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Global Perception of Sustainable Construction Project Risks

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Abstract

Sustainability goals move projects away from narrowly focused traditional management oriented ambitions of time, cost and quality, giving attention to economic, environmental and social impacts of construction projects. The recent literature identifies the critical project delivery attributes influencing sustainable building and infrastructure project outcomes as: trust and collaboration between key project participants, their commitment to sustainability, their early involvement and contract conditions. This paper presents results of the still ongoing study which is in relatively under-researched area and examines the global perception of sustainable Construction Project Risks. The survey goals were to compare different stakeholders' evaluation of risks and stakeholders influence on project success. Risk was defined as an implication of uncertainty that could potentially impact project goals, either positively or negatively. Opposite of hypothesis, which was that different stakeholders will prioritize risk sources differently, the findings suggest there is no significant discrepancy between the perceptions of different stakeholders about the sustainable project risks.

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Keywords: Sustainable construction projects; Risk Identification; Stakeholders

1. Introduction

Success in a construction project has been regarded as achieving project objectives, which traditionally have been provision on time, on budget, of a required performance or achievement (Williams 1995). Through the last few decades, from the UN Summit on Environment and Development in 1972, over the 'Agenda 21', which

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appeared at the UN 'Earth Summit' in 1992, the growing concerns for protecting the environment for the future generations produced sustainable development concept (IISD 2012). Sustainable development concept is a way to express society's demand for all aspects of decisions to be taken into account and it is a modern expression of the ambition to act responsibly, fairly, effectively, efficiently, sensitively, and with a view to the long term (FIDIC 2012). Although in contemporary research, there are additional areas proposed, the three basic areas of sustainability are economic, social and environmental aspect (UN 2002). In 1994 the concept of sustainable construction was born at a tactical level in the building sector and in civil engineering. New targets for projects were added to the common triple objectives (Fernandez-Sanchez and Rodriguez-Lopez 2010) to move projects away from the narrowly focused ambitions, which can potentially be optimized to the detriment of other important parameters such as robustness and societal, environmental and economic enhancement (FIDIC 2012). Examples of construction project sustainability aspects are, for economic effects: life cycle costs, cost-benefit of society, costs incurred by users; environmental effects are those on soil, air, water, biodiversity, energy consumption, waste, and social are effects on culture, accessibility, participation of all actors, security, social integration (FIDIC 2004).

Construction project involve numerous stakeholders, long production durations, an open production system, entailing significant interaction between internal and external environments (BS 6079-4:2006). It also has other unique attributes and such organizational and technological complexity that causes great amount of risks (Zou et al. 2007). PMI (PMBOK 2008) defines risk as an uncertain event or condition that, if occurs, has a positive or a negative impact on at least one project objective. In ISO 31000 Risk Management standard (2009) and in BS 6079-1 (2010), risk is defined as the 'effect of uncertainty on objectives'. Even before introducing sustainability goals in construction industry, it is claimed that construction is exposed to more risk and uncertainty than perhaps any other industry sector (Flanagan & Norman 1993).

Managing risks in construction projects has been recognized as a very important process in order to achieve project objectives (Zou et al. 2007). A lot of extensive researches have been undertaken in the field of risk management for construction projects recently. Major outcomes of these attempts are the identification of the project objectives related risks and the project phase related risks (Zou et al. 2007). There is little evidence of researches emphasized on the two-edged nature of risks – threats and opportunities (Bryde and Volm 2009, Zou et al. 2007, Chapman and Ward 2003). The focus of the studies is rather on the threats, i.e. negative impacts with specific risks being described exclusively in negative terms and also on events and conditions as known unknowns. Such a focus does not project the message that risk is more than threat (Bryde and Volm 2009) and can result in a lack of attention to uncertainty, which is proven by no common understanding as to what it is, in PRM literature (Perminova et al. 2008). The terms 'risk' and 'uncertainty' are often used in an interchangeable manner, but there is a formal difference between the two. In the plain English sense of 'lack of certainty', uncertainty is in part about 'variability' in relation to performance measures but also about 'ambiguity' associated with lack of clarity, lack of data, lack of detail, lack of structure to consider issues, known and unknown sources of bias (Ward & Chapman 2003). Uncertainty implies that either all the alternative possible outcomes cannot be identified, or that no probability can be attached to the alternative possible outcomes (Terje et al. 2011). In other words it is when the established facts are questioned and thereby the basis for calculating risks in the narrow sense (known negative events) or opportunities (known positive events) is questioned (Perminova et al. 2008). Since the definition of risk becomes 'the implications of uncertainty about the level of project performance achievable', we need to move focus from one of the products – risk management to the process – uncertainty management (Ward & Chapman 2003). With this definition, managing project risk and related uncertainty implies searching for and exploiting opportunities to enhance project performance that include synergies between the interests of different parties that may not be fully understood, ambiguity from all other sources, and the way uncertainty can accumulate. (Ward and Chapman 2008). Other products of uncertainty management are enhanced communications, more focus on project objectives, more focus on value analysis issues, and a range of widely appreciated spin-offs which are valuable in their own right (Ward & Chapman 2003). All of these products of uncertainty management are very desirable attributes for sustainable project to be successful, as it is showed further.

This paper seeks to explore and compare project stakeholders perception of uncertainties as sources of risk affecting success of sustainable construction project. Perception of sources of risks is compared for sustainable and traditional projects. Also, the perception of different stakeholder influence on project success is examined. The

remainder of the paper is structured as follows: first we outline the conceptual relation between project sustainability and uncertainty knowledge area; then we develop a research question through a salient literature review; next we set out the method employed for the survey; thirdly, we present the findings of the survey; the findings are then discussed, followed by some concluding remarks, limitations and areas for further work.

2. Sustainability and uncertainty relation in a construction project

Sustainable projects are followed by uncertainty in different means. Williams (1995) stated: “One aspect of the future is obvious: all new construction projects will be accomplished in an increasingly complex technical, economic, political and social environment”. Nowadays, it is confirmed that successful delivery processes planning, design, construction, and operations for sustainable projects are generally more complex and have more stakeholder interactions than delivery processes for their traditional counterparts (Lapinski et al. 2006, FIDIC 2012). Knowing that stakeholders are namely a major source of uncertainty in all stages of the Project Life Cycle (Ward & Chapman 2008) and that the complex processes for delivering sustainable projects are often unfamiliar to them (Klotz & Horman 2010), uncertainty and risk management, especially in relation to stakeholders becomes very significant for sustainable projects. Stakeholder-related uncertainty for sustainable project should, as for traditional one, encompass who the relevant stakeholders are and how they can influence a project (Ward & Chapman 2008). From an uncertainty management perspective, the purpose of defining and managing stakeholders is to reduce threats to project performance, and to pursue opportunities for Pareto improvements in the nature of project activities and the ultimate outcome of a project. (Ward & Chapman 2008).

Collaborative nature of projects, which is essential for success of sustainable projects (Klotz & Horman 2010) – specialization and the need to communicate with and between experts increases both costs and uncertainties. When sustainability issues are added to the mix of usual business practice of design and bidding, this creates more uncertainty for managers (Demaid & Quintas 2006). Managers’ attitudes and understanding of uncertainty do not create or eliminate it but the project deliveries could be highly affected by it (Perminova et al. 2008).

Goals for sustainable development tend to focus on broad problems, such as global warming, biodiversity, access to fresh water, and materials and energy use. While this whole society focus is absolutely essential, it makes it difficult for project owners to clearly specify the requirements for sustainable development (FIDIC, 2004). Working in local contexts that result from different national and international priorities for sustainability and different national business ethics produce an industrial world that is complex and liable to rapid and unpredictable change (Demaid & Quintas 2006). Sustainability is not responsible for this complexity or project participants trade-offs, rather it brings them together so that informed decisions can be made early (FIDIC 2012). Bryde and Volm (2009) examined the perceptions of owners about risks in German construction projects and confirmed practitioner support to conceptual developments in project risk that emphasize the management of uncertainty, rather than just specific events. The responses suggest that for owners, definitions of risk imply something unpredictable, uncertain or unknown. This confirms the views of Ward and Chapman (2003) and Perminova et al. (2008) that project risk is about managing uncertainty, since uncertainty is a necessary condition for risk.

In relation to sustainability assessment, there are two types of uncertainties: stochastic uncertainty refers to natural variability of the system, fundamental uncertainty is the inability to predict due to lack of knowledge about the system (Ness et al. 2007). By visualizing phenomena and highlighting trends, sustainability indicators simplify, quantify, analyze and communicate otherwise complex and complicated information (Singh et al. 2009). As the United Nations Commission on Sustainable Development (CSD) observed, “We measure what we value, and we value what we measure.” However, there is uncertainty and subjectivity when selecting indicators, because of a great disparity of criteria, dimensions and indicators without the existence of a global consensus for selecting them, the high degree of arbitrariness revealed by the indicators and the great differences in the number of indicators (Fernández-Sánchez & Rodríguez-López 2010). In the same research, the other problems of construction project sustainability assessment, cited from the various literatures are stated: the lack of participation of all the stakeholders involved in the project life cycle; the number of indicators that generally should be small and in the existing systems of indicators is very high and that there is the relative importance of the environmental area compared to social and economic areas.

Finally, one would think that, since so much effort by different organizations and institutions is put on methods and tools for delivering sustainable projects in construction, sustainable projects are delivered more efficiently than traditional ones. On the contrary, researches show that sustainable projects, similarly to traditional suffer from discrepancies between planned and performed achievement of project goals (Flyvbjerg et al. 2003, Oates & Sullivan 2012).

3. Studies of perception of project risks and attributes for success

In several researches, similarities between developments in the field of sustainability and developments in the field of risk have been proposed. Demaid and Quintas (2006) discuss fundamentally tension between understanding knowledge in relation to sustainability creation and use, and the drive to capture processes in formal documents and systems. They compare it with risk knowledge arena, since risk has the advantage of being further down the evolutionary line and both fields have strong dimensions of formal rules and socio-economic behaviors. They conclude that if formal procedures for risk and value management can be built into the management processes for major projects then sustainability issues can also be integrated into core procedures, rather than treated as additional, secondary constraints (Demaid & Quintas 2006).

Results of some researches that explained attributes of successful sustainable projects are shown in table 1. Although different methodologies were applied, these researches did not consider uncertainty aspect of attributes as sources of risks and did not consider all internal and external aspects of uncertainties that could affect project success achievement. However, these key success factors were analyzed in order to identify potential risk sources.

Table 1. Examples of Delivery Process Attributes Recognized as Critical to Sustainable Projects (adapted from Klotz and Horman (2010))

Attribute and description	Project phase(s)	Reference
Team members having previous experience with one other, efficient information exchange, trust and collaboration, team members commitment to sustainability	Planning	FIDIC (2004), Lapinski <i>et al.</i> (2006), Enache-Pommer and Horman (2009), Chinowsky <i>et al.</i> (2008), Swarup <i>et al.</i> (2011)
Owner commitment to sustainability, owners' choice of project delivery systems , project team procurement, contract conditions	All (esp. in Planning)	Gould (2005), Ling <i>et al.</i> (2004), Korkmaz <i>et al.</i> (2010)
Early involvement of key project participants	Planning	Riley and Horman (2005)
Design collaboration, Integrated design	Design	Riley <i>et al.</i> (2004), Korkmaz <i>et al.</i> (2010), Swarup <i>et al.</i> (2011), Kovacic (2012)
Emphasize on superior planning, design, and construction processes	All	Lapinski <i>et al.</i> (2006)
Hold a design charrette at the beginning of design	Design	Kibert (2004), FIDIC (2004)
Apply life-cycle assessment and energy modeling	Design	NIBS (2006)
Emphasize in bid documents the contractors' roles in sustainable project goals and documentation	Construction procurement	USGBC Research Committee (2008)
Require sustainability training for on-site workers	Construction	Deane (2005)
Involve building operators in the commissioning process	Construction, Operation	PGGGC (1999)

Researches that have examined perception of risks among different groupings were much more based on threats (Andi 2006, Bu Qammaz *et al.* 2009, de Camprieu 2007, Thomas *et al.* 2003, Zayed *et al.* 2008, Zou *et al.* 2007) and only some of them examined risks on project sustainability goals (de Camprieu, 2007, Zou *et al.* 2007), staying mainly on environmental aspects, as also underlined in research of Fernández Sánchez and Rodríguez-López (2010).

The findings of a study on owner's perception of risks of Bryde and Volm (2009) highlight the usefulness of taking a whole project life cycle view, incorporating planning, construction, operation and disposal. A further

study that would involve owners from different nationalities, including Western and non-Western is suggested as useful.

Although there are prior researches highlighting differences in perceptions between professional groups, such as owners and contractors (Thomas et al. 2003, Andi 2006, Wong and Hui 2006), a further research with a focus on project participants to identify their perceptions of risk and uncertainties throughout whole life cycle has also been recommended (Bryde and Volm 2009).

As seen, uncertainties as risk sources are, for sustainable projects, very important issue though challenging concept to define, understand and ultimately to manage. This is mainly due to the fact that risk often means different things to different people or institutions (Remenyi & Heafield, 1996). Every stakeholder has his own different meaning even to project success. Stakeholders always have distinct vested interests in a particular project and therefore the perception of success may also vary across various stakeholders (Bryde & Brown 2005). It is, therefore, not surprising that different participants think differently while they analyze the performance of a project. Hypothesis of this paper is that different stakeholders of construction project have different perception of project success, and therefore of related risks.

Our intention was to examine global perception of different stakeholders about uncertainties as sources of risks that could affect both positively or negatively sustainable project goals through the project life cycle. Idea was to compare the perception of sources of risks for sustainable and traditional projects for different stakeholders. Additionally, the perception of different stakeholder influence on project success was to be compared.

4. Research method

4.1. Questionnaire design and distribution

Data for this research were primarily gathered through a questionnaire. Supplement interviews were also conducted to crosscheck the results of the survey and to gain additional information. The adequacy and readability of the questionnaire was tested with a pilot study. Ten experts were involved in the pilot study, and their comments were incorporated into the final questionnaire. The questionnaire was designed with introduction and five major parts. In introduction, explanation of terms, procedure, survey structure and confidentiality statement were given. The first part of the survey asked for general information of the respondents. Part two and three were to explore presence of construction project management practice for project with traditional goals and for projects with sustainable goals, respectively. Part four examined the traditional project risks and stakeholders influence, while part five examined sustainable project risks and different stakeholder influence. In both part four and five, respondents were required to express their perception toward the importance of 27 sources of risks, that could affect either positively or negatively traditional and sustainable project success.

The predefined risk list for part four and five was, through iterative process of literature review, initial forming and construction professionals feedback, compiled from previous similar studies of Adams (2008), Andi (2006), De Camprieu (2007), Thomas et al. (2003), Mikic et al. (2012), Zou et al. (2007), but applying approach of formulating risk as uncertainty, recommended by Bryde and Volm (2009). Hence, for evaluating the importance of specific uncertainties as risk factors, offered in the risk list, expression was used: "Please evaluate how much each of the following risk factors affects both positively or negatively outcomes of the sustainable construction project". The similar question was for traditional project outcomes. From the stated reason of great disparity of sustainability indicators, sustainable project goals were not defined more precisely than project economic, social and environmental effects, but examples were given to explain each of the aspects. For the purpose of defining additional, specific sources of risks for sustainable projects, the literature referenced in Section 3, addressing the attributes of sustainable project success is consulted as well. Risks in the offered predefined risk list were sorted into five categories: Market Risks, General Project Risks, Risks in Feasibility and Design Phase, Risks in Construction Phase, Risks in Operating Phase, as shown in table 2. In the survey, Risk list was additionally described. Apart from stated literature, this type of risk division was partly also based on chronological risk classification, suggested by Bunni (2003). In the question for determining influence of different stakeholders on project success, respondents were pleased to mark the level of influence of the given stakeholders on traditional

construction project delivery achievement – in terms of cost, time, quality in part four and on sustainable construction project delivery achievement in part five of the survey.

In distributing the questionnaires, professionals and experts from construction project management area and related fields were contacted directly and through scientific and professional associations. Since the intention was to examine global perception of stakeholders, survey participants comprised of construction or civil engineers, mechanical engineers, electrical engineers, architects, economists, lawyers and the other with professional relation to construction projects from 56 countries, from all the continents. 311 respondents were contacted directly. The survey is still ongoing, but so far, 146 responses were received in total in a two months period. 115 responses were complete, received from all 56 countries and only complete responses were analyzed.

4.2. Approach of analyses

In this paper, results of parts one, four and five of the survey are presented. In the part one, respondents were asked about their profession, professional experience, types and values of construction projects they have taken part in. In part four, they were asked to mark the level of influence of the given stakeholders on traditional construction project delivery achievement. Also, the risk factors list was offered to evaluate the impact of each risk factor in relation to traditional project goals. In part five, the respondents were asked questions analogue to those in part four, but in relation to sustainable project outcomes (risk factors as uncertainties with potential positive and negative consequences to project economic, environmental and social performance).

A number of authors (e.g. Andi 2006, Baccarini 2001, Zhi 1995) adopted probability-impact method of risks consideration and analysis. Since uncertainty implies that no probability can be attached to the alternative possible outcomes (Terje et al., 2011), in this research, only impact was offered for evaluation by respondents, on a scale from 1 (very low) to 5 (very high). The respondents perceptions of impact were then averaged and compared. A descriptive comparison is given, portrayed graphically for both questions. Both the reliability and the validity of the survey data were checked, where methodology of Andi et al. (2006) was applied and minimum response rate has been considered and pointed in analysis of specific answers.

5. Results and discussion

54% of the respondents were construction or civil engineers, 8% mechanical engineers, 12% electrical engineers, 9% architects, 3% economist, 1% lawyer and 13% other. 34% of the respondents confirmed they have worked in Design Company, 43% in Contractor Company, 31% in Client Company, 35% in Consultant/Engineer company, 7% in maintenance company, 15% in state or local administration, 26% in education and 10% others. Around 74% of the respondents have participated in building projects, 20% in Industrial and 62% in Infrastructural projects. The criteria of minimum responses were fulfilled for contractors, designers, clients and consultants. Regarding project types, enough responses were received for buildings and infrastructure. Therefore, when considering respondents subgroups results, only these subgroups perceptions were analyzed and presented. The highest value project was, for 35% of the respondents, more than 10 million USD, for 15% of respondents was in the range of 5 – 10 M USD, for 34% in range of 1 – 5, and for 16% it was less than 1 M USD.

In table 2, the results of part five of the survey are presented. The risk list is given, with impact means as evaluated by all respondents in the third column. In further columns risk ratings are given, as evaluated by different stakeholders and as evaluated by respondents who participated on building and infrastructure projects separately. For better visualization, the rating is given (1 – 3) for the three risk factors with the highest impact means in each category.

Table 2. Risk factors ratings by different stakeholders' perception

Risk Category	Risk Factor No. and Short Description	Rating of Risk Factors
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		General	By Client	By Designer	By Contractor	By Engineer	For Buildings	For Infrastruct.
General Market Risks	1. Political conditions	3.21	1	3	1	2	1	1
	2. Economic conditions	2.60		1	3	3	3	3
	3. Legal conditions	2.69	3	3				
	4. Corruption presence	3.06	2	2	2	1	2	2
General Project Risks	5. Project Complexity	2.70	1	1	1	1	1	1
	6. Team Integration	2.50	3	2	3	3	3	2
	7. Stakeholder Collaboration	2.60	2	3	2	2	2	3
Risks in Feasibility and Design Phase	8. Client skills	2.40						
	9. Prefeasibility/Feasibility studies	2.76	2	2	2		2	2
	10. Quality of initial surveys	2.30		1	3	3	3	3
	11. Brief and Terms of Reference	2.50		3			2	
	12. Design contract parameters	2.59	3	3		3		
	13. Designer skills	2.83	1	1	1	1	1	1
Risks in Construction Phase	14. Ground conditions	2.43						
	15. Design quality	2.72		2		3		3
	16. Contract adequacy and elements	2.66		3				
	17. Contractor skills	2.85		1	2	3	2	2
	18. Resource issues	3.09	2	2	3			
	19. Financial resources	3.10	1	1	1	1	1	1
	20. Engineer skills	2.89	3		2	2	3	2
	21. Expropriation	2.23						
	22. Climatic conditions	1.70						
	23. Accidents on construction site	2.17						
Risks in Operating Phase	24. Force Majeure	2.32						
	25. Climatic uncertainties	2.17	2	3	3	3	3	3
	26. Resource scarcity	2.32	1	1	2	2	2	2
	27. Human performance	2.32	1	2	1	1	1	1

As we see, in the first category, only Client and Contractor don't see the Political conditions as a risk factor with the highest impact. For Client it is Economic Conditions, for the Contractor Corruption Presence. A political condition is also the risk factor with the highest impact in the list, which proved the need for this category of risks to be included in the survey. From general project risks, for all the stakeholders the highest impact has Project Complexity, which is in line with the conclusion that successful sustainable delivery processes are generally more complex and have more stakeholder interactions than delivery processes for their traditional counterparts (Lapinski et al. 2006) and that such nature of projects increases uncertainties (Klotz and Horman 2010). The highest mean in Feasibility and Design phase have Designer Skills, so insisting on Designers with experience, integrated design and design collaboration ((Riley et al. 2004, Demaid and Quintas 2006, Swarup et al. 2011) is confirmed opportunity for performance improvement. In Construction Phase, Financial Resources and Resource Issues were considered as having the highest impact on project sustainable goals. This perception is similar to what states Klotz and Horman (2010) and FIDIC (2012) that sustainable projects are perceived as more costly and that one of important risks to be considered in future is Resource scarcity and availability. This risk is also with the highest impacts for Clients in Operating phase, but for all the others stakeholders and generally, in the Operating phase, it is Human performance. That proves that uncertainty associated with human performance is an inevitable source of risk during the operation phase, not only for infrastructure, as suggested in FIDIC (2012).

When comparing impacts of risk sources for project traditional goals achievement with risk sources for sustainable project outcomes (figure 1), one may notice that two the most highly evaluated risk factors in each category are the same. Risks with much lower impact mean are: Legal Conditions, Contractor Skills, Force Majeure, Expropriation, Accidents on Construction Site, Resource Scarcity and Climatic Uncertainties. Risks with significantly higher impact on traditional project outcomes than on sustainable are: Economic Conditions, Quality of Initial Surveys, Engineer Skills.

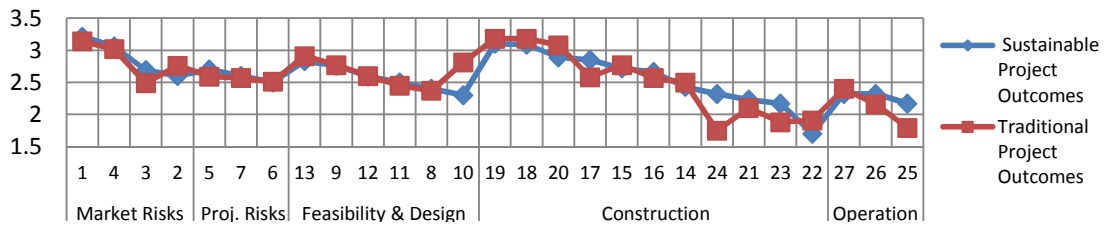


Fig. 1. Means of risk factors impacts on project traditional and sustainable outcomes

By the level of influence on project outcomes, stakeholders are generally, when considering all respondents answers, for project traditional outcomes sorted the same way as for sustainable outcomes. The order, starting from the highest is: Client, Designer, Contractor, Engineer, Planner, User/Operator, and Community Representatives. However, Contractor's, Designer's and Engineer's influence are evaluated with a more narrow range for project sustainable outcomes than for traditional. It is interesting to notice the difference between perceptions of different stakeholders (figure 2). For influence on traditional project outcomes, each stakeholder's view confirms the order stated for general results. Contractor's evaluation deviates the most, putting Client on the high first place. For projects sustainable outcomes (figure 2) we see two main differences. Firstly, there is much less dispersion of different stakeholders' evaluation. Secondly, the influence of all stakeholders, except the Client, is evaluated with higher means which produce gentler slope of the polyline. All four stakeholders, whose evaluation we look into, evaluate that Designer, Contractor and Engineer have almost equal influence. This confirms that team collaboration and integration are more important for achieving project sustainability goals than for traditional goals, as suggested by Riley et al. (2004), Korkmaz et al. (2010) and Swarup et al. (2011). By the view of Client and Contractor, Engineer's influence takes the second place, after the Client's. This is probably because practical knowledge about sustainability, as a relatively new subject, is still mainly distributed by Engineers/Consultants (FIDIC 2004, FIDIC 2012). Opinion of respondents who worked as Engineers/Consultants, similarly to the opinion of Designer is that Designer comes at the second place, after the Client, followed by the Contractor. The influence of Planner, User/Operator and Community services on sustainable project delivery achievement is rated much higher than on traditional project delivery achievement.

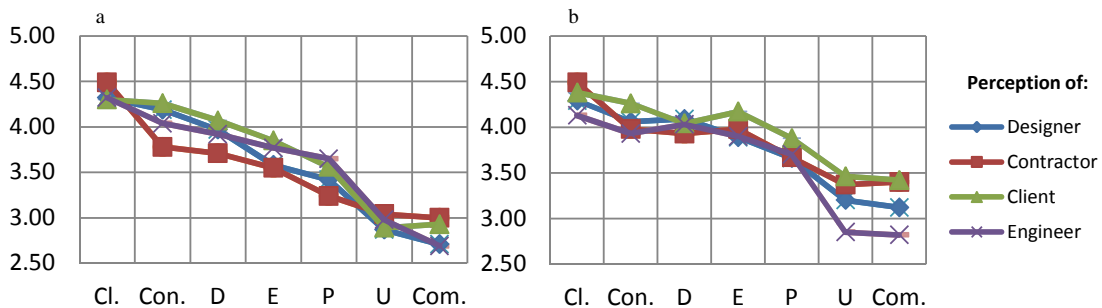


Fig. 2. Means of the level of influence of Client (Cl.), Designer (D), Contractor (Con.), Engineer (E), Planner (P), User/Operator (U) and Community Representative (Com.) on: (a) project traditional outcomes; (b) project sustainable outcomes

6. Conclusion and recommendations

In this paper, results of the survey of perception of different stakeholders on risk factors for traditional and sustainable project delivery achievement are presented. Risks are considered as implications of uncertainties, with possible both positive and negative impacts on project goals. Also, stakeholder perception is examined of how much the sustainable and traditional project delivery achievement is influenced by different stakeholders.

Results reveal that the risk with the highest impact on project outcomes is Political Conditions, the risk and the attribute not considered in many sustainable project researches. Through project life cycle phases, risks with highest impact are Project Complexity, Designer Skills, Financial Resources, Resource Issues and Human Performance. Although the hypothesis was that perception of different stakeholders might be different, they all extracted the same highest impact risks, with some discrepancies in evaluation of the second and third places inside risk categories. A conclusion is that although different stakeholders might define goals and success on project differently and they are engaged in different project life cycle phases, they all share perception of the sources of highest risks within phases.

By the level of influence on project outcomes, stakeholders are both for project traditional and sustainable outcomes, sorted, from the highest influence, as: Client, Designer, Contractor, Engineer, Planner, User/Operator, and Community Representatives. However, the influence of those stakeholders on sustainable project outcomes is more equally distributed. This, similarly to recent researches, underlines once more the importance of communication, collaboration and integration for achieving project sustainability goals.

Limitation of this research is that not all the stakeholders view could be analyzed. This mainly because the received data did not allow statistical representation, except for four stakeholders. However, with the goal to receive statistically better representation of global perception of the issues considered, the survey will be continued beyond this paper.

Since intention here was to capture global perception, there was not enough data to compare the risk perception of stakeholders across different countries. In order to do so, it is recommended to conduct perhaps a similar research in several countries, with a larger sample size. Interviews and content analysis are also recommended for future studies to perform qualitative analysis and receive deeper understanding of stakeholders' perception of risks.

References

- Adams, K. F. (2008). Risk Perception and Bayesian Analysis of International Construction Contract Risks: The Case of Payment Delays in a Developing Economy. *International Journal of Project Management*, 26, 138–148.
- Andi. (2006). The importance and allocation of risks in Indonesian construction projects. *Construction Management and Economics*, 24, 69–80.
- Aven, T., Renn, O., & Rosa, A. E. (2011). Review On the Ontological Status of the Concept of Risk, *Safety Science* 49 (2011) 1074–1079
- Baccarini, D., Archer, R. (2001). The Risk Ranking of Projects: A Methodology. *International Journal of Project Management*, 19, 139-145.
- British Standards BS 6079-1 (2010). Project management – Part 1: Principles and guidelines for the management of projects. British Standards Institute.
- Bryde, D. J., & Volm, J. M. (2009). Perceptions of owners in German construction projects: congruence with project risk theory. *Construction Management and Economics*, 27, 1059–1071.
- Bryde, D.J., & Brown, D. (2005). The Influence of a Project Performance Measurement System on the Success of a Contract for Maintaining Motorways and Trunk Roads, *Project Management Journal* 35 (4), 57– 65.
- Bunni, N.G. (2003). Risk and Insurance in Construction. London, New York: Spon Press, 2003. ISBN 0-419-21380-5.
- Bu-Qammaz, A. S., Dikmen, I., & Birgonul, M. T. (2009). Risk Assessment of International Construction Projects Using the Analytic Network Process. *Canadian Journal of Civil Engineering*, 36, 1170–1181.
- Camprieu, R. D., Desbiens, J. & Feixue, Y. (2007). 'Cultural' differences in project risk perception: An empirical comparison of China and Canada. *International Journal of Project Management*., 25, 683–693.
- Cox, R.F., Issa, R.R.A., & Aherns, D., (2003). Management's perception of key performance indicators for construction. *Journal of Construction Engineering and Management* 129 (2), 142–151.
- Deane, M. (2005). Costs and benefits of green building. Proc. of Sustainable Buildings Industry Council Ecobuild Conf., Sustainable Buildings Industry Council, Washington, D.C., USA
- Demaid, A., & Quintas P. (2006). Knowledge across cultures in the construction industry: sustainability, innovation and design. *Technovation* 26 (2006) 603–610. www.elsevier.com/locate/technovation
- Drexhage, J., & Murphy, D. (2012) Sustainable Development: From Brundtland to Rio 2012. International Institute for Sustainable Development (IISD), Canada

- Fernández-Sánchez, G., & Rodríguez-Lopez, F., (2010). A Methodology to Identify Sustainability Indicators in Construction Project Management—Application to Infrastructure Projects in Spain, *Ecological Indicators* 10 (2010) 1193–1201
- FIDIC (2004). Project Sustainability Management Guidelines
- FIDIC (2012). State of the World Report 2012 Sustainable Infrastructure
- Flanagan, R, Norman, G. (1993). Risk management and construction. Blackwell Science Pty Ltd, Victoria, Australia.
- Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). Megaprojects and Risk: An Anatomy of Ambition, Cambridge University Press, Cambridge.
- ISO 31000 Risk Management standard (2009)
- Klotz, L., & Horman, M. (2010). Counterfactual Analysis of Sustainable Project Delivery Processes, *Journal of Construction Engineering and Management* 136(5), 595–605
- Kovacic, I. (2012). Collaborative Planning Practice for Sustainable Buildings - A Case Study Research. International Scientific Conference People, Buildings and Environment 2012, Faculty of Civil Engineering, Brno University of Technology, Czech Republic, 26-37.
- Lapinski, A.R., Horman, M.J., & Riley, D. R. (2006). Lean processes for sustainable project delivery, *Journal of Construction Engineering and Management* 132(10), 1083–1091.
- Mikic, M., Arizanovic, D., & Ivanišević, N. (2012). Risks in infrastructure construction projects and BIM as a risk avoiding technique - Serbian market survey. International Scientific Conference People, Buildings and Environment 2012, Faculty of Civil Engineering, Brno University of Technology, Czech Republic, 26-37.
- National Institute of Building Sciences (NIBS) (2006). The whole building design guide. National Institute of Building Sciences, www.wbdg.org , Oct. 15, 2009.
- Ness, B., Urbel-Piirsalu, E., Anderberg, S. and Olsson, L. (2007). Categorising tools for sustainability assessment. *Ecological Economics*, 60, 498-508.
- Oates, D., Sullivan, K. T. (2012). Postoccupancy Energy Consumption Survey of Arizona's LEED New Construction Population. *Journal of Construction Engineering and Management*, 138(6), 742-750.
- Olander, S., & Landin, A. (2008). A comparative study of factors affecting the external stakeholder management process. *Construction Management and Economics*, 26(6), 553 – 561.
- Pennsylvania Governor's Green Government Council (PGGGC). (1999). Guidelines for creating high performance green buildings, Pennsylvania DEP, www.gggc.state.pa.us/publicn/gbguides.html , Oct. 15, 2009.
- Perminova, O., Gustafsson, M., & Wikstrom, K. (2008) Defining Uncertainty in Projects – A New Perspective. *International Journal of Project Management*, 26, 73-79.
- Project Management Institute. (2008). A Guide to the Project Management Book of Knowledge (PMBOK), fourth ed. Project Management Institute, Newtown Square, PA, USA.
- Remenyi D., & Heafield A. (1996). Business process re-engineering: some aspects of how to evaluate and manage the risk exposure, *International Journal of Project Management* 14(6) 349-357.
- Singh, R.K., Murty, H.R., Gupta, S.K., & Dikshit A.K. (2009). An overview of Sustainability Assessment Methodologies, *Ecological Indicators* 9 (2009) 189 – 212
- Swarup, L., Korkmaz, S., and Riley D. (2011). Project Delivery Metrics for Sustainable, High-Performance Buildings, *Journal of Construction Engineering and Management*, 137(12) 1043 – 1051.
- Thomas, A. V. , Kalidindi, S. N., & Ananthanarayanan, K. (2003). Risk perception analysis of BOT road project participants in India. *Construction Management and Economics*, 21, 393–407.
- Toor, S.R., & Ogunlana, S.O. (2008). Critical Coms of Success in Large-Scale Construction Projects: Evidence from Thailand Construction Industry. *International Journal of Project Management*, 26 (4), 420–430.
- UN (2002). Capacity Building for Sustainable Development: An Overview of UNEP Environmental Capacity Development Activities. © 2002 UNEP. ISBN: 92-807-2266-2. http://www.unep.org/Pdf/Capacity_building.pdf
- United States Green Building Council (USGBC) Research Committee. (2008). “A national green building research agenda.” [http://www.usgbc.org/ShowFile.aspx?DocumentID\(3402\)](http://www.usgbc.org/ShowFile.aspx?DocumentID(3402)) , Oct. 15, 2009.
- Wang, S. Q., Dulaimi, M. F., & Aguria, M. Y. (2004). Risk Management Framework for Construction Projects in Developing Countries. *Construction Management and Economics*, 22, 237–252.
- Ward, S., & Chapman, C. (2003). Transforming Project Risk Management into Project Uncertainty Management. *International Journal of Project Management*, 21, 97-105.
- Ward, S. and Chapman, C. (2008). Stakeholders and uncertainty management in projects. *Construction Management and Economics*, 26, 563-577.
- Williams, T. (1995). A classified bibliography of recent research relating to project risk management. *European Journal of Operational Research*, 85(1), 18–38.
- Zayed, T., Amer, M., & Pan, J. (2008). Assessing Risk and Uncertainty Inherent in Chinese Highway Projects Using AHP. *International Journal of Project Management*, 26, 408–419.
- Zhi, H. (1995). Risk management for overseas construction projects. *International Journal of Project Management*, 13(4) 231-237.
- Zou, P. X.W., Zhang, G., & Wang, J. (2007). Understanding the Key Risks in Construction Projects in China. *International Journal of Project Management*, 25, 601–614.