcing.

Case study:

The case study here presented deals with electric company. this company has the mission of supplying the safe and suitable electricity power for its users and customers through developing and exploiting its infrastructures. With respect to this company's job mission in terms of producing and transmitting the energy, this company is considered as a public service organization (selling the energy) and also is a project-based organization (constructing and developing projects). In other words, it can be considered as a project-based public service organization.

After we identified the effective factors in maintenance outsourcing and classify them in the BSC model, In order to identify the priority of our options for complete outsourcing, non- outsourcing or outsourcing with decision by gray system theory we Determine the importance of each factor in maintenance outsourcing process by a committee of experts in this field and identify attribute weights of options. Complete outsourcing refer to the state that organization put the both responsibility of maintenance and the decision about what repair and when it should be done on the selected vendor. While in the out sourcing with non-decision the vendor doesn't decide about what activity should be outsourcing and how or when it must be done. In this state the vender only do the determined work. In non-outsourcing organizations do all of their work by themselves.

Here our decision group has 25 persons, then the attribute weight of factors can be calculated based on the following table:

Table 2: The scale of attribute weights.

⊗W		scale
[0,0.1]	VL	Very low
[0.1,0.3]	L	Low
[0.3,0.4]	ML	Medium low
[0.4,0.5]	M	Medium
[0.5,0.6]	MH	Medium high
[0.6,0.9]	H	High
[0.9,1]	VH	Very high

Table 3: Weight of effective outsourcing factors in the BSC model.

The main criterion	Sub-criteria	⊗W
process	Control and monitoring	[0.91,1]
	Obtain access to new technology	[0.42,0.55]
	Higher productivity	[0.9,1]
	Speed on new problem	[0.63,0.93]
	Improvement of Working relationships	[0.65,0.91]
	Information Confidentiality	[0.51,0.65]
	More focus on core business	[0.52,0.61]
	Consolidations in workload	[0.42,0.53]
	Improvement of equipment performance	[0.62,0.9]
	Increasing service flexibility	[0.64,0.92]
	reduce maintenance time	[0.92,1]
Customer & market	Improvement in quality of service and productions	[0.93,1]
	Consistent service	[0.9,1]
	Improvement in images of organization	[0.55,0.61]
	Response to the variety of customer's demands	[0.53,0.64]
Learning & growth	achieve new ideas	[0.51,0.6]
	obtain specialist	[0.63,0.94]
	Update knowledge and skills	[0.61,0.93]
	Belonging to the organization	[0.66,0.93]
Financial	cost reduction	[0.9,1]
	Risk reduction	[0.92,1]
	Cost/service tradeoffs	[0.91,1]
	Increase revenue	[0.43,0.56]
	Optimum use of resource	[0.9,1]
	Increase return on assets	[0.9,1]

Table 4: The scale of attribute Ratings.

⊗v		scale
[0,1]	VP	Very poor
[1,3]	P	Poor
[3,4]	MP	Medium poor
[4,5]	F	Fair
[5,6]	MG	Medium good
[6,9]	G	Good
[9,10]	VG	Very good

Table 5: Decision making table.

The main criterion	Sub-criteria	Non-outsourcing	Activity outsourcing	Complete outsourcing
process	Control and monitoring	[3.2,4.5]	[6.2,9.1]	[4.2,5.5]
	Obtain access to new technology	[3.2,4.1]	[4.2,5.1]	[4.4,5.1]
	Higher productivity	[4.3,5.4]	[5.5,6.1]	[5.3,6.2]
	Speed on new problem	[5.1,6.2]	[3.5,4.2]	[6.5,9.1]
	Improvement of Working relationships	[5.2,6.4]	[4.5,5.6]	[5.2,6.1]
	Information Confidentiality	[9,10]	[4.5,5.4]	[3.2,4.4]
	More focus on core business	[3.1,4.3]	[5,6]	[6.3,9.4]
	Consolidations in workload	[3.4,4.5]	[5.1,6.3]	[6.1,9.3]
	Improvement of equipment performance	[4.3,5.1]	[5.5,6.2]	[6.6,9.2]
	Increasing service flexibility	[5.3,6.5]	[4.2,5.6]	[5.1,6.4]
	reduce maintenance time	[5.2,6.5]	[4.4,5.2]	[6.4,9.1]
Customer & market	Improvement in quality of service and productions	[4.4,5.6]	[4.2,5.6]	[5.2,6.1]
	Consistent service	[5.4,6.5]	[4.5,5.7]	[5,2,6.5]
	Improvement in images of organization	[5.2,6.7]	[4.2,5.4]	[5.3,6.2]
	Response to the variety of customer's demands	[6.2,9.1]	[5.7,6.4]	[6.8,9.2]
Learning & growth	achieve new ideas	[5.3,6.5]	[6.2,9.3]	[6.2,9.5]
	obtain specialist	[6.2,9.5]	[6.3,9.2]	[4.3,5.6]
	Update knowledge and skills	[6.5,9.1]	[6.4,9.1]	[4.5,5.3]
	Belonging to the organization	[6.4,9.1]	[5.3,6.5]	[4.2,5.6]
Financial	cost reduction	[1.3,3.5]	[4.5,5.7]	[4.2,5.3]
	Risk reduction	[6.2,9.1]	[5.5,6.4]	[3.1,4.7]
	Cost/service tradeoffs	[4.2,5.6]	[6.2,9.5]	[6.3,9.4]
	Increase revenue	[4.6,5.7]	[6.5,9.1]	[3.3,4.6]
	Optimum use of resource	[4.4,5.6]	[5.4,6.7]	[5.4,6.5]
	Increase return on assets	[4.3,5.5]	[5.3,6.5]	[5.2,6.3]

Then the rating value of factors in the electric company can be calculated as follow by Establishment of gray decision table and the opinion of experts and managements in this company that decision do by . The attribute values of ⊗vij arelinguistic variables based on grey numberand to identify attribute value of options

our decision group has 25 persons, then the attribute value of factors can be calculated based on the following table:

Table 6: Gray Decision table and the weighted of factors.

The main criterion	Sub-criteria	⊗W	Non-outsourcing	Activity outsourcing	Complete outsourcing
process	Control and monitoring	[0.91,1]	[3.2,4.5]	[6.2,9.1]	[4.2,5.5]
	Obtain access to new technology	[0.42,0.55]	[3.2,4.1]	[4.2,5.1]	[4.4,5.1]
	Higher productivity	[0.9,1]	[4.3,5.4]	[5.5,6.1]	[5.3,6.2]
	Speed on new problem	[0.63,0.93]	[5.1,6.2]	[3.5,4.2]	[6.5,9.1]
	Improvement of Working relationships	[0.65,0.91]	[5.2,6.4]	[4.5,5.6]	[5.2,6.1]
	Information Confidentiality	[0.51,0.65]	[9,10]	[4.5,5.4]	[3.2,4.4]
	More focus on core business	[0.52,0.61]	[3.1,4.3]	[5,6]	[6.3,9.4]
	Consolidations in workload	[0.42,0.53]	[3.4,4.5]	[5.1,6.3]	[6.1,9.3]
	Improvement of equipment performance	[0.62,0.9]	[4.3,5.1]	[5.5,6.2]	[6.6,9.2]
	Increasing service flexibility	[0.64,0.92]	[5.3,6.5]	[4.2,5.6]	[5.1,6.4]
	reduce maintenance time	[0.92,1]	[5.2,6.5]	[4.4,5.2]	[6.4,9.1]
Customer & market	Improvement in quality of service and productions	[0.93,1]	[4.4,5.6]	[4.2,5.6]	[5.2,6.1]
	Consistent service	[0.9,1]	[5.4,6.5]	[4.4,5.7]	[5,2,6.5]
	Improvement in images of organization	[0.55,0.61]	[5.2,6.7]	[4.2,5.4]	[5.3,6.2]
	Response to the variety of customer's demands	[0.53,0.64]	[6.2,9.1]	[5.7,6.4]	[6.8,9.2]
Learning & growth	achieve new ideas	[0.51,0.6]	[5.3,6.5]	[6.2,9.3]	[6.2,9.5]
	obtain specialist	[0.63,0.94]	[6.2,9.5]	[6.3,9.2]	[4.3,5.6]
	Update knowledge and skills	[0.61,0.93]	[6.5,9.1]	[6.4,9.1]	[4.5,5.3]
	Belonging to the organization	[0.66,0.93]	[6.4,9.1]	[5.3,6.5]	[4.2,5.6]
Financial	cost reduction	[0.9,1]	[1.3,3.5]	[4.5,5.7]	[4.2,5.3]
	Risk reduction	[0.92,1]	[6.2,9.1]	[5.5,6.4]	[3.1,4.7]
	Cost/service tradeoffs	[0.91,1]	[4.2,5.6]	[6.2,9.5]	[6.3,9.4]
	Increase revenue	[0.43,0.56]	[4.6,5.7]	[6.5,9.1]	[3.3,4.6]
	Optimum use of resource	[0.9,1]	[4.4,5.6]	[5.4,6.7]	[5.4,6.5]
	Increase return on assets	[0.9,1]	[4.3,5.5]	[5.3,6.5]	[5.2,6.3]

Table 7: The Weighted Normalized gray decision table.

The main criterion	Sub-criteria	Non-outsourcing	Activity outsourcing	Complete outsourcing
process	Control and monitoring	[0.320,0.495]	[0.620,1.000]	[0.420,0.604]
	Obtain access to new technology	[0.264,0.442]	[0.346,0.550]	[0.362,0.550]
	Higher productivity	[0.624,0.871]	[0.798,0.984]	[0.769,0.000]
	Speed on new problem	[0.353,0.634]	[0.242,0.429]	[0.450,0.930]
	Improvement of Working relationships	[0.528,0.910]	[0.457,0.796]	[0.528,0.867]
	Information Confidentiality	[0.459,0.650]	[0.230,0.351]	[0.163,0.286]
	More focus on core business	[0.171,0.279]	[0.277,0.389]	[0.349,0.610]
	Consolidations in workload	[0.154,0.256]	[0.230,0.359]	[0.275,0.530]
	Improvement of equipment performance	[0.290,0.499]	[0.371,0.607]	[0.445,0.900]
	Increasing service flexibility	[0.522,0.920]	[0.414,0.793]	[0.502,0.906]
	reduce maintenance time	[0.526,0.714]	[0.445,0.571]	[0.647,1.000]
Customer & market	Improvement in quality of service and productions	[0.671,0.918]	[0.640,0.918]	[0.793,1.000]
	Consistent service	[0.748,1.000]	[0.609,0.877]	[7.200,1.000]
	Improvement in images of organization	[0.427,0.610]	[0.345,0.492]	[0.435,0.564]
	Response to the variety of customer's demands	[0.357,0.633]	[0.328,0.445]	[0.392,0.640]
Learning & growth	achieve new ideas	[0.285,0.411]	[0.333,0.587]	[0.333,0.600]
	obtain specialist	[0.411,0.940]	[0.418,0.910]	[0.285,0.554]
	Update knowledge and skills	[0.436,0.930]	[0.429,0.930]	[0.302,0.542]
	Belonging to the organization	[0.464,0.930]	[0.384,0.664]	[0.305,0.572]
Financial	cost reduction	[0.205,0.614]	[0.711,1.000]	[0.663,0.930]
	Risk reduction	[0.627,1.000]	[0.556,0.703]	[0.313,0.516]
	Cost/service tradeoffs	[0.402,0.589]	[0.594,1.000]	[0.603,0.989]
	Increase revenue	[0.217,0.351]	[0.307,0.560]	[0.156,0.283]
	Optimum use of resource	[0.591,0.836]	[0.725,1.000]	[0.725,9.701]
	Increase return on assets	[0.595,0.846]	[0.734,1.000]	[0.720,0.969]

Now we do selection ideal vision by grey-based. We use R to denote the partition generated by condition attributes.

U0={[0.620,1.000], [0.362,0.550], [0.798, 1.000], [0.450,0.930], [0.528, 0.910], [0.459,0.650], [0.349, 0.610], [0.275,0.530],[0.445,0.900],[0.522,0.920],[0.647,1.000],[0.793,1.000],[7.200,1.000],[0.435,0.610], [0.392,0.640],[0.333,0.600],[0.418,0.940],[0.436,0.930],[0.464,0.930],[0.711,1.000],[0.627,1.000], [0.603,1.000],[0.307,0.560],[0.725,9.701],[0.734,1.000]}

Table 8: Compare between ideal vision and alternatives.

	$\Delta 1(k)$	$\Delta 1(k)$	$\Delta 1(k)$	$\min_i \min_k \Delta i(k)$	$\max_i \max_k \Delta i(k)$
Control and monitoring	0.505	0.000	0.396		
Obtain access to new technology	0.108	0.016	0		
Higher productivity	0.174	0.016	0.029		
Speed on new problem	0.296	0.501	0.000		
Improvement of Working relationships	0.000	0.114	0.043		
Information Confidentiality	0.000	0.299	0.364		
More focus on core business	0.331	0.221	0.000		
Consolidations in workload	0.274	0.171	0.000		
Improvement of equipment performance	0.401	0.293	0.000		
Increasing service flexibility	0.000	0.127	0.020		
reduce maintenance time	0.286	0.429	0.000		
Improvement in quality of service and productions	0.122	0.152	0.000		
Consistent service	0.000	0.138	0.028		
Improvement in images of organization	0.008	0.118	0.046		
Response to the variety of customer's demands	0.035	0.195	0.000		
achieve new ideas	0.189	0.013	0.000		
obtain specialist	0.007	0.030	0.386		
Update knowledge and skills	0.000	0.007	0.388		
Belonging to the organization	0.000	0.266	0.358		
cost reduction	0.505	0.000	0.070		
Risk reduction	0.000	0.297	0.484		
Cost/service tradeoffs	0.411	0.010	0.011		
Optimum use of resource	0.209	0.000	0.277		
Increase return on assets	0.164	0.000	0.000		
$\min_i \Delta i(k)$	0.000	0.000	0.000	0.000	
$\max_k \Delta i(k)$	0.484	0.501	0.505		0.505

Table 9: Grey relational grade.

$\xi i(k)$	$\xi 1(k)$	$\xi 2(k)$	$\xi 3(k)$
Control and monitoring	0.000	1.000	0.216
Obtain access to new technology	0.786	0.968	1.000
Higher productivity	0.655	0.968	0.943
Speed on new problem	0.414	0.008	1.000
Improvement of Working relationships	1.000	0.774	0.915
Information Confidentiality	1.000	0.408	0.279
More focus on core business	0.345	0.562	1.000
Consolidations in workload	0.457	0.661	1.000
Improvement of equipment performance	0.206	0.420	1.000
Increasing service flexibility	1.000	0.749	0.960
reduce maintenance time	0.434	0.150	1.000
Improvement in quality of service and productions	0.758	0.699	1.000
Consistent service	1.000	0.727	0.945
Improvement in images of organization	0.984	0.766	0.909
Response to the variety of customer's demands	0.931	0.614	1.000
achieve new ideas	0.626	0.974	1.000
obtain specialist	0.986	0.941	0.236
Update knowledge and skills	1.000	0.986	0.232
Belonging to the organization	1.000	0.473	0.291
cost reduction	0.000	1.000	0.861
Risk reduction	1.000	0.412	0.042
Cost/service tradeoffs	0.186	0.980	0.978
Optimum use of resource	0.586	1.000	0.451
Increase return on assets	0.675	1.000	1.000
r_i	0.669	0.730	0.768

where r_i represents the degree of relation between each comparative sequence and the reference sequence. The higher degree of relation means that the comparative sequence is more similar to the reference sequence than comparative sequences. Then in this case we can say We can say that the complete outsourcing is the most ideal alternative among other three attitude should be as an important alternative for the company. After complete outsourcing, activity outsourcing has maximum ranking and non-outsourcing in last rating.

Conclusion:

The purpose of this study was to develop a generic conceptual model for outsourcing process in maintenance sectors. In addition, it determined the situation about readiness of the organization to use maintenance outsourcing by ranking three level such as complete outsourcing, activity outsourcing and non-

outsourcing. we determined effected variables and factors involved in maintenance outsourcing process and developed a generic model for the maintenance outsourcing process in basedon BSC strategic model. then by the use of gray theory we determined the weight of effected factors in maintenance outsourcing and through the rate of these factors in the Yazd Electric Company by gray set approach deal with determine the ready, it concluded that the maintenance sector in this company is ready for doing complete outsourcing.

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