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A Multi-Criteria Network Assessment Model of IT Offshoring Risks from Service Provider's Perspective

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Abstract

The paper proposes a multi-criteria framework for assessment of Information Technology (IT) offshoring risks from provider's perspective using the Analytic Network Process (ANP). The authors present an overview of current literature on IT risks in software project development, IT outsourcing and offshoring. Then the network evaluation framework of offshoring risks is outlined and justified. The model is illustrated on a real case of evaluating IT offshoring risks from the point of view of a foreign service provider. The conclusion outlines possible future research directions.

Keywords: IT offshoring risks, outsourcing, ANP, AHP, Systems Thinking.

1. INTRODUCTION

The importance of outsourcing as a topic has generated much research, focused originally on domestic outsourcing (see Dibbern et al., 2004) and for the last decade also on offshore outsourcing (see Gonzalez et al., 2013). Oshri, Kotlarsky and Wilcocks (2015:3) define "sourcing is the act through which work is contracted or delegated to an external or internal entity that could be physically located anywhere. It encompasses various insourcing (keeping the work in-house) and outsourcing arrangements such as offshore outsourcing (when the work is outsourced to a third party), captive outsourcing (when the work is performed by a subsidiary of the same organization located on another continent), nearshoring (when the work is performed in a neighboring country like Mexico) and onshoring (work is outsourced within the same country). According to Oshri et al. (2015) a conservative estimate for the global outsourcing contract value of business and Information Technology (IT) services exceeded US$700 Billion by the end of 2014 while it was only about US$10 Billion in 1989.

Davis et al. (2006:741) define offshoring as "the provision of organizational products and services from locations in other countries, whether they are actually overseas or not." Since 2005 there is a greater focus on offshore outsourcing (see Lacity et al. (2009), Peslak (2012), Persson and Schlichter (2015)) as opposed to traditional domestic outsourcing (onshoring). The most comprehensive analysis of outsourcing research and practice is presented in Dibbern et al. (2004). They have explored in depth the outsourcing decision (whether to outsource or not), the reasons for outsourcing, what business activities in IT are being outsourced, how firms outsource and the outcomes of outsourcing and their

measurement. A detailed analysis of the topics in the IT outsourcing literature between 1992 and 2013 is presented in Liang et al (2016). Similar research issues are applicable also to offshoring though there are some specific aspects to it. According to Gonzalez et al. (2013:230), "the geographical as well as cultural distance which often exists between clients and providers of these services leads to the emergence of several risks which are specific to Offshore Outsourcing, such as those derived from having to battle with various time zones, different legislations or additional security and privacy problems. For this reason, an enterprise will only decide to venture into this new business area if it has additional incentives…". Lacity et al. (2009:140) conclude that researchers have found that offshore outsourcing poses considerably more challenges than domestic outsourcing. These are associated with various risks, some of which are related to the factors listed above. A very detailed systematic literature review of the reference theories and major topics in IT offshoring research in recent years is presented in Strasser & Westner (2015).

Papers on evaluation of risks in IT offshoring have only occasionally been published. That is contrasting with the fact that the topic of IT offshoring risks is ranked as the second most often researched topic in the empirical Information Systems offshoring literature according to Gonzalez et al (2013).

Risk areas represent organizational contexts that include many related risk factors, which together possess a threat to a software development project's success (Boehm, 1991). Research on IT offshoring risks is quite diverse. Outsourcing and offshoring risks can be explained with transaction cost theory (see Ngwenyama & Bryson, 1999). Chatfield and Wanniniaka (2008) have investigated IT offshoring risks and governance capabilities. The cost of risk in offshore systems development is explored in De Hondt & Nezlek (2009). The nature of offshoring and the dangers from it are analyzed in Hirschheim (2006), Herath & Kishore (2009) and elsewhere. A framework for managing IT offshoring including risk mitigation is provided in King (2008). A detailed analysis of risks in global software engineering is provided in Venter et al. (2012). An investigation of the effects of different relational norms on the link between behavioral risks and offshore software development success is presented in Matthew & Chen (2013). Most of the research on IT offshoring risks is from the client perspective (e.g. Abdullah & Venter (2012) and very few authors are treating this problem from a provider's perspective (e.g. Aundhe & Matthew (2009). Some papers integrate both perspectives on sourcing risk (e.g. Bunker et al., 2015). Most of the papers on offshoring risks are based on empirical analysis but there are also case studies on managing risk areas in IT offshoring (e.g. Persson & Schlichter, 2015). The above list of references dealing with aspects of offshoring risks and their management is by no means comprehensive and many more sources can be found in review papers like Verner et al. (2012).

The publications on IT offshoring risks are often dealing with several risks based on expert opinions (e.g. Davis et al. (2005), King (2008)). Sometimes research on this topic results in uncategorized large lists of risks like in Sakhtivel (2007) which makes their use in real decision making by practitioners difficult. Some papers deal with offshoring risks from the point of view of the client while others are dealing with IT offshoring risks from the point of view of the service provider (see Taylor,2005). Sourcing risks have been also explored from practitioner perspectives as in Bunker et al. (2015). Other previous research has focused just on IS development risks or on operational risks only.

According to Nakatsu & Iacovou (2009:57), the risks in IT offshoring are often analyzed in papers just at the level of checklists. We may point that such an approach does not take into account the relative importance of risks and provides little opportunity for analysis of risks for the purposes of their management in the context of a specific project.

Gonzalez et al (2013) summarize findings from the literature on IT offshoring but do not investigate the nature of the risk factors and how they can be used in decision making. Their findings show that Decision Making is ranked only ninth in the list of 13 research topics on IT offshoring and that it is the subject of only 8 papers out of a total of 127 included in their analysis (see Gonzalez et al., 2013). That indicates the need for more research on that topic.

While a few published papers deal with prioritization of risks in outsourcing using statistical methods (see Gandhi et al, 2012), there are no papers dealing with a systemic evaluation of the importance of risks in offshoring through the Analytic Network Process (ANP) (see Saaty, 2005), a multi-criteria decision making (MCDM) approach. ANP was previously applied to outsourcing risks from a client perspective by Keramati et al. (2013). However their model does

not consider offshoring risks and it is developed with the unattainable goal to generalize the results which is not possible as they are heavily context dependent. Those authors incorrectly consider that a limitation of their work. We claim instead that the strength of ANP is based on its results being relevant for risk modeling in the context of a particular software project and hence it is suitable as a tool for systemic prioritization of offshoring risks. The previous paragraphs summarize the main motivations of this research.

The *goal of this paper* is to provide a systemic framework for assessment of IT offshoring risks from the provider perspective based on the Analytic Network Process. The *contribution of the paper* is in the formulation of an ANP model of the IT offshoring risks from a service provider's point which was not reported previously in the literature and in its practical demonstration for evaluation of risks in a specific project context.

Typically risk management involves three steps (Ghadge et al., 2013): risk identification, risk assessment and risk mitigation. Risk mitigation issues are outside the scope of this paper. The next section proceeds with an analysis of what can be learned from past research on software risks associated with IT outsourcing, systems development and offshoring. It is followed in the third section by an attempt to address the second step above through the formulation of a systemic framework for ANP assessment of IT offshore outsourcing risks from a provider's perspective. It is followed by a demonstration of the use of the ANP model and a conclusion.

2. ON IT OFFSHORING RISKS

Risks in Information Technology represent a multifaceted research area that is closely related to other fields like IT failure (including project development and operational failure), project success etc. IT offshoring project risks may be applicable to all types of projects and on the other hand may be specific only to specific offshore outsourcing projects depending on their context. IT offshoring risks overlap also with risks in some global or distributed software development projects. Sometimes the notion of risks is replaced by the notion of barriers for software project success but the meaning of that is very similar to risks. IT risks may play a role only in specific project contexts and hence there cannot be a universal list of risks applicable to every situation. Therefore IT offshoring risks are a very complex notion related to the more general notions of IT risks, IT outsourcing risks, IT project success, IT project failure, global or distributed software development and IT operations. IT offshoring risks are important because their understanding and evaluation can lead to better chances for their mitigation.

We will deal in this section with the identification of the types of IT offshoring risks. One possibility is to take as a leading point the broader area of IT development and operations. Another option is to treat that question starting from the point of IT Outsourcing or a third one is to follow a more narrow perspective associated with factors that relate only to offshoring. We will explore each of these separately below.

Risks derived from research in software systems development

Software engineering risk management emerged in the 1980s and its principles were summarized in Boehm (1991) and several earlier publications by the same author. A good review on general IT risks can be found in Pfleeger (2000). Further insights on the nature of IT risks are provided in Bahli & Rivard (2005) and elsewhere.

The first empirically validated list of risk factors in software development projects was generated through a Delphi survey by Schmidt et al. (2001). They were grouped in 14 categories. The risk factors were shown by rank order and that was another major difference of those results from prior findings of other authors. These authors claim to contribute to the unification of research on risk management and software project management. While the large group of experts included in their Delphi study is a positive aspect of their project, it has a possible limitation in the fact that they came only from three countries.

Wallace et al. (2004) analyzed the existing literature on software development risks and have conducted multivariate statistical modeling of the types of risks which allowed them to reduce the number of relevant factors grouping them into seven categories: organizational environment risk, user risk, requirements risk, project complexity risk, planning control risk and team risks. Their work is valuable for uncovering the relationships between various groups of risks.

The most exhaustive investigation on risk factors in global software project management is probably presented in the detailed report by Verner et al. (2012). They analyzed 24 systematic literature reviews of global software development and generated a list of risk factors in 10 groups. However, no justification is provided for the way how the groups were chosen and their results do not have the empirical validation of the findings

of Schmidt et al. (2001). Research on software development risks has influenced work on outsourcing risks.

IT risks derived from studies of IT outsourcing

An early important paper by Earl(1996) considers the following types of risks in IT outsourcing: possibility of weak management, inexperienced staff, business uncertainty, outdated technology skills, endemic uncertainty as IT project development and operations have been always uncertain, hidden costs, lack of organizational learning, loss of innovative capacity, dangers of an eternal triangle involving the client, the outsourcing provider and the business analysts serving as intermediaries in the project, technology indivisibility, and fuzzy focus of outsourcing only on the supply side of IT and not on other aspects like generating new application ideas or harvesting the benefits of IT.

A more elaborate list of 18 outsourcing risk factors grouped in 10 categories is presented in Dibbern et al. (2004) which extends the work of Earl (1996) with results from several other authors from the field of Management and other areas.

Bahli & Rivard (2005) divided IT Outsourcing risk factors into two groups: (a) factors associated with the transaction (Asset specificity; Small number of suppliers; Uncertainty; Relatedness between business units and functions; Measurement problems), and (b) factors related to the client and the supplier (Degree of expertise with the IT operation; Degree of expertise with outsourcing).

Taylor (2007) used the work of Schmidt et al. (2001) as a starting point to develop a list of factors affecting outsourcing projects from the provider's perspective and gathered opinions from a group of 22 experts from ten organizations to generate a broader set of categories of outsourcing risks. Her framework includes 42 risk factors, differentiated by source—vendor risks, client risks, and third party risks—and type—project management,

Lacity et al. (2009) provide a much larger list of 28 IT outsourcing risks based on analysis of published research in journals. While such a list is more informative about the types of outsourcing risks it is not very practical for decision making because of the lack of grouping of the factors. This issue is related to the difficulty of humans to differentiate between more than seven plus or minus two objects as was found by psychologist George Miller in 1956, a fact used by Saaty in the late 1970s to propose some of the concepts for structuring decision problems with the Analytic Hierarchy Process (AHP) and its extension, the Analytic Network Process (ANP) (see Saaty,1990).

The most comprehensive catalog of outsourcing risks to date is presented in de Sà-Soares, Soares & Arnaud (2014). It is again based on analysis of previously published research. They create a very detailed list of outsourcing risks, undesirable consequences and customer-related negative outcomes from outsourcing with the hope that those are initial steps in creating a theory explaining outsourcing risks. Those however are not reflecting well the specifics of offshore software development which will be discussed more in the next subsection.

Risks derived from studies of IT offshoring

Various aspects of risks in outsourcing and offshoring were investigated by Tafti (2005). They are summarized as 15 factors in four groups: Loss of Enterprise Knowledge, Privacy and Security, Hidden Costs and Outsourcing Contract. Some authors like Davis et al. (2005) and King (2008) provide small lists of IT offshoring risks based on expert opinion or on speculation or anecdote evidence, a feature of many publications as noticed by Nakatsu & Iacovou (2009:58). The first empirically validated list of IT offshoring risks through a Delphi study was developed by Nakatsu & Iacovou (2009). They investigated also outsourcing and software development as well.

Nakatsu & Iacovou (2009) investigated the project management literature and generated a summary of IT general risk factors derived from it. That list consists of 24 risk factors categorized in six groups: Team-related (Staff turnover, Lack of team communication, Lack of required technical and business knowledge, Lack of motivation, Team conflicts); Organizational environment (Lack of top management support, Organizational politics, Stability of organizational environment, Changes in organizational priorities); Requirements (Original set of requirements is miscommunicated, Continually changing system requirements, Unclear system requirements); Planning and control (Lack of project management know-how, Poor planning of schedules and budget, Poor change controls, Failure to consider all costs); User-related(Lack of adequate user involvement, Failure to gain user commitment, Failure to manage end-user expectations, Conflicts between user departments) Project complexity (Difficulties with

integration, Large number of links to other systems, Processes being automated are complex, Inadequate understanding of new technology).

Using as a starting point Earl (1996) and other published sources, the same authors summarize 36 IT outsourcing risks in the following 11 groups: Client capabilities, Vendor capabilities, Vendor–client communications, Contract management, Strategic risks, Legal/regulatory, Security, Financial, Geopolitical, Firm reputation/employee morale, Technology risks, Noncompliance with embraced development methodologies, Incompatible development tools.

The above findings were used by Nakatsu & Iacovou (2009) as a baseline for their Delphi study on risk factors in IT offshoring projects which identified 25 factors applicable to IT offshoring. As a result, they identified the following unique IT risk factors that are special to offshore outsourcing:

- Language barriers in project communications;
- Cross-national cultural difference;
- Constraints due to time-zone difference;
- Unfamiliarity with international and foreign contract law;.
- Political instability in offshore destinations;
- Negative impact on image of client organization;
- Currency fluctuation.

Since their Delphi study produced also the rankings of the various risk factors, Nakatsu & Iacovou (2008:64) concluded that with the exception of language barriers in project communications none of these risks were ranked very highly in importance by the panel of experts. Such findings are valuable for gaining general understanding of risks in software development but they do not apply strictly to the context of a specific software project. While the results of Nakatsu and Iacovou (2008) provide valuable insights into the different types of risks in outsourcing and offshoring, their lists of risks are not very suitable for decision modeling as they have not provided groupings in categories.

A comprehensive list of 18 IT offshoring risks and risk mitigation practices is discussed in Sakhtivel (2007). Another feature of that research is the comparison of the level of risk in two extreme cases of IT offshoring – having a single vendor as an outsourcing provider and own subsidiary located overseas as the offshore developer.

Chatfield & Wanninayaka (2008) used also previously published research to generate a list of risk factors in IT offshoring that are in three groups: 22 client related risks, 20 Vendor related risks and 6 inter-firm relationship risks. Abdullah & Verner (2012) analyzed offshoring risks based on the published literature and analyzed them through qualitative data analysis on a number of cases. Most of the research on offshoring risks is from client's perspective with the exception of the next paper.

Aundhe & Mathew (2009) have investigated the risks in IT offshoring from the provider's perspective on the basis of the published literature and have validated them using data gathered in five case projects. They produce the following list of risks and context factors:

Table 1. IT Offshore Risk Factors from provider's perspective (Aundhe & Mathew, 2009)

1 Macroeconomic risks
Government policy and regulations
Exchange rate
2 Relationship specific risks
Changes in client's corporate structure
Client's experience in offshoring
Client culture
Asset specificity
Client size
3 Project specific risks
Schedule and Budget Management
Staffing
Requirements capture
Knowledge transfer
Client expectations management
Testing
4 Context factors (not risks)
Relationship Maturity
Nature of contract
Nature of service
Nature of client

Through the analysis of the above risks in five case studies the authors have concluded that there is a strong interaction between relationship specific and project specific risks. The context factors however do not influence macroeconomic risks and are used just for understanding of the risks. Most of the factors identified by Aundhe & Matthew (2009) are general outsourcing and systems development risks while the following items from Table 1 were defined specifically as offshoring risks:

- *Knowledge transfer* resistance by the foreign client is an important risk factor especially when the project is about downsizing;
- *Client culture* of the client that considers the outsourcing relationship just as a transaction, i.e. pay the fees and get the service, results in risks for the provider as greater cooperation is better;
- *Client sizes* as bigger clients have higher bargaining power.
- *Exchange rate fluctuations.*
- *Government policy to offshoring.*

Aundhe & Mathew (2009) have concluded that the group of Relationship risks affects the category of Project related risks and vice versa. They have found also that there is no interaction between the relationship risk factors while Project schedule and budget management is affected by poor client expectations management, ambiguity in requirements capture, uncertainty in staffing and the risk of resistance to knowledge transfer by the client. Their results do not show a way to evaluate the strength of the above mentioned relationships and hence the need to provide a tool for modelling of offshoring risk factors in the context of particular software project which is proposed in the next section.

3. ON A SYSTEMIC MULTI CRITERIA FRAMEWORK FOR ASSESSMENT OF IT OFFSHORING RISKS FROM THE PROVIDER'S PERSPECTIVE

The proposed framework for assessment of IT offshoring risks from the perspective of a service provider is systemic because it fulfills the criterion for systemicity that all factors need to be considered with their relevant inter-relationships in the context of the particular software project (see Midgley, 2011). The systemicity of the framework will be supported by the choice of the Analytic Network Process. Since the latter enables the modeling of interdependencies like those discussed in the Aundhe & Matthew (2009) paper, it is a more powerful approach than the Analytic Hierarchy Process (AHP), a Multi Criteria Decision Analysis (MCDA) method (see Saaty, 1990 and Saaty, 2005). The features of MCDA as a systemic approach were analyzed in Petkov & Petkova (1998) and some aspects of its application to the selection of activities to outsource and outsourcing providers are discussed in Petkov & Petkova (2010). More details on the theory of AHP and ANP, their applications and suitability for various problems can be found in Saaty (1990) and Saaty (2005). We will mention here only a few characteristics that support the claim that AHP and ANP support systems modeling:

- Both AHP and ANP support decision models that aim at prioritizing the factors, in our case IT offshoring risks. Hence the models created with them support the purposeful system of assessing along multiple criteria the relative importance of IT offshoring risks in the context of a specific project.
- AHP models a problem in the form of a hierarchy, a useful construct to handle the complexity in systems, while ANP is used to model problems with interdependent elements as is the case of assessment of IT offshoring risk factors.
- Both AHP and ANP allow the measurement of pairwise importance of the IT offshoring risk factors involved in the models using a ratio scale that can convert both quantitative and qualitative variables to numbers representing human judgment about the risks involved.
- ANP is implemented in several software packages that hide the complex mathematics of the method from the user. We used Super Decisions Plus.

Both AHP and ANP use expert judgment about the pairwise comparisons of quantitative and qualitative factors in a model using a scale defined in Table 2. Those can be expressed as crisp judgements by a single individual or as a consensus judgment of a group of experts.

Other possible extensions of comparison modes in AHP/ANP include interval judgements or fuzzy judgments which however increase considerably the amount of effort in evaluating an ANP model (see Saaty, 2005) and hence that reduces their relevance for practical decision making about risk evaluation.

As a result of using this scale we get ratios representing the expert judgments about the quantitative or qualitative factors included in an AHP/ANP. These are organized in a matrix of comparisons whose elements are reciprocal with respect to the main diagonal. The local priorities of the factors from the matrix of comparisons are the elements of the principal right eigenvector of the matrix of comparisons corresponding to its largest eigenvalue (Saaty, 1990). Up to this point the procedure of ANP is overlapping with the AHP.

Table 2. The AHP/ANP pairwise comparison scale (Saaty,1990)

Intensity of importance	Definition when comparing two factors in AHP /ANP
1	Equal importance of the factors
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extereme importance
2,4,6,8	Intermediate values

The steps in ANP modeling involve:

- The network structure in ANP allows to model dependencies among elements in the model. When these dependencies are among clusters in the network model they are called outer dependencies. Some clusters have loops within themselves indicating inner dependence (Saaty, 2005:121). Paired comparisons are needed for all connections in the model. If there are inconsistencies in the comparisons the software allows to improve the judgments that are contributing to the inconsistency index (defined in Saaty, 2005:28). If its value is below than 0.1, it is considered that the provided judgments are reasonably consistent and do not violate the transitivity principle (Saaty, 1990).
- The priorities derived from pairwise comparison matrices are each entered as a part of some column of a supermatrix. The supermatrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix. The next step is to weight the supermatrix with the weights of the criteria in the control hierarchy that relate the criteria used in the model to the overall goal. The weights of the elements in the model are obtained as the limiting values of the columns of the weighted supermatrix raised to high powers as was shown in Saaty (2005).

The details of the mathematics of ANP can be found in Saaty (2005). These are not provided for space reasons and because manual calculations of the results without supporting software are too time consuming from a practical point of view. The steps in formulating an ANP model are outlined in Saaty (2005:90-92) and also in the online tutorials for the Super Decisions software package available at: http://www.superdecisions.com/category/support/support-2/. More details on AHP/ANP can be found in Subramanian & Ramanathan (2012) and in Sipahi & Timur (2010).

The proposed framework for assessment of IT offshoring risks from the service provider's perspective is presented in figure 1 below.

Exploration of IT project context and its stakeholders
Expert evaluation of the project characteristics, the relationship between the client and the service provider, the macroeconomic environment and the specific project context factors from the provider's perspective
Build the proposed network model of IT offshoring risk factors with the Super Decisions software and if relevant adapt it by adding or deleting some factors
Pairwise assessment of the risks in the network model and their prioritization

Fig.1 Proposed framework for assessment of IT offshoring risks in a particular project context

The understanding of the project context in the first step of the framework is developed through analysis of the stakeholders and their interests along the considerations provided in Petkov, Petkova & Andrew (2013) and Aundhe & Mathew (2009). The second step involves data gathering and traditional systems analysis activities about the nature of the offshoring work to be analyzed along the list of IT offshoring risk factors defined in Table 1. The third step is based on expert formulation in the Super Decisions software of the

ANP model of offshoring risk factors from the point of the service provider as it is defined in Figure 2. If necessary the model may include additional risk factors. The last step involves the ANP assessment of the set of relevant risks for the specific project.

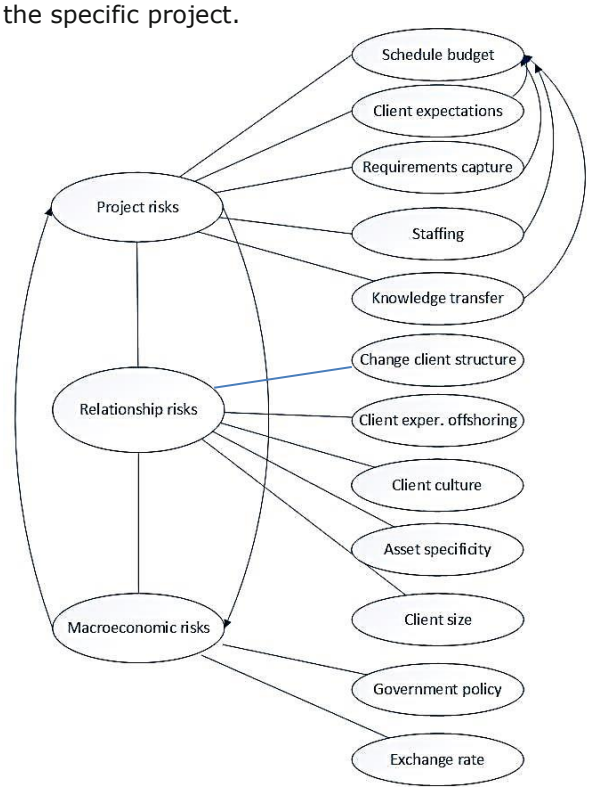

Fig. 2. Proposed ANP model of offshoring risk factors from the service provider's perspective (derived partly from the analysis of offshoring risks in Aundhe & Matthew (2009))

The ANP model includes the inner dependencies between project risks, relationship risks and macroeconomic risks within the Categories of risks cluster as well as the inner dependencies between schedule and budget management and the remaining Project related risk factors. It also shows no interference among the individual Relationship risk factors and the individual Macroeconomic factors following the previously mentioned findings of Aundhe & Matthew (2009).

Saaty (1990) recommends the use of Benefit/Cost, Benefit/Risk or Benefit/ [Cost*Risk] ratios as a way of modeling risk in AHP/ANP. Millet & Wedley (2003) reject that idea and propose the direct use of risks as criteria in the prioritization process or the use of risk as an adjustment factor for costs or benefits. The proposed framework for ANP evaluation of IT offshoring risks and the corresponding ANP model in Fig. 2 prioritizes offshoring risk factors directly following Millet & Wedley (2003). The next section illustrates the practical application of the model.

4. PRACTICAL ILLUSTRATION OF THE ANP EVALUATION OF IT OFFSHORING RISKS FROM PROVIDER'S PERSPECTIVE

The model for assessment of offshoring risks from the service provider perspective was applied to a practical problem involving a small Bulgarian software company that operates since 2007. It provides web 2.0 services, e-commerce and related software to Bulgarian, American and other clients. The company is closely linked to an US software service provider from its inception. Its president while on a visit to the US in December 2016 provided the evaluation of offshoring risks related to a specific project about a custom based e-commerce application for an US client that involved also interactive web page design and customer relationship management components. He was assisted by the first author in implementing the model with the Super Decision software.

Following the first step of the framework in Fig.1 the analysis began with a discussion of the project context factors: Relationship Maturity, Nature of contract, Nature of service and Nature of client. The project is of medium complexity and it was the first instance when the client company was working with this software provider. The client company was quite big and that was giving it leverage in the negotiations about the contract. The exchange rate fluctuations were not considered problematic as the Bulgarian currency is linked to the Euro and its exchange rate to the US dollar does not fluctuate like some other currencies. On the other hand, possible future changes in US government policy towards offshoring were considered as a moderate risk. It was considered (in similarity to the findings of Aundhe & Mathew, 2009) that Macroeconomic risks were far less important than Project and Relationship related risks.

The inner dependencies among the nodes in the Risk Categories cluster were assessed separately against each of them considered as a criterion. The pairwise comparisons matrices and the local priorities for them are listed next:

Comparisons with resp. to Project risks

	R. r.	M. r.	Local pr.
Relationship risks	1	9	0.9
Macroecon. risks	1/9	1	0.1

Comparisons with resp. to Relationship risks

	P. r.	M. r.	Local pr.
Project risks	1	8	0.888
Macroecon. risks	1/8	1	0.112

Comparisons with resp. to Microeconomic risks

	R. r.	M. r.	Local pr.
Relationship risks	1	2	0.667
Project risks	1/2	1	0.333

The comparisons of the risk factors related to the categories of Project risk, Relationship risk and Macroeconomic risks and the local priorities derived from those matrices are shown in the Appendix. The resulting priorities of the risk factors are in the last column of Table 3.

Table 3. IT Offshoring risks for the specific project from the service provider's perspective

Risk category	Prior.from limit super supermatrix	Priorities normalized in clusters
Macroeconomic risks	0.044	0.096
Project risks	0.205	0.442
Relationship risks	0.214	0.462
Offshoring risk factors		
Asset specificity risk	0.010	0.019
Changes client corp.str.	0.036	0.067
Client culture	0.025	0.046
Client expectations mgt	0.045	0.085
Client exp. in offshoring	0.056	0.104
Client size	0.088	0.164
Exchange rate fluct.	0.007	0.014
Government policy	0.037	0.069
Knowledge transfer	0.061	0.114
Requirements capture	0.118	0.220
Schedule, budget mgt.	0.036	0.068
Staffing fluctuations	0.017	0.032

The Appendix contains also the comparisons between risk factors with respect to Schedule and budget management reflecting the inner dependencies in the Project related risk factors shown in Fig. 2. The Super Decisions software generated the unweighted and the weighted supermatrices and produced the limit supermatrix which are in the Appendix as well. Since any comparison between both clusters of Risk categories and Offshoring risks in our model (see Fig. 2) is not needed because the risk categories are just groupings of the risk factors and they should not be compared to each other, the sum of priorities for each cluster is equal to 0.5 as is evident from the second column of Table 3. These are used to generate the normalized priorities (their sum is equal to 1) within each cluster that are shown in the third column.

The risks with highest priorities are the danger of ambiguity in Requirements capture (22%), Client size (16.4%), Knowledge transfer on the problem by the client to the offshore provider (11.4%), client experience with offshoring (10.4%) and client expectations management (8.5%). Hence it was necessary to keep close contact with the client in the continuous verification of the project requirements and about the progress on the project as well as applying other possible mitigation strategies for those risks.

The least important risks were as follows: Exchange rate fluctuations (1.4%), followed by Asset specificity risk (1.9%), Staffing fluctuations for the developer (3.2%). That was due to the relative staffing stability of the provider, the fact that it had previous experience with similar projects for other clients and because historically the exchange rate of the US dollar to the Euro is stable (since the currency of the country of the provider is linked to the Euro).

The expert that provided the pairwise comparisons for the assessment of the risks for the particular project considered here found the results of the model adequate as they delivered a more precise quantitative expression of the importance of the risks associated with the project in comparison to the traditional approach for evaluation of risks based on perceptions.

5. CONCLUSION

We analyzed in this paper what is known from past research on IT offshore outsourcing risks which is a highly important topic in IT offshoring according to Gonzalez et al. (2013). The understanding of those risks was developed through investigation of findings of previous publications on software development project risks, IT outsourcing risks and from studies of IT offshoring risks with a focus of the service provider perspective as it is researched to a smaller degree compared to risks from the client perspective and there are no papers on prioritizing their interactions in the context of a specific project. A justification is provided for the use of the Analytic Network Process (see Saaty, 2005) for modeling such risks in a framework that is proposed in this paper. The practical application of the model is illustrated on the problem for modeling risks for a specific IT offshoring project

from the point of view of an Eastern European outsourcing provider serving US clients.

The theoretical validity of the model is supported by the fact that it was developed following the findings on offshoring risks from the provider's perspective by Aundhe & Matthew (2009). It is using the Analytic Network Model (see Saaty, 2005) which has been applied successfully in various problems according to Sipahi & Timor (2010).

The proposed framework for assessment of IT offshoring risk factors from the service provider perspective in the context of a particular project can be used for better understanding and management of risks in practice. To the best knowledge of the authors there is no published account of a systemic ANP framework for prioritizing of risks in IT offshoring risks from the provider perspective and hence the theoretical contribution of this paper.

Possible directions for further work include the practical application of the ANP framework for modeling and prioritizing of IT offshoring risks in additional situations developed both from the client and provider perspective. Another possibility is comparing the results from ANP models of offshoring risks with those obtained through unstructured text analysis as in Abdullah & Verner (2012), or through using Bayesian Networks or another technique for modeling of relationships between risks. The proposed framework and the corresponding Analytic Network Model are a step in improving the understanding of IT offshore outsourcing risk factors from a service provider's perspective.

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8. Appendix: Further results from the ANP model of offshoring risks produced with the Super Decisions software

Table A1 Pairwise Comparisons of the risk factors related to Project risks

	C. e.	K. t.	R. c.	S. b.	S	Local priorities
Client expectations	1	1/3	1/4	1	1/3	0.11621
Knowledge transfer		1	1/3	2	4	0.23906
Requirements capture			1	2	6	0.42161
Schedule & budget mgt				1	7	0.17787
Staffing					1	0.04525

Table A2 Pairwise Comparisons of the risk factors related to Relationship risks

	A.s.	C.c.s.	C. c.	C.e.o.	C.s	Local priorities
Asset specificity	1	1/4	1/3	1/5	1/6	0.04718
Changes in client struct.		1	2	1/3	1/2	0.16728
Client culture			1	1/2	1/3	0.11561
Client exper. offshoring				1	1/3	0.25991
Client size					1	0.41002

Table A3 Pairwise Comparisons of the risk factors related to Macroeconomic risks

	E. r.	G. r.	Local priorities
Exchange rate fluctuations	1	1/5	0.16667
Government regulation to offshoring		1	0.83333

Table A4 Pairwise Comparisons of the risk factors related to Schedule & budget management as a result of the inner dependencies within the Offshoring risks cluster

	C. e.	K. t.	R. c.	S	Local priorities
Client expectations	1	3	1/2	2	0.29545
Knowledge transfer		1	1/2	2	0.16774
Requirements capture			1	4	0.42969
Schedule & budget mgt				1	0.10742

Table A5. Offshoring risks evaluation unweighted supermatrix (part1)

	Risk categories			**Various risks**		
	Macroec.	Project ris	Relationsh	Asset spe	Ch. Cl.str.	Cl. Culture
Macroeconomic risk	0	0.1	0.11111	0	0	0
Project risk	0.33333	0	0.88889	0	0	0
Relationship risk	0.66667	0.9	0	0	0	0
Asset specifity risk	0	0	0.04718	0	0	0
Changes in client corporate str	0	0	0.16728	0	0	0
Client culture	0	0	0.11561	0	0	0
Client expectatations	0	0.11621	0	0	0	0
Client experience in offshoring	0	0	0.25991	0	0	0
Client size	0	0	0.41002	0	0	0
Exchange rate fluctuations	0.16667	0	0	0	0	0
Government policy	0.83333	0	0	0	0	0
Knowledge transfer	0	0.23906	0	0	0	0
Requirements capture	0	0.42161	0	0	0	0
Schedule and budget managem	0	0.17787	0	0	0	0
Staffing	0	0.04525	0	0	0	0

Table A5. Offshoring risks evaluation unweighted supermatrix (Part 2)
Various risks (continued)

Cl.expecta	Cl.ex.offsh	Client size	Exc. rate f	Gov.policy	Knowl. Tr	Req.cap	Sch.budge	Staffing
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0.29545	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0.16744	0
0	0	0	0	0	0	0	0.42969	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0.10742	0

Notes:

- The above table is in two parts for page space reasons.
- The priorities in the weighted supermatrix are all equal to half of the values in Table A5 as the two clusters (Risk categories and Offshore risks) have the same weight.

Table A6. Offshoring risks evaluation – the limit supermatrix (part1)

	Macroec.	Project ris	Relationsh	Asset spec	Ch. Cl.str.	Cl. Culture
Macroeconomic risk	0.0443	0.0443	0.0443	0	0	0
Project risk	0.2051	0.2051	0.2051	0	0	0
Relationship risk	0.21412	0.21412	0.21412	0	0	0
Asset specifity risk	0.0101	0.0101	0.0101	0	0	0
Changes in client corporate str	0.03582	0.03582	0.03582	0	0	0
Client culture	0.02476	0.02476	0.02476	0	0	0
Client expectatations	0.04539	0.04539	0.04539	0	0	0
Client experience in offshoring	0.05565	0.05565	0.05565	0	0	0
Client size	0.0878	0.0878	0.0878	0	0	0
Exchange rate fluctuations	0.00738	0.00738	0.00738	0	0	0
Government policy	0.03692	0.03692	0.03692	0	0	0
Knowledge transfer	0.06125	0.06125	0.06125	0	0	0
Requirements capture	0.11782	0.11782	0.11782	0	0	0
Schedule and budget managem	0.03648	0.03648	0.03648	0	0	0
Staffing	0.01712	0.01712	0.01712	0	0	0

Note:
Part 2 of Table A6 is not provided here for space reasons as all its columns contain zeroes just like the last three columns in part 1 of the table. Note that non-zero columns in the limit supermatrix in ANP have the same elements as are the first three columns here. They provide the priorities of all the elements in the clusters of the ANP model.