

# Identification of Pattern used in Determination of Critical Success Factors in ITS Projects, Case Study: Road Maintenance and Transportation Organization

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## Abstract

One of the risks recognized by relevant authorities is the risk of outsourcing ITS projects. The purpose of this study was to design and explain the pattern of determining the critical success factors in outsourcing large-scale ITS projects in the Ministry of Roads and Urban Development (Road Maintenance and Transportation Organization). This study was performed using qualitative method. The participants in the research were the ITS experts experienced in large-scale projects, 25 of whom were selected purposefully as the sample. Theoretical coding method was used to analyze the information obtained by having experts' opinion. The method included open coding and axial coding. The paper aims to develop a local model to recognize vital factors in outsourcing of large-scale ITS projects with regard to social and cultural characteristics of relevant organizations in Iran. Using in-depth interview with experts in relevant filed, a model was developed. The results obtained by theoretical coding methods showed that the critical success factors in outsourcing large-scale ITS projects in the Ministry of Roads and Urban Development are organizational factors, management factors, environmental factors and individual factors. Each of these factors includes a number of sub-sections that can be taken into account particularly. This local pattern can be applied for determining the critical factors in the Ministry of Roads and Urban Development (Road Maintenance and Transportation Organization). In addition to this, its outputs, including critical success factors and prioritization and preparation of outsourcing large-scale ITS projects can be exploited by the senior managers of the executive agencies for more accurate and consistent planning. The latter would prevent waste of resources and treasury.

**Keywords:** Critical success factors, outsourcing, intelligent transportation system (ITS), information technology (IT), large-scale project.

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## 1. Introduction

Today's managers have found that they should forget about barren tenures that are not their actual activities, and focus on the negotiating, supporting, analyzing, solution providing, and helping roles. It is under this condition that outsourcing organizational activities is considered an executive necessity and an inevitable strategy for organizations [Alizadeh, 2012]. One of the risks currently recognized by the authorities is the risk of outsourcing ITS projects. Outsourcing refers to relying on external forces to perform value-added activities [Harland et al. 2005]. Moving towards ITS projects creates some risks for the consumer and supplier. Those individuals involved in outsourcing must consider more risks compared to the internal projects of the organization. Therefore, a more regular and precise management is needed to reduce the effects of outsourcing and its risks on the failure or cessation of the project [Hazel, 2012]. Outsourcing with an emphasis on two strategic directions aims to develop competitive advantages, first, by focusing on the main investigation and resources of the organization, which are referred to as core activities, and second, by outsourcing the activities that are not the strategic needs of the organization nor the organization has a special capability in that context [Campbell, 2010]. Nowadays, by consider information technology outsourcing as a strategic decision significant advantages can be reached for the organizations, namely reduced costs, increased services, increased access to ITS experts and improved quality of information technology services. Therefore, the advantages of outsourcing creates both attraction and repulsion to this issue, especially in the area of information systems.

However, outsourcing might confront some risks under certain conditions, and result in unfavorable and unexpected results deviating the

organization from its strategic path, and even destroy it [Blecher, 2007]. Despite the advantages of outsourcing, many of its projects fail. Negative consequences of outsourcing are financial problems and impossibility of paying the entire amount of the contract, dissatisfaction with the amount of saving or improved efficiency of the operations compared to what was expected. Also, poor quality of the services provided, competitive market and decreased prices, along with variation and improvement of the services, changes in the organizational strategic plan) leading to its failure as well [Mojsilovic et al. 2007].

The prolonged information system projects has made many Iranian companies and organizations attend information system outsourcing and invest huge capitals in this area. Unfortunately, neglecting the problems prevailing in this area, for example neglecting the management risk of outsourcing these projects, has increased the possibility of failure in these projects. Unofficial statistics indicates reduced tendency in outsourcing information systems. As the information and communication technologies get more complex and specialized, a growing trend is observed towards outsourcing information technology in the companies.

The current study was conducted regarding the importance of outsourcing large-scale ITS projects and moving towards specializing functional patterns, considering the lack of academic studies in the context of critical success factors of outsourcing large-scale ITS projects.

## 2. Theory and Literature Review

Critical success factors include the characteristics, conditions, or variables having significant effect on the competitive success of the organization, if managed correctly. Pinto and Slevin (1987) know critical success factors as the factors significantly improving the chance of implementation of projects. Watson and Frolick

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(1993) believe that critical success factors or Key Performance Indicators (KIPs) are things that must be implemented correctly if the organization wants to be successful [Rahnavard and Gholami, 2012]. Critical success factors are limited factors having a vital role in success of the organization, and the organization must provide them if it wants to survive. In other words, any critical success factor is a platform that the works related to it must be done perfectly to make the organization a successful one [Rockart, 1979]. Outsourcing in this study refers to transfer of some internal activities and the right of decision-making for them to an external supplier through a contract [Rivard and Aubert, 2015]. Large-scale Project is a temporary effort made to achieve a specific goal [Marchewka, 2009]. It is also a temporary effort made to create a product, service, or result [Tuhri, 2013]. ITS projects are those projects related to information technology. The major difference between ITS projects and other projects is that a major part of ITS projects evaluation criteria are intangible. Many indicators in information technology are qualitative, which should be quantified [Ibnorrasoul, Khani-Jagharq, 2004; Lacity and Khan, 2016]. Outsourcing ITS projects in this study refers to performing the identifying, designing, and mounting part of an ITS project or transferring human resource or other resources of the ITS projects in this section of the project life cycle, and the right of decision making about their activities, to one or more external suppliers by a contract. The main objective of ITS managers by outsourcing is to reduce the total costs and increase the total value of the company. On the other hand, Claver et al. (2002) believe that the reasons for outsourcing information systems include cost saving, increasing the flexibility of information system section, focusing on ITS strategies, resolving problems and daily issues, saving in technology costs, increasing the quality of information systems, increasing the access to new technologies, and reducing the risks

[Samantra et al 2014]. The purpose is to specify a proper pattern for prioritization and determining the importance of factors involved in outsourcing large-scale ITS projects and the interaction between them (based on critical success factors), which will be exploited by the senior and strategic managers of the organization in outsourcing decision-making in this area. In outsourcing, the definition of success from the employer's or customer's perspective is certainly different from its definition from the executor's or contractor's perspective. Therefore, success factors will also be different. In the literature, the success factors in outsourcing the projects, especially ITS projects, are also investigated. Outsourcing the project is a strategic decision, whose success influences the organization, and the success of its implementation requires special studies [Chow and Cao, 2008].

There is a little history available for the critical factors of outsourcing large-scale ITS projects due to its relatively recent emergence. Outsourcing large-scale ITS projects in national organizations is very new. The research was carried out to achieve the proper pattern of determining the critical success factors in outsourcing large-scale ITS projects. Moreover, the most critical success factors in outsourcing large-scale ITS projects, and the criteria influencing their criticality is identified in the following.

### 3. The Organization Studied (Ministry of Roads and Urban Development)

As the custodian of the arterial road network of the country being in charge of maintenance, optimization, and securing the roads, the Ministry of Roads and Urban Development has a special place in national development and increasing national economic efficiency. Having the annual statistics of about 600 million tons of goods, 900 million passengers, and 10 million ton transit of

goods, the road transportation sector encompassed more than 90% of the movement of goods and passengers [rmto.ir, 2016]. The state sector has no contributions in tenure issues, and the Road Maintenance and Transportation Organization is responsible for the state obligations, including policy-making, planning, surveillance, and outsourcing large-scale projects in this sector as the main organization of transportation agencies.

This organization has a very important position in promoting traffic safety by making optimal use of the arterial road network in the country. Some of its responsibilities include proposing revision and operational strategies and take advantage of new technologies to reduce traffic accidents and fatalities.

The most important task of Road Maintenance and Transportation Organization is to develop information technology in area of transportation, which is considered in the Road Maintenance Organization's agenda under the title Intelligent Transportation System (ITS).

Information technology office and road management centers of the country, as the main organs under the supervision of the highest authority and the deputy of organizational

planning, are responsible for defining and developing large-scale and national projects in this area of the arterial road network of the country in the Ministry of Road and Urban Development. Examples of these large-scale projects include the national plan of equipping the arterial roads, traffic violations registration systems (ITS), electronic vehicle registration (EVR) system, weighting in move (WIM) system, intelligent toll system (ETC), car communications system (CVT), etc. to name a few. All these large-scale national projects in the area of information technology are being planned and implemented by outsourcing to the private sector.

#### 4. Methodology

This research is a qualitative study regarding its approach. Theoretical coding with grounded theory approach [Glaser and Strauss, 1967] was used to analyze the information. Theoretical coding refers to the operations during which the data are analyzed, conceptualized, and put together in a new format. It is the main process through which the theory is formulated based on the data [Strauss and Corbin, 1998]. The pattern structure of vital factors in outsourcing of large-scale ITS projects is shown in Figure 1.

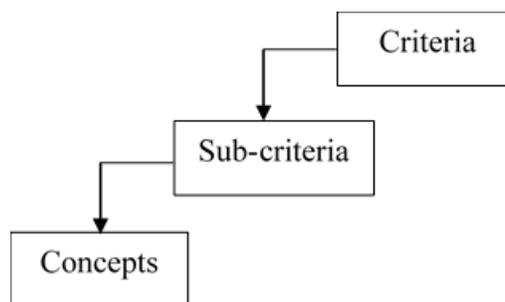


Figure 1. Structure of outsourcing of large-scale ITS projec

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### 4. 1 Participants

Research participants are IT specialist, and by specialist we mean experts who were at least involved in 7 projects. The sampling method used in this study was purposive sampling. The number of samples selected in this study was 25 individuals. In fact, a repetition was observed in the information obtained after the twenty second interview. But the interviews were continued up to the twenty fifth interview, and the data were quite repetitive after the twenty second interview.

In order to estimate the validity and reliability of the data, different test were performed on the collected data. Consideration of validity of a measurement tool means that to what extend a measurement tool is able to be efficient and what does it calculate. Data reliability is a state that exists when data is adequately complete and error free to be convincing for its purpose and context. Validity was carried out by Confirmatory Factor Analysis, and reliability is carried out by Content validity. In order to examine reliability, the score relevant to each sub-categories of questioner and the total variance must be calculated. Using Equation 1 the Cronbach's alpha can be estimated.

$$r_{\alpha} = \frac{J}{J-1} \left( 1 - \frac{\sum_{j=1}^n S_j^2}{S^2} \right) \quad 1$$

Where J is the number of sub-categories in questioner forms,  $S_j^2$  is the variance of component i for the current sample of persons and  $S^2$  is variance of the observed total test scores.

### 4. 2 Method of Collecting Information

Exploration and semi-structured interviews were used in this study. In qualitative studies, the questions are included in an interview guide, focusing on the issues or the area that must be covered and the paths that must be followed up [Houman, 2010]. The data in this study were collected step by step by referring to the literature and based on the contents of exploration interviews. The research questions were designed and specified in advance. The method of answering to the question were also considered as open answer, so that the answers would fit into pre-designed categories. The interview process is so that the researcher asked the questions and the respondent gave his/her answer in an open way. After accomplishing the interviews and reaching theoretical saturation in the research categories and identifiers in the sample studied, the interviews were implemented. The interviews were studied and reviewed for a couple of times after implementation to eliminate any problem or deficit. Table 1 illustrates main and secondary vital factors being effective in success of outsourcing of large-scale ITS project

**Table 1. The criteria, sub-criteria and concepts of the model**

Main factors	Secondary factors		Concepts
Individual Factors	Category 1	User's contribution	3
	Category 2	Technical expertise	3
	Category 3	Flexibility	3
Organizational Factors	Category 1	Supplier's perception of the customer's organization	7

	Category 2	Allocation of sufficient resources	7
	Category 3	Organizational trust	4
	Category 4	Monitoring	8
	Category 5	Organizational culture	10
	Category 6	Quality of relationships	7
	Category 1	Senior management support	8
	Category 2	Competent project Manager	8
	Category 3	Optimal management of the contracts	6
Management Factors	Category 4	Human resource management	8
	Category 5	Cost management	6
	Category 6	Creation of steering committee	5
	Category 7	Identifying and selecting the supplier	9
	Category 8	ITS standards	6
Environmental Factors	Category 1	Government policies	4
	Category 2	Rules and regulation	5
	Category 3	Activities of the competitors	3

### 4. 3 Data Analysis Method

Analyzing the information in this step was accomplished based on the theoretical coding method. The coding stages used in this study are:

1. Open coding
2. Axial coding

In open coding stage, the interviews were implemented and summaries were developed from the documents studied. In open coding stage of the present study, the interviews implemented were carefully examined, and the three questions raised during this investigation that are, in fact, the components of presenting the pattern of determining critical success factors in outsourcing large-scale ITS projects in the Ministry of Roads and Urban Development,

including the critical values of outsourcing large-scale ITS projects, and the key factors influencing their success were identified.

### 5. Results and Discussion

The outcome of this stage is summarization of the mass of information obtained by the interviews and documents into concept and categories that are common in the questions. Open coding brings the subjects and concepts from the depth to the surface. These subjects and concepts are taken from the primary research question, the concepts within the literature, or the terms used in the interview. Open coding and data conceptualization was first done to identify the values of outsourcing, and then to identify the

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criteria and sub-criteria of outsourcing large-scale ITS projects.

Given the conceptualization done in the area of identifying the core values of outsourcing large-scale ITS projects in the Ministry of Roads and Urban Development, five values were identified as the values of outsourcing large-scale ITS projects, including the communications outside the organization, moral and social responsibilities of outsourcing, guiding the human resource, continuous learning and improvement, focusing on the outcomes and the values created, which determine the success of outsourcing large-scale ITS projects.

Given the core values identified, open coding is done to identify the factors influencing outsourcing of large-scale ITS projects in Ministry of Roads and Urban Development. It has to be noted that according to the methodology of “qualitative content analysis”, the number of categories extracted from the primary literature review to identify the criteria were modified and adjusted several times during the process of data analysis. Finally, 4 categories were selected as the ultimate main categories. These main categories include organizational factors, individual factors, management factors, and environmental factors. Since flexible using of a theoretical framework in the coding stage helps a qualitative researcher, the frameworks available in the outsourcing literature, some of which were examined in the second part of the this study, were considered flexibly to answer the questions raised in this stage of open coding. However, for the sake of flexible use of this framework, there is the possibility of modifying and adjusting it until the end of qualitative phase of the study.

Axial coding was done in the next stage. The purpose of axial coding is to create a relationship between the categories generated (in open coding stage). This is usually done based on paradigm pattern and helps the theorist to accomplish the process of theorizing more conveniently. The

foundation of linking in axial coding is based on development of one of the categories. One faces an organized set of codes and primary concepts in axial coding, which is the result of precise and elaborate investigation of the articles and interview in open coding stage. The focus of this stage is mainly on the codes and concepts, not the data. However, new codes and concepts might also appear in this stage, but the main task is to review and examine the primary codes and move towards organizing the subjects, concept, and categories, as well as defining the core of key concepts in the analysis.

Finally, 126 sub-categories were also identified related to the main categories. The relationship between the factors extracted for the pattern of determining the critical success factors in outsourcing large-scale ITS projects in the Ministry of Roads and Urban Development was also presented according to the axial coding performed in the framework of conceptual model of the research. Therefore, according to the qualitative stage of pattern design, the conceptual pattern of the research, which indicates how the criteria of pattern of critical success factors in outsourcing large-scale ITS projects are related, were presented. Figure (1) shows the conceptual pattern of the research resulted from the qualitative stage of designing the pattern of critical success factors in outsourcing large-scale ITS projects. According to this figure, the critical success factors in outsourcing large-scale ITS projects are as follows.

1. Organizational factors (organizational trust, allocation of sufficient resources, supplier’s perception of the customer’s organization, monitoring, organizational culture, and quality of relationships).
2. management factors (identifying and selecting the supplier, information technology standards, creation of steering committee, competent project management, human resource

management, cost management, optimal management of the contracts, and senior management support).

3. Environmental factors (rules and regulation, activities of the competitors, and government policies) and
4. Individual factors (technical expertise, flexibility, and user's contribution).

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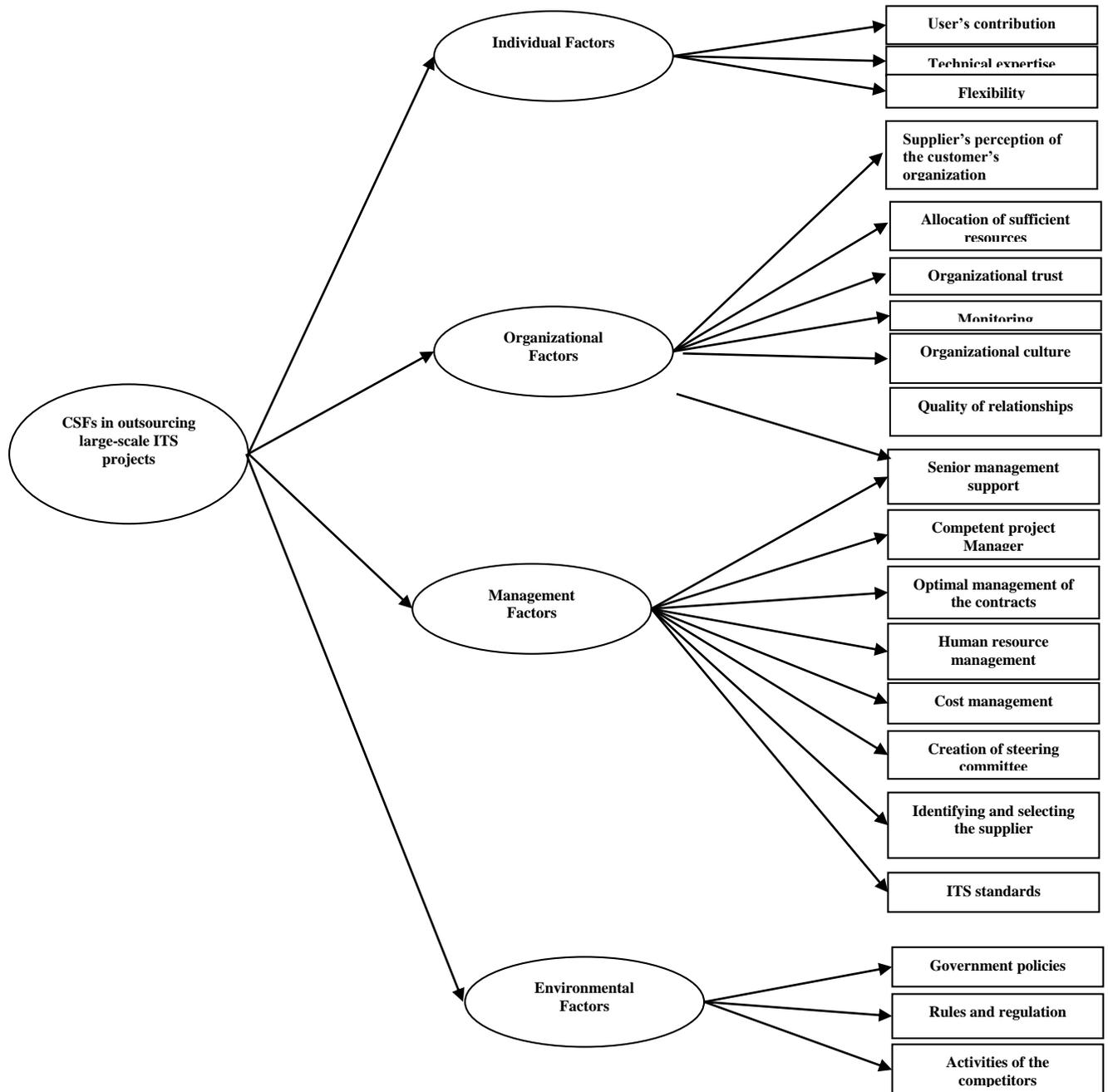


Figure 2. Conceptual model of the research

## 6. Conclusion

A grounded model was designed in this study to specify the pattern of critical success factors in outsourcing large-scale ITS projects. The components comprising the pattern of critical success factors in outsourcing large-scale ITS projects included criteria and sub-criteria, in which the relationships between the criteria and sub-criteria were explained.

The pattern of critical success factors in outsourcing large-scale ITS projects consists of primary and secondary components. This kind of models consists of indicators that are considered as the core of the model and base of evaluation of outsourcing large-scale ITS projects, and are called model criteria. The pattern of critical success factors in outsourcing large-scale ITS projects consists of 4 primary components, which include 20 secondary components. According to the experts' opinion and ground theory method provided in the research, the four main factors influencing success of outsourcing large-scale ITS projects were organizational factors, management factors, environmental factors, and individual factors.

Therefore, the major features of the pattern of outsourcing large-scale ITS projects are:

- Using qualitative approach in this study, in which the pattern of determining the critical success factors in outsourcing large-scale ITS projects was designed using qualitative approach and qualitative content analysis.
- Individual, organizational, management, and environmental factors are the primary components of the pattern of determining the critical success factors in outsourcing large-scale ITS projects.
- Explaining the relationship between the components of the pattern of determining the critical success factors in outsourcing large-scale ITS projects.

The pattern of determining the critical success factors in outsourcing large-scale ITS projects are provided by the Ministry of Roads and urban Development and aims to fill the gap of functional patterns, which is the inability in professional and detailed look in the area of success of outsourcing large-scale ITS projects, by a professional and detailed look. Comparing the designed pattern with the literature and theory of the study regarding the patterns of success of outsourcing large-scale ITS projects indicated and the research findings in the area of effective factors (individual, organizational, management, and environmental factors) on the success of outsourcing large-scale ITS projects were in accordance with the studies conducted by Mikaeili and Sedaghati (2009), Moudi (2011), Gorla and Somers (2014), Gonzalez et al. (2005), Sislian and Satir (2000), Pandi and Bansal (2003), Power (2006), Kremic and Tukel (2006), Grewal et al. (2008), McIvor (2005), and Brown and Wilson (2005). With respect to the conducted research, to improve and update the outsourcing results, inflation consistency index, positive view on private sectors and annual budget of government ministries must be taken into account in future research works. In addition, more emphasis on choosing the appropriate supplier, supplier management and control, research into identifying the preferred supplier, comparing supplier performance, supplier assessment and supplier flexibility can be carried out in the future.

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### 7. References

- Alizadeh Khoshkhesal, I. (2012) "Presenting a pattern to evaluate the productivity of outsourcing cloth distribution system in corps logistics", Dissertation, Imam Hossein University
- Barfield, W. and Dingus, T. A. (2014) "Human factors in intelligent transportation systems", (ITS), Psychology Press.
- Blecher, M. (2007) "Outsourcing IT governance to deliver business value", *Information Systems Control Journal*, Vol. 4, pp. 13-14
- Brown, D. and Wilson, S. (2005) "The black books of outsourcing: how to manage the changes, challenges, and opportunities", John Wiley and Sons
- Campbell, J. D. (2010) "Outsourcing in maintenance management: A valid alternative to self-provision", *Journal of Quality in Maintenance Engineering*, Vol. 3, pp.18-24.
- Chow, T. and Cao, D. B. (2008) "A survey study of critical success factors in agile software projects. *Journal of Systems and Software*", V01. 81, No. 6, pp. 961-971.
- Claver, E., González, R., Gascó, J. and Llopis, J. (2002) "Information systems outsourcing: reasons, reservations and success factors. *Logistics Information Management*", Vol. 15, No. 4, pp. 294-308.
- Gonzalez, R., Gasco, J. and Llopis, J. (2005) "Information systems outsourcing risks: a study of large firms", *Industrial management and Data systems*, Vol. 105, No.1, pp. 45-62.
- Gorla, N. and Somers, T. M. (2014) "The impact of ITS outsourcing on information systems success", *Information and Management*, Vol. 51, No. 3, pp. 320-335.
- Grewal, C. S., Sareen, K. K. and Gill, S. (2008) "A multi criteria logistics-outsourcing decision making using the analytic hierarchy process", *International Journal of Services Technology and Management*, Vol. 9, No. 1, pp.1-13.
- Harland, C., Knight, L., Lamming, R. and Walker, H. (2005) "Outsourcing: assessing the risks and benefits for organizations, sectors and nations", *International journal of Operation and Production Management*, Vol. 25, No.9, pp. 831-850.
- Hazel, T. (2012) "The move to outsourced ITS projects: key risks from the provider perspective", *Proceedings of the 2010 ACM SIGMIS CPR conference on Computer personnel research Atlanta, Georgia, USA: ACM*.
- Kremic, T., Icmeli Tukel, O. and Rom, W. O. (2006) "Outsourcing decision support: a survey of benefits, risks, and decision factors", *Supply Chain Management: an International Journal*, Vol. 11, No.6, pp. 467-482.
- Lacity, M. C., Khan, S., Yan, A. and Willcocks, L. P. (2010) "A review of the IT outsourcing empirical literature and future research directions", *Journal of Information Technology*, Vol. 25, No.4, pp. 395-433.
- Lau, Y. Y. and Ng, C. W. L. (2015) "Adoption of intelligent transportation system: Hong Kong bus", *Research at PolyU Speed*, Issue 3, Working paper series No. 4
- Mallik, S. (2014) "Intelligent transportation system", *International Journal of Civil Engineering Research*, Vol. 5, No. 4, pp.367-372
- McIvor, R. (2005) "The outsourcing process: strategies for evaluation and management", Cambridge Universit
- Mikaeili, F. and Sedaghati, H. (2006) "Evaluation the risks of outsourcing IT projects – case study: Iranian Force and Water Resources

Development Company (Water-Force)", Industrial Management Studies, Vol. 13, pp. 19-40.

-Marchewka, J. T. and Oruganti, S. (2014) "A combined model of ITS outsourcing partnerships and success", Communications of the IIMA, 13(2), 6.

-Power, M. (2006). "The outsourcing handbook: how to implement a successful outsourcing process", Kogan Page Publishers Press

-Rahnavard, F. and Khavandkar, J. (2008) "The effect of knowledge sharing on the success of outsourcing information technology services", Journal of IT Management, Vol.1, No.1, pp. 49-64.

-Ran, B., Jin, P. J., Boyce, D., Qiu, T. Z. and Cheng, Y. (2012) "Perspectives on future transportation research: impact of intelligent transportation system technologies on next-generation transportation modeling". Journal of Intelligent Transportation Systems, 16(4), 226-242.

-RMTO (2016) Road Maintenance and Transportation Organization website

-Rivard, S. and Aubert, B. A. (2008) "Information technology outsourcing", New York: ME Sharpe.

-Rockart, J. (1979) "Chief executives define their own information needs", Harvard Business Review, March 79.

-Samantra, C., Datta, S. and Mahapatra, S. S. (2014) "Risk assessment in ITS outsourcing using fuzzy decision-making approach: An Indian perspective", Expert Systems with Applications, Vol. 41, No. 8, pp.4010-4022.

-Sislian, E. and Satir, A. (2000) "Strategic sourcing: a framework and a case study", Journal of Supply Chain Management, Vol. 36, No. 2, pp.4-11.

-Teichler, U. (2007) "Higher education in globalization world", London: Springer Publisher.