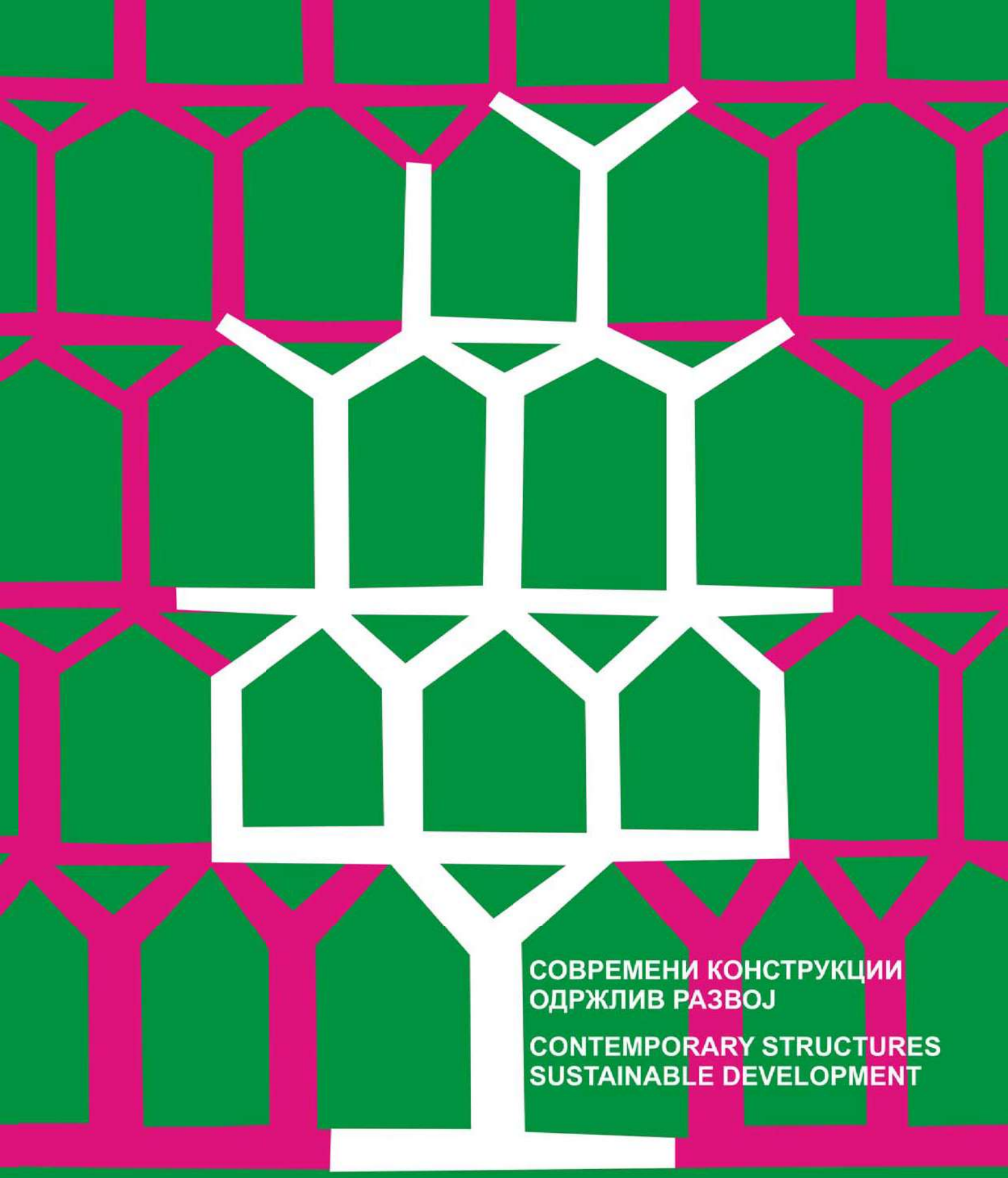

СОВРЕМЕНИ КОНСТРУКЦИИ ОДРЖЛИВ РАЗВОЈ

CONTEMPORARY STRUCTURES SUSTAINABLE DEVELOPMENT

ДГКМ
ДРУШТВО НА ГРАДЕЖНИ КОНСТРУКТОРИ НА МАКЕДОНИЈА

MASE
MACEDONIAN ASSOCIATION OF STRUCTURAL ENGINEERS

16 МЕЃУНАРОДЕН СИМПОЗИУМ
16 INTERNATIONAL SYMPOSIUM

ОХРИД, МАКЕДОНИЈА
OHRID, MACEDONIA
1 - 3 октомври 2015
OCTOBER, 1st - 3rd, 2015

MASE ДГКМ

Macedonian Association of Structural Engineers
Друштво на градежните конструктори на Македонија

Proceedings
Зборник на трудови

16th International Symposium
16ти Меѓународен симпозиум

MASE Awards
Признанија на ДГКМ

Book of abstracts
Апстракти

Ohrid, Macedonia, 1 – 3 October 2015
Охрид, Македонија, 1 – 3 Октомври 2015

BOOK OF ABSTRACTS
OF THE 16th INTERNATIONAL SYMPOSIUM OF MASE
АПСТРАКТИ
16ТИ МЕЃУНАРОДЕН СИМПОЗИУМ НА ДГКМ

Publisher:
MASE - Macedonian Association of Structural Engineers
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1000 Skopje, Republic of Macedonia
e-mail: mase@gf.ukim.edu.mk; web-site: www.mase. gf.ukim.edu.mk
Издавач:
ДГКМ - Друштво на Градежни Конструктори на Македонија
Градежен Факултет, ул. Партизански одреди бр. 24 П.Ф. 560,
1000 Скопје, Република Македонија
e-mail: mase@gf.ukim.edu.mk; web-site: www.mase.gf.ukim.edu.mk

Editor: **Meri Cvetkovska, President of MASE**
За издавачот: **Мери Цветковска, Претседател на ДГКМ**

Printing: **JOFI-SCAN „Skopje"**
Печатница: **ЈОФИ-СКЕН „Скопје"**

Number of copies: **350**
Тираж: **350**
ISBN 608-4510-24-8

ДГКМ
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IMPLEMENTING CONSTRUCTION EXPERIENCE INTO SUSTAINABLE DESIGN MANAGEMENT FOR IMPROVEMENT OF THE DESIGN PHASE

SUMMARY

Construction projects are challenged in implementing sustainability issues which increases their complexity. For delivering a sustainable construction project it is necessary to gain insight into construction site experience and problems that occur during construction phase related with construction documentation. Therefore, a research is undertaken and a questionnaire was filled out by construction site managers. It is concluded that it is necessary to strengthen the quality of the project design phase. Also the project design phase needs a more coherent management of the design process that integrates the sustainability issues. Strengthening the knowledge base of the project design team on sustainability is a necessity in delivering high quality project documentation.

Keywords: sustainable design management, design phase, construction phase

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ИМПЛЕМЕНТАЦИЈА НА ИСКУСТВА ОД ИЗГРАДБА ЗА УНАПРЕДУВАЊЕ НА ОДРЖЛИВОСТА НА ПРОЕКТНИОТ МЕНАЏМЕНТ ВО ПРОЕКТНА ФАЗА

РЕЗИМЕ

Градежните проекти се соочуваат со предизвици, како имплементација на одржливоста, со што се зголемува нивната комплексност. За испорака на одржливи проекти извршено е истражување за знаењето при изградба и проблемите кои настануваат во фазата на изградба на објектите, а се поврзани со проектната документација. Пополнета е анкета од раководители на градилишта. Заклучено е дека потребно е да се зајакне квалитетот на проектната фаза. Потребен е менаџмент на проектниот процес кој ги интегрира одржливите принципи. Зголемување на степенот на знаење на проекниот тим во однос на одржливост е неопходно заради испорака на високо квалитетна проектна документација.

Клучни зборови: одржлив проектен менаџмент, проектна фаза, фаза на изградба

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1. INTRODUCTION

Construction industry is identified as the largest consumer of energy and raw materials as well as main pollutant with detrimental consequences on the environment and human living, comfort and health, (Bakens 2003; Oteiza and Tenorio 2007; Woolley and Kimmins 2000). To mitigate these emerging issues, the contemporary society efforts are engaged in the concept of sustainability, with a goal of reconciling the human and natural habitat by establishing three main pillars such as the environmental, economic and social (Elkington 1999).

The projects in the construction industry are titled as largest and most complex projects in terms of management and their successful outcome is predetermined by the quality of the applied management. In order to increase the project quality, many countries, such as Germany, Japan, Australia, have developed their own project management standards and methodologies. Global efforts have been made on establishing Project Management standards, such as the standards of the International Project Management Association (IPMA), PMBoK standard (Project Management Institute 2013), etc.

The ISO 21500 standard was initiated by the British Standard Institute, member of the ISO organization, and developed as a cooperation of 31 countries directly involved in the delivery of the standard and 5 participating countries as observers. According to the ISO 21500 standard a project is "*a unique set of processes consisting of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective*". Processes used in projects are generally categorized into three major types: project management processes, delivery and support processes.

Project management according to the Project Management Institute (Project Management Institute 2013) as well as the ISO 21500 standard (Zandhuis 2013) is realized by means of 5 process groups such as: initiation, planning, execution, monitoring and closing. The project life-cycle starting from project initiation until the very beginning of the construction consists of: pre-project phase, planning and design phase and contractor selection phase, (Bennett 2003), followed by the construction process defined by: project mobilization phase, project operations phase, project closeout and termination phase.

The GPM P5 Standard delivered by GPM Global, ("GPM P5" 2015), incorporates sustainability into the project processes and deliverables. It incorporates the impact of the activities and the project onto the environment, society, the corporate bottom line and the local economy through the P5 concept, based on the following categories: People, Profit, Process and Product. Founded on these principles, the PRiSM methodology leverages the ISO standards, the GRI G4 indicators and the UN Global Compact Ten Principles and it structures the processes of the project management in a logical framework. The life-cycle phases of a project are articulated as: introduction, growth, maturity and decline, meaning that it considers the whole life-cycle of a project or a product. Therefore this methodology integrates product sustainability with a company's organizational sustainability and maturity.

As stated by several authors, the design phase is the most important in the buildings life-cycle (Bogenstätter 2000; Koskela et al. 2002) and the decisions made in this phase influence the following phases such as construction, operation and demolition. In the early design phase the client brief and the definition of clients' needs have been noted as highly critical (Masat 1996). Frequent changes of the design that occurduring the construction phase haveits repercussions on the construction management, i.e., they influence the "steel triangle" of management: time, scope and costs. The design process in construction is often seen as poorly planned, poorly managed as well as fragmented work process(Barber et al. 1998). The defects caused by the design are in a largest share due to the poor coordination between the different participating disciplines (Koskela et al. 2002) lack of communication and coordination between them (Koskela et al. 2002), deficient planning and/or resource allocation, frequent changes (Sverlinger 1996). In different studies it was concluded that the majority of construction problems were due to the insufficient client briefing (Bresnen 1991; Barton 1996). Authors conclude that one of the most significant waste types in construction project design is unnecessary rework caused by two reasons: insufficient clarity of the optimal order of design tasks and if the order exists there are factors distracting the order of tasks (Koskela et al. 2002). Having these managerial issues in mind and putting an effort to implement the concept of sustainability into

construction projects easily becomes a demanding task that increases projects' complexity. In order to assure the success of construction projects it is necessary to examinethe quality of the project documentation used at the construction site. Another important issue that needs to be consideredis materials' usage, on-time completion and effective communication among stakeholders, IT usage and implementation of health and safety procedures.As many authors have been stated (Azhar 2011; Azhar et al. 2011; Bynum et al. 2013; Liu et al. 2015) BIM software during design and construction significantly improves the construction process in terms of decreasing construction errors, decreasing time and costs.

Consequently, the main research problem that imposes is how construction site managers with different work experience assess aforementioned issues relevant for project's sustainability and success. Additionally, their evaluation of importance of construction project phases is examined.

In the next section a short review of design management methodologies is presented, followed by display of the research methodology, results and conclusion.

2. RESEARCH METHODOLOGY

2.1. Sample

Survey on construction site was conducted in order to explore assessment of various issues relevant for project's sustainability and success, as well as, importance that is putted on construction project phases.Therefore, 108 construction site managers whose formal background differs from architects, civil engineers and other engineers were asked to fulfill a questionnaire which took approximately 10 minutes. All participants in the study were male. Of them, 29 had work experience up to 5 years, from 6 to 20 years of work experience had 44 participants and 35 noted more than 20 years of work experience.

2.2. Measures

The questionnaire used in the study consisted following statements:

1 Project documentation for building construction was complete and accurate.

2 Changes occur in the project documentation during construction.

3 Substitution of materials during construction occurs.

4 The construction of buildings you have been working on has been completed on-time.

5 Consultation of all participants (investor, designer, constructor, supplier etc.) is necessary from the beginning of the design process in order to gain more efficient, faster and economical construction process.

6 Software related to the construction is used during the construction work.

7 The office undertakes appropriate measures in a short period when there are problems regarding the environment and safety of the workers.

Participants (construction site managers) were asked to assess the items on a 5-point scale from 1-completely disagree to 5-completely agree. Additionally, they needed to rank four construction project phases from 1 to 4 according to their relative importance, such as: Phase 1: design phase, Phase 2: preliminary works, Phase 3: preparation works and Phase 4: construction phase.

On the base of work tenure, respondents were categorized into three groups: work experience up to 5 years, work experience between 6 and 20 years, work experience more than 20 years.

3. RESULTS

Kruskal-Wallis test was performed in order to analyze how construction site managers with different work experience assess aforementioned issues relevant for project's sustainability and success, as well as, how they evaluate importance of construction project phases.

Obtained results (Table 1) demonstrated that surveyed participants with work experience between 6 and 20 years assessed correctness/accuracy of the project's documentation, as well as, changing/shifting in documentation highly in comparison to their colleagues with shorter 9up to 5 years) and longer work tenure (more than 20 years) ($H(2)=10.66$, $p<0.01$ and $H(2)=7.13$, $p<0.05$, respectively).

Assessed issues	Work experience	N	Mean Rank
Project documentation for building construction was complete and accurate.	Up to 5 years	29	47.57
	6-20 years	44	65.69
	More than 20 years	35	46.17
	Total	108	
Changes occur in the project documentation during construction.	Up to 5 years	29	50.74
	6-20 years	44	63.56
	More than 20 years	35	46.23
	Total	108	
Substitution of materials during construction occurs.	Up to 5 years	29	48.52
	6-20 years	44	56.73
	More than 20 years	35	56.66
	Total	108	
The construction of buildings you have been working on has been completed on-time.	Up to 5 years	29	56.52
	6-20 years	44	59.64
	More than 20 years	35	46.37
	Total	108	
Consultation of all participants (investor, designer, constructor, supplier etc.) is necessary from the beginning of the design process in order to gain more efficient, faster and economical construction process.	Up to 5 years	29	58.84
	6-20 years	44	59.78
	More than 20 years	35	44.26
	Total	108	
Software related to the construction is used during the construction work.	Up to 5 years	28	54.20
	6-20 years	44	60.64
	More than 20 years	35	45.50
	Total	107(one respondent did not answer)	
The office undertakes appropriate measures in a short period when there are problems regarding the environment and safety of the workers.	Up to 5 years	28	54.93
	6-20 years	44	57.58
	More than 20 years	35	48.76
	Total	107(one respondent did not answer)	

Table 1. Differences in assessment of construction process sustainability and success issues among site managers

Three groups of respondents, as was found, differed in their assessment of need for coordination and consultation among all stakeholders in the project. The lowest evaluation was given by the most experienced construction site managers ($H(2)=8.32$, $p<0.05$).

Applied Kruskal-Wallis test revealed that three groups of participants differ in ranking of phase 1 and phase 3, but not in given ranks of phases 2 and 4 (Table 2). Participants with work tenure from 6 to 20 years ranked the design phase as less important compared to their counterparts with shorter and longer

work tenure (H(2)=6.40, p<0.05). Preparation phase was ranked as less important by construction site managers with more than 20 years work experience (H(2)=11.56, p<0.01).

Construction project's phases	Work experience	N	Mean Rank
Phase 1: design phase	Up to 5 years	29	51.24
	6-20 years	44	62.97
	More than 20 years	35	46.56
	Total	108	
Phase 2: preliminary works	Work experience	29	54.66
	Up to 5 years	44	49.25
	6-20 years	35	60.97
	More than 20 years	108	
Phase 3: preparation works	Total	29	47.64
	Work experience	44	47.89
	Up to 5 years	35	68.50
	6-20 years	108	
Phase 4: construction phase	More than 20 years	29	61.22
	Total	43	55.26
	Work experience	35	46.47
	Up to 5 years	107(one respondent did not answer)	

Table 2. Differences in evaluation of construction phase importance among site managers

In general, surveyed site managers assessed the seven issues relevant to sustainability of construction projects as average or above the average compared to the midpoint (which was 3) of the ranking scale (from 1 to 5). They evaluated highly the need for consultation and coordination during the project. Results showed that 23,1% of the respondents ranked design phase as the most important. Preliminary works phase was ranked as the most important by 21,1% of the participants. Only 3,7% of the surveyed site managers ranked preparation works phase as the most important, while half of them (51,9%) ranked building phase as the most important.

4. CONCLUSION

From the conducted survey more than 50% of the respondents stated that the construction phase is the most important phase and only 3,7% of respondents stated that the most important phase is a preparatory works phase. Findings demonstrated that work experience is important when relevance of different construction project phases was evaluated.

From survey' results for project documentation issues occurring in the construction phase key management steps could be established.

Regarding the project documentation construction managers have identified major problems in the project quality in terms of fully developed design. Main issues were insufficient detail drawings causing delays in the construction process, tension between the constructor, designer and the investor. Also materials substitution has been a consequence of poor design documentation, or due to the financial pressure of the investor or by changing the investors' desire.

Least and most experienced site managers evaluated documentation accuracy at evidently lower level than their colleagues with work experience between 6 and 20 years. Probably, these results could be explained with higher engagement in detailed documentation analysis due the lack of experience/practice of the first group and higher deliberation of skilled site managers. On the other hand, these two groups of respondents stated that the documentation shifting is rare. From the survey, as expected, health and work safety procedures, as well as environment protection standards are completely incorporated.

According to the obtained results, intensified cooperation between the design team and investor is highly demanded in order to firmly establish the design goals. This need for cooperation and coordination was rated highly by the most experienced participants in the study. The investor should be fully familiarized by the design team proposals.

For increase of the quality of the design phase the design team should implement tools that would enable evaluation of the design proposals in terms of economic, social and environmental issues and to have legitimate scientific evidence on propping up their design proposal in front of the investor. In this way the investor would have more confidence in the design team and would be less likely prone to demand design change especially during the construction. Further research is needed on the knowledge and capability of the design offices to implement these tools in the design process. Besides these hard techniques, soft techniques could be also applied, such as passive solar design based on empirical studies, which also require a degree of knowledge to be full and correctly implemented.

Findings indicate that more efforts should be placed on on-time completion of construction projects and on software use to facilitate the design process.

Future studies should include all stakeholders in construction projects and to investigate their perceptions of other important aspects of sustainability. Implications of the considered issues on employees and final users of build structures should be also examined.

REFERENCES

[1] Azhar, S. (2011). "Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry." Leadership and Management in Engineering, 11(3), 241–252

[2] Azhar, S., Carlton, W. A., Olsen, D., and Ahmad, I. (2011). "Building information modeling for sustainable design and LEED® rating analysis." Automation in Construction, Building Information Modeling and Changing Construction Practices, 20(2), 217–224

[3] Bakens, W. (2003). "Realizing the sector's potencial for contributing to sustainable development." UNEP Industry and Environment, (Април-Септември), 9–12

[4] Barber, P. R., Sheath, D. M., Walker, S., Graves, A. P., and Tomkins, C. R. (1998). "A comparison of design management techniques in construction and the automotive industry." Product and Process Modelling, Building Research Establishment, Watford, 67–74

[5] Barton, R. T. (1996). "The application of value management to the development of project concepts." The Organization and Management of Construction 2, 115–123

[6] Bennett, F. L. (2003). The Management of Construction: A Project Life Cycle Approach. Routledge

[7] Bogenstätter, U. (2000). "Prediction and optimization of life-cycle costs in early design." Building Research & Information, 28(5-6), 376–386

[8] Bresnen, M. J. (1991). "Construction contracting in theory and practice: A case study." Construction Management and Economics, 9(3), 247–262

[9] Bynum, P., Issa, R. R. A., and Olbina, S. (2013). "Building Information Modeling in Support of Sustainable Design and Construction." Journal of Construction Engineering and Management, 139(1), 24–34

[10] Elkington, J. (1999). Cannibals with Forks: Triple Bottom Line of 21st Century Business. Capstone Publishing Ltd, Oxford

[11] "GPM P5." (2015). GPM Global, <http://www.greenprojectmanagement.org/> (Jul. 29, 2015)

[12] Koskela, L., Huovila, P., and Leinonen, J. (2002). "Design management in building construction: from theory to practice." Journal of Construction Research, 3(01), 1–16

[13] Liu, S., Meng, X., and Tam, C. (2015). "Building Information Modeling Based Building Design Optimization for Sustainability." Energy and Buildings

[14] Masat, J. (1996). “Masat, J. ‘Towards a zero defect construction culture.’ (1996): 2-83.” Applications of the Performance Concept in Building, National Building Research Institute, Haifa, 2–83

[15] Oteiza, I., and Tenorio, J. A. (2007). “La innovación en las técnicas, los sistemas y los materiales de construcción.” Jornada J7: Evaluación de la sostenibilidad en la Edificación, Madrid.

[16] Project Management Institute. (2013). A guide to the project management body of knowledge (PMBOK guide)

[17] Sverlinger, P.-O. (1996). “Organizational coordination in the design phase.” Building Economics and Construction Management

[18] Woolley, T., and Kimmins, S. (2000). Green Building Handbook Volumes 1 and 2: Green Building Handbook: Volume 2: A Guide to Building Products and their Impact on the Environment. Routledge, London

[19] Zandhuis, A. (2013). ISO 21500 Guidance on Project Management - a Pocket Guide. Van Haren Publishing, Zaltbommel