Available online at www.sciencedirect.com

ScienceDirect

International Journal of Project Management 35 (2017) 1120–1132

International Journal of Project Management

www.elsevier.com/locate/ijproman

Can project sustainability management impact project success? An empirical study applying a contingent approach

Marly M. Carvalho *, Roque Rabechini Jr

Production Engineering Department, Polytechnic School University of São Paulo, São Paulo, Brazil

Received 29 February 2016; received in revised form 22 February 2017; accepted 23 February 2017
Available online 14 March 2017

Abstract

This study aims to propose and to validate a research model on project sustainability management. Moreover, it investigates the relation between project sustainability management and project success. The methodological approach is a survey-based research, using structural equation modelling to validate the research model. The hypotheses were tested based on a field study involving 222 projects distributed among eight industries and two countries. The results show a low degree of commitment to social and environment aspects of the surveyed projects. The structural model proposed shows a significant and positive relation between project sustainability management and project success and in reducing the social and environmental negative impact.

Keywords: Sustainability; Project management; Project sustainability management; Project success; Project performance; Project complexity; Contingent approach; Triple bottom line

1. Executive summary

Despite the importance of sustainability, surprisingly little explicit guidance exists on including this subject in project management literature, which motivated this special issue.

This paper help to bridge this knowledge gap by proposing and validating a new research model for project sustainability management. This model refers to product and project perspectives. The product perspective is deployed in two building blocks: design for environment, and environmental technologies. The project perspective encompasses three building blocks: the project management process & knowledge areas focusing on sustainability, the green procurement and partnership, and social responsibility in the project. To develop and validate the model, we surveyed 222 projects throughout a wide range of industrial sectors, applying structural equation modelling.

Beyond that, the research results show that the sustainable perspective on PM can help to improve project success and reduce negative social and environmental impact and so companies should pay more attention in introducing sustainability in project management practices.

Our findings also show that most studied companies are facing substantial challenges to integrating sustainability into project management.

2. Introduction

The bridge between project management and sustainability is still being built. This subject has been receiving more attention from professionals and scholars (Silvius et al., 2013); however, it is still a challenge in the project management (PM) field (Martens and Carvalho, 2016, 2017a).

Brones et al. (2014) go further and suggest that intersection between Ecodesign and project management is a “missing link for the integration of sustainability”. Taking into consideration the triple bottom line (TBL) – economic, environmental and social – perspectives of sustainability (Elkington, 1998) the lack

* Corresponding author at: Av. Prof. Almeida Prado, trav 2, n 128, 05508-900 São Paulo/SP, Brazil.
E-mail addresses: marlymc@usp.br, marly.carvalho@poli.usp.br (M.M. Carvalho).

http://dx.doi.org/10.1016/j.ijproman.2017.02.018
0263-7863/00/

of academic literature is still stronger in the PM field. Some authors point out this gap in the literature and in practice (Carvalho and Rabechini, 2011; Marcelino-Sádaba et al., 2015; Singh et al., 2012; Thomson et al., 2011).It can be incorporated into organizations by developing new projects, driven by sustainability principles (Labuschagne et al., 2005).

To construct the bridge between sustainability and project management it is necessary to go beyond an axiological mind set on sustainability (Bolis et al., 2014), demanding also processes, tools and techniques related to the TBL in a project perspective that can be applied and, positively impact project success (Carvalho and Rabechini, 2011).

In the project management field, some initiatives have been underway, such as Fernandez-Sanchez and Rodriguez-Lopez, 2010; Carvalho and Rabechini, 2011; Martens and Carvalho, 2016a, 2017a; Marcelino-Sádaba et al., 2015. However, in the widespread Bodies of Knowledge (BoK) as the Project Management Body of Knowledge (PMBOK) (PMI, 2013), sustainability is poorly addressed (Brones et al., 2014). Lastly, a major gap remains regarding the social dimension of sustainability (Morioka and Carvalho, 2015), considering issues related to labour practices for employees and contractors, and to the engagement of all external and internal stakeholders (Labuschagne et al., 2005; Singh et al., 2012).

According to Marcelino-Sádaba et al. (2015), there are many pending questions concerning sustainability and project management. Particularly the relation between project sustainability management (PSM) and success still lack empirical evaluation. The attitude towards sustainability can range from defensive to proactive, aligned with the stakeholders' perspective (Schaltegger et al., 2012). However, we intend to analyse the sustainability not only as a requirement but also as a source of competitive advantage, i.e., contributing to project success (Carvalho and Rabechini, 2011).

Therefore, this study aims to contribute to bridging this research gap by proposing and validating a research model for project sustainability management (PSM). It also aims to relate PSM and project success.

In this context, given this ongoing discussion in the literature and the lack of in-depth quantitative studies, we formulate the following research questions: RQ1 — How could the concepts of sustainability be integrated into project management? and RQ2 — what is the relation between project sustainability management and project success?

The methodological approach is a survey-based research, using structural equation modelling to validate the research model.

This article is organized in six sections, as follows. Section 2 provides the background on project sustainability management, and Section 3 also presents the research model and hypotheses. The research design is presented in Section 4, followed by the results, in Section 5. Section 6 presents the research conclusions.

3. Literature review and research model

Recent literature reviews on sustainability in the project management field (Marcelino-Sádaba et al., 2015; Martens and Carvalho, 2017b; Morioka and Carvalho, 2015; Silvius and Schipper, 2014) pointed out the lack of literature bridging sustainability and PM literature. Brones et al. (2014) argue that the main project management frameworks, such as PMBoK, ICB, ISO 21500:2012 and Prince2, poorly considered environmental sustainability. Silvius and Schipper (2014) corroborate by concluding that PM standards fail to address sustainability.

Integrating sustainability and project management can stretch the system boundaries of PM (Silvius and Schipper, 2014), but there are many pending questions and the integration is difficult (Marcelino-Sádaba et al., 2015).

Sustainability in the PM area can be viewed through different lenses. Carvalho and Rabechini (2011) suggest that there is both an internal perspective and an external perspective of sustainability in PM. The internal perspective is related to the PM process and PM areas, along the project life cycle. The external perspective is related to the sustainable development in a broad perspective, concerning the project social and environmental impacts.

Some researchers have been particularly interested in the link between PM and Ecodesign or, the environmental perspective of sustainability (Johansson and Magnusson, 2006; Knight and Jenkins, 2009; Ny et al., 2008; Tingström and Karlsson, 2006; Tingström et al., 2006; Vezzoli and Sciama, 2006; Brones et al., 2014, 2017). Others, particularly in the public sector and, in the construction industry, are concerning with the social dimension of sustainability (Campbell et al., 2008; Fellows and Liu, 2008; Leurs et al., 2008; Almansi and Tammarazio, 2008; Kuper et al., 2009; Barry et al., 2009; Raven et al., 2009; Madden and Morawski, 2011). However, in the context of Triple Bottom Line (TBL), considering environmental, social and economic aspects, less study has been developed (Pulaski and Horman, 2005; Fernandez-Sanchez and Rodriguez-Lopez, 2010; Korkmaz et al., 2010; Corder et al., 2010; Carvalho and Rabechini, 2011; Thomson et al., 2011; Laws and Loeber, 2011; Martens and Carvalho, 2016, 2017a; Morioka and Carvalho, 2015; Marcelino-Sádaba et al., 2015).

Marcelino-Sádaba et al. (2015) propose a four-dimensional framework including sustainability in the triple bottom line perspective (economic, social, and environmental) in project management. For Martens and Carvalho (2016, 2017a), the key issues involve the strategic but also tactic perspectives in four factors: sustainable innovation business model, stakeholder management, economic and competitive advantage, and environmental policies and resources saving.

Integrating sustainable product and project lifecycle management is a starting point for aligning project management and sustainable development principles (Labuschagne and Brent, 2005, 2008). In the PM context, the term sustainability can refer to product and/or project, as in other PM knowledge areas, such as scope and quality (Carvalho and Rabechini, 2011). The project scope management, for instance, can refer to "Product scope. The features and functions that characterize a product, service, or result; and/or Project scope. The work performed to deliver a product, service, or result with the specified features and functions. The term project scope is sometimes viewed as including product scope." (PMI, 2013, p.103). In analogy in this research, project sustainability management refers to both product and project. Silvius and Schipper (2015) corroborates that sustainability can refer to product and process. Additionally, when we refer to the product we are meaning also service and other intangibles results of the project. It is important to note that the proposed model did not include the organizational sustainability perspective. Fig. 1 illustrates the research model context.

3.1. Sustainability in product perspective

Life cycle analysis literature (Labuschagne and Brent, 2005) is in a mature stage, such as the ISO 14062 and ISO 14006 standards, and can integrate environmental aspects into the product perspective towards a more sustainable PM context (Marcelino-Sádaba et al., 2015). However, project management area still lacks in integrating this literature (Brones et al., 2014; Brones and Carvalho, 2015).

The integration between Design for Environment (DfE) and PM can foster the involvement with environmental sustainability since the initiating process; aligning the stakeholders' expectations with the project's purpose on sustainability, stablishing success criteria related to environment impacts of the project.

For Glavič and Lukman (2007), both terms Design for Environment or Ecodesign can be understood as "a product development process that takes into account the complete life cycle of a product and considers environmental aspects at all stages of a process", and encompasses eco-efficiency, remanufacturing, recycling, source reduction, waste minimization in the life cycle. Ecodesign initially started by focusing on tangible products but moved also towards services-oriented life cycle design (Bhamra and Evans, 1999), for avoiding "impact transfer and lead to environmentally-sound services" (Bonvoisina et al., 2014). The resource utilization, such as water and energy, also plays a critical role in environmental perspective (Labuschagne and Brent, 2005).

The environmental technology (ET) can be understood as the systematic knowledge and its application for making efficient use of natural resources while reducing/recycling wastes, to control/minimize the risks and reduce pollution (Glavič and Lukman, 2007). For Kuehr (2007), ET can be separated into the following four categories, differing in their ecological effectiveness: "measuring technologies on the environment, cleansing technologies or end-of-pipe approaches, cleaner technologies, clean technologies or zero impact technologies".

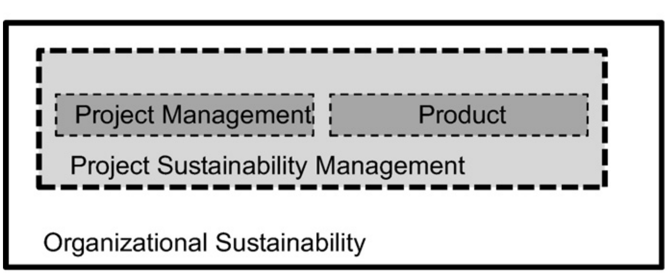

Fig. 1. Sustainability in PM context.

3.2. Sustainability in project perspective

For Carvalho and Rabechini (2015), PM Process & Knowledge areas (PMfS) should address issues related to sustainability in the TBL perspective. Particularly relevant in introducing sustainability in the PM areas of scope, human resource-stakeholder-communication (soft side), procurement and risk. Silvius and Schipper (2014) also identify several opportunities for introducing sustainability guidelines into all project management processes.

The dimensions for managing sustainable projects includes sustainable project products, processes, organizations commitment to sustainability and, sustainability trained and aware persons (Marcelino-Sádaba et al., 2015). For instance, sustainable project products, to be positioned in the social perspective as policies derived from the Corporate Social Responsibility (CSR), positioned in the environmental dimension as ecodesign and, in the economic perspective in compliance with ISO standards (ISO 26000, ISO 14000 among others).

Implementation obstacles range from lack of key stakeholders' attention to insufficient capabilities for sustainability management (Carvalho and Rabechini, 2011). Brones et al. (2014) identified the supply chain, quality, deadlines and risk, as the most critical aspects of integrating environmental aspects into project management. For Silvius and Schipper (2014), it is needed to close the competence gap of project managers concerning sustainability, particularly in five key-competences: systems thinking competences, anticipatory competences, normative competences, strategic competences and interpersonal competences.

The soft side is critical to introduce sustainability in PM once the stakeholder commitment is needed (Carvalho and Rabechini, 2015). The stakeholders' management can be the connection between traditional project management and the social and ethical aspects, improving their participation and coordination (Marcelino-Sádaba et al., 2015), being a path for more sustainable project management (Weninger et al., 2013).

The supply chain of the project is also a relevant issue (Silvius and Schipper, 2014). The green procurement (GP&P) in PM area is still in the embryonic phase. Only projects with greater complexity (Lenferink et al., 2013), and subject to a regulatory environment (Zhu and Sarkis, 2006) are more concerned with sustainability issues. Hwang and Ng (2013) argue that one of the challenges for green construction project management is the difficulty in selecting subcontractors that provide green construction services, associated with the uncertainty and the high cost of employing green equipment and materials. Kuei et al. (2015) show that external factors, such as customer pressures and regulatory pressures, were critical adopting green practices in supply chains.

Finally, the social responsibility (SR) is an important aspect of meeting TBL pillars. The key principles in social responsibility, according to ISO 26000:2010 are: accountability, transparency, ethical behaviour, respect for stakeholder interests, respect for the rule of law, respect for international norms of behaviour, and, respect for human rights (International Standard, 2010). All these principles can be applied to the PM context. Khang and Moe

(2008) identified some environments being more susceptible to political corruption, exploring ethical issue in projects context, studied ethical behaviour related to projects. For Labuschagne and Brent (2005), social responsibility encompasses internal human resources, external population, stakeholder participation and macro social performance. Additionally, occupational health and safety management standards guidelines, such as OHSAS 18001:2007 and ISO/CD 45001 (British Standards Institute, 2007; International Standard, 2016) compliance are particularly relevant, as highlighted in some studies in the PM literature (Kometa et al., 1995; Kumaraswamy and Thorpe, 1996; Lim and Mohamed, 1999; Carvalho and Rabechini, 2011; Almahmoud et al., 2012).

The previous discussion lead us to propose that project sustainability management (PSM) refers to product and project perspectives. In the literature discussed on project sustainability management (PSM), two constructs refers to sustainability in product perspective: Design for Environment (DfE), and environmental technologies (ET), while the project perspective encompasses the PM process & knowledge areas focusing on sustainability (PMfS), the green procurement and partnership (GPP), and social responsibility in the project (SR).

3.3. Project success

Project success (PS) is a multidimensional construct. The traditional project success approach is related to the compliance with scope, time and cost objective (Wit, 1988). For Shenhar and Dvir (2007) project success can be deployed into more strategic dimensions as the following: project efficiency, impact on the team, impact on the customer, business and direct success, and preparation for the future. More recently, an environmental and social sustainability dimension has been incorporating (Carvalho and Rabechini, 2015; Martens and Carvalho, 2017b). Pulaski and Horman (2005) developed a model in sustainable construction integrating sustainable objectives into project management practices, developing a rating system in eight categories: four related to project performance measuring (cost, quality, schedule, process efficiency) and four representing sustainable building objectives (safety/health, maintainability, resources used, and leadership in energy and environmental design (LEED) credit).

Other studies suggest environment damages reduction (Atkinson, 1999; Carvalho and Rabechini, 2015; Chan and Chan, 2004; Lam et al., 2007; Ellatar, 2009; Kumaraswamy and Thorpe, 1996; Pulaski and Horman, 2005), social benefits (Atkinson, 1999; Carvalho and Rabechini, 2015; Ellatar, 2009; Kumaraswamy and Thorpe, 1996), compliance to standards and legislation (Carvalho and Rabechini, 2015; Ellatar, 2009; Pocock et al., 1996) and reduction of health and safety issues (Carvalho and Rabechini, 2015; Chan and Chan, 2004; Lam et al., 2007; CII, 2006; Ellatar, 2009; Lim and Mohamed, 1999; Kometa et al., 1995; Kumaraswamy and Thorpe, 1996; Pulaski and Horman, 2005; Toor and Ogunlana, 2010; White and Fortune, 2002).

4. Research model and hypotheses

The previous discussion leads us to the research model and hypotheses proposed in Fig. 2.

Project sustainability management (PSM) refers to product and project perspectives. The product perspective is deployed into the variables discussed in Section 2 as follows: Design for Environment (DfE), and environmental technologies (ET), while the project perspective relates to PM process & knowledge areas focusing on sustainability (PMfS), green procurement and partnership (GPP), and social responsibility in the project (SR).

There is a lack of confirmatory studies on the relation between sustainability and project performance. Martens and

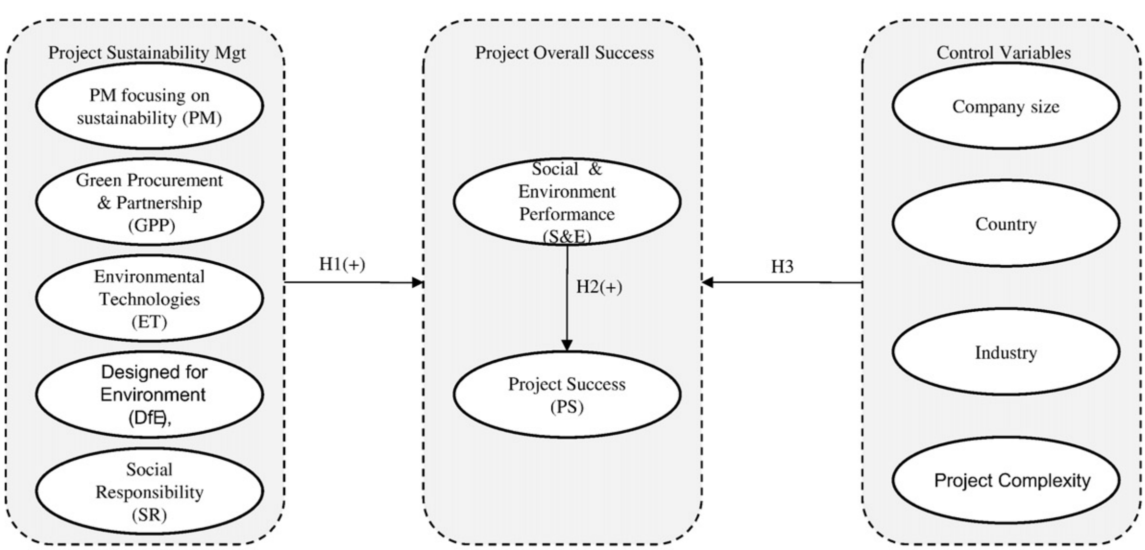

Fig. 2. Conceptual model and hypotheses. Note: To simplify the understanding of the model, some arrows were not shown.

Carvalho (2016, 2017a) suggest based on an expert panel that sustainability has a positive impact on project performance. Thus, it suggests the importance of investigating following hypothesis:

Hypothesis 1a. A more sustainable project management positively influences project success.

The project sustainability management can influence sustainable issues as safety/health, maintainability, resources used, and leadership in energy and environmental design (LEED credit) (Pulaski and Horman, 2005). Martens and Carvalho (2017b) pointed out that project sustainability management could affect also a sixth dimension proposed by Carvalho and Rabechini (2015) that includes the environmental and the social success. From these arguments, we derive the following hypothesis:

Hypothesis 1b. A more project sustainability management positively influences social and environmental performance.

The results of the few qualitative research available relating sustainability and project success are somehow controversial. In construction projects, for instance, Hwang and Ng (2013) suggest that green construction projects are more expensive while Pearce (2008) argue that the key aspect is to identify and justify the use of sustainability elements that do not influence the cost or that even save costs. Thus, to analyse in-depth the effect of social and environmental performance on project success, the following hypothesis is proposed:

Hypothesis 2. A better social and environmental performance positively influences project success.

Due to the complex nature of project success construct, the choice of control variables is an important part of the research model (Carvalho et al., 2015). Moreover, Shenhar (2001) highlight the importance of contingent theory in PM field. The control variables frequently applied in contingent studies in PM are: project complexity (Carvalho et al., 2015; Shenhar, 2001; Shenhar and Dvir, 1996; Shenhar et al., 2002, 2005), country (Ahsan and Gunawan, 2010; Carvalho et al., 2015; Khang and Moe, 2008; Prasad et al. 2013), industry sector (Carvalho et al., 2015; Carvalho and Rabechini, 2015; Ibbs and Kwak, 2000; Pennypacker and Grant, 2003; Raz et al. 2002; Zwikael and Ahn, 2011), and company size (Carvalho et al., 2015; Carvalho and Rabechini, 2015). From these studies, we derive the following hypothesis:

Hypothesis 3. The control variables (country, sector, company size and project complexity) affect project success.

5. Research methods

This study aims to investigate the relation between project sustainability management and success, considering sector, country and project complexity, as control variables. The first step of the research was the literature review and conceptual model proposition, presented in the previous section. For empirical validation, a survey-based research was developed, following the guidelines from literature (Flynn et al., 1990; Forza, 2002).The structural equation modelling (Hair et al., 2014) was applied to validate the research model and to check the research hypotheses.

5.1. Sample procedures

The unit of analysis is the project. The respondents selected for this research are project managers or team members, one respondent per project. The research was performed in two countries, Brazil and Peru. The use of a non-probabilistic sample is due to the need for ease of access to project data and respondents.

The unit of analysis is the project. Each project manager was interviewed on behalf of one particular project by the researchers and projects data and documents were collected. The analysis was ex-post facto, i.e., the project is already finished. This approach was chosen because the success perception can vary over time (Shenhar and Dvir, 2007) and for this kind of confirmatory research is important to avoid this effect. Moreover, it is important to highlight that we did not address multiple stakeholders for analysing project success. The minimum sample size required to use the multivariate analysis test applied was calculated by the G*Power 3.0 software (Faul et al., 2007), considering statistical significance level of 5%, power level of 95%,effect size of 15% and number of predictors of 5 (Hair et al., 2005), which resulted in an expected sample size of 138 elements.

Four hundred and fifteen project management professionals were contacted, 225 accepted to participate, three of them had not the documents available; thus, remaining 222 valid projects (53%). The selection criteria were the availability for being interviewed by the researchers and for providing the requested project documentation (project reports). Besides, this is an ex-post facto study, as such, the selected project has already occurred. This sample is larger than the one calculated by the G*Power 3.0 software.

5.2. Research instrument

The first version of the research instrument, based on the literature review presented in Section 2, was submitted to face validation of its clarity and representativeness to measure the constructs researched (Netemeyer et al., 2003; Venkatraman and Grant, 1986). Three professors specialized in the PM area and, two belonging to the sustainability area, performed the test. For face validation, five professionals of the PM area were interviewed to perform the questionnaire's pre-test. After validations, the questionnaire was revised and applied in person, by the researchers.

The final version of the questionnaire comprised 39 questions, which are formulated as a statement on each manifest variable, applying Likert scale, ranging from *total disagreeing* to *total agreeing*. We have summarized the latent variables, manifest variables and references in Table 1. Appendix A presents the summary of the research questions on PSM, the code of latent and manifest variables and the descriptive statistics.

Table 1
Research instrument topics and main references.

Construct	Main issues of the manifest variable (question item)	Main references
Design for Environment (DfE)	Life cycle management, life cycle management	Glavič and Lukman (2007), Bhamra and Evans (1999), ISO 14062 and ISO 14006, Marcelino-Sádaba et al. (2015), Brones et al. (2014), Brones and Carvalho (2015), Bonvoisina et al. (2014). Labuschagne and Brent (2005)
	Eco-efficiency	Glavič and Lukman (2007), Bhamra and Evans (1999), ISO 14062 and ISO 14006, Marcelino-Sádaba et al. (2015), Brones et al. (2014), Brones and Carvalho (2015), Bonvoisina et al. (2014). Labuschagne and Brent (2005)
	Resource utilization	Glavič and Lukman (2007), Bhamra and Evans (1999), ISO 50001, Labuschagne and Brent (2005)
Environmental Technologies (ET)	Measuring technologies on the environment, cleansing technologies or end-of-pipe approaches, cleaner technologies, clean technologies or zero impact technologies	Glavič and Lukman (2007), Kuehr (2007),
Green Procurement & Partnership (GPP)	Selecting subcontractors based on sustainability criteria	Silvius and Schipper (2014), Lenferink et al. (2013), Zhu and Sarkis (2006), Hwang and Ng (2013), Kuei et al. (2015)
	Selecting partnership based on sustainability criteria	
PM Process & Knowledge areas (PMfS)	PM Knowledge areas focusing on sustainability	Carvalho and Rabechini (2015), Silvius and Schipper (2014), Marcelino-Sádaba et al. (2015)
	PM processes focusing on sustainability	Carvalho and Rabechini (2015), Silvius and Schipper (2014), Marcelino-Sádaba et al. (2015)
Social Responsibility (SR)	Stakeholders commitment with social responsibility	Khang and Moe (2008), Labuschagne and Brent (2005), Kometa et al. (1995), Kumaraswamy and Thorpe (1996), Lim and Mohamed (1999), Carvalho and Rabechini (2011) and Almahmoud et al. (2012)
	Social responsibility principles	ISO 26000
	Health and safety principles	OHSAS 18000
Project success (PS)	Project efficiency	Wit (1988), Shenhar and Dvir (2007), Carvalho and Rabechini (2015), Martens and Carvalho (2017b), Pulaski and Horman (2005)
	Impact on the team	Shenhar and Dvir (2007), Carvalho and Rabechini (2015), Martens and Carvalho (2017b)
	Impact on the customer	Shenhar and Dvir (2007), Carvalho and Rabechini (2015), Martens and Carvalho (2017b)
	Business and direct success	Shenhar and Dvir (2007), Carvalho and Rabechini (2015), Martens and Carvalho (2017b)
	Preparation for the future	Shenhar and Dvir (2007), Carvalho and Rabechini (2015), Martens and Carvalho (2017b)
Social and Environment impact (S&E)	Environment damages reduction	Atkinson (1999), Carvalho and Rabechini (2015), Chan and Chan (2004), Lam et al. (2007), Ellatar (2009), Kumaraswamy and Thorpe (1996), Pulaski and Horman (2005),
	Social benefits	Atkinson (1999), Carvalho and Rabechini (2015), Ellatar (2009), Kumaraswamy and Thorpe (1996),
	Compliance to standards and legislation	Carvalho and Rabechini (2015), Ellatar (2009), Pocock et al. (1996)
	Health and safety	Carvalho and Rabechini (2015), Chan and Chan (2004), Lam et al. (2007), CII (2006), Ellatar (2009), Lim and Mohamed (1999), Kometa et al. (1995), Kumaraswamy and Thorpe (1996), Pulaski and Horman (2005), Toor and Ogunlana (2010), White and Fortune (2002).
Control variables	Project complexity	Carvalho et al. (2015), Shenhar (2001), Shenhar and Dvir (1996), Shenhar et al. (2002, 2005),
	Country	Ahsan and Gunawan (2010), Carvalho et al. (2015), Khang and Moe (2008), Prasad et al. (2013),
	Industry sector	Carvalho et al. (2015), Carvalho and Rabechini (2015), Ibbs and Kwak (2000), Pennypacker and Grant (2003), Raz et al. (2002), Zwikael and Ahn (2011)
	Company size	Carvalho et al. (2015), Carvalho and Rabechini (2015).

Four questions relate to the control variables: project complexity, company size, industry, and country. For defining small, medium and large firms, we used the Brazilian SEBRAE classification related to their annual gross income (www.sebrae.com.br). For industry sector, we used macro clusters based on the codes of economic activities CNAE (http://www.cnae.ibge.gov.br/) of the Brazilian Institute of Geography and Statistics (IBGE). Project complexity was evaluated through project document analysis, according to several parameters suggested by the literature (see Table 1).

5.3. Variables operationalization

The measurement model specification should be carefully done, as suggested by Diamantopoulos and Winklhofe (2001), to be analysed theoretically and empirically in depth, in order to decide between the formative and reflective models (Coltman et al., 2008).

For Hair et al. (2014), the measurement model must be based on conceptual reasoning previously to data collection, as the logic behind each model is different. In the reflective model the direction of causality goes from the construct (latent variables) to its indicator (manifest variable) (Henseler et al., 2009; Tenenhaus et al., 2005), which are interchangeable; thus, the correlation and internal consistence are fundamental (Diamantopoulos and Winklhofe, 2001). In contrast, in the formative model, the relationship goes from the indicator to the construct (Hair et al., 2014).The suitability of either using the formative or reflective measurement models was analysed by the confirmatory tetrad analysis (CTA), as suggested by Gudergan et al. (2008).

5.3.1. Dependent variable

Project success (PS) latent variable (LV) was operationalized as perceptual measures of performance (Venkatraman and Ramanujam, 1986). To measure project success perception, a first-order reflective measurement model (Peng and Lai, 2012; Carvalho and Rabechini, 2015) was designed, based on the five dimensions of success proposed by Shenhar and Dvir (2007). The research instrument uses the assertions adapted from the following success dimensions as manifest variables (MV): efficiency, impact on clients, impact on staff, direct business and success and, preparation for the future.

Furthermore, a latent variable to measure the success of project related to sustainability, was created. Thus, the social and environmental impact (S&E) variable was created as a formative measurement model. We have summarized the latent variables, manifest variables and references in Table 1 and detailed the research instrument in Appendix A.

5.3.2. Independent variables

The project sustainability management (PSM) was designed as multidimensional and reflective second-order latent variable (LV) represented by a system of interrelated and complementary first-order LVs: environmental technologies (ET), designed for environment (DfE), PM process & knowledge areas focusing on sustainability (PMfS), green procurement and partnership (GPP), and social responsibility (SR). This model design assumes that all first-order LVs are important and complementary manifestations of PSM, which is theoretically consistent with our earlier discussion in Section 2.

Thus, the PSM construct can be understood, as a nomological net of relationships of the five first-order LVs that are important for project success, and not individual effects of each. All latent variables and their manifest variables (MV) are detailed in Table 1.

5.3.3. Control variables

The four control variables are nominal — company size, country, industry and, project complexity. These variables were operationalized as dummy formative variables in the structural model, applying a value equal to 1 (one) was attributed to the projects that belonged to the same category and 0 (zero) to all other categories, as suggested by Falk and Miller (1992).

Project complexity was evaluated according to technology, complexity, novelty, pace, team multidisciplinary, and geographic dispersion (see Table 2). The maximum score achieved by a project could be 30 points (five points for each variable). According to the project score, it was classified in one of three categories: low, medium and high overall complexity (see Table 2). The industry was classified in eight options, the country was classified in two options (Brazil and Peru) and company size in three categories (Small, Medium, and Large) as presented in Table 2.

Table 2
Control variable.

Variable	Category	n	%
Complexity	High	59	27%
	Medium [a]	157	71%
	Low	6	3%
Industry	Services	32	14%
	Construction	29	13%
	Information technology	31	14%
	Telecommunications	10	5%
	Energy, oil & gas	18	8%
	Automotive & auto-parts	20	9%
	Chemical & pharmaceutics	12	5%
	Others [a]	70	32%
Company size [b]	Large [a]	110	50%
	Medium	58	26%
	Small	54	24%
Country	Brazil [a]	188	85%
	Peru	34	15%

[a] Note: As any category might be used as a reference (Falk and Miller, 1992) for dummy variable, the categories with the highest numbers of projects were selected.
[b] According to the SEBRAE (www.sebrae.com.br) categories for company size.

5.4. Data analysis

Structural equation modelling can be performed by applying partial least squares SEM (PLS-SEM) and covariance-based SEM (CB-SEM). To choose one between these approaches, we followed the guidelines suggested by Hair et al. (2014), selecting the partial least squares path modelling (PLS-PM), because the structural model is complex (many constructs and many indicators); including nominal variables (all control variables). Thus, mixing formative and reflective measurement models; besides, the normality of the variables and the normality of the residuals were not verified. The SmartPLS 3 software (Ringle et al., 2015) was used for evaluating the measurement model and structural model.

To estimate the significances of the structural model, the bootstrap was used, once it is robust for non-normal data (Hair et al., 2014), running 3000 resamplings directly on the SmartPLS 3.0 software, which is greater than the minimum suggested by the literature (Tenenhaus et al., 2005).

All descriptive statistics and normality test were performed by SPSS 17 software (SPSS Inc. Released, 2008).Two measures were used for testing the normality of distributions, skewness and kurtosis as suggested by Hair et al. (2014).

6. Results

6.1. Demographics

Our sample was composed of 222 projects, in eight industries, collected in Brazil and in Peru. Regarding the project complexity

Table 3
Sample descriptive statistics.

	Characteristics	Mean	Median	Standard deviation
Project	Budget (thousand dollars)	$ 868.73	$ 320.00	$ 673.67
	Schedule (months)	14	12	12
	Team size (number of members)	24	10	55
Interviewee	Age (years)	32.61	30.50	7.58
	PM experience (years)	6.02	5.00	5.21

control variable, the sample predominantly has a medium complexity (71%). Considering the company size, the major part of the projects is developed in large size companies (50%). The sample was composed by companies from several industry sectors, particularly services (14%), Information Technology (14%) and construction (13%). Table 2 presents the project distribution according to country, industry, company size and, project complexity.

The project in the sample averages 14 months, and 24 team members. Considering budget, there is a widespread distribution average of $ 868.73 thousand dollars and median in 320 thousand dollars.

The interviewees were 32 years old, on average, with six years of experience in project management (PM). Just 5.4% of the sample has a professional certification in project management or, a Master's degree in the field. Table 3 presents the descriptive statistics of the projects surveyed and of the interviewees.

In Appendix A, the results of the PSM manifest variables show that in the studied projects, for most variables the degree of use is in average below the point 3 on the Likert scale, it means that in most variables the project sustainability management is barely performed. The manifest variable SR3 related to the compliance with the OHSAS 18000 principles scored the highest degree of use.

6.2. Measuring model evaluation

6.2.1. Reflective indicators

Project success (PS) and project sustainability management (PSM) were designed in a reflective way, as mentioned before. The measurement model reliability and validity were analysed by the composite reliability indicator (Henseler et al., 2009) and Cronbach's alpha coefficient (Cronbach and Meehl, 1955), both should be above the threshold of 0.70. Moreover, the convergent validity was an analysis based on the Average Variance Extracted (AVE) (Henseler et al., 2009; Fornell and Lacker, 1981) that should be at least above the threshold of 0.5 (Henseler et al., 2009). SmartPLS 3.0 software (Ringle et al., 2015) was used to generate the scores for composite reliability indicator, Cronbach's alpha and AVE of for the first-order latent variables. In the next step, the scores generated by SmartPLS were used to enable the calculation of the second-order PSM with the aid of an electronic spreadsheet.

In this study, for project success (PS) just a single round of calculations was needed to validate the measurement model. For PSM, all the first-order LVs linked with PSM were validated in the second round and, in this process, 8 indicators were excluded from the model as loadings were below the threshold. The final measurement model and its indicators are detailed in Appendix A. Table 4 shows the score for all validation criteria for both reflective LVs PS and PSM.

All reflective LVs show significant loading factors and higher than 0.6, which result in an AVE higher than the minimum value of 0.5 (Fornell and Lacker, 1981), with Cronbach's alpha and the CR higher than 0.7 (Chin and Newsted, 1999; Henseler et al., 2009; Tenenhaus et al., 2005), as shown in Table 4.

Discriminant validity was evaluated at the indicator level and at the latent variable level, applying the Fornell and Lacker (1981) criterion as performed in Leal-Rodríguez et al. (2014) and, Carvalho et al. (2015). Table 4 shows the results for all the reflective LVs, in which the square root of the AVE is higher than the correlation among them, which confirms discriminant validity (Henseler et al., 2009; Tenenhaus et al., 2005). For the discriminant validation, the indicators' loading factor for their respective LV was also analysed, which must be higher than in any other LV, which was verified.

6.2.2. Constructs measured by formative indicators

For all control variables (company size, industry, country and, project complexity), each category was coded as a dummy variable (see Table 2), which was later modelled as a formative indicator, as suggested by Falk and Miller (1992).

The formative measurement model was also applied to the dependent variables social and environment project success (S&E), as mentioned before, composed of indicators related to all assertions, as mentioned in Section 3.

The content validity was considered adequate for these variables as all the relevant categories were represented in the model estimation. The evaluation of validity and reliability in formative measurement models is different from the reflective model once the correlation between the formative indicators is

Table 4
Validation scores and latent variables correlation.

		ET	DfE	GSC	PM	SR	PSM	PS	AVE	Composite Reliability	Cronbachs Alpha
1st order LVs	ET	0.9192*							0.8449	0.9561	0.9387
	DfE	0.7926	0.8678*						0.7530	0.9241	0.8914
	GPP	0.8158	0.7053	0.8798*					0.7741	0.9112	0.8529
	PMfS	0.8517	0.8010	0.7532	0.8405*				0.7064	0.9665	0.9621
	SR	0.6628	0.6596	0.6920	0.7507	0.8177*			0.6687	0.8897	0.8347
2nd order	PSM	0.9203	0.8752	0.8504	0.9689	0.8165	0.8878*		0.7882	0.9770	0.9752
	PS	0.1892	0.1981	0.1196	0.1667	0.1850	0.1885	0.8177*	0.6687	0.9096	0.8762

* Note_1: The diagonal contains the AVE square root.
Note_2: The model was estimated by using SmartPLS 2.0.M3 software (Ringle et al., 2005).

Table 5
Bootstrapping results.

Hypothesis		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	Standard error (STERR)	T Statistics (|O/STERR|)	P value
	PSM → ET	0.9203	0.9206	0.0112	0.0112	819.382	0.0000
	PSM → DfE	0.8752	0.8764	0.0158	0.0158	553.887	0.0000
	PSM → GPP	0.8504	0.8512	0.0201	0.0201	424.029	0.0000
	PSM → PMfS	0.9689	0.9689	0.0048	0.0048	2.012.577	0.0000
	PSM → SR	0.8165	0.8168	0.0289	0.0289	282.402	0.0000
H01a	PSM → PS	0.1632	0.1504	0.0762	0.0762	21.419	0.0324**
H01b	PSM → S&E	0.3293	0.32	0.0633	0.0633	52.044	0.0000*
H02	S&E → PS	0.1861	0.1848	0.0748	0.0748	24.872	0.0130**
H03	Size → PS	0.0001	0.0243	0.0847	0.0847	0.0018	0.9986
	Size → S&E	0.1374	0.1367	0.0722	0.0722	19.039	0.0572
	PComplex → S&E	0.09	0.0911	0.1356	0.1356	0.6632	0.5074
	PComplex → PS	−0.0327	−0.0042	0.0873	0.0873	0.3752	0.7076
	Country → PS	0.0098	−0.0007	0.0637	0.0637	0.1543	0.8774
	Country → S&E	0.1928	0.1932	0.0639	0.0639	30.146	0.0026*
	Industry → PS	−0.23	−0.1136	0.2244	0.2244	1.025	0.3056
	Industry → S&E	−0.0206	−0.0448	0.1316	0.1316	0.1566	0.8756

Note: *significant for 99%; ** significant for 95%.

neither necessary, nor desired. The suitability of using formative was analysed by the confirmatory tetrad analysis (CTA) (Gudergan et al., 2008).

6.3. Evaluation of the structural model: hypothesis testing

The full structural model summarized in Fig. 2 was tested on the SmartPLS 3.0. software. The nomological validity was based on the effect size calculated by bootstrapping in SmartPLS software.

The SmartPLS 3 software (Ringle et al., 2015) performed the validation of the measurement models and the structural model. Table 5 shows the results of bootstrapping. The four control variables have no effect on PM Success. Just two control variables have a significant effect on S&E impact, to mention: company size and country. Thus, to simplify the understanding of the model, Fig. 3 shows the significant control variables.

Fig. 3 presents the research model validated. It is possible to verify that the research hypotheses are significant, achieving the main study objective, by validating a measurement model for project sustainability management (PSM), and by validating both the hypotheses: the relation between PSM and project success (PS) and, the relation between PSM and social & environmental impacts (S&E), H1a and H1b, respectively. Moreover, the research model reveals the impact of S&E in PS, as stated in H2.

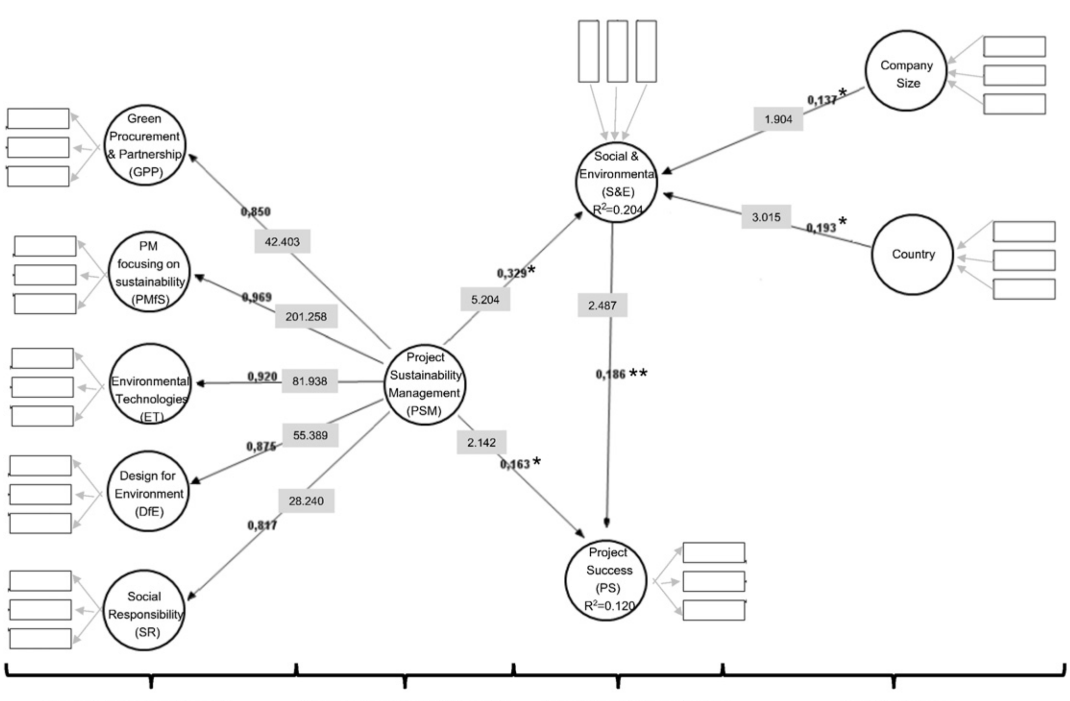

Fig. 3. Research model results. Note: T Student-values of the correlations in gray estimated in SmartPLS 3. * significant at α < 0.05 and **significant at α < 0.01. R^2 values and path coefficients also calculated in SmartPLS 3 software.

Table 6
Structural research model: significances and effects.

Hypotheses		Path coefficient	P value	R^2	R^2 adjusted
H1a	PSM → PS	0.1632	0.0324 **	12.0%	11.2%
H2	S&E → PS	0.1861	0.0000 *		
H1b	PSM → S&E	0.3293	0.0130 **	20.4%	19.8%

* Significant for 99%.
** Significant for 95%.

Table 6 presents the results of the structural model concerning the significances and the effects. The impact of project sustainability management (PSM) on social & environmental (S&E), H1b, is positive and significant with a moderate effect according to Cohen (1977) and Hair et al. (2014) with R^2 equal 0.204 (20% effect). The impact of project sustainability management (PSM) on project success (PS), H1a, is also positive and significant; however, the magnitude of the effect is weak because R^2 is 0.120 (12% effect). The research model also reveals that PS is significant and has a positive impact on both PSM and S&E, with a total adjusted effect of 11.2%.

7. Discussion and conclusion

This paper sets out to answer the RQs: RQ1 — how integrating sustainability into project management? and RQ2 — what is the relation between project sustainability management and project success? For RQ1, this paper provides new contributions to the current literature by proposing and validating a measurement model for Project Sustainability Management (PPM) using five building blocks: PM process & knowledge areas focusing on sustainability (PMfS), green procurement and partnership (GPP), Design for Environment (DfE), environmental technologies (ET), and social responsibility in project context (SR). These five constructs integrate the extant literature, which helps develop the bridge connecting sustainability and project management. Moreover, for RQ2, the research model verified the significant and positive impact of PSM on project success dimensions. However, the effect magnitude of the model is moderate. It could be related to the low degree of use for most variables on the project sustainability management in the surveyed projects.

The structural model presented and tested throughout a wide range of industrial sectors and contexts allows relating project success and project social & environmental impacts with project sustainability management. The validation of the research hypotheses helps to bridge the gap in the literature regarding sustainability and project management (Brones et al., 2014; Silvius and Schipper, 2014) and in the understanding of the relation between sustainability and project performance (Martens and Carvalho, 2016, 2017a, 2017b). The results reinforce the perspective of positive and significant impact, as suggested in the previous qualitative research like Martens and Carvalho (2016, 2017a).We could not identify a negative influence on project performance if related to costs, as pointed out by Hwang and Ng (2013) in the construction sector.

The contingent effect of the country was identified as suggested by Carvalho et al. (2015) but, other contingent effects, such as project complexity, suggested by Shenhar (2001) and by other authors, could not be verified.

7.1. Implications for practice

This survey shows that the lack of studies on sustainability in project management reflects also in the state of practice. Most of the studied variables were barely used in the projects of the sample. Most companies are facing substantial challenges to integrate sustainability into project management (Martens and Carvalho, 2016, 2017a).This paper offers the research instrument (Appendix A) that can be applied by companies as a diagnoses tool or, a checklist that can help to introduce sustainability in projects. Moreover, the results suggest that the sustainable perspective on PM can help to improve project success and reduce negative social and environmental impact and so companies should pay more attention in introducing sustainability in project management practices.

7.2. Limitations and future research agenda

The methodological approach limits the generalization of the study findings, due to the bias of non-probabilistic sample. Moreover, the sample was not probabilistically stratified by sector, country, company size and project complexity thus, leading to asymmetries among categories, making it difficult to verify the hypothesis related to the control variables. Thus, for a future research agenda, in a more confirmatory and generalized perspective, using a probabilistic and stratified sample should be applied.

Moreover, the ex-post facto research design cannot allow analysing the project sustainability management in different lifecycle phases and it could be an interesting research issue. Moreover, the project success can vary according to the stakeholder perspectives and so apply multiple perspectives in the research design can help to understand the conflicts on different project success dimension in future research agenda.

The project sustainability management designed construct is one of the possible links between PM and sustainability. The boundaries of both topics can be analysed from the individual perspective (project manager competences as in Silvius and Schipper (2014), in project perspective as in our study, or in an organizational (Marcelino-Sádaba et al., 2015) and strategic perspective (Martens and Carvalho, 2016, 2017a). The link between these two areas can encompass many theoretical possible perspectives in the environmental literature, in corporate social responsibility and on ethics that can help to improve the research model in a future research agenda.

Conflict of interest

There is no conflict of interest.

Acknowledgments

The authors gratefully acknowledge the financial support of the National Council for Scientific and Technological Development (CNPq).

Appendix A. Summary of the research variables and descriptive statistics

PSM latent variables	Code	Manifest variables	Descriptive statistics			
			Mean	Median	Mode	σ
PM Process & Knowledge areas focusing on sustainability (PMfS)	PMfS1	Follow up meeting concerning sustainability issues	2.46	2	2	1.22
	PMfS2	Sponsor commitment with sustainability	2.61	2	2	1.25
	PMfS3	In the initialization and planning phases, it was clear the alignment between corporate sustainability strategy and project sustainability management	2.82	3	3	1.23
	PMfS4	There are stakeholders requirements related to sustainability	2.85	3	3	1.19
	PMfS5	The project product/services foreseen review and acceptance have targets for sustainability to be achieved.	2.65	3	2	1.15
	PMfS6	Stakeholders participated in project meeting related to sustainability in the project-planning phase.	2.56	2	2	1.14
	PMfS7	The scope definition considered corporate sustainability guidelines	2.70	3	3	1.22
	PMfS8	The project deliverables were designed to be sustainable.	2.72	3	3	1.14
	PMfS9	Project communication with stakeholders and project reports explicit present sustainability performance, compared with the target planned.	2.67	3	3	1.12
	PMfS10	The project WBS has deliverables and work packages related to sustainability.	2.43	2	2	1.13
	PMfS11	The project closure process considered aspects of sustainability involving all PM areas of knowledge.	2.66	3	3	1.09
	PMfS12	The project product/service development took into account the sustainability requirement.	2.86	3	4	1.17
Green Procurement & Partnership (GPP)	GPP1	Project procurement took into consideration sustainability aspect to select products.	2.76	3	2	1.16
	GPP2	The project supply chain took into consideration sustainability aspect to select suppliers.	2.72	3	4	1.15
	GPP3	The material supply system is aligned to project strategies for sustainability.	2.63	3	3	1.10
Environmental technologies (ET)	ET1	Clean technologies were prioritized and applied along the project product development.	2.86	3	3	1.15
	ET2	Clean technologies were prioritized and applied during the project execution phase.	2.85	3	4	1.15
	ET3	The project final product/service control considered aspects of clean technology performance.	2.76	3	3	1.15
	ET4	Systems and technologies involved in the project have a high degree of adherence to aspects of sustainability impact prevention more than control.	2.72	3	3	1.14
Design for Environment (DfE)	DfE1	The team applied life cycle management (LCM), life cycle assessment (LCA), life cycle engineering (LCE) and life cycle cost (LCC) during project development.	2.48	2	2	1.15
	DfE2	The team applied Design for Environment (DFE), Design for Disassembly (DFD) and Design for Energy Saving (DFES) or other DFXs methods related to sustainability along the development of the project.	2.26	2	3	1.06
	DfE3	The ISO 14000 principles were applied in the project.	2.53	2	2	1.13
	DfE4	The project performance evaluation system considers aspects of environment sustainability.	2.54	3	3	1.12
Social Responsibility (SR)	SR1	Project manager is committed to social responsibility in project context	2.99	3	4	1.23
	SR2	ISO 26000 principles observance in project context	2.88	3	3	1.10
	SR3	OHSAS 18000 principles observance in project context	3.19	3	3	1.20
	SR4	Stakeholders commitment with social responsibility in project context	3.06	3	4	1.17

References

Ahsan, K., Gunawan, I., 2010. Analysis of cost and schedule performance of international development projects. Int. J. Proj. Manag. 28 (1), 68–78.

Almahmoud, E.S., Doloi, H.K., Panuwatwanich, K., 2012. Linking project health to project performance indicators: multiple case studies of construction projects in Saudi Arabia. Int. J. Proj. Manag. 30 (3), 296–307.

Almansi, F., Tammarazio, A., 2008. Mobilizing projects in community organizations with a long-term perspective: neighbourhood credit funds in Buenos Aires, Argentina. Environ. Urban. 20 (1), 121–147.

Atkinson, R., 1999. Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. Int. J. Proj. Manag. 17, 337–342.

Barry, M.L., Steyn, H., Brent, A.C., 2009. Determining the most important factors for sustainable energy technology selection in africa. S. Afr. J. Ind. Eng. 20 (2), 33–51.

Bhamra, T.A., Evans, S., 1999. The next step in ecodesign: service-oriented life cycle design. IEEE International Symposium on Electronics and the Environment-ISEE:pp. 263–267. http://dx.doi.org/10.1109/ISEE.1999.765887.

Bolis, I., Morioka, S.N., Sznelwar, L.I., 2014. When sustainable development risks losing its meaning. Delimiting the concept with a comprehensive literature review and a conceptual model. J. Clean. Prod. 83, 7–20.

Bonvoisina, J., Lelaha, A., Mathieuxa, Fabrice, Brissauda, D., 2014. An integrated method for environmental assessment and ecodesign of ICT-based optimization services. J. Clean. Prod. 68, 144–154.

British Standards Institute, 2007. BS OHSAS 18001:2007: Occupational Health and Safety Management Systems — Requirements. BSI Global, London.

Brones, F.A., Carvalho, M.M., 2015. From 50 to 1: integrating literature toward a systemic ecodesign model. J. Clean. Prod. 96, 44–57.

Brones, F.A., Carvalho, M.M., Zancul, E.S., 2014. Ecodesign in project management: a missing link for the integration of sustainability in product development? J. Clean. Prod. 80 (1), 106–118.

Brones, F., Carvalho, M.M., Zancul, E.S., 2017. Reviews, action and learning on change management for ecodesign transition. J. Clean. Prod. 142, 8–22.

Campbell, C., Gibbs, A., Maimane, S., Yugi, N., 2008. Hearing community voices: grassroots perceptions of an intervention to support health volunteers in South Africa. Sahara J. 5 (4), 162–177.

Carvalho, M.M., Rabechini, R., 2011. Construindo Competências para gerenciar projetos. 3ª edição. Editora Atlas, São Paulo (422 pp.).

Carvalho, M.M., Rabechini, R., 2015. Impact of risk management on project performance: the importance of soft skills. Int. J. Prod. Res. 53 (2), 321–340.

Carvalho, M.M., Patah, L.A., Bido, D.S., 2015. Project management and its effects on project success: cross-country and cross-industry comparisons. Int. J. Proj. Manag. 33 (7), 1509–1522.

Chan, A.P.C., Chan, A.P.L., 2004. Key performance indicators for measuring construction success. BIJ 11, 203–221.

Chin, W.W., Newsted, P.R., 1999. Structural equation modeling analysis with small samples using partial least squares. In: Hoyle, R.H. (Ed.), Statistical Strategies for Small Sample Research. Sage Publications, Thousand Oaks, CA, pp. 307–341.

Coltman, T., Devinney, T.M., Midgley, D.F., Venaik, S., 2008. Formative versus reflective measurement models: two applications of formative measurement. J. Bus. Res. 61, 1250–1262.

Construction Industry Institute (CII), 2006. Leading indicators during project execution. Resarch Summary 220-1. The University of Texas in Austin.

Cohen, J., 1977. Statistical Power Analysis for the Behavioral Sciences. second ed. Academic Press, New York.

Corder, G.D., McLellan, B.C., Green, S., 2010. Incorporating sustainable development principles into minerals processing design and operation: SUSOP (R). Miner. Eng. 23 (3), 175–181.

Cronbach, L.J., Meehl, P.E., 1955. Construct validity in psychological tests. Psychol. Bull. 52, 281–302.

Diamantopoulos, A., Winklhofe, H.M., 2001. Index construction with formative indicators: an alternative to scale development. J. Mark. Res. 38, 269–277.

Elkington, J., 1998. Canibals with Forks: The Triple Bottom Line of 21st Century Business. New Society Publishers, Canadá.

Ellatar, S.M.S., 2009. Towards developing an improved methodology for evaluating performance and achieving success in construction projects. Sci. Res. Essays 4, 549–554.

Falk, R.F., Miller, N.B., 1992. A Primer for Soft Modeling. The University of Akron Press, Ohio.

Faul, F., Erdfelder, E., Lang, A.G., Buchner, A., 2007. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav. Res. Methods 39, 175–191.

Fellows, R., Liu, A., 2008. Impact of participants' values on construction sustainability. Proc. Inst. Civ. Eng. Eng. Sustain. 161 (4), 219–227.

Fernandez-Sanchez, G., Rodriguez-Lopez, F., 2010. A methodology to identify sustainability indicators in construction project management-application to infrastructure projects in Spain. Ecol. Indic. 10 (6), 1193–1201.

Flynn, B.B., Kakibara, S.S., Schroeder, R.G., Bates, K.A., Flynn, E.J., 1990. Empirical research methods in operations management. J. Oper. Manag. 9, 250–284.

Fornell, C., Lacker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement errors. J. Mark. Res. 18, 39–50.

Forza, C., 2002. Survey research in operations management: a process-based perspective. Int. J. Oper. Prod. Manag. 22, 152–194.

Glavič, P., Lukman, R., 2007. Review of sustainability terms and their definitions. J. Clean. Prod. 15 (18), 1875–1885.

Gudergan, S.P., Ringle, C.M., Wende, S., Will, A., 2008. Confirmatory tetrad analysis in PLS path modeling. J. Bus. Res. 61, 1238–1249.

Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 2005. Multivariate Data Analysis. fourth ed. Prentice Hall, New Jersey.

Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., 2014. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Sage, Thousand Oaks.

Henseler, J., Ringle, C.M., Sinkovics, R.R., 2009. The use of partial least squares path modeling in international marketing. Adv. Int. Mark. 20, 277–319.

Hwang, B.-G., Ng, W.J., 2013. Project management knowledge and skills for green construction: overcoming challenges. Int. J. Proj. Manag. 31, 272–284.

Ibbs, C.W., Kwak, Y.H., 2000. "Assessing Project Management Maturity.". Proj. Manag. J. 31, 32–43.

International Standard, 2010. ISO 26000:2010. Guidance on Social Responsibility (Geneva).

International Standard, 2016. ISO/CD 45001. Occupational Health and Safety Management Systems — Requirements (Draft).

Johansson, G., Magnusson, T., 2006. Organising for environmental considerations in complex product development projects: implications from introducing a "green" sub-project. J. Clean. Prod. 14 (15–16), 1368–1376.

Khang, D.B., Moe, T.L., 2008. Success criteria and factors for international development projects: a life-cycle-based framework. Proj. Manag. J. 39 (1), 72–84.

Knight, P., Jenkins, J.O., 2009. Adopting and applying eco-design techniques: a practitioners perspective. J. Clean. Prod. 17 (5), 549–558.

Kometa, S., Olomolaiye, P., Harris, F., 1995. An evaluation of clients' needs and responsibilities in the construction process. Eng. Constr. Archit. Manag. 2, 57–76.

Korkmaz, S., Riley, D., Horman, M., 2010. Piloting evaluation metrics for sustainable high-performance building project delivery. J. Constr. Eng. Manag. ASCE 136 (8), 877–885.

Kuehr, R., 2007. Environmental technologies: from a misleading interpretations to an operational categorization and definition. J. Clean. Prod. 15 (13–14), 1316–1320.

Kuei, C.-h., Madu, C.N., Chow, W.S., et al., 2015. Determinants and associated performance improvement of green supply chain management in China. J. Clean. Prod. 95, 163–173.

Kumaraswamy, M.M., Thorpe, A., 1996. Systematizing construction project evaluations. J. Manag. Eng. 12, 34.

Kuper, M., Dionnet, M., Hammani, A., Bekka, Y., Garin, P., Bluemling, B., 2009. Supporting the shift from state water to community water: lessons from a social learning approach to designing joint irrigation projects in Morocco. Ecol. Soc. 14 (1).

Labuschagne, C., Brent, A.C., 2005. Sustainable project life cycle management: the need to integrate life cycles in the manufacturing sector. Int. J. Proj. Manag. 23, 159–168.

Labuschagne, C., Brent, A.C., 2008. An industry perspective of the completeness and relevance of a social assessment framework for project and technology management in the manufacturing sector. J. Clean. Prod. 16 (3), 253–262.

Labuschagne, C., Brent, A.C., Van Erck, R.P.G., 2005. Assessing the sustainability performances of industries. J. Clean. Prod. 13 (4), 373–385.

Lam, E.W.M., Chan, A.P.C., Chan, D.W.M., 2007. Benchmarking the performance of design-build projects: development of project success index. BIJ 14 (5), 624–638.

Laws, D., Loeber, A., 2011. Sustainable development and professional practice. Proc. Inst. Civ. Eng. Eng. Sustain. 164 (1), 25–33.

Leal-Rodríguez, A.L., Roldán, J.L., Ariza-Montes, J.A., Leal-Millán, A., 2014. From potential absorptive capacity to innovation outcomes in project teams: the conditional mediating role of the realized absorptive capacity in a relational learning context. Int. J. Proj. Manag. 32, 894–907.

Lenferink, Sander, Tillema, Taede, Arts, Jos, 2013. Towards sustainable infrastructure development through integrated contracts: experiences with inclusiveness in Dutch infrastructure projects. Int. J. Proj. Manag. 31 (4), 615–627.

Leurs, M.T.W., Mur-Veeman, I.M., Sar, R., Schaalma, H.P., Vries, N.K., 2008. Diagnosis of sustainable collaboration in health promotion: a case study. BMC Public Health 8:382. http://dx.doi.org/10.1186/1471-2458-8-382 (PMid:18992132 PMCid:PMC2605462).

Lim, C., Mohamed, M.Z., 1999. Criteria of project success: an exploratory re-examination. Int. J. Proj. Manag. 17, 243–248.

Madden, P.B., Morawski, J.D., 2011. The future of the Canadian oil stands: engineering and project management advances. Energy Environ. 22 (5), 579–596.

Marcelino-Sádaba, S., González-Jaen, L.F., Pérez-Ezcurdia, A., 2015. Using project management as a way to sustainability. From a comprehensive review to a framework definition. J. Clean. Prod. 99, 1–16.

Martens, M.M., Carvalho, M.M., 2016. The challenge of introducing sustainability into project management function: multiple-case studies. J. Clean. Prod. 117, 29–40.

Martens, M.M., Carvalho, M.M., 2017a. Key factors of sustainability in project management context: a survey exploring the project managers' perspective. Int. J. Proj. Manag. 35 (6), 1084–1102.

Martens, M.M., Carvalho, M.M., 2017b. Sustainability and success variables in the project management context: an expert panel. Proj. Manag. J. 47 (6), 24–43 (December/January).

Morioka, S.N., Carvalho, M.M., 2015. Sustainability and management of projects: a bibliometric study. Production. http://dx.doi.org/10.1590/0103-6513.058912 ahead of print, pp. 0–0).

Netemeyer, R.G., Bearden, W.O., Sharma, S., 2003. Scaling Procedures: Issues and Applications. Sage Publications, Thousand Oaks.

Ny, H., Hallstedt, S., Robèrt, K.-H., Broman, G., 2008. Introducing templates for sustainable product development: a case study of televisions at the Matsushita Electric Group. J. Ind. Ecol. 12 (4), 600–623.

Pearce, A.R., 2008. Sustainable capital projects: leapfrogging the first cost barrier. Civ. Eng. Environ. Syst. 25 (4), 291–300.

Peng, D.X., Lai, F., 2012. Using partial least squares in operations management research: a practical guideline and summary of past research. J. Oper. Manag. 30, 467–480.

Pennypacker, J.S., Grant, K.P., 2003. Project management maturity: an industry benchmark. Proj. Manag. J. 4–9 (March).

PMI, Project Management Institute, 2013. A Guide to the Project Management Body of Knowledge (PMBoK). fifth ed. Project Management Institute Inc., Maryland.

Pocock, J.B., Hyun, C.T., Liu, L.Y., Kim, M.K., 1996. Relationship between project interaction and performance indicators. J. Constr. Eng. Manag. 122 (2), 165–176.

Prasad, S., Tata, J., Herlache, L., McCarthy, E., 2013. Developmental project management in emerging countries. Oper. Manag. Res. 6 (1-2), 53–73.

Pulaski, M.H., Horman, M.J., 2005. Continuous value enhancement process. J. Constr. Eng. Manag. ASCE 131 (12), 1274–1282.

Raven, R., Jolivet, E., Mourik, R.M., Feenstra, C.F.J., 2009. ESTEEM: managing societal acceptance in new energy projects a toolbox method for project managers. Technol. Forecast. Soc. Chang. 76 (7), 963–977.

Raz, T., Shenhar, A.J., Dvir, D., 2002. "Risk Management, Project Success, and Technological Uncertainty.". R&D Management 32, 101–109.

Ringle, C.M., Wende, S., Will, A., 2005. SmartPLS 2.0 M3 (Beta). University of Hamburg, Germany.

Ringle, C.M., Wende, S., Becker, J.-M., 2015. SmartPLS 3. SmartPLS GmbH, Boenningstedt (http://www.smartpls.com).

Schaltegger, S., Freund, F.L., Hansen, E.G., 2012. Business cases for sustainability: the role of business model innovation for corporate sustainability. Int. J. Innov. Sustain. Dev. 6 (2):95–119. http://dx.doi.org/10.1504/IJISD.2012.046944.

Shenhar, A.J., 2001. One size does not fit all projects: exploring classical contingency domains. Manag. Sci. 47, 394–414.

Shenhar, A.J., Dvir, D., 1996. Toward a typological theory of project management. Res. Policy 25, 607–632.

Shenhar, A.J., Dvir, D., 2007. Reinventing Project Management: The Diamond Approach to Successful Growth and Innovation. Harvard Business School Press, Boston.

Shenhar, A.J., Tishler, A., Dvir, D., Lipovetsky, S., Lechler, T., 2002. Refining the search for project success factors: a multivariate, typological approach. R&D Manag. 32, 111–126.

Shenhar, A.J., Dvir, D., Milosevic, D., Mulenburg, J., Patanakul, P., Reilly, R., Ryan, M., Sage, A., Sauser, B., Srivannaboon, S., Stefanovic, J., Thamhain, H., 2005. Toward a NASA-specific project management framework. Eng. Manag. J. 17, 8–16.

Silvius, A.J.G., Schipper, R., 2014. Sustainability in project management competencies: analyzing the competence gap of project managers. J. Hum. Resour. Sustain. Stud. 2, 40–58.

Silvius, A.J.G., Schipper, R., 2015. Developing a maturity model for assessing sustainable project management. J. Mod. Proj. Manag. 3, 16–27.

Silvius, A.J.G., Schipper, R., Nedeski, S., 2013. Sustainability in project management: reality bites 1. PM World J. 2 (2), 1–14.

Singh, R.K., Murty, H.R., Gupta, S.K., Dikshit, A.K., 2012. An overview of sustainability assessment methodologies. Ecol. Indic. 15 (1), 281–299.

SPSS Inc. Released, 2008. SPSS Statistics for Windows, Version 17.0. SPSS Inc., Chicago.

Tenenhaus, M., Esposito Vinzi, V., Chatelin, Y.-M., Lauro, C., 2005. PLS path modeling. Comput. Stat. Data Anal. 48, 159–205.

Thomson, C.S., El-Haram, M.A., Emmanuel, R., 2011. Mapping sustainability assessment with the project life cycle. Proc. Inst. Civ. Eng. Eng. Sustain. 164 (2), 143–157.

Tingström, J., Karlsson, R., 2006. The relationship between environmental analyses and the dialogue process in product development. J. Clean. Prod. 14 (15–16), 1409–1419.

Tingström, J., Swanström, L., Karlsson, R., 2006. Sustainability management in product development projects — the ABB experience. J. Clean. Prod. 14 (15–16), 1377–1385.

Toor, S.-ur-R., Ogunlana, S.O., 2010. Beyond the "iron triangle": stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. Int. J. Proj. Manag. 28, 228–236.

Venkatraman, N., Grant, J.H., 1986. Construct measurement in organizational strategy research: a critique and proposal. Acad. Manag. Rev. 11, 71–87.

Venkatraman, N., Ramanujam, V., 1986. Measurement of business performance in strategy research: a comparison of approaches. Acad. Manag. Rev. 11, 801–814.

Vezzoli, C., Sciama, D., 2006. Life cycle design: from general methods to product type specific guidelines and checklists: a method adopted to develop a set of guidelines/checklist handbook for the eco-efficient design of NECTA vending machines. J. Clean. Prod. 14 (15–16), 1319–1325.

Weninger, C., Huemann, M., Oliveira, J.C., Barros Filho, L.F.M., Weitlaner, E., 2013. Experimenting with project stakeholder analysis: a case study. In: Silvius, A.J.G., Thap, J. (Eds.), Sustainability Integration for Effective Project Management. IGI Global.

White, D., Fortune, J., 2002. Current practice in project management — an empirical study. Int. J. Proj. Manag. 20, 1–11.

Wit, A., 1988. "Measurement of Project Success.". Int. J. Proj. Manag. 6, 164–170.

Zhu, Q.H., Sarkis, J., 2006. An inter-sectoral comparison of green supply chain management in China: drivers and practices. J. Clean. Prod. 14 (5), 472–486.

Zwikael, O., Ahn, M., 2011. "The Effectiveness of Risk Management: An Analysis of Project Risk Planning across Industries and Countries.". Risk Anal. 31, 25–37.