Achieving sustainability through integrating risk management into the architectural design process

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Received 1 September 2017
Accepted 14 December 2017

Abstract

Purpose – The purpose of this paper is to develop a framework integrating risk management (RM) into the architectural design process (ADP) as an approach for delivering sustainable construction projects.

Design/methodology/approach – A research methodology, which consisted of literature review and field study, is designed to accomplish four objectives. First, to provide a comprehensive literature review of the concepts of sustainability, ADP and RM. Second, to present and synthesis the results of two relevant studies focused on identifying, quantifying and classifying the risks associated with ADP; and investigating the perception and application of Egyptian architectural design firms (ADFs) towards integrating RM into ADP as an approach for delivering sustainable construction projects. Third, to develop a framework that integrates RM into ADP towards delivering sustainable construction projects. Finally, to draw conclusions and recommendations to improve the practice of delivering sustainable construction projects among ADFs, construction professionals and governmental authorities.

Findings – ADP is a fundamental phase of the construction process because the decisions adopted during this phase affect the project performance throughout its life cycle. While RM is widely applied in different sectors of the construction industry, its application in ADP received scant attention in construction literature. The research identified 18 key risks that affect the sustainable delivery of construction projects during ADP. The architect, the client and the project manager are the highest ranked responsible parties for the occurrence of these key risks. The field study highlighted the need to develop a framework to facilitate integrating RM into ADP.

Research limitations/implications – This paper focused only on the integration of RM into ADP.

Originality/value – The conducted literature review and field study provided an in-depth understanding of the key risks that affect the sustainable delivery of construction projects during ADP. Through its five stages, the proposed framework is expected to serve as a foundation for integrating RM into ADP as an approach for delivering sustainable projects. This ideology has received scant attention in construction literature. The developed framework represents a synthesis that is novel and creative in thought and adds value to the knowledge in a manner that has not previously occurred.

Keywords Risk management, Framework, Architectural design process, Sustainable construction projects

Paper type Research paper

1. Introduction

Being one of the biggest industries worldwide, the construction industry plays a significant role towards achieving the social and economic sustainable development objectives at national and international levels. Socially, it is mainly concerned with delivering sustainable projects that translate the community needs into designs that specify technical characteristics, functional performance criteria and quality standards. In addition, it aims to complete these projects on time, as specified and in the most cost-effective manner to produce a product that matches or exceeds end users' expectations

Journal of Engineering, Design and Technology
Vol. 16 No. 1, 2018
pp. 25-43
© Emerald Publishing Limited
1726-0531
DOI 10.1108/JEDT-09-2017-0087

(Ahmed and Kangari, 1995; Hudson, 1999; Bowen *et al.*, 1999). Economically, the construction industry helps increasing countries' gross domestic product (GDP), offering job opportunities and providing most of countries' fixed capital assets and infrastructure that enable other supporting industries to prosper. Contrary, the unsustainable practices of the construction industry in terms of resources and energy consumption, pollution and waste generation called for the construction industry to be more sustainable and consider its environmental, social and economic impacts on the surrounding environment (Chileshe, 2011; Rafindadi *et al.*, 2014). Because of its nature, the construction industry is subject to more risks than any other industries. This could be attributed to the complex and dynamic nature of construction projects and the involvement of multitude of participants and organisations with different objectives and skills. Architectural design process (ADP) is a crucial phase of the construction project's life cycle. This is because the decisions made during this phase affect the performance of the project throughout its life cycle. Failing to consider risk factors during this phase will affect the sustainability of the construction project (Abdellatif and Othman, 2006). Although risk management (RM) is widely applied in different phases of the project life cycle, its application in the design process encountered a scant attention in construction literature (Goral, 2007; Banaitiene and Banaitis, 2012). Accordingly, this paper aims to develop a framework integrating RM into ADP as an approach for delivering sustainable construction projects.

2. Research objectives and methodology

To achieve the above-mentioned aim, a research methodology, based on literature review and field study, is designed to achieve four objectives:

(1) building a comprehensive background about the research topic through reviewing the concepts of sustainability, ADP and RM;

(2) presenting and synthesising the results of two relevant studies carried out by Abdelwahab and Othman (2016) and Othman and Abdelwahab (2016) aimed to identify, quantify and classify the risks associated with ADP and to investigate the perception and application of Egyptian ADFs towards integrating RM into ADP as an approach for delivering sustainable construction projects;

(3) developing a framework to facilitate the integration of RM into ADP towards delivering sustainable construction projects; and

(4) outlining research conclusions and recommendations useful to ADFs and construction professionals and governmental authorities concerned with sustainable construction development.

3. Literature review

3.1 Sustainability

3.1.1 Background and concept development. Sustainability, in a broad sense, is the capacity to endure. All the needs of current and future generations for survival and wellbeing depend largely on the natural environment, either in a direct or an indirect way. Sustainability aims to create and maintain the social, economic and environmental conditions that allow humans to exist with nature in "productive harmony" in the present and the future (USEPA, 2009). Sustainability has become a wide-ranging term that can be applied to almost every facet of life on Earth, ranging from a local to a global scale and over various time periods. The existence of more than 200 different definitions for sustainable development (Parkin *et al.*, 2003) highlighted its importance and illustrated the efforts made by different academic and practical disciplines to define and understand its implications to their fields. However, all definitions agree that it is of prime importance to consider the future of the planet and develop innovative ways to protect and enhance the Earth while satisfying various stakeholders' needs (Boyko *et al.*, 2006). Scientific evidence showed that humanity is living unsustainably. This is obvious in the form of using non-renewable resources, land dereliction, waste generation, water contamination, energy consumption, to name a few (Othman, 2010). Returning human use of natural resources to within sustainable limits will require a major collective effort. Since the 1980s, sustainability has implied the integration of social, economic and environmental spheres to meet the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). It promotes a balanced approach by taking account of the need to continue in business but does not seek profitability at the expense of the environment or society's needs (MaSC, 2002). Sustainability is concerned with protecting environmental quality, enhancing social prosperity and improving economic performance (Addis and Talbot, 2001). According to Maxwell (2014), it is necessary to integrate sustainability concepts from the very beginning of any project to ensure the successful delivery of sustainable projects. Sustainability has three aspects as follows:

(1) The environmental aspect of sustainability which focuses on using natural resources efficiently and reducing waste, pollution, effluent generation and emissions to the environment. In addition, it aims to reduce the negative impact on human health, encourage the use of renewable raw materials and eliminate toxic substances (Othman *et al.*, 2013).

(2) A socially sustainable society is one that is fair and accomplishes social justice when it comes to distributing its resources within itself. It is a society that would not discriminate in the rights of its individuals based on their ethnicity, sex, religion, age or social background (BenzuJK, 2009). These rights, which lead to a quality standard of living, include religious rights, right to housing, right to social security, right to work, freedom of speech, right to travel and right to own property.

(3) A society with a high population under the poverty line cannot achieve sustainability, as this is accompanied by high unemployment rate, lack of education and low-quality health care systems (Karlsson, 2009). An economically self-sustaining society is one that is able to use the available resources efficiently to provide its individuals with their needs without reaching out for help from neighbouring societies or countries.

3.1.2 Sustainability in construction. In spite of the construction industry's vital contribution towards achieving the national and international social and economic sustainable development objectives, it is known for its negative impact on the environment. It affects the environment in two ways, namely, consuming resources and creating pollution and waste. According to a report by the Willmott Dixon Group (2015), the construction industry accounts for around 45-50 per cent of global energy usage, nearly 50 per cent of worldwide water usage and around 60 per cent of the total usage of raw materials. Moreover, the construction industry contributes to 23 per cent of air pollution, 50 per cent of climate change gases, 40 per cent of drinking water pollution and 50 per cent of landfill wastes. These unsustainable practices called for the construction industry to be more sustainable. Adopting sustainability concepts during the construction process will save the environment, improve building performance, achieve client satisfaction and provide better value for money (Addis and Talbot, 2001; Thomson *et al.*, 2003; Abdellatif and Othman, 2006). Through the application of sustainability in construction, a number of benefits will be achieved. Environmentally, sustainability will help reducing the use of non-renewable resources, minimising environmental risk and uncertainty, reducing waste and pollution and increasing the reuse and recycling of building materials (Kim, 1998). Socially, sustainability will focus on identifying clients' and end-users' requirements and ensuring that the developed design fulfils their needs and meets their expectations. Moreover, it encourages the involvement and seeking of feedback from various stakeholders, who are affected by the built environment, ensures health and safety requirements are met for building users, considers people with special needs and provides support as well as adding value to communities and the supply chain. Finally, economically, sustainability supports the growth in the construction industry that helps increasing GDP, offering job opportunities and increasing clients' profit and investment return (Chen and Chambers, 1999; Addis and Talbot, 2001; WS Atkins Consultants, 2001).

3.2 The architectural design process

3.2.1 Overview and importance. As one of the key processes in the construction industry, ADP plays a pivotal role towards achieving successful delivery of projects. It was meant to be a very critical process, as it involves the most important decisions that affect the project performance throughout its life cycle. For instance, decisions concerning end-users' participation, cost estimation, material selection, systems and design features are very critical decisions that affect the project successful completion positively if well-managed or negatively if ignored (Goral, 2007).

3.2.2 Project life cycle. Typical project life cycle consists of phases; each one has its own definition, scope of work and participants. According to the Royal Institute of British Architects (RIBA, 2013) plan of work update, the typical project life cycle is composed of eight stages, namely, strategic definition, preparation and brief, concept design, developed design, technical design, construction, handover and closeout and use (RIBA, 2013). This paper will focus on the design stages, namely, concept design, developed design and technical design stages:

3.2.2.1 Concept design stage. This stage focuses on preparing the concept design including outline proposals for structural design, building services systems, outline specifications and preliminary cost information along with relevant project strategies in accordance with design programme. It agrees alterations to brief and issues final project brief. This stage ensures the development of sustainability strategies, the preparation of maintenance and operation plans, handover strategies and risk assessment. It is important to review the project execution plan to make sure that every aspect is well-implemented and that construction strategies and health and safety issues are clearly stated (RIBA, 2013).

3.2.2.2 Developed design stage. This stage is concerned with preparing Developed Design, including coordinated and updated proposals for structural design, building services systems, outline specifications, cost information and project strategies in accordance with Design Programme. It is no doubt to say that updating sustainability issues, maintenance and operational issues are to be checked permanently in every stage. It is very essential that the change control procedures are implemented to ensure that any change is well-controlled. RIBA (2013) plan of work recommended that this stage may be overlapped with other stages to well-bind the whole project cycle (RIBA, 2013).

3.2.2.3 Technical design. This stage ensures that all the architectural, structural designs and building services information, specialist subcontractor design and specifications are prepared in accordance with the Design Programme. In addition, during this stage, sustainability aspects are well-established as well as maintenance and operational issues and risk assessment are reviewed. The RIBA (2013) plan of work suggests that any change in planning is well-addressed in this stage before starting the site works (RIBA, 2013).

3.3 Risk and risk management

3.3.1 Definition and background. Because of the dynamic nature of the construction industry, it involves different types of participants and organisations with different objectives and skills. Construction projects are subject to different types of risks that may affect their successful completion. These risks may cause project failure, clients' dissatisfaction, cost overruns, etc. According to Raftery (1994), risk could be defined as:

> The exposure to the possibility of economic or financial loss or gain, physical danger or injury or delay as a consequence of the uncertainty associated with perusing a particular course of action.

3.3.2 Risk management process. RM process consists of three stages.

3.3.2.1 Risk identification. It is an investigation process for all risks that encounter the construction project and affect its delivery. Implementing this process at an early stage of the project life cycle enables the client and stakeholders to be aware of the associated risks and helps controlling them electively. Winch (2002) stated that the first step in RM process is usually an informal step based on previous experiences in identifying possible risks. The identification of the possible risks is a task conducted by the organisation no matter how the allocation of these risks is done. It is important to highlight that RM is not only about responding to risks, but in a more professional way, it is about being well-prepared for the potential risks occurring unexpectedly. A number of techniques are usually used for risk identification, including brainstorming, interviews, questionnaires, consulting experts, Delphi technique, historical data and checklists (Smith *et al.*, 2006; Lester, 2007; PMI, 2013).

3.3.2.2 Risk analysis. Risk analysis takes place with respect to both individual and combined risks. It helps the client and project stakeholders to build their own future vision for the probability and severity of risk occurrence which helps in the decision-making process. A number of methods are available for a typical project risk assessment. The choice of the suitable method is dependent on some factors, such as the type of risk, project scope, cost of methods, adaptability, complexity, completeness, usability, validity and credibility (Lichtenstein, 1996). Risks could be analysed quantitatively and/or qualitatively. First, quantitative risk analysis requires numerical data input as well as performing some calculations. Quantitative methods, such as Monte Carlo simulation and sensitivity analysis, which needs a lot of effort are not necessary for all projects. Small projects may not need to follow the whole steps of quantitative analysis, while medium to large projects are necessarily have to. Second, qualitative risk analysis is based on experience of the team involved to determine the risk probability and severity.

3.3.2.3 Risk response. Based on the results gained from the previous two stages, there are three possible responses:

(1) *Risk Avoidance or Reduction*: The identification of risks in the early stage enables the project client and stakeholders to find methods for risk avoidance or reduction such as redesign or further investigation for alternative solutions.

(2) *Risk Transfer*: It enables the transfer of risk from one party to another based on the capabilities of the party to deal with risk and without changing the total amount of risk mentioned in the contract.

(3) *Risk Retention*: In some cases, retaining the risk is the only option (Ehsan *et al.*, 2010).

3.4 Review of relevant field studies

This section presents the results of two recent studies conducted by Abdelwahab and Othman (2016) and Othman and Abdelwahab (2016). The first study focused on identifying, classifying and explaining the risks that affect the sustainable delivery of construction projects during the design phase based on extensive literature review and cases studies. The second study quantified the identified risks and investigated the perception and application of a representative sample of 44 Egyptian ADFs towards integrating RM into ADP as an approach for delivering sustainable construction projects (Figures 1 to 3 and Tables I and II). The research work carried out in the above-mentioned papers highlighted a gap in construction literature with regard to integrating of RM within ADP as an approach for delivering sustainable construction project.

Responses of 25 of 44 Egyptian ADFs revealed that they are aware and perceive the concept of sustainability and its underlying principles and benefits. However, these firms mentioned that because of a number of reasons this concept is not applied during the design process. Responses indicated that the lack of the practical application and availability of successful local examples is the main cause for not applying sustainability in ADFs in Egypt. This raises an important issue concerning the gap between the theoretical and applicable sides of sustainability. In addition, another reason was added by respondents that integrating sustainability principles in design is not a mandatory requirement by clients or the government. Furthermore, respondents stated that lack of senior management persuasion of the benefits of integrating RM in the design process hinders its adoption and application. Finally, respondents stated that the dominant culture in the construction industry in terms of reluctance to change and adopt new approaches as well as improper support to training programmes and lack of resources availability are other reasons to hinder adopting RM during the design process as an approach towards delivering sustainable construction projects. Responses indicated that most respondents believe that it is quite necessary to integrate RM into design to deliver sustainable projects with mean value (3.44/5), median and mode (3/5).

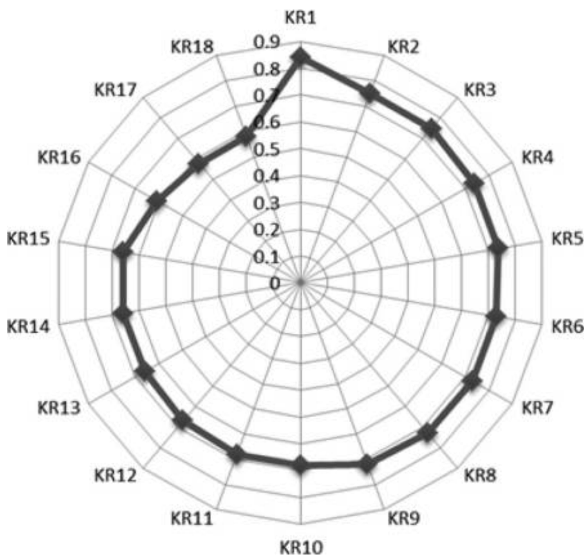

Figure 1.
Relative importance index for probability of risks affecting the design process

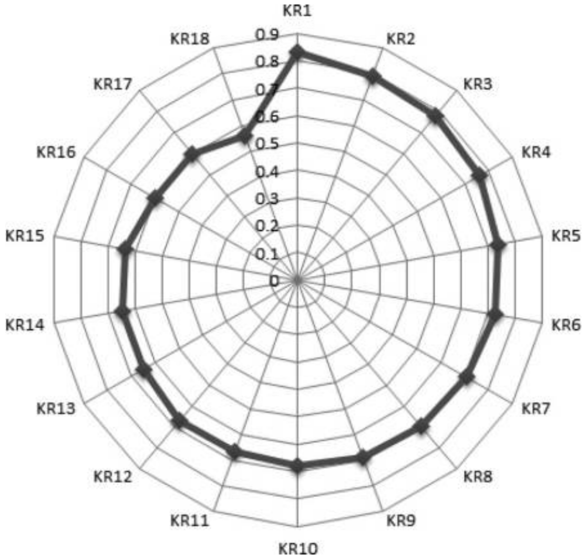

Figure 2.
Relative importance index of severity of risks in design process

	Severity / Probability	1 Very low	2 Low	3 Medium	4 High	5 Very High
1	Very High				KR1	
2	High			KR18	KR2,KR3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	
3	Medium					
4	Low					
5	Very Low					

Figure 3.
Risk matrix for key risks affecting the design process

4. Risk management for sustainability framework (RM4SF)

4.1 Definition and importance of the framework

A framework is defined as a structure for describing a set of concepts, methods and technologies required to complete a product process and design (Joseph and Mohapatra, 2009). The RM for Sustainability Framework (hereinafter referred to as "the Framework" or the "RM4SF") is a proposed framework developed by this research to integrate RM into ADP as an approach for delivering sustainable construction projects.

4.2 The need for the framework

The construction industry is a complex and risky business. Despite the nature and characteristics of the different phases of the construction process, the design phase represents one of the most important phases. This is because many of the decisions that take place during the design phase affect the project performance and sustainability throughout its life cycle. Although RM is a well-established disciple in construction, its application in

Table I. Identification, quantification and classification of the key risks affecting the sustainable delivery of construction projects during design phase

		Quantification of key risks affecting the sustainable delivery of construction projects during design phase					Classification according to source					Classification of risks according to design phase		
No.	Risks	Probability	Severity	Result	RII	Final rank	Architect	Client	Stakeholders	Contractor	Project manager	Concept design phase	Developed design phase	Technical design phase
KR1	Design cost overrun	4.20	3.8	15.96	0.83	1	×	×	×	×	×	×	×	×
KR2	Brief changes by the client	3.76	3.96	14.89	0.79	2	×	×				×	×	×
KR3	Design variations by the architect	3.76	3.88	14.59	0.78	3	×	×				×	×	×
KR4	Design process takes longer than needed	3.64	3.72	13.54	0.76	4	×	×			×		×	×
KR5	Lack of coordination between design participants	3.72	3.56	13.24	0.74	5	×	×	×	×	×	×	×	×
KR6	Incomplete environmental analysis	3.40	3.64	12.38	0.73	6	×	×	×	×	×	×	×	×
KR7	Tight project design schedule	3.64	3.40	12.38	0.71	7	×	×			×	×	×	×
KR8	Design errors and omissions	3.64	3.36	12.23	0.70	8	×				×	×	×	×
KR9	Non-compliance to building codes, regulations, laws and standards	2.92	4.16	12.15	0.69	9	×		×		×	×	×	×
KR10	Skills gap of qualified architects and design managers	3.68	3.24	11.92	0.68	10	×		×		×	×	×	×
KR11	Stakeholders change project requirements at later stages	3.40	3.44	11.70	0.67	11	×		×		×			×
KR12	Uncoordinated and incorrect construction documents	3.36	3.48	11.69	0.67	12	×	×		×	×	×	×	×
KR13	Specifying outdated construction materials and technology	3.28	3.36	11.02	0.65	13	×			×	×		×	×
KR14	Lack of consideration of environmental requirements	3.32	3.24	10.76	0.65	14	×				×		×	×
KR15	Failure to carry out the work in accordance with contracts	3.60	2.80	10.08	0.64	15	×	×	×	×	×	×	×	×
KR16	Lack of considering whole project life cycle cost	3.32	3.00	9.96	0.60	16	×	×		×		×	×	×
KR17	Lack of communication and coordination between governmental authorities and ADFs over planning and approvals	3.04	3.20	9.73	0.60	17	×	×	×	×	×	×	×	×
KR18	Public objections	2.88	3.00	8.64	0.56	18	×	×	×	×	×	×	×	×

Table II. Classification of the key risks affecting the sustainable delivery of construction projects during design phase according to sustainability

No.	Risks	Classification according to sustainability Economic	Social	Environmental	Explanation
KR1	Design cost overrun	×	×		Design cost overrun is ranked as the highest risk that affect the sustainable delivery of construction projects during design phase (Othman and Abdelwahab, 2016). Design cost overrun could be a result of causes such as lack of information and definition of project scope, inadequate design, design variation, not allocating sufficient resources and time to develop appropriate design (Bassioni *et al.*, 2013). Design cost overrun reduces the value delivered to the client and end users, extends the design period which affects the feasibility of the project and increases their dissatisfaction (Baloyi and Bekker, 2011)
KR2	Brief changes by the client	×	×		Changing the project brief, after it has been established and especially in later stages, has an impact on the project cost, time and quality. Late changes to the project brief are considered as key risks that affect the project sustainability through being a source of increasing cost, delaying design, creating disputes and litigation between project stakeholders (CIC, 1994; Kubal, 1994; O'Brien, 1998; Veenendaal, 1998)
KR3	Design variations by the architect	×	×	×	Architects are responsible for providing designs that reflect client requirements and end-users' needs. However, design variations conducted by the architect because of reasons such as lack of understanding client requirements (Othman *et al.*, 2004), unclear and incomplete project brief as well as ignoring the client and behave unilaterally (Barrett and Stanley, 1999) has a major impact on the project sustainability in terms of estimated cost overrun, design rework, client dissatisfaction and generated waste
KR4	Design process takes longer than needed	×	×		Delay in providing design because of factors such as slow decision making by the client and lack of information provision is considered one of the most important risks that affect the project sustainability. This is because delayed design process leads to cost overrun and client dissatisfaction. In addition, it will prevent the client from launching the project on the defined date which will affect the project profitability (Othman *et al.*, 2004; Subramani *et al.*, 2014)
KR5	Lack of coordination between design participants	×	×		Lack of coordination between design participants was ranked the fifth highest risks (with RII 0.74 out of 1), that affect the sustainable delivery of construction projects during the design phase. Lack of coordination between the design parties (i.e. client, designer, government authorities) resulted in creating conflict which affects participants' behaviour as well as the project progress in terms of cost and time (Othman *et al.*, 2004)
KR6	Incomplete environmental analysis	×	×	×	The design phase is often determinant for the environmental performance of projects throughout their life cycle. Lack of considering environmental requirements during the design phase (Best and Valence, 1999) affects the sustainable delivering of construction projects. This is obvious in the time needed to change the design to fulfil the environmental requirements, the increase of financial implication, the delay of getting approvals for construction and the adverse impact of client dissatisfaction

(*continued*)

No.	Risks	Classification according to sustainability Economic	Social	Environmental	Explanation
KR7	Tight project design schedule	×	×	×	Architects and other design professionals have target dates by which their documentations must be delivered. Based on their needs, some clients are in hurry to complete their projects to meet business opportunities. Accordingly, inadequate time is available for architects to develop appropriate design that considers social, economic and environmental requirements which affects the sustainable delivery of construction projects (ICE, 1996a, 1996b; Othman *et al.*, 2004)
KR8	Design errors and omissions	×	×	×	Design errors and omissions usually occur usually in every project. They are instructions (or lack of instructions) in the plans and specifications that, if followed by the contractor will require replacement or correction at a cost or result in a construction failure. The Building Research Establishment (BRE) in the UK found that errors in buildings had 50% of their origin in the design stage and 40% in the construction stage (Building Research Establishment, 1981). Design errors can adversely influence project performance, sustainability and can contribute to failures, rework during construction, time and cost overruns, accidents and loss of life. The National Economic Development Office (1987) concluded that most of the project-based errors are avoidable by having adequate knowledge and better management practices
KR9	Non-compliance to building codes, regulations, laws and standards	×	×	×	Building codes, regulations, laws and standards are a set of rules that specify the standards for the constructed projects. Buildings must conform to regulations the codes to obtain planning permission, usually from a local council. The main purpose of building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. The building codes become law of a particular jurisdiction when formally enacted by the appropriate governmental or private authority (Ching and Winkel, 2016). Non-compliance to building codes, regulations, laws and standards affect the sustainability of the delivered project socially, economically and environmentally
KR10	Skills gap of qualified architects and design managers	×	×	×	Skills gap is one of the pressing problems that encounter the construction industry generally and ADFs in particular (ASTD, 2012). It is the gap between what are the skills needed by the organisation and what are the available skills. Skills gap of qualified architects and design manager is a barrier to growth, innovation, delivering service and product on time, meeting the quality standards and meeting economics and social requirement. Closing the skills gap has a direct connection with improving productivity, human development and economic growth (Aring, 2012)

(*continued*)

Table II.

Table II.

No.	Risks	Economic	Social	Environmental	Classification according to sustainability Explanation
KR11	Stakeholders change project requirements at later stages	×	×	×	Smith and Wyatt (1998) stated that the early stages of the project are crucial to its success. This is because the significant decisions made during these early stages affect the sustainability and performance of the project. As a result, changing the project requirements, after it has been established and in particular at later stages, has an impact on project cost, time and quality. Late changes to the requirements are considered a major source of dispute and litigation globally throughout the construction industry (CIC, 1994; Kubal, 1994; O'Brien, 1998; Veenendaal, 1998)
KR12	Uncoordinated and incorrect construction documents	×	×		Uncoordinated and incorrect construction documents produced during the design phase are a result of the unfamiliarity of the designer with the project, time shortage, misunderstanding, information overload, over manning, etc. (Wantanakorn *et al.*, 1999). Such contradiction between documents affects the sustainable delivery of projects in terms of time, cost and effort needed to rectify the incorrect project documentation and resolve the contradictory between different documents, such as drawings and specification in an endeavour to make sure that the client requirements are correctly reflected (Othman *et al.*, 2004)
KR13	Specifying outdated construction materials and technology	×	×		Rapid improvement of construction materials and technology, coupled with the lack of designer's experience to follow-up these improvements resulted in specifying outdated materials and technology which were no longer produced or available in the market. This affects the sustainability of the delivered project because of the delay, cost and effort required to change the specified materials and technology to match market availability (Tunstall, 2006 and Tenah, 1985)
KR14	Lack of consideration of environmental requirements			×	ADFs are responsible for delivering construction projects that fulfill the needs of the society taking into account the adverse impact of the project on the surrounding environment. Failing to consider environmental requirements during the design process will affect the sustainability of the delivered design. During the design process, architects should focus on design that: reduces waste, effluent generation, emissions to environment; reduces impact on human health; uses renewable raw materials; and eliminates toxic substances (Othman and Nadim, 2010)
KR15	Failure to carry out the work in accordance with contracts	×	×	×	Contracts are designed to organise the relationship between different project participants and reduce the potential risks that lead to project failure. Failing to carry out the work in accordance with contracts leads to disputes, time delay, cost overrun, poor quality, environmental non-compliance and client dissatisfaction (Othman and Harinarain, 2009)

(*continued*)

Table II.

No.	Risks	Classification according to sustainability Economic	Social	Environmental	Explanation
KR16	Lack of considering whole project life cycle cost	×	×	×	Decisions taken during the design process are increasingly required to consider full life cycle cost to facilitate the specification choice for different construction projects. This is because client's selections of materials and equipment made at early stages of the project life cycle affect the performance of the building and its sustainability (Whyte and Scott, 2010; CIB, 1996)
KR17	Lack of communication and coordination between governmental authorities and ADFs over planning and approvals	×	×		Lack of communication and coordination between governmental authorities and ADFs over planning and approvals has a number of impacts on the sustainable delivery of construction projects. These impacts include or example lack of regulatory updating and changing government regulation and codes (O'Leary, 1992). As a result, the project brief and building design has to be modified to abide to regulations and codes which, consumes time and increase cost and lead to client dissatisfaction (Othman *et al.*, 2004)
KR18	Public objections	×	×	×	Failing to engage the public to identify their requirements and constraints during the design phase lead to project failure. This is obvious when the project outcomes, for example, violate national or local regulations and planning policy, deteriorate the public image and affect the surrounding environment in a negative way (Manowong, 2010; Zschiesche, 2012)

ADP received scant attention in construction literature. This highlighted the need to consider the risk factors that affect the project sustainability during the design phase. Developing a framework for the integration of RM into ADP will facilitate delivering sustainable construction projects successfully and improve the design process, which consequently improves the whole construction process. This needed is highlighted as a result of the survey questionnaire conducted with Egyptian ADFs (Othman and Abdelwahab, 2016).

4.3 Aim and objectives of the framework

This framework aims to facilitate the integration of RM into ADP as an approach to deliver successful sustainable projects. The framework consists of five main steps (Figure 4):

(1) define the integration barriers;

(2) establish the integration objectives;

(3) develop the integration plan;

(4) implement the integration plane; and

(5) monitor and control the integration plan.

4.4 Description of the proposed framework

4.4.1 Define the integration barriers. The objective of this step is to define the barriers that hinder the integration of RM into ADP. This objective will be achieved through studying the current practices of ADP, identifying, validating and classifying the barriers of integration. In addition, it requires identifying the social, economic and environmental impacts of not integrating RM in ADP. Attaining this objective calls for setting strategic matters such as selecting the team who will conduct these studies, allocate study budget and resources needed. Gaining top management support is essential to facilitate securing the needed resources, accepting and implementing the study recommendations. During this stage, a number of tool and techniques are required to define the integration barriers, namely, literature review, survey questionnaires, interviews, case studies, brainstorming and team consensus. The involvement of certain personnel will help achieving the objective of this stage. They will include representatives of client organisations, project managers, design and construction teams, different project stakeholders, risk managers and sustainability specialists.

4.4.2 Establishing the integration objectives. Towards enabling ADFs improve the sustainable delivery of construction projects during the design phase, the objective of integrating RM into ADP is essential to be established and communicated to all employees. This objective could be achieved through using brainstorming techniques and team

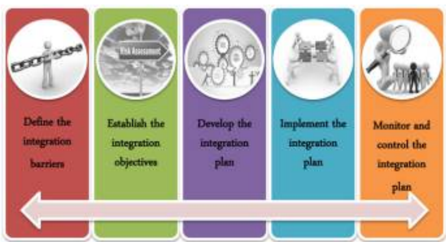

Figure 4.
Detailed description of the developed framework

consensus to generate and select objectives that address the identified problem and overcome the integration barriers. Engaging employees in ADFs to establish the integration objectives gives team members ownership to these objectives and encourages them to accomplish them. During this stage, the evaluation matrix will be used to rank these objectives according to their significance to the organisation. Moreover, this function will result also in defining the criteria to be used to measure the effectiveness of integrating RM into ADP towards delivering sustainable projects during the design phase. The people to be involved to achieve the objective of this stage include senior management of ADFs, design managers, members of the design and construction teams and other employees related to the study.

4.4.3 Develop the integration plan. The aim of this step is to set the procedures and actions necessary to accomplish the integration objectives. It will include developing a work breakdown structure and a responsibility matrix, where the first downsizes the work into manageable work packages and the latter links the activity to be done and the responsible person. Within each phase of the design process (i.e. concept design phase, developed design phase and technical design phase), RM components, namely, Risk Identification (RI), Risk Analysis (RA) and Risk Response (RI), will be integrated to achieve the social, economic and environmental dimensions of sustainability (Figure 5). In addition, training programmes for architectural design team have to be offered to provide architects to equip them with knowledge and skills needed to integrate RM in the design process. Furthermore, the integration plan should include performance management procedures, corrective actions to be taken in case the plan did not go as planned. Finally, a communication plan among project participants has to be developed to portray the reporting structure of the integration process.

4.4.4 Implement the integration plane. Within this stage, the plans developed in the previous stage will be implemented. The implementation plans require the application of RM steps into the different design process activities. In addition, employees involved in the integration process have to be trained and equipped with all tools and technologies required to guarantee the successful execution of plans. Moreover, senior management support and offering required facilities will help achieving the integration objectives. The implementation stage should use the work authorisation system, which provides for verification of predecessor activities and the permission to begin successor activities. This ensures the quality of work performed. People involved in this stage will include the design team, senior management and other related personnel to the stage.

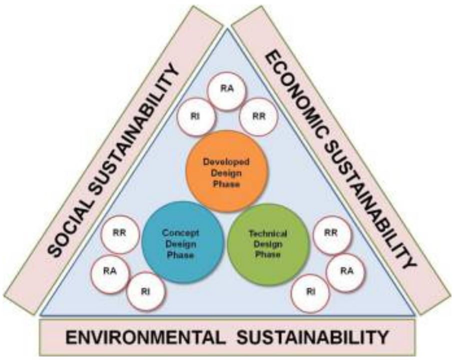

Figure 5.
The integration of risk management into architectural design process

4.4.5 Monitor and control the integration plan. The aim of this stage is to monitor, evaluate and control the results revealed from the integration of RM into ADP. The activities to be conducted during this stage include measuring results against the performance measures developed earlier, identifying and evaluating causes of failure and issues that resulted in deviation from the original plans. The tools that will be used in this stage are change control procedures, financial controls procedures and defect management procedures. Documented learned lessons, comments and feedback from the implementation team will enable taking corrective actions if plans were not implemented as planned. Furthermore, this will help improving the design process towards delivering sustainable projects. This stage also involves documenting learned lessons and sharing them with government authorities, decision-makers, design and construction teams and related project stakeholders.

4.5 Benefits and limitations of the framework

The main benefit of the proposed framework is integrating RM into ADP to facilitate the delivery of sustainable construction projects during the design phase. It encourages all project participants to contribute positively, communicate openly and cooperate effectively towards overcoming the key risks that affect ADP. However, there are several limitations, some of which are:

- The effective adoption and application of the framework depends to a large extent on the willingness of the senior management, design team, client organisation and project participants to participate in the integration of RM into ADP to develop sustainable construction projects. If they do not have the desire to use the framework, then its adoption will be limited.
- The application of the framework is time-consuming, and because of the time constraints in construction projects, where insufficient time is spent on improving ADP through identifying key risks that affect its performance, this framework might not be accepted by some sectors of the industry.

5. Conclusion and recommendations

The construction industry plays a pivotal role towards the social and economic development of countries worldwide. At the social level, it aims to construct projects and infrastructure facilities that fulfil the community needs, meet or exceed clients' and end-users' requirements on time, within budget and as specified. At the economic level, it increases countries' GDP, offers job opportunities and supports other industries to excel. However, it has a negative impact on the environment in terms of resources and energy consumption, pollution and waste generation. This called for the construction industry to be more sustainable. ADP is one of the important stages of the construction process, as many of the decisions adopted during this stage affect the sustainability and performance of the project throughout its life cycle. RM is widely applied in different phases of the construction projects; however, its application in ADP received scant attention in construction literature. The research identified 18 key risks that affect the sustainable delivery of construction projects during ADP. The architect, the client and the project manager were the highest ranked responsible parties for the occurrence of these key risks. Based on the results of the field study conducted by the authors, the research developed a framework to facilitate the integration of RM into ADP as an approach for delivering sustainable construction projects. Based on the above, the research comes to the following conclusions:

- ADFs are advised to reconsider the key risks that affect the sustainable delivery of construction projects during the design phase. Adopting the framework developed by this research is recommended as an approach for integrating RM into ADP.
- Senior management of ADFs is required to overcome the obstacles that hinder the integration of RM into ADP through changing dominant culture, providing essential training and offering needed resources.
- Integrating the different players of the construction project during the design phase helps improving the project design and makes better utilisation of their varied experience and skills. In addition, this guarantees that their requirements are reflected early in the design process to avoid the risk and consequences of late changes.
- Governmental authorities responsible for the construction industry are required to set the rules, establish the regulations and offer incentives that ensure the integration of RM into APD to enhance the sustainability of the delivered projects and the industry at large.

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