School of Engineering

Advances in Business Management:

The Incorporation of Sustainability in Software Engineering Projects and the Potential Impact on Project Success in the Context of Jordanian Public Universities

BY:

Amin Khalifeh

Student number: 1610641

PhD Thesis

Submission date: June 2020

Acknowledgements

I would first like to thank my Director of Studies, Dr Peter Farrell, who guided me to the finish line. I would particularly like to thank him for being a continual sounding board, never giving up on me, showing excellent guidance and patience when reading drafts, and providing invaluable feedback. Also, I would like to thank Dr Yassin Osman for his great efforts with me as a second supervisor and fantastic supportive leader.

I could not have done this work without the support of my father, my mother, and my family, who kept me going when the light at the end of the tunnel was flickering out. I would like to express special thanks to my wife for her encouragement, patience, and continuous support.

This work resulted in four papers for publication to date, two published, one accepted but under review, and the last one is under preparation. All in high quality and respectful peer-reviewed journals (SJR Q1).

Published papers:

- Khalifeh, A., Farrell, P., Al-edenat, M., 2019. The impact of project sustainability management (PSM) on project success: A systematic literature review. *Journal of Management Development*. Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JMD-02-2019-0045. Emerald Publishing Limited.
- Khalifeh, A., Farrell, P., Alrousan, M., Alwardat, S. and Faisal, M. 2020. Incorporating sustainability into software projects: a conceptual framework. *International Journal of Managing Projects in Business*, Vol. 13 No. 6, pp. 1339-1361. https://doi.org/10.1108/IJMPB-12-2019-0289. Emerald Publishing Limited.

Abstract

The move towards more sustainable outcomes under the triple bottom line (TBL) theory of sustainability (economic, environmental, and social) is one of the greatest challenges for organisations. Projects may have a pivotal role in the achievement of sustainability, as they are an ideal tool for bringing about change. Over the last decade, there has been growing attention to the incorporation of sustainability into projects (project sustainability). However, there are some criticisms regarding this incorporation, and one of the most important criticisms is that this incorporation may have a negative impact on project success, which is crucial and directly linked to the success of organisations as a whole. A systematic literature review revealed that to date, the relationship between project sustainability and project success has been inadequately researched in both developed and developing countries. There is an evident lack of research about this relationship in developing countries of the Arab world in particular. Further, it has been found that most of the few relevant contributions are conceptual in nature and focus mainly on manufacturing and construction projects. There is a lack of research which explores this relationship in some important projects such as information systems and technology (IS&T), services, and telecommunications projects. One of the most important of IS&T projects is software projects where this research focuses.

Currently, there is no recorded contribution which focuses on the relationship between project sustainability (PS) and project success in the software industry. This gap in the literature is the main basis of the current thesis. Therefore, this study aims to make a novel contribution to the literature by investigating the potential impact of software project sustainability (SPS) on project success. To achieve this aim, the author has developed a conceptual framework that helps in the empirical examination of the relationship between these two concepts. The proposed framework consists of six constructs which have been developed based on the analysis of the best contributions in the relevant literature. The first four constructs, which are independent variables (IVs) and represent SPS, are economic considerations (ECCs), environmental concerns (EVCs), social responsibilities (SRs), and TBL-related quality requirements (QRs). These constructs encompass a unique combination of TBL-related aspects for incorporating sustainability into processes and products of software projects and form a significant part of the contribution of this thesis. The fifth construct, project success (PSCS), was positioned as a dependent variable (DV), and the sixth construct, project complexity, was set as a control variable in the proposed framework. The development of the framework is affiliated with the triple bottom line (TBL) theory, the ISO/IEC 25010:2011 product quality model of systems and software, the Sustainability Checklist of the International Project Management Association (IPMA), the contingency theory, and the multidimensional model of Shenhar and Dvir (2007) for measuring project success.

An empirical study was conducted to validate the proposed framework and test the research hypotheses. A quantitative methodology was applied using a hand-delivered self-administered questionnaire as the data collection technique. 172 questionnaires were distributed randomly, targeting key stakeholders of internal software projects of the ten Jordanian public universities. Out of the 153 returned questionnaires, 140 were considered valid, after examining for missing data, suspicious response patterns, data distribution, outliers, response rate, and non-response bias. This constituted a high response rate of 81.4%. The final data set was then analysed using the partial least squares structural equation modelling (PLS-SEM). The conceptual framework was validated as a model by establishing the internal consistency reliability, convergent validity, and discriminant validity. The results showed a good level of commitment towards the economic considerations (ECCs), social responsibilities (SRs), and TBL-related quality requirements (QRs) of SPS in the surveyed sample, while it was found that the environmental concerns (EVCs) were barely considered. The analysis revealed a significant relationship between the four constructs of SPS and project success. The relationship of ECCs, SRs, and QRs to project success was positive, while it was negative for EVCs. However, it was found that the overall relationship of the four constructs "combined" with project success is significant and positive. Also, the analysis revealed that project complexity has no significant effect on the relationship between SPS and project success. Therefore, it was concluded that SPS can impact project success significantly and positively, especially if SPS is considered as a net of the four constructs' relationships with project success, and not the solo relationship of each.

This study may contribute towards a more sustainable orientation in the software industry, as it provides empirical evidence of a significant positive relationship between SPS and project success. This is considered important due to the present contradictions in the relevant literature regarding the relationship between project sustainability, in general, and project success. Also, this study gives academics and practitioners a better understanding of how software projects can be managed sustainably; and it provides them with a validated model for measuring whether the incorporation of sustainability supports or impedes the success of these projects. Moreover, software companies – or other relevant organisations – may use the proposed model as a measurement tool to evaluate environmental and social impacts of their current products and project management practices. Consequently, these organisations may pay more attention to incorporating sustainability into their projects. Finally, it can be argued that the findings of this study, along with the methodological approach used, constitute a valuable contribution to knowledge and provide a good basis for relevant works in future. It is hoped this research will contribute to the sustainability and success of organisations and society at large.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AIPM - Australian Institute of Project Management.

APM - The Association for Project Management.

AVE - Average variance extracted.

BEMs - Business Excellence Models.

C/SCSC - Cost and schedule Control Systems Criteria.

CB - Covariance based.

CB-SEM - The covariance-based structural equation modelling.

CEOs - Chief executive officers.

CPM - Critical Path Method.

CS - Corporate sustainability.

CSR - Corporate Social Responsibility.

DFE - Design for environment.

DJSI - The Dow Jones Sustainability Indexes.

DV - Dependent variable.

ECCs - Economic considerations.

EFQM - European Foundation for the Quality Management.

EVCs - Environmental concerns.

EVM - Earned Value Management.

f^2 - The effect size.

FURPS - The model of Functionality, Usability, Reliability, Performance, and Supportability.

GBP - Great British Pound.

GDP - Gross domestic product.

GERT - The Graphical Evaluation and Review Technique.

Green IT - Green information technology.

GRI - The Global Reporting Initiative.

GUI - Graphical user interface.

H - Hypothesis.

HCST - The Higher Council of Science and Technology.

HRM - Human resource management.

ICT - Information and communication technology.

IEEE - The Institute of Electrical and Electronics Engineers.

IPMA - International Project Management Association.

IS&T - Information systems and technology.

ISO - International Organisation for Standardisation.

IT - Information technology.

IVs - Independent variables.

KPIs - Key performance indicators.

LCA - Life cycle assessment.

LCC - Life cycle costing.

LULUCF - Land use and land-use change and forestry.

LV - Latent variable.

MVs - Manifest variables.

NFRs - Non-functional requirements.

O&M research - Organisation and methods research.

OB - Research objective.

P-value - Probability value.

PERT - Program Evaluation and Review Technique.

PLS - Partial least squares.

PLS-SEM - The partial least squares structural equation modelling.

PMI - Project Management Institute.

PQF - Pragmatic Quality Factor.

PQM - Product Quality Model of the ISO/IEC 25010:2011 standard.

PS - Project sustainability (the incorporation of sustainability into projects).

PSCS - Project success.

Q - Question.

Q^2 - The predictive relevance of the structural model.

QRs - The TBL-related Quality Requirements of software products.

R&D - Research and development.

R^2 - The coefficient of determination.

RQ - Research question.

RSS - The Royal Scientific Society.

SDIs - Sustainable development indicators.

SEM - Structural Equation Modelling.

SLR - Systematic literature review.

SPS - Software project sustainability.

SQuaRE - The System and Software Quality Requirements and Evaluation.

SRG - Sustainability Reporting Guidelines.

SRs - Social responsibilities.

SSE - The sum of the squared prediction errors.

SSO - The sum of the squared observations.

TBL - Triple bottom line of sustainability (economic, environmental, and social).

TQM - Total Quality Management.

UcSoftC - The User Centric Software Certification.

UK - The United Kingdom.

UN - The United Nations.

UNCSD - United Nations Commission on Sustainable Development.

US - The United States or The United States of America.

USD - United States Dollar.

WBCSD - The World Business Council for Sustainable Development.

WBS - Work Breakdown Structure.

WW2 - The Second World War.

β-value - Path coefficient, a standardized regression coefficient (beta).

List of Definitions

In the context of the current thesis, relevant key terms are defined, as follows:

Internal software project: defined as a project that has no external customer (the customer is the organisation itself) but is self-contained within the business. This type of projects is managed internally and is funded by investors and capital reserves, not from an external customer (Lock, 2007; Hobbs and Besner, 2016; Lehmann, 2018). An internal software project can be regarded as enabling project, as it should enable an organisation to operate more efficiently and thus realise greater benefits in the future (e.g. developing a registration portal, financial system, or accounting software to enhance the day-to-day activity of the company).

Project management: the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. It is the process by which a project is achieved successfully (Turner, 2014; PMI, 2017).

Project process sustainability: the sustainability of project processes and their interrelated activities such as project management processes and delivery and support processes (Silvius and Schipper, 2015; Carvalho and Rabechini, 2017; Khalifeh et al., 2019).

Project product sustainability: the sustainability of deliverables over the life cycle of projects (Labuschagne and Brent, 2005; Gareis et al., 2013; Khalifeh et al., 2019).

Project success: completing a project within time or earlier, within or below budget, meeting customers' requirements and having their satisfaction, and achieving business goals (Shenhar and Dvir, 2007).

Project: a temporary and unique endeavour to instigate beneficial change, such as the provision of products or services (Turner, 2014; PMI, 2017).

Software process sustainability: the sustainability of managing software development and its engineering processes; it is the sustainability in project interrelated activities during the development of a software product (Naumann et al., 2015; Malik and Khan, 2018).

Software product sustainability: the sustainability of software 'itself' as a product (Albertao et al., 2010; Penzenstadler, 2013).

Software project sustainability: the incorporation of sustainability into software projects, includes demonstrating commitment and consideration of the three dimensions of sustainability (economic, environmental, and social) in processes and products of software projects (Albertao et al., 2010; Naumann et al., 2011; Lami et al., 2012; Becker et al., 2016; Silvius et al., 2017; Condori-Fernandez and Lago, 2018; Malik and Khan, 2018).

Software project: a temporary and unique endeavour to develop or create an intended software product (Murray and Sandford, 2013; PMI, 2017; Mulcahy, 2018).

Sustainability: there are many definitions of sustainability (as mentioned in section 2.2.4). However, in the context of the current thesis and based on the TBL theory, it is defined as the consideration of environmental and social needs besides the economic interest to achieve short- and long-term success (Elkington, 1998; Kleindorfer et al., 2005; Baumgartner and Ebner, 2010; Thomas and Lamm, 2012; Silvius and Schipper, 2014; Khalifeh et al., 2020).

Word count:

Whole document = 76,000. Introduction to conclusion = 55,000

Chapter 1 - Introduction

Currently, there is no recorded contribution focused on the relationship between project sustainability (PS) and project success in the software industry. This omission is the main basis of the current thesis. Therefore, this study aims to make a new contribution to this relationship by investigating the potential impact of software project sustainability (SPS) on project success.

1.1 Overview

Organisations broadly recognise projects as fundamental to the attainment of strategic objectives. Achieving objectives usually includes change, which should be managed differently from the management of the usual work of organisations (Turner, 2014). Projects are considered as temporary and unique endeavours to instigate beneficial change, such as the provision of products or services, and project management is the process by which this change is achieved successfully (Turner, 2014; PMI, 2017). Projects form more than 20% of global economic activity and more than 30% of economic activity in some emerging economies (Turner et al., 2013). The growing reliance on project management has resulted from the increasing complexity and ambiguity of tasks that organisations face in deploying resources and competencies to create competitive advantage (Peter and Ashley, 2004; Gareis, 2006). Due to the significant contribution of project management in global development and global economies, it is necessary to develop competencies related to it at all levels – individual, team, organisational, and societal levels (Gareis and Huemann, 2007). Therefore, project management has developed into a mature academic discipline, underpinned by theories of different schools of thought (Anbari, 1985; Söderlund, 2002; Kolltveit et al., 2007; Turner et al., 2010; Biedenbach and Müller, 2011). According to Turner et al. (2013), the literature discusses nine main schools: Optimisation, Modelling, Governance, Behaviour, Success, Decision, Process, Contingency, and Marketing. However, the door remains open for the extension and addition of new schools (Silvius, 2017), as project management is argued to be "increasingly drawing on and making contributions to research in other fields of management" (Turner et al., 2013: 5).

Pasian and Silvius (2016) found that some new project management schools are developing, the most notable of which is 'sustainability'. The United Nations recognises that sustainability is one of the most significant challenges of our time (Glenn and Gordon, 1997; Glenn et al., 2009). Sustainability is derived from the concept of sustainable development; the World Commission on Environment and Development defines it as "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs" (Brundtland, 1987: 17). Subsequently, a broader and more acceptable concept of sustainability has emerged based on the triple bottom line (TBL) of environmental, economic, and social dimensions (Elkington, 1998). Instead of totally focusing on economic interest, the concept of sustainability considers the TBL as the basis for achieving short and long-term success by creating a rational use of resources, with respect to human needs and without harming future generations (Elkington, 1998, Knoepfel, 2001; Kleindorfer et al., 2005; Baumgartner and Ebner, 2010; Gimenez et al., 2012; Thomas and Lamm, 2012; Silvius and Schipper, 2014). According to Aarseth et al. (2017), there are more than 100 definitions of the concept of sustainability, and it is widely agreed through them that the broader TBL of sustainability need to be simultaneously balanced.

Since the 1970s, there has been a continuous drive to incorporate sustainability effectively in all fields (Meadows et al., 1972; Brundtland, 1987; Gladwin et al., 1995; Elkington, 1998; Abidin and Pasquire, 2007; Meadows and Randers, 2012; Marcelino-Sádaba et al., 2015; Glenn and Florescu, 2015). Many organisations are now keen to incorporate sustainability into their daily activities (Thomas and Lamm, 2012; Van den Brink et al., 2012; Marcelino-Sádaba et al., 2015) and associate it with their strategic objectives (Tharp, 2012). The majority of CEOs in companies (93%) declare that a change towards sustainability will be critical to the future success of their organisations (Tharp, 2012). Therefore, organisations should consider the TBL wherever they operate and wherever their customers and suppliers operate (Tharp, 2012) in order to tackle one of the greatest modern challenges (Alwi et al., 2014).

Projects help organisations achieve long-term objectives, and since they make up about a third of the world's gross domestic product, the potential impact from incorporating sustainability into projects - project sustainability - is beyond imagination, and this incorporation is essential for a more sustainable future (Tharp, 2012; Weninger and Huemann, 2015; Økland, 2015; Huemann and Silvius, 2017). The link between sustainability and projects was mentioned in the World Commission on Environment and Development report (Brundtland, 1987). The opening keynote of the World Congress of the International Project Management Association (IPMA) in 2008 asked the project management profession to “take responsibility for sustainability” (Silvius and Schipper, 2014: 64). Marcelino-Sádaba et al. (2015: 4) declare that projects are “the ideal instrument for change management”; they “can improve ties between the business strategy and sustainability initiatives”, and the required change towards sustainability can be better achieved by incorporating sustainability into projects. Similarly, many authors declare there is an urgent need for project sustainability, as projects involve many resources that interact daily with the surrounding environment and are therefore considered an important tool for achieving sustainability for organisations and global society (Gareis et al., 2013; Martens and Carvalho, 2014, 2016b; Silvius, 2017). Hence, it seems reasonable to link sustainability with project management (Gareis et al., 2009; Silvius, 2012; Aarseth et al., 2017).

The last ten years have witnessed significant interest in project sustainability in the literature (Silvius and Schipper, 2014; Marcelino-Sádaba et al., 2015; Aarseth et al., 2017). There is growing attention in relevant publications to project sustainability, and the literature has built a base to support this paradigm shift in managing projects; such as Labuschagne and Brent (2005, 2008), Klakegg and Haavaldsen (2011), Silvius et al. (2012), Gareis et al. (2009, 2013), Eskerod and Huemann (2013), Brones et al. (2014), Silvius and Schipper (2014; 2015), Brones and Carvalho (2015), Martens and Carvalho (2016a, 2016b, 2017), Huemann and Silvius (2017), Carvalho and Rabechini (2017), and Aarseth et al. (2017). Recently, Pasian and Silvius (2016) and Silvius (2017) proposed that sustainability should be considered a new school of thought for project management. Silvius (2017: 1491) suggests that the recognition of schools is built on three criteria: content, community, and impact. The content criterion is “having a shared perspective or vision and having common methods and/or tools”; the community criterion is “a significant publication base, a number of leading authors and presence on events”; and the impact criterion is “integration into practice and integration into standards”. Silvius (2017) concludes that based on all three recognition criteria, sustainability is qualified to be considered a new school in project management.

1.2 Research problem

Authors such as Eid (2009), Maltzman and Shirley (2010), and Taylor (2010) declare that project sustainability can influence project success. Therefore, it is argued that sustainability should be incorporated carefully into projects (Aaltonen and Kujala, 2010), as the success of projects is crucial and directly linked to the success of organisations as a whole (De Wit, 1988; Kerzner, 2004). Project success is "at the heart of project management", and "interest in the topic of project success is evident in the streams of research that identify 'schools' or 'perspectives' in the field" (Müller and Jugdev, 2012: 758). Table 1.1 summarises the key ideas of each school and their relevance to project success. Adapted from Anbari (1985), Söderlund (2002), and Turner et al. (2013).

Table 1. 1: The nine schools of project management: key ideas and relevance to project success

School	Key idea	First prominence	Relevance to project Success
Optimisation	Optimising one or two project objective(s) by mathematical processes	The late 1940s	Defines the objective(s), breaks projects into smaller components, and strives for cost and time efficiency to achieve optimum outcomes
Modelling	Use of hard and soft-systems theories to model projects	The 1950s	Obtains a full view of the total system to achieve multiple objectives under multiple constraints successfully
Governance	Governing projects and the relationship between project participants	The 1970s	Defines objectives and success criteria and reviews points along the process to achieve beneficial change
Behaviour	Managing relationships between people on projects	The mid-1970s	Closely associated with the governance school and considers projects as temporary organisations to achieve successful change
Success	Finding an appropriate path to desired outcomes	The mid-1980s	Aims to increase the likelihood of success by focusing on project success factors and project success criteria
Decision	Categorising project types to select appropriate systems	The late 1980s	Supports project success by improving decision-making at various levels over time
Process	Defining success and failure; identifying causes	The late 1980s	Gives better decisions by processing information to achieve success.
Contingency	Information processing through project life cycles	The early 1990s	Emphasises on remembering past success factors to manage new complicated projects
Marketing	Communicating with all stakeholders to obtain their support	The mid-1990s	Looks for success by addressing the links between project objectives and strategic business goals

It can be noted that project success is a common endeavour among the agreed nine schools of thought, as the schools aim to understand the different perspectives of project management that lead to project success (Söderlund, 2002; Müller and Jugdev, 2012; Turner et al., 2013). Rolstadås et al. (2014: 657) conclude, "we see the recent publications on project management schools as a novel approach that increase the understanding of what leads to success".

However, some authors argue that long-term sustainability orientation may conflict with the temporary character of projects and that the two are perhaps not innately compatible (Eid, 2009; Tharp, 2012; Huemann and Silvius, 2017). According to Silvius et al. (2012: 30) incorporating sustainability into projects "stretches the systems boundaries of project management" (e.g. cost and time constraints), which may have a negative impact on project success. The Packard Foundation (2002) declared that the high capital cost of incorporating sustainability in some projects makes it hard to rely on returns that could be obtained over the long-term from lower operational costs. In some cases, high cost may mean that projects are not taken beyond the initial concept and design phases (Pearce, 2008). Besides the cost and time barriers, Hwang and Ng (2013), in their study about green construction projects, state that incorporating sustainability in these types of projects makes planning harder, causes more variations in design, causes difficulty in selecting subcontractors, causes uncertainty in the required materials and equipment, requires more coordination with different parties, and leads to more unexpected circumstances at project closure. Moreover, it has been argued that incorporating environmental and social aspects into projects means extra requirements and specifications (Maltzman and Shirley, 2010; Taylor, 2010), greater overheads (Pujari, 2006; Plouffe et al., 2011), more complications and pressure on project managers, practitioners, and decision-makers (Knight and Jenkins, 2009), a higher level of expectations (Marcelino-Sádaba et al., 2015), and increased tension between stakeholders (Achterkamp and Vos, 2006; Singh et al., 2007; Tam et al., 2007; Brandoni and Polonara, 2012; De Brucker et al., 2013). Therefore, despite a commitment to sustainability, many organisations face difficulties in incorporating this concept in projects due to barriers against project success.

On the other hand, Joel Makower states that "many companies are discovering that embedding sustainability into their projects, program and portfolio management practices delivers a direct and impressive positive impact on the bottom line" (PMI, 2011: 1). The global survey of IBM (2008) indicates that "47 % of organisations have begun to redesign their business models on the basis of sustainability, treating sustainable development as a new source of innovation, a new opportunity for cutting costs and a new mechanism for gaining competitive advantage" (Calero and Piattini, 2015: 5). Similarly, PMI (2011: 1) declares that by incorporating sustainability into projects, "companies see increased market share and improved profits, while meeting growing client and government demands for more socially responsible business practices". According to Michaelides et al. (2014), many big corporations such as Nike, Toyota, and Zara have incorporated sustainability into projects to increase their credibility with customers; thus, projects are able to succeed, and companies are able to win more market share. They conclude that sustainability should be considered a critical success factor for projects. Likewise, Kometa et al. (1995), Lim and Mohamed (1999), Chan and Chan (2004), and Almahmoud et al. (2012) assert that sustainability-related aspects such as health, safety, and environmental performance are necessary for project success. Khalilzadeh et al. (2016: 352) declare that project sustainability has "a positive and significant relationship" with project success. Carvalho and Rabechini (2017: 1120,1129) also found "a significant and positive relation between project sustainability management and project success", with no "negative influence on project performance if related to costs". Also, in the study of Borchardt et al. (2011: 49), "a cost reduction of about 10% was observed" and "a reduction of energy consumption was also noticed", which indicates that project sustainability could support project success. Incorporating sustainability "does not mean sacrificing profitability. In fact, the opposite is often true" (PMI, 2011: 4). Porter and Linde (1995), Murugesan (2008), Watson et al. (2010), Marcelino-Sádaba et al. (2015), and Sánchez (2015) found that incorporating sustainability does not necessarily lead to high budgets, and by applying the best methods and advanced technology to identify and utilise resources effectively, reducing cost and enhancing profitability are possible. Daneshpour (2015: 321) concludes that "sustainability is the crucial factor for project success".

Yet, there are some contradictions regarding the incorporation of sustainability into projects (project sustainability). According to Marcelino-Sádaba et al. (2015), project sustainability is difficult, and there are many unanswered questions regarding it. One of the most critical questions regarding project sustainability is its impact on the success of projects. Project success remains among the top priorities; it is of significant concern in the project management literature, and the schools of thought pay great attention to it (Cooke-Davies, 2002; Ika, 2009; Müller and Jugdev, 2012; Rolstadås et al., 2014). Recently, sustainability and project success were among the most notable topics for research in the International Project Management Association (IPMA) conferences of 2016 and 2017 (Martínez-Perales et al., 2018). However, the relationship between project sustainability and project success has been inadequately researched until now, and more studies should be conducted in both developed and developing countries. There is an obvious lack of research regarding this relationship in the developing countries of the Arab world in particular. Also, most of the few relevant contributions are conceptual in nature and focus mainly on manufacturing and construction projects (Silvius and Schipper, 2016; Carvalho and Rabechini, 2017). There is a lack of research which study this relationship in some important projects such as software projects where this research is focused. Software systems are considered as pervasive drivers of change in society (Calero and Piattini, 2017; Penzenstadler et al., 2018), and incorporating sustainability into software projects - software project sustainability (SPS) - is gaining importance. Many notable contributions on SPS have recently been made. However, in terms of the relationship with project success, the question that remains is ‘does software project sustainability (SPS) support project success?’. Therefore, this research works on these gaps and intends to make a new contribution by studying the relationship between these two concepts empirically and within a developing country from the Arab world.

1.3 Research aim and objectives

The **aim** of this research is to investigate the potential impact of software project sustainability (SPS) on project success.

To achieve this aim, the following research questions are established:

Research question 1: how has the concept of sustainability been translated from theory into practice and incorporated into software projects?

Research question 2: how is project success being evaluated in relevant literature?

Research question 3: can software project sustainability (SPS) support project success?

Subsequently, the resulting research objectives are:

Objective 1 (OB1): to explore how the concept of sustainability can be translated from theory into practice and incorporated into software projects.

Objective 2 (OB2): to investigate how project success is being evaluated in relevant literature.

Objective 3-A (OB3-A): to develop and validate a model that helps in examining the relationship between SPS and project success based on explicit constructs for both concepts.

Objective 3-B (OB3-B): to examine the potential impact of SPS on project success empirically.

The methodology for achieving OB1 and OB2 was a systematic literature review (SLR). For OB3-A, SLR, face validation, questionnaire survey and statistical analysis were used, respectively, for developing and validating the research model. However, OB3-B was totally based on a questionnaire survey and statistical analysis.

1.4 Overview of the research framework and hypotheses

To achieve the aim of the current research, the author of the current research conducted a systematic literature review (SLR) to achieve OB1 and OB2. After that, to contribute to the accomplishment of OB3-A and OB3-B, the author has developed a conceptual framework (based on the findings of SLR as discussed in chapter 3) that helps in examining the relationship between software project sustainability (SPS) and project success empirically. The proposed framework consists of six constructs which were developed based on the analysis of the best contributions in the relevant literature. The first four constructs are independent variables (IVs) and represent SPS, which are: economic considerations (ECCs), environmental concerns (EVCs), social responsibilities (SRs), and TBL-related quality requirements (QRs). These constructs encompass a unique combination of TBL-related aspects for incorporating sustainability into the processes and products of software projects; and form a significant part of the contribution of this thesis. The fifth construct is project success (PSCS) and it was positioned as a dependent variable (DV). The sixth construct is project complexity, it was positioned as a control variable in the proposed framework. The development of the framework is affiliated with the triple bottom line (TBL) theory of sustainability (Elkington, 1998), the Product Quality model of systems and software (ISO/IEC 25010:2011, 2018), the Sustainability Checklist of the International Project Management Association (IPMA) (Silvius et al., 2012), the contingency theory (Fiedler, 1964), and the theoretical models of Shenhar et al. (1997 and 2001), Shenhar and Dvir (2007), and Shenhar (2011) for measuring project success.

Figure 1.1 shows the proposed framework of the current research. To investigate the potential impact of SPS on project success in-depth, the potential impact of each construct of SPS on project success was examined; then, the potential impact of all of the constructs "combined" on project success was examined as well. Additionally, the potential impact on project success was inspected under different levels of project complexity. Therefore, the research hypotheses were developed as the following:

Hypothesis 1: Incorporating economic considerations in the processes of software projects has a significant and positive relationship with project success.

Hypothesis 2: Incorporating environmental concerns in the processes of software projects has a significant and positive relationship with project success.

Hypothesis 3: Incorporating social responsibilities in the processes of software projects has a significant and positive relationship with project success.

Hypothesis 4: Incorporating TBL-related quality requirements in the products of software projects has a significant and positive relationship with project success.

Hypothesis 5: Software project sustainability (SPS) has a significant and positive relationship with project success.

Hypothesis 6: Project complexity has a significant impact on project success.

All these hypotheses are expressed in the alternative form, but it is recognised that statistical testing is undertaken against the null.

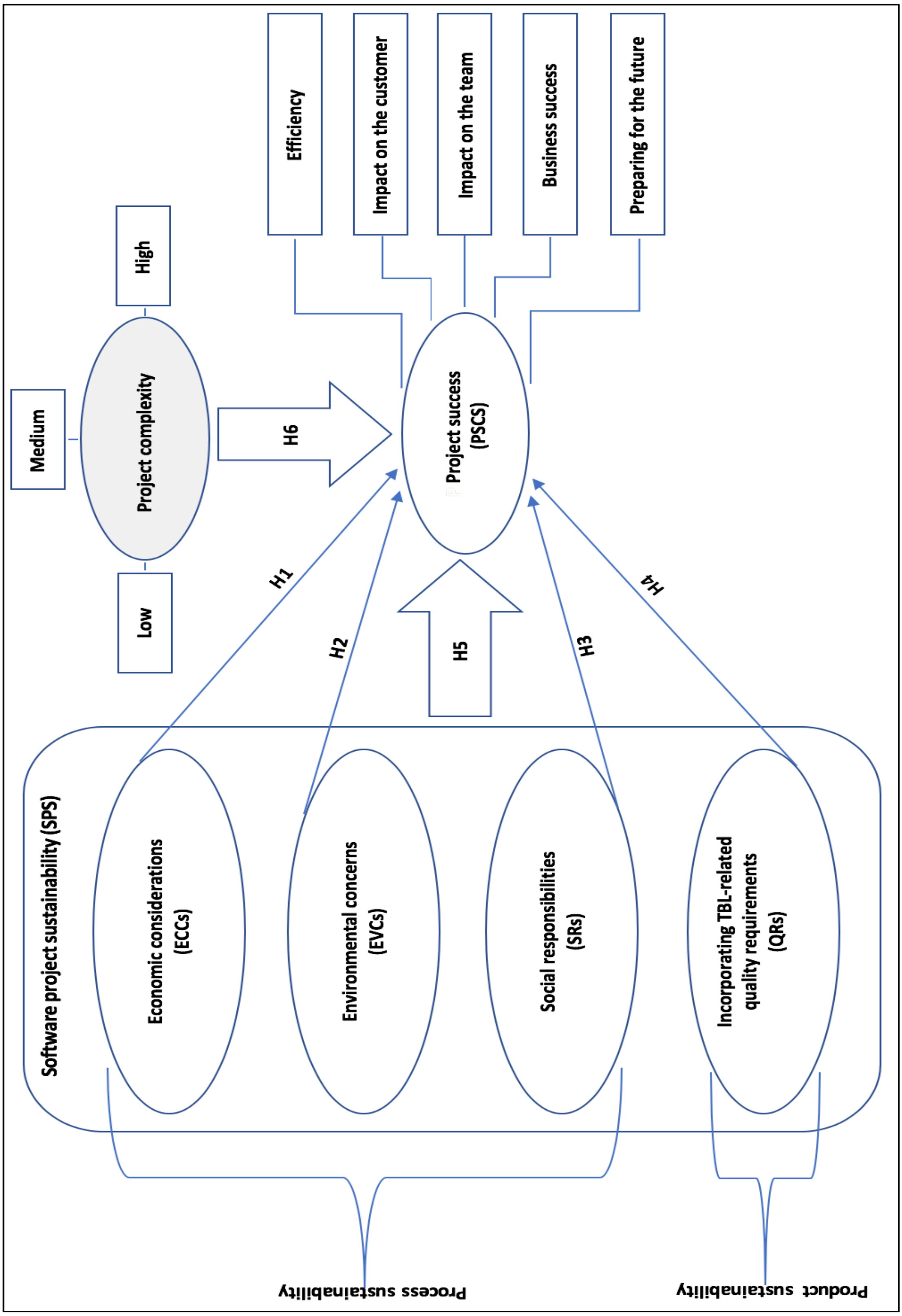

Figure 1. 1: Overview of the research framework and hypotheses

1.5 Overview of the research methodology

The first stage of the current study included conducting a systematic literature review (SLR) and developing a conceptual framework so that the hypotheses could be proposed and tested. This research is exploratory in nature, as it intends to develop a better understanding of a given phenomenon (Tranfield et al., 2003; Krippendorff, 2018). It has been argued that a literature review is essential for appraising knowledge based on existing relevant theories, and that an extensive range of information, results, contributions, and insights can be obtained from already published work (Martens and Carvalho, 2014; Silvius and Schipper, 2016). Therefore, the author carried out a systematic bibliographic search (Marcelino-Sádaba et al., 2015; Carvalho and Rabechini, 2017) on related published materials to identify and classify relevant variables of both concepts – software project sustainability (SPS) and project success. The main sources of publications are academic journals, books, official websites of relevant organisations, and conference proceedings (Shannon, 2002; Tranfield et al., 2003; Silvius and Schipper, 2014; Carvalho and Rabechini, 2017; Aarseth et al., 2017). Following the approach of Silvius and Schipper (2014) and Marcelino-Sádaba et al. (2015), search engines such as Google Scholar and Scopus were used to find relevant publications.

For data selection, the author searched for publications before 2019. The selection was conducted in three steps. The first step was to prove the originality of this research and its significant contribution to knowledge by finding related works that focus particularly on the relationship between project sustainability and project success (discussed in detail in section 2.1). In this step, the search had two constructs (project sustainability and project success); the key search terms of the first construct were 'sustain project', 'sustainable project', 'project sustainability', 'project sustainable development', 'project social responsibility' or 'green project', and the key search terms of the second construct were 'project success', 'project management success', and 'project performance'. The second step aimed to find publications related to software project sustainability (SPS) to explore how the concept of sustainability has been translated from theory into practice and incorporated into software projects (discussed in detail in section 3.1). In this step, the search had one construct and the key terms were 'sustain software', 'sustainable software', 'software sustainability', 'sustain software project', 'sustainable software project', 'software project sustainability', 'green software', and 'software social responsibility'. The third step aimed to find publications related to project success in order to explore the most used criteria and models for evaluating project success. In this step, the search also had one construct, and the key terms were 'project success', 'project management success', and 'project performance'. For data extraction, the author used databases of academic libraries such as EBSCO, Science Direct, Emerald Insight, Business Source Premier, JSTOR, and official websites of relevant organisations to retrieve the full texts of the required publications. To filter the relevant publications, the author read the abstracts of the selected publications in each step independently. Moreover, to extend the search to find more contributions, the author reviewed the references in all of the selected works. Following the methodology of Jarvis et al. (2003), Hsieh and Shannon (2005), and Duriau et al. (2007), the author applied content analysis to analyse the final selected publications in-depth. Each publication was read carefully, and aspects related to the subject area were identified and classified under several constructs to form the main variables of the proposed framework (Bauer, 2007; Martens and Carvalho, 2016a; Krippendorff, 2018).

The second stage of this research focused on empirical testing and validation. Following Carvalho and Rabechini (2017), a survey-based study was conducted to validate the proposed conceptual framework as a model and to examine the potential impact of software project sustainability (SPS) on project success empirically. The research instrument for collecting primary data was a self-administered questionnaire. The first version of the questionnaire was reviewed by eight experts (four academics and four practitioners) in the fields of sustainability and software projects from the United Kingdom and Jordan. The main purpose of this review was to ensure the content validity, clarity, readability, structure, and representativeness of the research instrument (Dillman, 1991; Carvalho and Rabechini, 2017). Based on the results and recommendations of the initial review, the questionnaire was corrected and modified, and all given suggestions and improvements were considered. After that, the author conducted a pilot study on 20 of the relevant respondents to detect further errors and uncover any ambiguities or confusions, as well as to validate the instrument and ensure its reliability for collecting data (Sekaran and Bougie, 2016; Fink, 2017). The final version of the questionnaire consisted of 44 questions, required approximately 15 to 20 minutes completion time, and was to be hand-delivered to the target respondents. Following Hair et al. (2017), the sufficient sample size for the statistical analysis in the current study is 129 of relevant respondents. The targeted population was the key stakeholders (project managers, project team, and senior management) of the internal software projects of

Jordanian public universities. Jordan is a developing country located in the heart of the Arab world, and the software industry contributes significantly to its gross domestic product (GDP) as discussed in section 2.1.3.2. The reason behind focusing on internal projects is the possibility of having the key stakeholders in the same place, unlike external projects (Lock, 2007). Also, the reason for targeting the key stakeholders of these projects is their strong influence in evaluating project success (Davis, 2017). Based on Saunders et al. (2016), 172 questionnaires were distributed randomly using a cluster sampling technique. A total of 153 questionnaires were returned, resulting in an initial response rate of nearly 89%. However, among the returned questionnaires, 13 were considered unusable and were therefore excluded. Thus, this resulted in 140 valid questionnaires, producing an actual response rate of 81.4% with a sample larger than the minimum sample size required for analysis. The collected data were analysed using the partial least squares structural equation modelling (PLS-SEM), since it is suitable for exploring and predicting such complex relationships (Hair et al., 2011).

To sum up, this research is quantitative in design, with a positivist philosophy. Generally, this research is associated with a deductive approach, as the focus is on using data to test a theory. However, it also incorporated an inductive approach in the first stage, where data from the literature were used to develop a conceptual framework. The methodological choice of this research is a mono method quantitative with a cross-sectional time horizon; it has used a questionnaire as a single data collection technique, with a corresponding quantitative analytical procedure (Saunders et al., 2016).

1.6 Summary of the research contribution

The whole contribution of the thesis is presented in detail in section 6.2. In summary, this research provides empirical evidence regarding the potential impact of software project sustainability (SPS) on project success. This is considered significant due to the present contradictions in the literature regarding the incorporation of sustainability into projects and its impact on project success. Some authors argue that project sustainability (PS) may have a negative impact on project success, while others say the opposite. These contradictions frustrate and impede moving towards a more sustainable orientation in projects, which make up about a third of the organisations' activity worldwide. The relationship between these two concepts remains among the top priorities and of significant concern for researchers and practitioners. However, this relationship has been inadequately researched until now, and more studies need to be conducted. Currently, there is no recorded contribution which focuses on the relationship between project sustainability (PS) and project success in the software industry and within the context of Arab countries. Therefore, participating in filling this gap is the main contribution of this thesis.

Furthermore, whilst the current literature has some notable contributions regarding the incorporation of sustainability into software projects, these contributions have mostly focused on either project product or project process, or on one or two dimensions of sustainability rather than the three dimensions of the TBL theory. This thesis goes beyond previous research of software sustainability and contributes significantly by presenting a new set of TBL-related aspects for incorporating sustainability into the processes and products of software projects. Therefore, the proposed model provides academics and practitioners (e.g. business leaders, decision-makers, project managers, software engineers, and consultants) with useful guidance on how to incorporate, enhance, and monitor sustainability in their software projects in a comprehensive way. Also, software companies - or other relevant organisations - may use the proposed model as a measurement tool to evaluate the environmental and social impacts of their current products and project management practices. Consequently, these organisations may pay more attention to incorporating sustainability into their project management practices.

1.7 Chapter summary

The relationship between project sustainability and project success has been inadequately researched. Yet, there are some contradictions regarding this relationship. Some authors argue that project sustainability may have a negative impact on project success, while others say the opposite. These contradictions frustrate and impede moving towards a more sustainable orientation. Based on the conducted systematic literature review, it has been found that most of the few relevant contributions are conceptual in nature and focus mainly on manufacturing and construction projects. Currently, there is no recorded contribution which focuses on the relationship between project sustainability and project success in the software industry. Therefore, this study aims to make a novel contribution to the literature by investigating the potential impact of software project sustainability (SPS) on project success empirically.

Chapter 2 - Literature review

This chapter proves the originality of the current study by presenting the knowledge gaps of the related works that were analysed after conducting a systematic literature review. Also, it contributes to the first and second objectives of this research by exploring how sustainability can be incorporated into software projects and how project success is being evaluated in the relevant literature. This chapter consists of four main sections. Section 2.1 highlights the related works and gaps in knowledge and sheds light on the study context. Section 2.2 introduces the theoretical background and definitions of the study terms. Section 2.3 reviews the relationship between sustainability and projects and how sustainability can be incorporated into software projects from product and process perspectives. Finally, Section 2.4 concludes the main findings.

2.1 Related works and gap analysis

This section aims to prove the originality of this research and its significant contribution to knowledge by finding related works that focus particularly on the relationship between project sustainability and project success. The author carried out a systematic literature review (SLR) by selecting, extracting, analysing, and critically appraising relevant literature that met pre-specified criteria by using transparent, well-organised, and replicable steps (Tranfield et al., 2003; Littell et al., 2008; Aarseth et al., 2017). For data selection, the author searched for publications before 2019 based on three main criteria; (i) the used language is English, (ii) the relationship between PS and project success has been considered clearly, and (iii) particularly for empirical works, sustainability should have been considered under the widely-used concept of triple bottom line (TBL) (Keating, 1994), since it “captures the essence of sustainability” (Savitz, 2013: 5). This was in order to gain a comprehensive view of the relationship between PS and project success. The search had two constructs (project sustainability and project success); the key search terms of the first construct were ‘sustain project’, ‘sustainable project’, ‘project sustainability’, ‘project sustainable development’, ‘project social responsibility’ or ‘green project’, and the key search terms of the second construct were ‘project success’, ‘project management success’, and ‘project performance’.

The initial sample selection resulted in 37 studies, where both of the search constructs were detailed in some way. To filter the relevant studies from the initial selection, the author read the abstracts of the 37 selected studies independently. Nineteen studies were classified irrelevant and were removed from the initially selected sample since they were not focusing mainly on the relationship between project sustainability (PS) and project success. Although 18 studies were selected after the first filtration, another 5 studies were then filtered out by content analysis for two main reasons. First, some studies were concerned about the critical success factors of the relationship between sustainability and projects or project management and not on the relationship between project sustainability (PS) and project success. Second, some studies focused on sustainability success in projects, rather than focusing on the success of the project itself.

The final selected sample included 13 studies which precisely focused on the relationship between project sustainability (PS) and project success and served the exact purpose of this study. The fact that only a few relevant studies were retrieved confirms the findings of Silvius and Schipper (2016) and Carvalho and Rabechini (2017) that the relationship between PS and project success has been inadequately researched and that there remains a lack of empirical evaluation. More studies should be conducted in both developed and developing countries. There is an obvious lack of research regarding this relationship in the developing countries of the Arab world in particular. Also, most studies have focused on the infrastructure, engineering, and construction sectors, with no focus on how the incorporation of sustainability into software projects can impact project success. The findings of this study reveal five empirical works and eight conceptual studies up to the end of 2018, which is closely aligned to the findings of the systematic work of Silvius and Schipper (2016). In their study, they found that only seven studies addressed this relationship, six of which were conceptual in nature and only one of which was empirical. Compared with their findings, the final selected sample for this study contained more empirical works. The justification is that four new empirical studies were published over the past three years in 2016, 2017, and 2018, and were therefore not included in the work of Silvius and Schipper (2016). **However, in all of these contributions, there was no focus on software projects nor on Arab countries.**

2.1.1 Conceptual studies

The findings revealed eight conceptual studies (Table 2.1): Madlener et al. (2006), Maltzman and Shirley (2010), Mishra et al. (2011), Eskerod and Huemann (2013), Craddock (2013), Kaysi (2013), Silvius and Schipper (2016), and Fuentes-Ardeo et al. (2017).

Mishra et al. (2011) focus on the role of ethics in project success. They identify ethics as the fourth most significant dimension in project-based organisations and will result in project sustainability. In their opinion, considering ethics will increase customers' loyalty and satisfaction and will create trust, morality, values, brotherhood, and harmony among team members. They conclude that keeping in mind social impacts and ethical standards is essential for all successful projects. However, their study places emphasis only on social sustainability and not on the TBL of sustainability. Similarly, Eskerod and Huemann (2013) focus mainly on social sustainability by discussing the relationship between stakeholder management and project success. They claim that stakeholder management is a core activity for project success and that it is a necessity in the future of sustainable project management.

Craddock (2013) links project sustainability and project success through Business Excellence Models (BEMs). His view is that the broad perspective of sustainability fits well with the concepts of Total Quality Management (TQM) and Corporate Social Responsibility (CSR), and that BEMs provide a framework to address sustainability through the movement of TQM. As an example, he links project success to the European Foundation for the Quality Management (EFQM) model, which is one of the BEM ideas that has eight fundamental concepts of excellence, one of which is taking responsibility for a sustainable future. He concludes that over the years, project success has changed from being confined to the implementation phase of projects to include success criteria that reflect the product of projects at the same time. However, his study focuses mainly on business excellence, and not on the relationship between project sustainability and project success particularly. Fuentes-Ardeo et al. (2017) believe that incorporating sustainability into project management can directly impact project success. They studied how the interaction between project management sustainability and project knowledge management can influence project success. However, their main focus was on how project knowledge management can be a key success factor when integrating sustainability in project management, not on the relationship between project sustainability and project success.

Kaysi (2013) adds sustainability as the seventh element of project success beside time, cost, scope, quality, risk, and benefit. He describes how the London Velodrome Park in 2011 is considered a successful project, despite over-running the estimated cost (£20 million estimated cost in 2004 and £105 million total completion cost in 2011). The success of the project was in its sustainability legacy and its motto. He states, "it is the greenest venue in the

Olympic Park, delivered all sustainability promises or exceeded, it is one of the most efficient buildings in the history of the games" (Kaysi, 2013: 29). However, his main focus was solely on environmental sustainability. Similarly, Maltzman and Shirley (2010) discuss sustainability from the environmental dimension (green project management), by focusing on waste elimination and relating it to quality and eventually to project success. Madlener et al. (2006) focus on TBL dimensions and propose a conceptual framework for enhancing the long-term success of land use and land-use change and forestry (LULUCF) projects. They define and structure relevant economic, social, and environmental aspects for incorporating sustainability in different stages of these projects (e.g. planning, design, implementation, monitoring, and ex-post evaluation). They conclude by providing a set of recommendations to further develop and promote their framework as a checklist when dealing with these types of projects. Likewise, Silvius and Schipper (2016) focus on TBL by developing a conceptual framework for exploring the relationship between project sustainability and project success. They also provide a conceptual mapping that provides a better understanding of how considering different sustainability dimensions may affect the criteria of project success. Based on their conceptual mapping, most relationships are expected to be positive, but in terms of completing projects within time and budget, expectations are uncertain. Table 2.1 summarises the main aspects of the conceptual studies and identifies the related gaps.

Table 2. 1: Summary of conceptual studies with related gaps

<table>
<tr><th rowspan="2">Study</th><th rowspan="2">Study Type</th><th rowspan="2">Industry Focus</th><th rowspan="2">Country Focus</th><th colspan="2">Related Gaps</th></tr>
<tr><th>Considering the Arab world</th><th>Considering software projects</th></tr>
<tr><td>Madlener et al. (2006)</td><td>Academic paper</td><td>Single industry focus</td><td>Developed and developing countries</td><td rowspan="8">No</td><td rowspan="8">No</td></tr>
<tr><td>Maltzman and Shirley (2010)</td><td>Book</td><td rowspan="4">General</td><td rowspan="4">Not specified</td></tr>
<tr><td>Mishra et al. (2011)</td><td rowspan="2">Academic paper</td></tr>
<tr><td>Eskerod and Huemann (2013)</td></tr>
<tr><td>Craddock (2013)</td><td>Book chapter</td></tr>
<tr><td>Kaysi (2013)</td><td rowspan="2">Academic paper</td><td>Single industry focus</td><td>Developed country, UK.</td></tr>
<tr><td>Silvius and Schipper (2016)</td><td rowspan="2">General</td><td rowspan="2">Not specified</td></tr>
<tr><td>Fuentes-Ardeo et al. (2017)</td><td>Conference Paper</td></tr>
</table>

2.1.2 Empirical studies

Only five empirical studies (Table 2.2), which covered a time frame of five years between 2013 and 2018, were found to focus clearly on this relationship: Adriana and Ioana-Maria (2013), Martens and Carvalho (2016a and 2016b), Khalilzadeh et al. (2016), and Carvalho and Rabechini (2017). These five studies consisted of four journal articles and one book chapter. The research strategy of four studies was a survey (questionnaires), and only one study used multiple case studies based on company reports. Three studies focused on both developed and developing countries, while two studies focused only on developing countries. Three studies examined different types of industries such as oil and gas, banking, real estate, cosmetics, chemicals, electronics, information technology, construction, automotive, aerospace, communication, mining, retail, electricity, agriculture, and medicine. As for the other two studies, one was based on experts (practitioners and academics) from different universities, and the other examined only the oil and gas sector.

Adriana and Ioana-Maria (2013) studied the relationship between the integration level of sustainability in project and project success based on the reports of 35 companies. Martens and Carvalho (2016a) identified relevant key variables of project sustainability and investigated the impact of these variables on project success based on the perspectives of experts (practitioners and academics) from different universities. Khalilzadeh et al. (2016) studied the relationship between sustainability factors and project success, focusing on the oil and gas sectors in the South Pars (a region between Iran and Qatar). Martens and Carvalho (2016b) conducted multiple-case studies in four companies from different sectors in Brazil and the USA to investigate how sustainability is introduced in projects and how it can impact project success. Carvalho and Rabechini (2017) proposed and validated a research model for project sustainability management and investigated its relationship with project success based on different types of projects in Peru and Brazil. The findings of these five empirical studies are discussed in section 6.1.4. Table 2.2 summarises the main aspects of these studies and identifies the related gaps.

Table 2. 2: Summary of empirical studies with related gaps

<table>
<tr><th rowspan="2">Study</th><th rowspan="2">Study Type</th><th rowspan="2">Study Strategy</th><th rowspan="2">Industry Focus</th><th rowspan="2">Country Focus</th><th colspan="2">Related Gaps</th></tr>
<tr><th>Considering the Arab world</th><th>Considering Software projects</th></tr>
<tr><td>Adriana and Ioana-Maria (2013)</td><td>Book Chapter</td><td>Multiple case studies (Company reports)</td><td>Multiple industry focus</td><td>Developed and developing countries</td><td rowspan="5">No</td><td rowspan="5">No</td></tr>
<tr><td>Khalilzadeh et al. (2016)</td><td rowspan="4">Academic paper</td><td rowspan="4">Survey (questionnaires)</td><td rowspan="2">Single industry focus</td><td>Only developing countries</td></tr>
<tr><td>Martens and Carvalho (2016a)</td><td rowspan="2">Developed and developing countries</td></tr>
<tr><td>Martens and Carvalho (2016b)</td><td rowspan="2">Multiple industry focus</td></tr>
<tr><td>Carvalho and Rabechini (2017)</td><td>Only developing countries</td></tr>
</table>

Empirically, it is clear that interest in this subject emerged only in 2016 and is limited to a few studies by a few authors. Only the study of Adriana and Ioana-Maria (2013), which was conducted first, was a book chapter. The fact that these studies are few and recent justifies the argument that the incorporation of sustainability in projects, in general, is a new, emerging topic in the literature and remains underrepresented by a lack of research (Silvius et al., 2012; Carvalho and Rabechini, 2017; Aarseth et al., 2017). Therefore, this research works on the identified gaps and intends to make a new contribution by studying the relationship between software project sustainability (SPS) and project success empirically and within a developing country from the Arab world, which is Jordan.

2.1.3 The study context: software in Jordan

2.1.3.1 General information about Jordan

Jordan officially called the Hashemite Kingdom of Jordan, and the capital city of it is Amman. It is located on the east bank of the River Jordan and almost half of it is covered by the Arabian Desert. The total area of Jordan is approximately 89.342 kilometres square, and the population is 8.2 million based on the statistics of year 2017. It gained independence in 1945 and the first crowned king was King Abdullah who ruled until 1951. Then, His Majesty King Hussein bin Talal ruled Jordan from 1951 and until 1999. After that, His Majesty King Abdullah II took over on 7th February 1999 (WorldAtlas, 2017). Figure 2.1 shows the map of Jordan.

Figure 2. 1: Map of Jordan
(University of Texas Libraries, 2019)

The official language in Jordan is Arabic; and the first foreign language is English. The religion of 93% of Jordanian citizens is Islam and Christianity forms 6%, with the majority being Orthodox or Catholic. Other minorities include small Druze and Baha'i contingents. The official currency of the country is the Jordanian Dinar, it is around 1.41 United States Dollar (USD $) and 1.13 Great British Pound (GBP £) in July 2019 (Salameen, 2015; Oanda, 2019).

Jordan is classified by The World Bank (2020) as an upper-middle-income developing country. According to the World Health Organisation (2013: 13) "Jordan has limited natural resources and suffers from severe freshwater scarcity; it is ranked among the five most water-poor countries in the world". Also, it suffers from a lack of natural resources such as oil and gas and mainly relies on imported energy resources to meet domestic demand, which consumes 40% of the country's budget. However, Jordan enjoys abundant quantities of phosphate and potash, making the country the second-largest exporter of phosphates in the world, with an annual production of around 7 million tons. Phosphate and potash together generated $564 million which constitutes about 22% of Jordan's domestic export earnings. Tourism also considered one of the greatest contributors to Jordan’s economy especially the area of the Dead Sea and Petra which are among the most famous historical places in the world (Alrousan, 2015).

2.1.3.2 The importance of software industry in Jordan

Jordan’s economy depends mainly on the service sector which contributes to more than 70% of total GDP. In 2011, foreign investments in this sector reached around $1.5 billion, focusing on different industries such as banking, education, health, tourism, and information and communication technology (OECD, 2013; Alrousan, 2015).

Information technology (IT) is among the most important industries in the service sector. The spurt in the growth of IT sector and its significant contribution to the socio-economic development of the country has led the government of Jordan to create a favourable policy and regulatory environment for the further growth of this sector (INTAJ, 2018). Jordan showed steady growth in information technology (IT) infrastructure (software and hardware) in the last decade. It has a strong IT agenda, which may have a big impact on the development of the country. Strategic plans have been developed, and investments have been allocated to: optimise IT infrastructure and regulate its market, enhance the environment for e-commerce development (e.g. taxes, telecommunications and internet infrastructure, and electronic and online payment systems), and increase IT knowledge, literacy and liberalise. The country is ranked in third place among Arab countries with respect to IT and e-commerce readiness, respectively after UAE and Bahrain (Ministry of Information and Communications Technology, 2007; Al-Khaffaf, 2011; Alrousan, 2015). Over the last few decades, top IT companies in Jordan have become global leaders in the information technology (IT) sector and contribute to the growth of technology not only in Jordan but globally. As shown in Figure 2.2, revenues of the IT industry in Jordan have grown from $547 million in 2014 to reach $750 million in 2018.

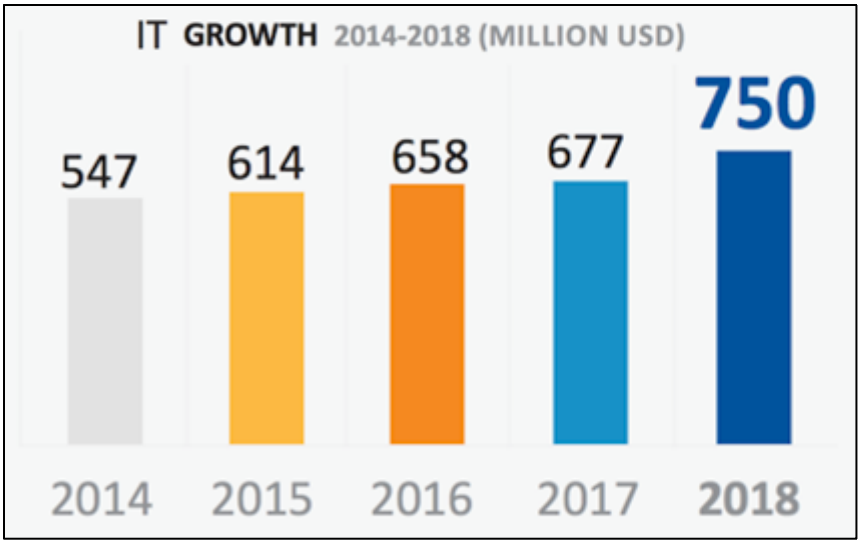

Figure 2. 2: Revenues of the IT industry in Jordan 2014-2018 (INTAJ, 2018)

Software industry lies at the heart of information and communication technology. The software makes extra downstream economic activity than hardware, and development and spending on software is increasing faster than spending on IT overall - 4.8 % a year between 2008 and 2013, compared to 3.3 % for all IT spending - (IDC, 2009; Calero and Piattini, 2015). According to Charles Fishman, cited by Kitchin and Dodge (2011: 3), “Software is everything. In the history of human technology, nothing has become as essential as fast as software”. Rocheska et al. (2015: 87) state, “the software industry is one of the key pillars of the digital economy that generates extensive and multiplicative effects on the development of other industries”. Stroustrup (2012: 48) concludes, "our civilization runs on software".

The software industry has been considered as an opportunity for the economic growth of Jordan (INTAJ, 2018). The enormous dependency on telecommunication technologies, competition in e-business, internationalisation of business processes, and the need for embedding software in many products, have led the country to allocate notable efforts to the development of the software industry and raise its contribution to the gross domestic product (GDP). These efforts were embodied by supporting and enhancing relevant key success factors of the software industry such as information and communication technology (ICT) infrastructure, intellectual property rights and entrepreneurship, education, and replicating the experience of key software exporters (Abdali and Mohammad, 2005; Mohammed, 2011). The main software development areas in Jordan are system integration, accounting packages, banking, web-based and online applications, health and safety applications, Arabisation (making the software usable in the Arabic language), games development, insurance packages, software conversion from 3rd to 4th generation, and mobile applications (Mohammed, 2011; INTAJ, 2018). As shown in Figure 2.3, software development has led the charts of revenues of the IT industry in Jordan with the highest rank of $182.5 million in 2018, followed by software licence sales with $90.4 million (INTAJ, 2018).

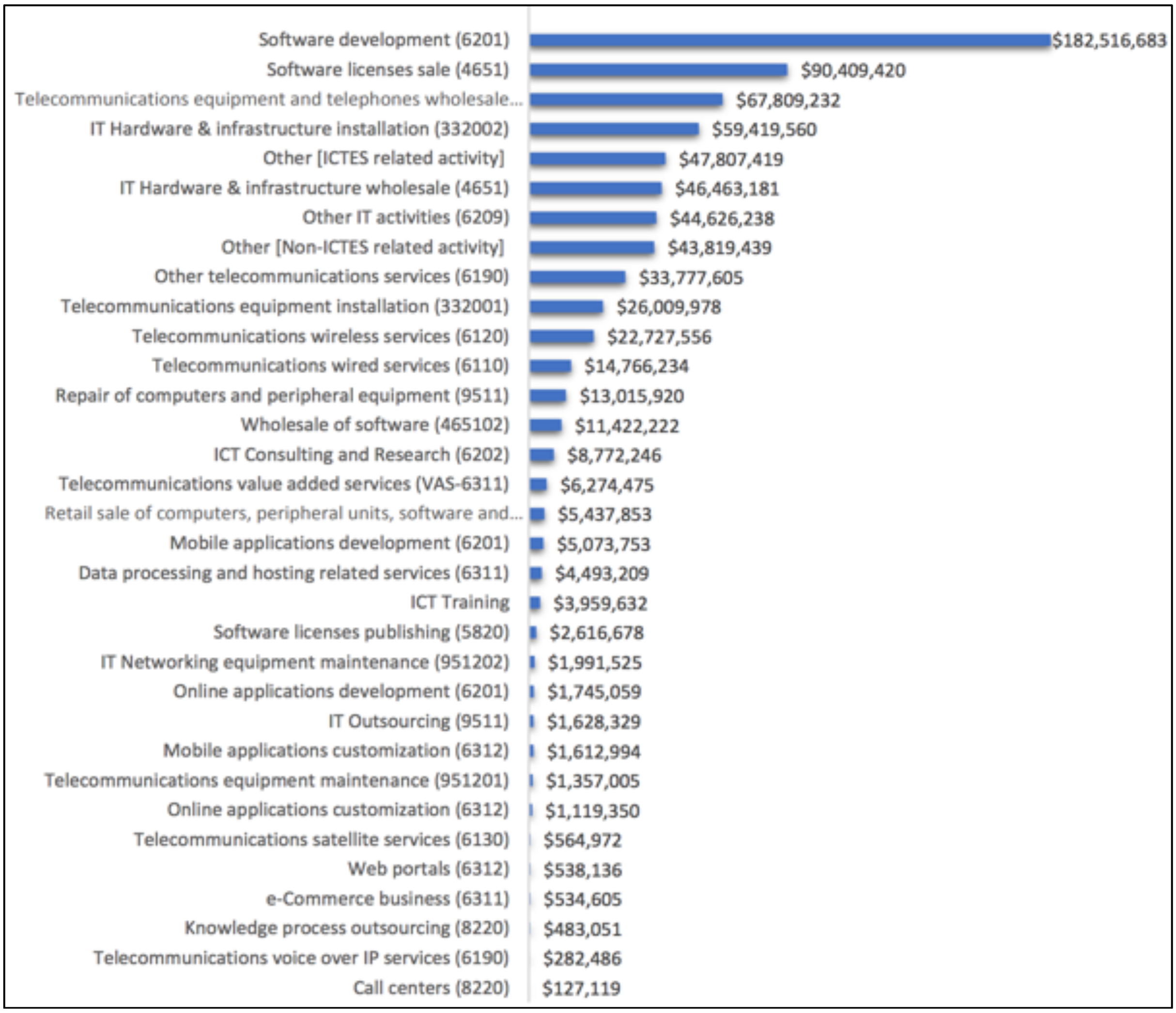

Figure 2. 3: Revenues of the IT industry activities in Jordan 2018

(INTAJ, 2018: 13)

The major research and development (R&D) projects of the software industry are limited to the universities (mainly the public universities), large software companies, and R&D centres of the Royal Scientific Society (RSS) and the Higher Council of Science and Technology (HCST) (Mohammed, 2011). However, in terms of sustainability in software projects, the findings of the systematic review in section 2.1 reveal that there were no relevant contributions have been conducted in any of these Jordanian organisations. Therefore, this research intended to make a new contribution by targeting software projects of the ten Jordanian public universities; particularly, the internal software projects of these universities.

2.2 Background and definitions

2.2.1 Projects

Over the last 60 years, organisations have made use of projects to accomplish their strategic objectives and to tackle the persisting tedious activities, uncertain conditions, and ambiguities which impact their economic and social status (Peter and Ashley, 2004; Gareis, 2006). Based on Turner (2014) and the Project Management Institute (PMI, 2017), projects can be defined as temporary and unique endeavours to make a beneficial change in the form of products, services, or results; and project management is the process by which this change is achieved successfully. Through projects, capabilities and resources are deployed to create a valuable change and competitive advantage by producing deliverables which fulfil planned objectives (Turner, 2014; PMI, 2017).

An objective is defined as “an outcome toward which work is to be directed, a strategic position to be attained, a purpose to be achieved, a result to be obtained, a product to be produced, or a service to be performed” (PMI, 2017: 712). A deliverable is defined as “any unique and verifiable product, result, or capability to perform a service that is required to be produced to complete a process, phase, or project. Deliverables may be tangible or intangible” (PMI, 2017: 4). According to Turner (2014), deliverables can be the result of different types of projects (e.g. civil engineering and construction projects, research and development projects, manufacturing projects, and information systems projects) and can come in the form of producing a beneficial outcome or return, satisfying some purpose, solving a problem, or exploiting an opportunity.

Lock (2007) classifies projects into four different general types: civil or chemical and construction projects; manufacturing projects; management projects (often internal projects for the companies’ own benefits); and pure scientific projects which may have no precise objective, time, or budget. Figure 2.4 shows the different types of projects based on Lock (2007).

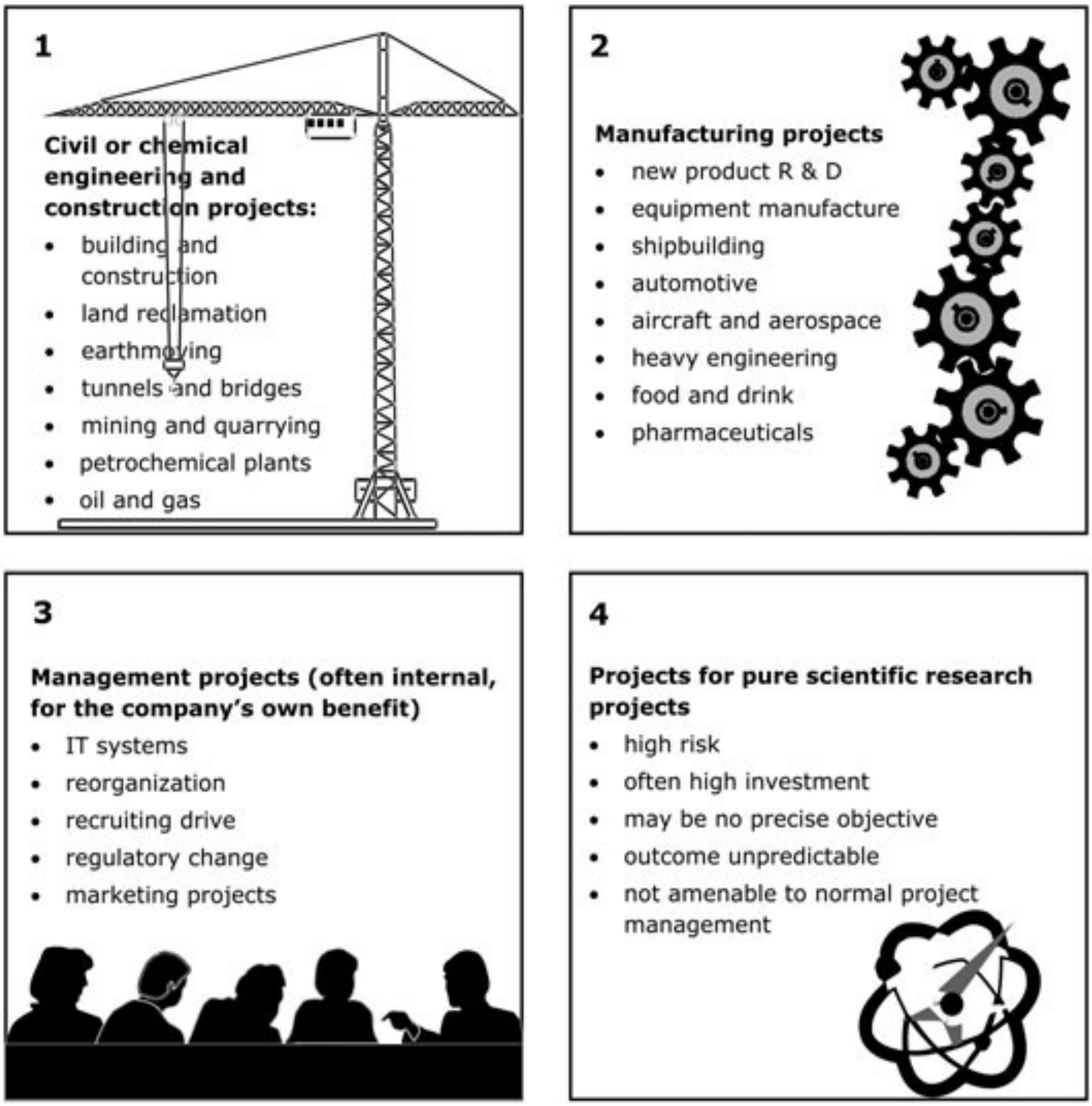

Figure 2. 4: Four project types
(Lock, 2007: 5)

Turner (2007: 98) states, "in order to produce the desired beneficial outcome, the asset must function in certain ways. Thus, the management of the delivery of those functions is an inherent part of project management. Also, the achievement of the benefit must be managed". PMI (2017) concludes that by applying and integrating the project management processes appropriately, organisations can execute their projects efficiently and effectively so that beneficial outcomes can be achieved (PMI, 2017).

2.2.2 Project management

Many attempts have been made to define project management. According to Atkinson (1999: 337), project management is "the application of a collection of tools and techniques to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost and quality constraints". The UK Association for Project Management (APM) defines it as "the process by which projects are defined, planned, monitored, controlled and delivered such that the agreed benefits are realised" (APM, 2014: 3). For the project management institute (PMI), it is "the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements" (PMI, 2017: 10). Turner (2007: 8) concludes that project management is "the process which defines the objectives of the project (both the change and the benefit it should deliver), and the means of obtaining the objectives, and then monitors progress towards their successful delivery".

In Ancient Egypt, project management was known unofficially; however, the actual execution and the theory regarding present project management commenced during the Second World War (WW2), when the stability of the equal participation of the male and female personnel changed. The percentage of inexperienced women who participated in human resources elevated from 19.75 to 27% between 1938 and 1945 (Gazeley, 2008). To fix the failure of the talented workforce and to increase effectiveness (LaBrosse, 2007), companies started to use systems to standardise their management practices and to control their projects.

Turner et al. (2010) declare that project management developed from operations research in the 1940s, whereas Kwak and Anbari (2009) argue that it originated in the 1980s from three schools of management: operations research and management science, organisational management theory, and real business practices and their applications. Bredillet (2010) reports an earlier interest in the economic aspects of projects in 1914. Lock (2007) mapped the historical development of project management as shown in Figure 2.5.

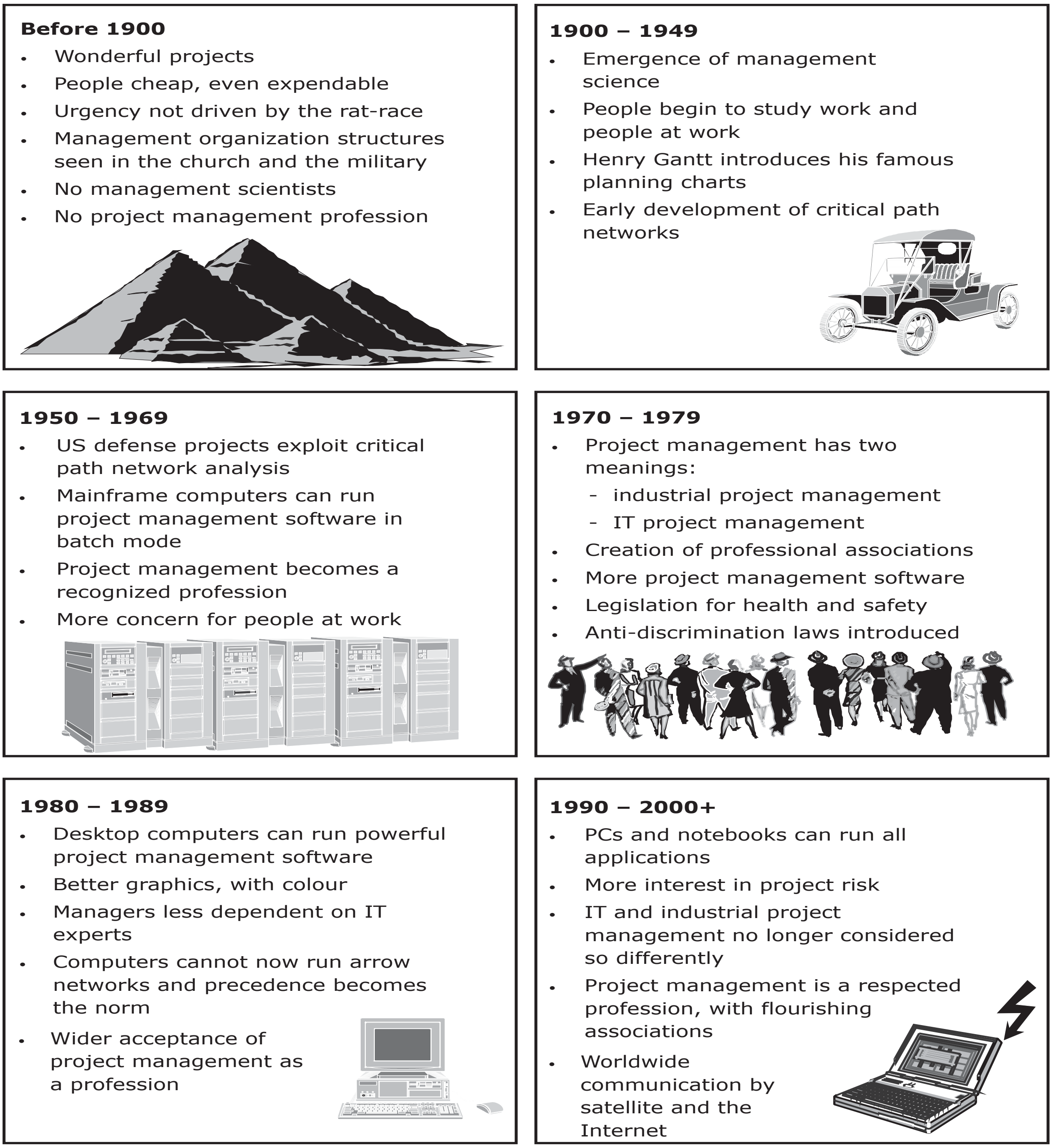

Figure 2. 5: Whistle-stop journey through project management history
(Lock, 2007: 2)

Prior to the mid-1980s, project management was restricted to the projects of defence, construction, engineering, and information technology. In the prevalent time, it has widened its scope and now includes different areas of management development. Currently, projects form more than 20% of global economic activity and more than 30% of the economic activity in some emerging economies (Turner et al., 2013). In this context, project management contributes significantly to value creation worldwide by developing relevant competencies at all levels – individual, team, organisational, and societal levels (Gareis and Huemann, 2007). Consequently, during the last three decades, project management and its educational programs have grown quickly to support the need for competence (Umpleby and Anbari, 2004; Atkinson, 2006).

In the 1950s, knowledge development of project management had a client-based approach. This implies that the information was processed in accordance with the client's requirements. Early important contributions have been made to the new project management by the military of the United States. This includes developing the concepts of Program Evaluation and Review Technique (PERT); cost and schedule Control Systems Criteria (C/SCSC) which transformed into Earned Value Management (EVM); and Work Breakdown Structure (WBS) (Morris, 1997). Also, construction corporations had noteworthy early contributions such as the Critical Path Method (CPM) - by DuPont - invented from the Operations Research field. In the 1960s and 1970s, project management has undergone a paradigm shift by the development of the computer industry (Brooks, 1995).

In the mid-1980s, the knowledge development of project management was led by professional associations such as the International Project Management Association (IPMA), the UK Association for Project Management (APM), the Project Management Institute (PMI), and the Australian Institute of Project Management (AIPM). These associations developed their bodies of knowledge and certification programs. Their focus was very user oriented and did not always adhere to recognized academic standards (Turner et al., 2013). Currently, project management has developed into a mature academic discipline, underpinned by theories of different schools of thought (Anbari, 1985; Söderlund, 2002; Kolltveit et al., 2007; Turner et al., 2010; Biedenbach and Müller, 2011).

2.2.3 Schools of thoughts in project management

According to Turner et al. (2013), the literature discusses nine main schools: Optimisation, Modelling, Governance, Behaviour, Success, Decision, Process, Contingency, and Marketing. These schools are defined as "a group of researchers investigating and developing common methods, tools and techniques (for practitioners to use), often with one or more lead researchers providing the vision in that area" (Turner et al., 2013: 8).

2.2.3.1 Optimisation school

According to Morris (1997), the modernised project management originated from Operations Research, amidst the 1940s and 1950s. Gass and Assad (2005) stated that, amidst and after world war II, the development of the optimisation theory witnessed an elevation, especially in the US and UK. For instance, network scheduling techniques in optimisation tools and practices, such as the Program Evaluation and Review Technique (PERT) and Critical Path Methods (CPM), reflect the origin of project management at present in the science of management. Bar (Gantt) charts were developed for production scheduling in the early 1900s by Henry Gantt, and network scheduling methods were expanded amidst the 1950s (Archibald and Villoria, 1967). Following developments included the Theory of Constraints, levelling heuristics and resource allocation, the Critical Chain, resource-constrained scheduling, the Monte Carlo Simulation of project networks and cost estimates, the Graphical Evaluation and Review Technique (GERT), and project crashing (Anbari, 1985; Söderlund, 2002; Kolltveit et al., 2007; Turner et al., 2010 and 2013; Biedenbach and Müller, 2011). The main principle of the optimisation school is based on defining project objectives, breaking it into smaller parts or tasks, ensuring careful planning, scheduling, and estimating, and striving to execute project tasks in a cost and time-efficient manner to attain optimum outcomes successfully (Söderlund, 2002; Turner et al., 2013). The present school was inclined towards a Taylorian approach during its initial establishment, whereby activities are achieved through mechanised means. Once the projects were defined and analysed, they perform in foreseeable ways (Turner et al., 2013). Optimisation thinking deals with projects as complex missions which require the employment of appropriate methods, strategies, and techniques to execute tasks and achieve pre-determined objectives (Söderlund, 2002).

2.2.3.2 Modelling school

The development of project management continued in a way to improve decision making in projects and other management disciplines such as operations and supply chain management. Thus, there was a need to include more behavioural and organisational factors. This led to the adoption of soft systems modelling to cover the limitations of most optimisation algorithms in reflecting the important social part in projects (Turner et al., 2013). Project management thinking has developed from optimising one or two objectives (e.g. cost and time) to focus on the interactions amongst the components of project management and modelling its total systems (Williams, 2002). Thus, the hard systems approach of the optimisation school has developed into the soft systems approach of the modelling school, in which a complex problem is divided into smaller parts, each part is solved alone, and then all of the parts are integrated in order to solve the whole problem (Turner et al., 2013). The modelling school aims to solve problems of planning and management as well as public policies that often have contradictory, uncertain, or unclear multi-objectives. This is by addressing organisational, political, behavioural, and other matters affecting projects and their environments (Checkland, 1972; Yeo, 1993; Neal, 1995; Gass and Assad, 2005). Turner et al. (2013: 3-4) summarises that the modelling school is about sense-making, understanding, and acting. It is "a mirror to reflect the project and shape our understanding of it … as well as formulating and adopting of lessons learned from previous and ongoing projects to enhance the total project management system and the approaches used for modelling it".

2.2.3.3 Governance school

The governance school experienced two main movements. The first one examined the relationship between project management and contract management, and the second one observed the methods of governance on projects and in project-oriented organisations. The sub-school of contract considers one of two perspectives; it either looks at the project as a 'legal entity' in its own right and portrays how to manage relationships between parties and that entity (Turner, 2004), or it considers the project as an interface amidst two 'legal entities', the contractor and the client, and explains how to manage that interface (Barnes, 1983). The second sub-school began by considering the project as a 'temporary organisation'. Then, it moved on by investigating the methods of governance in both project-oriented organisations - that hosts the project - and the project 'itself' as a temporary organisation (Lundin and Söderholm, 1995; Turner and Keegan, 2001; Turner and Müller, 2003).

2.2.3.4 Behaviour school

The behaviour school is closely related to the governance school and aims to achieve successful change. It considers the project – as a temporary organisation - a social system which includes team building, organizational behaviour, human resource management, communication, and leadership. The first initiatives of the behaviour school originated in the 1970s. Examples include the works of Galbraith (1973) on designing complex organisations, Wilemon (1973) on conflict management in temporary organisational systems, Thamhain and Wilemon (1975) on managing conflict in project life cycle, and Youker (1977) on 'projectised' organisation and organisational alternatives for project management. In the 1980s and 1990s, related works such as Fangel (1987), Graham (1989), Briner et al. (1996), Pinto (1996), Pinto and Trailer (1998) became more interested in studying project start-up, planning, leadership skills, project management skills, team formation, politics and power in projects, and maintenance. More recently, researchers such as Massey et al. (2003), Thamhain (2004), and DeLisle (2004) have focused on project teams and virtual project teams, and Eckes (2002) has focused on 'team dynamics' in Six Sigma projects. Anbari et al. (2004) studied the cross-cultural issues in projects, Müller and Turner (2005) studied communication between the project sponsor and the project manager from the perspective of agency theory, and Müller and Turner (2007b) showed different profiles of leadership in projects. Turner et al. (2007) and Huemann et al. (2007) shifted from the strictly organisational behaviour view to the human resource management (HRM) view. They found that project-oriented organisations should adopt project-specific HRM practices different from the traditional practices of the HRM theory.

2.2.3.5 Success school

Over the past 40 years, there has been a shift in the literature regarding project success, and considerable works have been conducted on the success school (Söderlund, 2002; Jugdev and Mu¨ller, 2005; Turner et al., 2013). The success school focuses mainly on project success and failure based on two major components: project success factors and project success criteria. Project success factors are defined as "the elements of a project that can be influenced to increase the likelihood of success; the independent variables that make success more likely", whereas project success criteria defined as "the dependent variables which measure project success; these are the objectives we wish to achieve from the project" (Turner et al., 2013: 17). The traditional criteria that were used to measure project success were cost, time, and specifications, otherwise known as quality or scope (Larson and Gobeli, 1989; Joslin and Müller, 2015), and the "iron triangle" (Atkinson, 1999), or triple constraints (Dalcher, 2014). However, the development of the literature illustrates other success criteria besides the iron triangle that should be considered for measuring the success of project outcomes, such as achieving stakeholder satisfaction, meeting business objectives and strategic goals, creating new markets and technology, and creating social and environmental impacts. These criteria give more focus on multiple stakeholder judgments (e.g. project managers, project teams, owners, clients, users, sponsors, and senior management), and emphasise the evaluation of project outcome success over time (Pinto and Slevin, 1987; Atkinson, 1999; Turner et al., 2009; Shenhar, 2011; Turner and Zolin, 2012; Müller and Jugdev, 2012; Dalcher, 2014; Davis, 2017). There are many theories, models, and methods related to this school. Examples include the systematic approach of Pinto and Slevin (1988), the criteria of Wateridge (1998), the macro and micro viewpoints of Lim and Mohamed (1999), the square route framework of Atkinson (1999), the logical framework method (LFM) of Baccarini (1999), the multidimensional framework of Shenhar et al. (1997 and 2001), the two distinct views of Collins and Baccarini (2004), the retrospective method of Nelson (2008), the success criteria of Müller and Turner (2007a), the model of Thomas and Fernandez (2008), the strategic approach of Shenhar (2011), and the four-level model of Dalcher (2014). Also, the widely used 'balanced scorecard' and 'key performance indicators'(KPIs) are important tools for project success (Cooke-Davies, 2002; Jugdev and Müller, 2005; Barclay and Osei-Bryson, 2010; Toor and Ogunlana, 2010; Albert et al., 2017).

2.2.3.6 Decision school

The decision school concentrates on the factors related to project initiation and completion (e.g. project approval, funding, closure, and termination), which lead to project success or failure. This school addresses the reasons behind investing in a project (e.g. economic, political, or cultural reasons). It includes the methodology of soft systems in project management and looks at vagueness in decision-making in the pre-project stage (Söderlund, 2002; Turner et al., 2013). The literature on this school addresses two major points. The first point focuses on decision-making in the initial stages of the project, specifically addressing how perfect decisions are made and the impact of such decisions on the project. Many relevant contributions have focussed on project failures and major project disasters and the reasons behind them. Further, relevant contributions have aimed to portray how such project calamities can be overcome (Morris, 1997; Söderlund, 2002). The second point focuses on the information processing of projects. This is linked to the process school and the success school, in which a project is seen as a tool for processing information to reduce process uncertainty and make successful decisions (Söderlund, 2002; Winch, 2004).

2.2.3.7 Process school

This school considers the project as a process. The idea is to define an organised process from the initial stages until the achievement of the final objectives. This school gained popularity in Europe in the late 1980s. Most project management standards adopt this thinking approach and describe the project as a structured process (Turner et al., 2013). According to Turner (2009), project management is concerned with changing assumptions into practical applications, whereby you have a perception of goals which you aspire to achieve. Similarly, project management is a procedure rather an instructive method that helps in reaching the final goal. Thus, with regards to this procedure, Winch (2004) states that we convert dreams into reality. According to Shenhar and Dvir (2004) and Crawford et al. (2005), in this school, the project is an algorithm that assists you in tackling the problem to reach the desired situation. A key area of research is project categorisation that suggests different methods, which relate to several aspects of the project.

2.2.3.8 Contingency school

The contingency theory was proposed by the Austrian psychologist Fred Edward Fiedler in his landmark 1964 article, "A Contingency Model of Leadership Effectiveness" (Fiedler, 1964). It is an organisational theory that claims that there is no best way to organise a company, to lead a corporation, or to make decisions. Instead, the optimal course of action is dependent (contingent) upon the internal and external situations. In project management, the contingency school is concerned with addressing the differences between various projects types and project organisations. It considers the most suitable methodologies for different project settings and adjusts project management processes according to the requirements of the project. It emphasises that every project is different; therefore, the leadership style, management approach, and regulations are required to be adjusted in accordance with the necessities of each project (Turner et al., 2013). Early contributions to this school focus on project typology (Turner and Cochrane, 1993; Shenhar and Dvir, 1996). More recently, the focus has been on project categorisation systems and on the different leadership styles, skills, and competencies required to manage various types of projects and ensure that capabilities are aligned with strategy (Crawford et al., 2006; Müller and Turner, 2007b). Turner et al. (2013: 20) concludes, “this approach asserts that an organisation’s ability to manage complex new projects is related to its ability to remember factors associated with past successes. It considers limitations on this ability due to classifications systems that have evolved over time, rather than being actively designed through a logical, organised categorisation process".

2.2.3.9 Marketing school

The marketing school focuses on how organisations market and sell projects to their customers and on selling project management services to senior managers. This school is mainly devoted to identifying the needs of stakeholders and investigating the ways of managing early stages; the school is also concerned with the interactions between contractors and clients, the internal marketing of the project to the organisation, and the formation of project organisations (Söderlund, 2002; Turner et al., 2013). Silvius (2017: 1481) concludes that the marketing school "can be considered a reaction to the observed disconnect between the growing importance of projects and project management in organisations, and the view that project management is an operational/tactical matter that is not of much relevance or value to the organisation's strategy or performance". Table 2.3 summarises the key idea of each school.

Table 2. 3: The nine schools of project management and their key ideas (Turner et al., 2013: 10)

School of Project Management	Key idea	Sub-schools	Came to prominence	Key variable or unit of analysis
Optimization School	Optimize project duration by mathematical processes		Late 1940s	Time
Modelling School	Use of hard and soft-systems theory to model the project	Hard systems	1950s	Time, cost, performance, quality, risk, etc.
		Soft Systems	Mid 1990s	
Governance School	Govern the project and the relationship between project participants	Contracts	1970s	The project, its participants and governance mechanisms
		Temporary organization	Mid 1990s	
		Project-based organization	Late 1990s	
Behaviour School	Manage the relationships between people on the project	OB	Mid 1970s	People and teams working on projects
		HRM	Early 2000s	
Success School	Define success and failure Identify causes		Mid 1980s	Success criteria and success factors
Decision School	Information processing through the project life cycle	Project selection	Late 1980s	Information on which decisions are made
		Information processing	Late 1980s	
Process School	Find an appropriate path to the desired outcome		Late 1980s	The project, its processes and sub-processes
Contingency School	Categorize the project type to select appropriate systems		Early 1990s	Factors that differentiate projects
Marketing School	Communicate with all stakeholders to obtain their support	Stakeholders	Mid 1990s	Stakeholders and their commitment to the project and project management
		Internal marketing	Mid 1990s	
		Value of project management	Mid 2000s	

However, the door is still open for the extension and addition of new schools (Silvius, 2017), as project management is "a relatively young field of study as an academic discipline" and “increasingly drawing on and making contributions to research in other fields of management” (Turner et al., 2013: 5 and 6). Pasian and Silvius (2016) found that new project management schools are emerging, the most notable of which being sustainability. Silvius (2017) suggests that sustainability should be considered a new school of thought for project management. He declares that the recognition of schools is built on three criteria: content, community, and impact. The content criterion is “having a shared perspective or vision and having common methods and/or tools”, the community criterion is “a significant publication base, a number of leading authors and presence on events”, and the impact criterion is “integration into practice and integration into standards” (Silvius, 2017: 1491). He concludes that based on all three recognition criteria, sustainability is qualified to be considered as a new school in project management.

2.2.4 Sustainability

The low degree of commitment towards social and environmental responsibility means that the current business processes of companies are not managed sustainably (Carvalho and Rabechini, 2017). Meadows et al. (2004) declare that the planet’s natural resources will be exhausted and that the negative impacts on society will increase if growth in economies and population continue at the same speed. The United Nations recognises that sustainability is one of the most significant challenges of our time (Glenn and Gordon, 1997; Glenn et al., 2009). Sustainability is derived from the concept of sustainable development; the World Commission on Environment and Development report defines sustainable development as “a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs” (Brundtland, 1987: 17). The report concludes that it is the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”; it aims to promote harmony between humanity and nature and among human beings, as well as satisfy the requirements of the economy, society, and the environment (Brundtland, 1987: 41).

Subsequently, a broader and more acceptable concept of sustainability has emerged based on integrating the triple bottom line (TBL) theory of environmental, economic, and social dimensions (Elkington, 1998). Instead of totally focusing on economic interest, the concept of sustainability considers the TBL as the basis for achieving short- and long-term success by creating a rational use of resources, with respect to human needs and without harming future generations (Elkington, 1998, Knoepfel, 2001; Kleindorfer et al., 2005; Baumgartner and Ebner, 2010; Gimenez et al., 2012; Thomas and Lamm, 2012; Silvius and Schipper, 2014). The main idea behind the TBL theory is that none of these dimensions can be developed without considering and affecting the other two dimensions (Elkington, 1998 and 2013; Savitz, 2013). According to Silvius and Schipper (2014: 69), sustainability is "about balancing or harmonising social, environmental and economic interests" (Figure 2.6). Aarseth et al. (2017) declare, there are more than 100 definitions of the concept of sustainability, and it is widely agreed through them that the broader TBL of sustainability needs to be considered and simultaneously balanced.

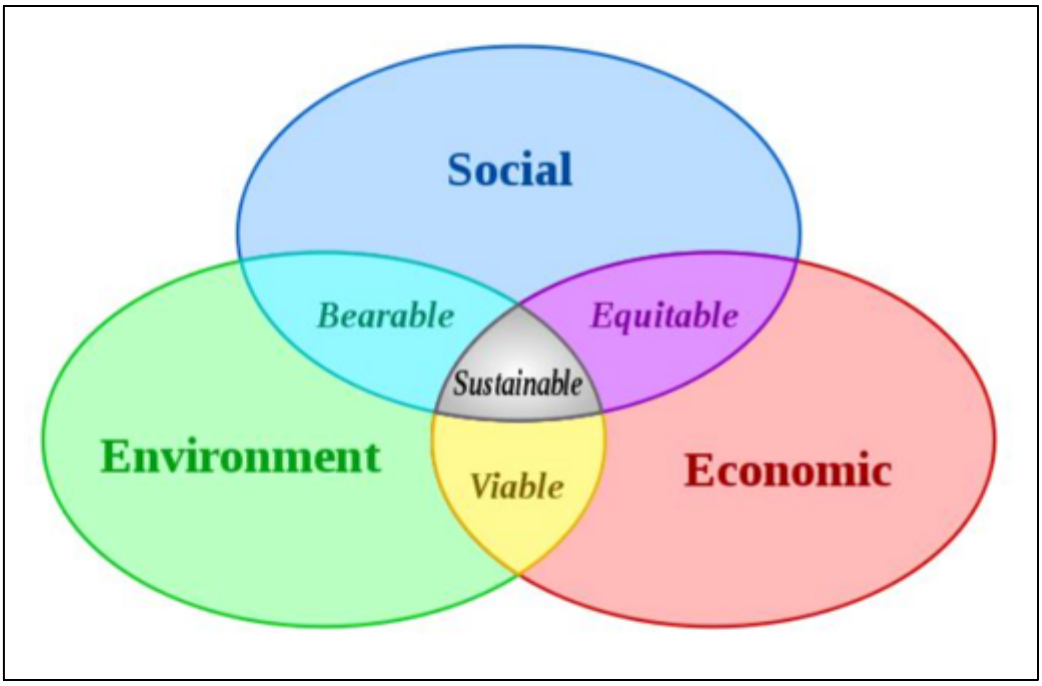

Figure 2. 6: The triple bottom line (TBL) of sustainability
(Silvius et al., 2013: 3)

The Collins dictionary defines the word sustainability as "the ability to be maintained at a steady level without exhausting natural resources or causing severe ecological damage" (Collins, 2019). Penzenstadler and Fleischmann (2011: 1) states that sustainability is "the capacity to endure and, for humans, the potential for long-term maintenance". Likewise, Calero and Piattini (2015: 6) affirm that sustainability refers to the capacity of something to last for a long time. In terms of business, Deloitte and Touche organisation defines sustainability as "adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future" (Labuschagne et al., 2005: 373). The Dow Jones Sustainability Indexes define it as "a business approach that creates long-term shareholder value by embracing opportunities and managing risks derived from economic, environmental and social developments" (Silvius et al., 2017: 1135). Baumgartner and Ebner (2010: 77) declare that "sustainable development when incorporated by the organisation is called corporate sustainability (CS)" and that "it contains all three pillars: economic, ecological and social". Martens and Carvalho (2016a: 24) conclude that sustainability is "a broader concept of sustainable development" and that it is "based on the integration of three dimensions (economic, environmental, and social)". The economic dimension focuses on financial aspects and business value; it is concerned with maintaining assets and protecting the capital of the shareholders, maximising profit and generating wealth, reducing costs, and generating capital growth and liquidity by consuming added value - interest - rather than capital. The environmental dimension focuses on preserving the environment and on the management, usage, and protection of natural resources (e.g. air, land, water, raw materials, and minerals); it is concerned with ensuring energy efficiency, reducing climate change, balancing local ecosystems, and reducing waste, environmental accidents, emissions, pollution, and hazardous, toxic, and harmful materials. The social dimension focuses on the relationships between individuals and groups and preserving social capital and its solidarity; it is concerned with balancing conflicting interests, structuring mutual trust and communication inside and outside a social system, encouraging diversity, providing equal opportunities and responsible governance structure, providing democratic processes, and ensuring the quality of life (Elkington, 1998; Penzenstadler and Femmer, 2013a; Savitz, 2013; Becker et al., 2016; Martens and Carvalho, 2017; Marnewick, 2017).

On the other hand, some other contributions such as AlWaer et al. (2008), Naumann et al. (2011), Pade-Khene et al. (2011), Penzenstadler and Femmer (2013a), Eskerod and Huemann (2013), and Malik and Khan (2018) have added more dimensions to the TBL (e.g. technical, individual/human, cultural, values, and political). According to Acar (2017: 22), "it is possible to include human and technical sustainability on the others in order to have only three main dimensions, as cited in the UN". Condori-Fernandez and Lago (2018: 29) argue that "the social dimension and the individual dimension share the same social nature"; therefore, the individual dimension can be included in the social dimension. Similarly, the other proposed dimensions are considered to be already included in the TBL. Therefore, Silvius et al. (2017: 1135) declare, "consensus seems to be lacking on the fourth pillar". Also, Silvius and Schipper (2014) conclude that 86% of studies used TBL as a dominant theory in defining the concept of sustainability. In addition, most of the "related works" in section 2.1, particularly the empirical studies, have used the TBL as a theoretical base for project sustainability. Therefore, this study focuses only on the TBL theory, as it is widely accepted (Keating, 1994) and as it "captures the essence of sustainability" (Savitz, 2013: 5).

2.2.5 Project success

The traditional criteria that were used to measure project success were cost, time, and specifications, otherwise called quality or scope (Larson and Gobeli, 1989; Joslin and Müller, 2015). These criteria are known as the "iron triangle" (Atkinson, 1999) or triple constraints (Dalcher, 2014). Many writers such as Morris and Hough (1987), De Wit (1988), Pinto and Slevin (1988), Saarinen (1990), Ballantine et al. (1996), Wateridge (1998), and Turner (2014) agree that these criteria should be used in measuring project success, but not exclusively. When considered alone, these criteria are subject to extensive criticism (De Bakker et al., 2010) because they only measure the success of how a project was managed (project management success, so-called project efficiency) without considering the project outcomes (Atkinson, 1999; Cooke-Davies, 2002).

However, the development of the literature illustrates other success criteria that should be considered for measuring the success of project outcomes - effectiveness - besides the iron triangle. These criteria include achieving stakeholder satisfaction, meeting business objectives and strategic goals, creating new markets and technology, and creating social and environmental impacts. These criteria give more focus on multiple stakeholder judgments (e.g. project managers, project teams, owners, clients, users, sponsors, senior management), and place emphasis on the evaluation of project outcome success over time (Pinto and Slevin, 1987; Atkinson, 1999; Turner et al., 2009; Shenhar, 2011; Turner and Zolin, 2012; Müller and Jugdev, 2012; Dalcher, 2014; Davis, 2017).

As a result, project success is judged by its efficiency and effectiveness (Belout, 1998). Efficiency "focuses on optimisation of the available resources by doing things right, while effectiveness revolves around the fulfilment of objectives and the contribution to achieving organisational goals by doing the right things" (Dalcher, 2014: 14). Therefore, measuring project success should encompass project outcome success as well as project management success. Project outcome success refers to the strategic success of deliverables, which means meeting initial project objectives and other benefits gained for all stakeholders over time. Project management success is mainly related to the success of project processes (De Wit, 1988; Pinto and Slevin, 1988; Atkinson, 1999; Baccarini, 1999; Shenhar, 2011; Müller and Jugdev, 2012; Turner, 2014; Davis, 2017) and is defined as "the application of a collection of tools and techniques to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost and quality constraints" (Atkinson, 1999: 337).

There are many theories, models, and methods for evaluating project success, such as the systematic approach of Pinto and Slevin (1988), the criteria of Wateridge (1998), the macro and micro viewpoints of Lim and Mohamed (1999), the square route framework of Atkinson (1999), the logical framework method (LFM) of Baccarini (1999), the multidimensional framework of Shenhar et al. (1997 and 2001), the two distinct views of Collins and Baccarini (2004), the retrospective method of Nelson (2008), the success criteria of Müller and Turner (2007a), the model of Thomas and Fernandez (2008), the strategic approach of Shenhar (2011), and the four-level model of Dalcher (2014). Also, the widely used 'balanced scorecard' and 'key performance indicators'(KPIs) are important tools for project success (Cooke-Davies, 2002; Jugdev and Müller, 2005; Barclay and Osei-Bryson, 2010; Toor and Ogunlana, 2010; Albert et al., 2017). However, according to Davis (2014) and Silvius and Schipper (2016), among the most cited works for measuring project success are Pinto and Slevin (1988), Shenhar et al. (1997 and 2001), Shenhar and Dvir (2007), and Shenhar (2011).

2.3 The relationship between sustainability and projects

Since the 1970s, there has been a continuous drive to incorporate sustainability effectively in all fields (Meadows et al., 1972; Brundtland, 1987; Gladwin et al., 1995; Abidin and Pasquire, 2007; Meadows and Randers, 2012; Marcelino-Sádaba et al., 2015; Glenn and Florescu, 2015). According to Martens and Carvalho (2014: 3), under the TBL theory of sustainability, organisations should develop ways to reduce their negative environmental and social impacts to achieve a standard of excellence and enhance their economic value. The authors add, "in the modern era, it is impossible to think of economic development without the parallel construct of protecting the environment and the mutual benefits to society". Tharp (2012: 2) states that focusing on “sustainability results in improved corporate reputation, higher brand equity, better risk management, and increased access to capital, and is vital to attracting and retaining top talent”. Therefore, many organisations are now keen to incorporate sustainability into their daily activities (Thomas and Lamm, 2012; Van den Brink et al., 2012; Marcelino-Sádaba et al., 2015) and associate it with their strategic objectives (Tharp, 2012). The global survey of IBM 2008 indicates that “47 % of organisations have begun to redesign their business models on the basis of sustainability, treating sustainable development as a new source of innovation, a new opportunity for cutting costs and a new mechanism for gaining competitive advantage” (Calero and Piattini, 2015: 5). The majority of CEOs (93%) declare that change towards sustainability is critical to the future success of their organisations (Tharp, 2012). Therefore, organisations should consider the TBL wherever they operate and wherever their customers and suppliers operate (Tharp, 2012) in order to tackle one of the highest modern challenges (Alwi et al., 2014). Labuschagne et al. (2005) conclude that organisations should broaden their vision regarding the society and environment and incorporate sustainability into their activities. This could be achieved by considering incorporating sustainability during the preparation and review of their business strategies, supporting new agreements and negotiations that encourage sustainable practices, and developing new projects driven by sustainability principles.

However, moving towards sustainability requires radical changes in the economic, environmental, and social dimensions of organisations (Elkington, 1998). Among the most important company activities that significantly help in achieving these changes is the development of new projects driven by sustainability principles (Labuschagne et al., 2005). Projects help organisations achieve long-term objectives, and since they make up about a third of the world's gross domestic product, the potential impact from incorporating sustainability into projects - project sustainability - is beyond imagination. This incorporation is considered essential for a more sustainable future (Tharp, 2012; Weninger and Huemann, 2015; Økland, 2015; Huemann and Silvius, 2017). The link between sustainability and projects was mentioned in the World Commission on Environment and Development report (Brundtland, 1987). The opening keynote of the World Congress of the International Project Management Association (IPMA) in 2008 asked the project management profession to “take responsibility for sustainability” (Silvius and Schipper, 2014: 64). Marcelino-Sádaba et al. (2015: 4) declare that projects are “the ideal instrument for change management”; they “can improve ties between the business strategy and sustainability initiatives", and the required change towards sustainability can be better achieved by incorporating sustainability into projects. Similarly, many authors declare that there is an urgent need for project sustainability, as projects involve a large number of resources that interact daily with the surrounding environment and are therefore considered an important tool for achieving sustainability for organisations and the global society (Gareis et al., 2013; Martens and Carvalho, 2014, 2016b; Silvius, 2017). It is, therefore, reasonable to argue that sustainability and projects are interlinked (Gareis et al., 2009; Silvius, 2012; Aarseth et al., 2017).

It can be concluded that the link between sustainability and projects has been built on 'achieving the required change'. In essence, sustainability is concerned with generating beneficial change (Brundtland, 1987), and projects are the ideal tools that can significantly help in achieving this change (Marcelino-Sádaba et al., 2015; Silvius, 2017).

2.3.1 Incorporating sustainability into projects (project sustainability)

Over the last few years, the family standards of the International Organisation for Standardisation (ISO) 14000 have been used as a key tool for incorporating sustainability into projects (Marcelino-Sádaba et al., 2015; Carvalho and Rabechini, 2017). According to Marcelino-Sádaba et al. (2015), ISO/TR 14062:2002 environmental management and the principles of life cycle assessment (LCA) ISO 14040:2006 are the most quoted and used standards for Integrating environmental aspects into product design and development. LCA is a widely used technique for assessing the environmental impacts of a product during its entire lifecycle (Schmidt and Taylor, 2006; Finkbeiner et al., 2006; Kurczewski and Lewandowska, 2010; Thomson et al., 2011; Blengini et al., 2012; Tchetchian et al., 2013; Carvalho and Rabechini, 2017). These standards aim to support organisations in adopting technical solutions to minimise negative environmental impacts during the product's life cycle (e.g. optimising product energy consumption, managing resources, optimising design for recyclability, and using environmentally friendly materials and operations during product production and the disposal) (Miles and Russell, 1997; Darnall et al., 2001; Sverdrup and Svensson, 2004; Rivoire et al., 2007; Gordo et al., 2009; Hilty and Lohmann, 2011). Similarly, the terms design for environment (DFE) and eco-design have been used interchangeably to incorporate environmental aspects into project products (Marcelino-Sádaba et al., 2015; Carvalho and Rabechini, 2017). They 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, striving for products, which make the lowest possible environmental impact throughout the product's life cycle". These terms encompass waste minimization, source reduction, health and safety, eco-efficiency, recycling, and remanufacturing (Glavič and Lukman, 2007: 1880). Eco-design at first began by concentrating on tangible products (Bhamra and Evans, 1999) and then moved likewise to services-oriented life cycle design to provide environmentally-sound services (Bonvoisina et al., 2014).

According to McKenzie (2009), Willis et al. (2009), and Valdes-Vasquez and Klotz (2013), a truly sustainable project takes into account the social impacts it has on the community (e.g. the end-users and people involved) and considers cultural, well-being, health, safety, and educational impacts. Considering all of these aspects improves project performance and people's quality of life. There are different studies and frameworks in the literature which focus on the social aspects of project sustainability. Heller and Keoleian (2003) utilise LCA to assess the sustainability of the US food system by associating several social indicators with different phases of the system. Examples include associating farmers' age with the planting and production phases and comparing the amount of food wasted to the amount of food donated to food gatherers to assess social sustainability throughout the end of life stage. Likewise, Manik et al. (2013) add social aspects such as working conditions, cultural heritage, and human rights to the LCA to assess the impact of the biofuel industry on social sustainability. Edum-Fotwe and Price (2009) identify factors in different levels (e.g. material, building, and urban) to assess the social impact of construction projects. Also, Schieg (2009) underline the external and internal dimensions of social responsibility for implementing corporate social responsibility (CSR) activities successfully in project management.

The benefits of sustainability are not just limited to social and environmental aspects; the economic value of organisations may also be enhanced (Fiksel et al., 1999). On the other hand, there are some claims that green products are more costly (Cazier and Hopkins, 2011). According to Finkbeiner et al. (2006), incorporating environmental aspects in product development is considered effective only if it leads to an enhanced product. Brones et al. (2014) proclaim that filling the existing gap between project management and eco-design could enhance the effectiveness of product development. In this context, it is argued that economic aspects are undoubtedly one of the most important aspects of an enhanced product. Pujari (2006) and Plouffe et al. (2011) declare that the high cost of environmental innovations is still a challenge. However, there is a possibility of cost reduction (Borchardt et al., 2011). Kengpol and Boonkanit (2011) propose a framework to support decision-making in the design phase for more eco-effective products in terms of cost and time. Pearce (2008) identifies techniques for cost-effective product sustainability: integrated design and right-sizing, effective problem framing/solving the right problem, leveraging of free resources, dematerialization (possibility of outsourcing), and holistic cost management. Westkämper (2002, and 2003) asserts that communication (e.g. with manufacturers) is essential for maximising the profit of any product, as it can reduce assembly, integration, repairing, updating, and dismantling costs. Also, the life cycle costing (LCC) approach for measuring the product's total cost during its entire lifecycle has been used in several studies - such as Gluch and Baumann (2004), Schmidt and Taylor (2006), Ness et al. (2007), Lewandowska and Kurczewski (2010), Kurczewski and Lewandowska (2010), and Akadiri et al. (2013) - to support decision making with regards to environmental and economic costs for a more sustainable product. It is worth mentioning that LCC is not limited to product cost, as it is an economic approach to evaluate the total costs of a product and/or process during its entire lifecycle (Gluch and Baumann, 2004). Maltzman and Shirley (2010: 48) declare that in projects, "there will be costs associated with monitoring and controlling the aspects of environmental and sustainability objectives. Data collection and analysis to help evaluate both the product of the project and the project management process are included as some of those costs".

However, Knight and Jenkins (2009), Bovea and Pérez-Belis (2012), and Hallstedt et al. (2013) argue that considering only one or two dimensions of sustainability does not actually reflect product sustainability because the TBL theory is not applied. Hallstedt et al. (2013) contribute by identifying key strategic aspects for product sustainability focusing on the TBL. They focus on providing senior management support, ensuring the effective inclusion of sustainability in the initial stages of product innovation, utilising the experience and knowledge of procurement staff, incorporating social aspects during the product life cycle, allocating responsibility for implementing sustainability in the product innovation process, and supporting decision-making for future projects of product development by sharing knowledge, building capability, and utilising assessment and decision guiding tools. Likewise, Shen et al. (2010), Yao et al. (2011), and Yuan (2017) argue that a sustainable project must include economic and social considerations beside environmental protection, as they can have a great impact on the community and can improve the performance of projects in the short- and long-terms. Shen et al. (2010) incorporate sustainability in a project feasibility study. Based on 87 feasibility study reports, they propose 35 attributes for economic, environmental, and social project performance. Similarly, by referring to some relevant feasibility studies, Yao et al. (2011) propose 24 key indicators to measure the performance of highway projects sustainability. On the other hand, Yuan (2017) identifies 27 relevant factors to investigate stakeholders' major concerns regarding railway project sustainability. Also, Tsai and Chang (2012) present a checklist of essential elements that should be considered during the design phase for sustainable highway projects. Additionally, some studies focus on project sustainability in terms of design and specifications (Eid, 2009; Aarseth et al. 2017), achieving benefits (Silvius et al. 2012), product materials (Akadiri et al. 2013), business case and investment analysis (Weninger and Huemann 2015), and product quality and project success (Martens and Carvalho 2016b).

Incorporating sustainability in projects is a complex process, as decisions should be taken carefully and from a multi-criteria perspective, based on the TBL, and taking into consideration multiple stakeholders (Fiksel et al., 1999; Dalkmann et al., 2004; Ugwu et al., 2006; Thabrew et al., 2009; De Brucker et al., 2013; Dobrovolskienė and Tamošiūnienė, 2016; Martens and Carvalho, 2017). Silvius et al. (2012: 96) argue that whilst the TBL theory is clear, "in practice balancing social, environmental and economic interests is a Herculean task". Besides, risk management "should be applied continuously with information made available when critical decisions are being made … to improve performance against objectives by contributing to efficient use of resources, reducing waste, reducing fraud, improving service delivery, lowering the cost of capital, improving innovation and doing things properly" (Silvius et al., 2017: 1139). Decision-makers "have been burdened with a multitude of pressures from interested parties", such as environmental agencies, communities, consumers, and workers. These pressures "must be weighed alongside the need to provide a guarantee of a reasonable return on investment and long-term viability" (Martens and Carvalho, 2017: 1088). According to Hwang and Ng (2013), the capability of project managers in decision-making is the most important managerial skill for overcoming project sustainability challenges such as selecting specific materials, technologies, subcontractors, and equipment. Likewise, Abidin and Pasquire, (2007), Pearce (2008), Aaltonen and Kujala (2010), Mishra et al. (2011), Marcelino-Sádaba et al. (2015), and Aarseth et al. (2017) admit that considering sustainability in decision-making is critical and necessary for delivering sustainable projects successfully. Silvius et al. (2017:1140) conclude, "sustainability should be considered in project management decision-making and that decision-making is a critical skill for (more) sustainable projects". Therefore, "tools and practices to support decision-making are necessary for systematically including sustainability criteria in project evaluation, production, and processes and in project selection" (Martens and Carvalho, 2017: 1087).

There are many available frameworks in organisations, such as the Sustainability Reporting Guidelines (SRG) by the Global Reporting Initiative (GRI), and the Indicators of Sustainable Development by the United Nations Commission on Sustainable Development (UNCSD). They have been developed based on a set of sustainable development indicators (SDIs) to be used as instruments for sustainable business practices (Labuschagne et al., 2005; Singh et al., 2012; Silvius, 2015a; Marcelino-Sádaba et al., 2015). These frameworks include an extensive set of indicators related to the TBL (Silvius et al., 2013; Marcelino-Sádaba et al., 2015) and "allow organisations to evaluate the sustainability aspects of different policies and projects, as well as to monitor progress" (Silvius et al., 2013: 3). To move from theory into practice, companies can select relevant sustainability indicators according to their operations or industry to facilitate decision-making and manage related risks (Silvius et al., 2013; Marcelino-Sádaba et al., 2015).

Several studies have focused on TBL aspects and developed relevant indicators as a key decision-making method for assessing sustainability performance; these studies include Dalkmann et al. (2004), Ugwu et al. (2006), Singh et al. (2007), Kengpol and Boonkanit (2011), Bond et al. (2012), Khalili-Damghani et al. (2013), and Schrettle et al. (2014). This approach has also been used by many authors to operationalise relevant TBL aspects and incorporate sustainability into projects; such studies include Fiksel et al. (1999), Keeble et al. (2003), Azapagic (2004), Khan et al. (2004), Labuschagne et al. (2005), Pulaski and Horman (2005), Shen et al. (2005), Labuschagne and Brent (2006), Mulder and Brent (2006), Díaz Aguado and Nicieza (2008), Xing et al. (2009), Gareis et al. (2009), Edum-Fotwe and Price (2009), Fernández-Sánchez and Rodríguez-López (2010), Yao et al. (2011), Talbot and Venkataraman (2011), Sarkis et al. (2012), Liu et al. (2013), Yuan (2013), Jones et al. (2013), Wang et al. (2013), Zhang et al. (2014), Kumar and Katoch (2014), and Yuan (2017). According to Marcelino-Sádaba et al. (2015: 13), it "seems to be the easiest and most efficient way to run sustainable project management". Martens and Carvalho (2014) conclude that by using this approach, the incorporation of sustainability into projects will be much more feasible and effective. However, many authors declare that the approach of focusing on TBL aspects and developing relevant indicators is still in its infancy with no consensus on any specific tools or measures, as it depends on project context (MacGillivray, 1995; Gasparatos et al., 2009, Bond et al., 2012; Bell and Morse, 2013; Silvius and Schipper, 2015; Tam, 2015; Martens and Carvalho, 2017). Silvius et al. (2017: 1137) conclude, "a universal set of sustainability indicators for projects may therefore be illusive".

2.3.2 The two perspectives of incorporation

The last ten years have witnessed significant interest in project sustainability in the literature (Silvius and Schipper, 2014; Marcelino-Sádaba et al., 2015; Aarseth et al., 2017). There is growing attention in relevant publications to project sustainability, and the literature has built a base to support this paradigm shift in project management. Relevant studies include Labuschagne and Brent (2005, 2008), Klakegg and Haavaldsen (2011), Silvius et al. (2012), Gareis et al. (2009, 2013), Eskerod and Huemann (2013), Brones et al. (2014), Silvius and Schipper (2014; 2015), Brones and Carvalho (2015), Martens and Carvalho (2016a, 2016b, 2017), Huemann and Silvius (2017), Carvalho and Rabechini (2017), and Aarseth et al. (2017).

In general, two perspectives appear in the literature with regards to incorporating sustainability into projects (project sustainability): project process sustainability and project product sustainability. Project process sustainability is about the sustainability of project processes and their interrelated activities (e.g. project management processes and delivery and support processes), whereas project product sustainability is about the sustainability of deliverables over the life cycle of projects (Labuschagne and Brent, 2005 and 2006; Gareis et al., 2013; Silvius and Schipper, 2015; Carvalho and Rabechini, 2017; Kivilä et al., 2017). These perspectives are compatible with defining project sustainability as "the planning, monitoring and controlling of project delivery and support processes, with consideration of the environmental, economic and social aspects of the life-cycle of the project's resources, processes, deliverables and effects, aimed at realising benefits for stakeholders, and performed in a transparent, fair and ethical way that includes proactive stakeholder participation" (Silvius and Schipper,2014: 79). However, the majority of contributions have mainly focused on achieving more sustainable project outcomes (product or service), and less concern has been given to the sustainability of project processes (Gareis et al., 2009, 2013; Marcelino-Sádaba et al., 2015; Silvius, 2017).

In this context, the findings reveal that four empirical studies – out of the five studies mentioned in section 2.1.2 – have concerned both project process sustainability and project product sustainability. The study of Carvalho and Rabechini (2017) proposed a model for incorporating sustainability into the project process and project product. Project process sustainability contains three blocks: green procurement and partnership, sustainability knowledge areas and project management process, and project social responsibility. Project product sustainability comprises two blocks: environmental technology and design for the environment. Similarly, the studies of Martens and Carvalho (2016a and b) proposed a model for incorporating sustainability into project process and project product based on a list of key variables distributed in three blocks: the environmental dimension, economic dimension, and social dimension. However, it seems that the empirical study by Adriana and Ioana-Maria (2013), which was based on company reports, concerns only the sustainability of project process, as there is no clear information about project product sustainability. On the other hand, the study by Khalilzadeh et al. (2016) is based on the principles of sustainability (Silvius and Schipper, 2016) that should be considered when incorporating sustainability into project management, and not on the incorporation itself. However, these principles already focus on both project process sustainability and project product sustainability.

2.3.3 Sustainability 'IN' software projects (software project sustainability)

Most existing contributions regarding project sustainability have come from the manufacturing and construction sectors (Calero and Piattini, 2017; Huemann and Silvius, 2017; Marnewick, 2017). In the software world, relevant contributions are few, and software project sustainability (SPS) requires further research. However, similar to the manufacturing and construction sectors, two perspectives can be recognised in the relevant literature of software project sustainability: software product sustainability and software process sustainability. Software product sustainability concerns the sustainability of software 'itself' as a product (sustainability of project outcomes). Meanwhile, software process sustainability concerns the sustainability of managing software development and its engineering processes; it is the sustainability in project interrelated activities during the development of a software product (Albertao et al., 2010; Penzenstadler, 2013; Naumann et al., 2015; Malik and Khan, 2018). Both of these perspectives will be discussed in the following two sections (2.3.3.1 and 2.3.3.2). Also, as in manufacturing and construction, it can be noticed that the approach of integrating several aspects related to TBL dimensions have been used by several authors to incorporate sustainability into software projects.

In this context, it is important to mention that most relevant contributions related to SPS, such as Cabot et al. (2009), Koziolek (2011), Jansen et al. (2011), Kocak (2013), Calero et al. (2013a), Venters et al. (2014a), and Koçak et al. (2015), have focused on the environmental and/or economic dimension(s) of sustainability and have paid almost no attention to the social dimension. On the other hand, other contributions such as Naumann et al. (2011), Penzenstadler and Femmer (2013a), and Malik and Khan (2018) have added more dimensions to the TBL (e.g. technical and/or individual/human). According to Acar (2017: 22), "it is possible to include human and technical sustainability on the others in order to have only three main dimensions, as cited in the UN". Also, Calero and Piattini (2017: 3) did not consider technical sustainability "because it does not map directly onto any of the resources needed for software construction. Technical issues, such as maintainability or evolvability, will influence the other three dimensions". Condori-Fernandez and Lago (2018: 29) argue that "the social dimension and the individual dimension share the same social nature"; therefore, the individual dimension can be included in the social dimension. Silvius et al. (2017: 1135) declare, "consensus seems to be lacking on the fourth pillar". Also, Silvius and Schipper (2014) conclude that 86% of studies used the TBL as a dominant theory in defining the concept of sustainability. In addition, most "related works" in section 2.1 – particularly empirical studies – use the TBL as a theoretical base for project sustainability. Therefore, this study focuses only on the TBL, as it is widely accepted (Keating, 1994) and as it "captures the essence of sustainability" (Savitz, 2013: 5).

Software projects belong to the information systems and technology (IS&T) sector (Watson et al., 2010; Mahaux et al., 2011; Calero and Piattini, 2015). IS&T has diffused in many areas of our lives, improving businesses and social activities and facilitating life with many benefits. However, IS&T has also contributed to several economic, environmental, and social problems. Such problems include the consumption of large amounts of resources and energy during the production, usage, and disposal of IS&T components; significant contributions to greenhouse gas emissions due to the high consumption of electricity; the creation of opportunities for unethical practices; and the increase in youth unemployment

(Murugesan, 2008; Calero and Piattini, 2015; Antonova, 2015). IS&T is one of the most important sectors worldwide which play a significant role in the concept of sustainability (Huemann and Silvius, 2017; Marnewick, 2017). Therefore, since software lies “at the heart” of IS&T (Mahaux et al., 2011: 20), it is argued that incorporating sustainability in software projects will play a vital role in achieving more sustainable orientation (Naumann et al., 2011; Penzenstadler and Femmer, 2013a; Malik and Khan, 2018).

Sustainably within IS&T concentrates on the concept of green information technology (Green IT), and it encompasses two different perspectives – ‘Green by IT’ and ‘Green in IT’ (Hedman and Henningsson, 2011; Calero and Piattini, 2015; Marnewick, 2017). Green by IT is about achieving sustainability through IT, mainly by hardware and software. This can be achieved by using IT in process automation and logistics optimisation, telepresence, cloud management, remote collaboration, measuring carbon footprints, reducing waste and greenhouse gas emissions, efficient resources utilisation, aiming to save energy and reduce environmental problems. Meanwhile, Green in IT (Green in hardware and/or Green in software) is about making IT ‘itself’ sustainable; this can be achieved by using clean and renewable energy for powering data centres, using co-location services and outsourcing for data centres, optimising storage capacity, the virtualisation of servers, using power management software in IT infrastructure, dealing with unwanted hardware in a Green way (reusing, refurbishing, recycling, or disposing of unwanted hardware in an environmentally friendly manner), designing environmentally sound IT infrastructure, manufacturing IT components with minimal or zero impact on the environment, and developing more sustainable software in a more sustainable manner (Murugesan, 2008; Bachour and Chasteen, 2010; Faucheux and Nicolaï, 2011; Donnellan et al., 2011; Mohan et al., 2012; Kern et al., 2013; Erdelyi, 2013; Naumann et al., 2015; Unhelkar, 2016; Calero and Piattini, 2017).

To sum up, Green by IT and Green in IT are two completely different concepts. In the first concept, which is out of the scope of this study, the aim of projects is “to reduce the environmental impact of operations using IT”. Meanwhile, in the second concept, the aim of projects is “to reduce the environmental impact of IT” (Bachour and Chasteen, 2010: 1). However, “there is some confusion and misunderstanding with regard to the concepts and terms used” (Calero and Piattini, 2017: 7), and definitions in the literature, in general, “mix these two perspectives” (Calero and Piattini, 2017: 4).

As with Green IT, software project sustainability (SPS) can be divided into 'sustainability BY software project' and 'sustainability IN software project'. Therefore, it should be noted that this study focuses particularly on sustainability "IN" software projects and on its potential impact on project success.

2.3.3.1 Software product sustainability

In the software engineering literature, sustainability is considered a non-functional requirement (Amsel et al., 2011; Calero et al., 2013b; Penzenstadler et al., 2014; Venters et al., 2014a; Alharthi et al., 2016) and has been linked to the quality characteristics of software products (Albertao et al., 2010; Naumann et al., 2015; Condori-Fernandez and Lago, 2018; Malik and Khan, 2018). In this context, there are two requirements that software products should satisfy when they are being developed – functional requirements and non-functional requirements. Based on the IEEE-830 standard of the Institute of Electrical and Electronics Engineers, functional requirements are "the fundamental actions that must take place in the software in accepting and processing the inputs as well as in processing and generating the outputs"; these requirements are related to the "What" of a software product (Calero et al., 2015: 232). On the other hand, non-functional requirements are defined by the IEEE-610 standard as the degree to which software meets the needs or expectations of stakeholders (Venters et al., 2014a). These are "requirements that constrain or set some quality attributes upon functionalities"; they can be understood as the "How" of software products, as they are related to performance efficiency, reliability, maintainability, security, and other quality characteristics (Calero et al., 2015: 232). According to Calero et al. (2013b: 2), "software sustainability is related to non-functional requirements … as it is obvious that sustainability is a way to improve a software product, and then it must be related to the how and not to the what". Therefore, "it will be possible to incorporate sustainability in the development of a software product, in the form of non-functional requirements and ensure that the final products are environmentally friendly" (Calero et al., 2013a: 4). Penzenstadler et al. (2014) and Lago et al. (2015) support this perspective and confirm that sustainability should be explicitly considered as a non-functional quality requirement of software systems. Venters et al. (2014b: 3) conclude, "by defining software sustainability as a non-functional requirement it allows us to move away from the focus of thinking about how we sustain existing software, to understanding how we can develop sustainable software in the future".

Many authors support this perspective for incorporating sustainability in software projects. However, in most cases, the focus is on one or two dimensions of sustainability and not on the three dimensions of the TBL theory. For instance, Koziolek (2011) focuses on the economic dimension of software sustainability. He proposes several quality characteristics, such as maintainability, portability, modifiability, and evolvability, as essential non-functional requirements for long-living software systems. Likewise, Jansen et al. (2011) pay attention to the economic dimension and present a method for assessing the sustainability of long-lived software intensive systems. Their 'TechSuRe' method defines sustainability in terms of risk and how software can stay economically viable over its entire lifecycle. They consider characteristics such as upgrade or backwards compatibility, functional suitability, and interoperability. On the other hand, Cabot et al. (2009: 1) focus on the environmental dimension and define sustainability as "the exploitation of an (eco)system that does not degrade or adversely change the system beyond what is acceptable". They propose a taxonomy framework for integrating sustainability as a non-functional requirement in software systems based on the environmental concerns of stakeholders. Kocak (2013) and Kocak et al. (2015) adopt the characteristics of the ISO/IEC 9126 and ISO/IEC 25010 quality models to integrate environmental sustainability in software products. Their focus was on green performance, and they show that quality characteristics such as reliability, usability, and performance efficiency have significant energy-related impacts on the environmental sustainability of software products. Similarly, Calero et al. (2013a, 2013b, and 2015) believe that prime attention should be given to the environmental dimension of software product sustainability which is – in their opinion – already an economic and social demand. Based on the ISO/IEC 25010 quality model, they propose energy efficiency, resource optimisation, capacity optimisation, and "perdurability" (reusability, modifiability, and adaptability) as important non-functional requirements of software environmental sustainability. The environmental dimension was also the main concern for the sustainability of software systems in Taina (2010 and 2011), Roher and Richardson (2013), García-Mireles and Villa-Martínez (2017), Mireles et al. (2017), and García-Mireles et al. (2018).

Venters et al. (2014a) take a step further by considering the economic and environmental dimensions together. They suggest that the sustainability of software systems is strongly related to cost efficiency, energy efficiency, and resource utilisation. By embedding McCall's software quality model, they propose that software sustainability is "a composite, non-functional requirement … of core quality attributes including extensibility, interoperability, maintainability, portability, reusability and scalability" (Venters et al., 2014a: 5). Also, it can be observed that attention was given mainly to the economic and environmental dimensions in Amsel et al. (2011) and Beghoura et al. (2017), as they consider the energy consumption of software products as the main aspect in their proposed evaluation tools. On the other hand, Johann and Maalej (2013) and Al Hinai and Chitchyan (2014, 2015, and 2016) concentrate on the social dimension of software sustainability. Several quality characteristics can be recognised in their studies as non-functional requirements for software social sustainability, including accessibility, reliability, compatibility, acceptability, usability, resilience, availability, adaptability, privacy, safety, and security. Also, the study of Ahmad et al. (2017) gives prominence to the social dimension by proposing "impactibility", which consists of "social acceptance and user connectedness", as new non-functional characteristics for software sustainability. Duffy (2014) concludes that software sustainability could be achieved through 'usability', particularly in the social dimension.

However, there are some contributions which consider the three dimensions of the TBL and propose several non-functional quality requirements for incorporating sustainability into software products. Albertao et al. (2010) introduce common quality requirements among TBL dimensions with some metrics to assess the sustainability of software projects. In terms of software product sustainability, they classify these requirements into "development-related properties", which include modifiability, reusability, portability, and supportability, and "usage-related properties", which include performance, dependability, usability, and accessibility. Naumann et al. (2011) add energy efficiency and hardware obsolescence to Albertao et al. (2010) in their GREENSOFT model and propose different classifications for software product sustainability. They incorporate modifiability and reusability into software development stages, whereas portability, supportability, performance, dependability, usability, and accessibility are included in the software usage stage of their model. Based on the GREENSOFT model, the Quality Model for Green and Sustainable Software of Kern et al. (2013) classifies and links such requirements to each dimension of sustainability. For example, the model relates adaptability, hardware obsolescence, and energy efficiency to the economic and environmental sustainability of software products and relates requirements such as accessibility and usability to social sustainability. Likewise, in the Generic Model of Penzenstadler and Femmer (2013a) and the framework of Raturi et al. (2014), there are several non-functional requirements of software products that have been linked to the three dimensions of sustainability. Moreover, Saputri and Lee (2016) developed a methodology to determine software sustainability requirements. In their proposed meta model, which encompasses the TBL theory, they include quality characteristics such as usability and performance - which are non-functional requirements - for incorporating sustainability into software products.

Most non-functional requirements of software sustainability are adopted from the characteristics and sub-characteristics of well-known quality models and international standards such as Boehm's quality model, McCall's Quality Model, Pragmatic Quality Factor (PQF), Systemic Quality Model, Dromey's Quality Model, The User Centric Software Certification (UcSoftC) Model, the International Organisation for Standardisation (ISO) 9126 and 25010, and the FURPS model of Functionality, Usability, Reliability, Performance and Supportability (Raturi et al., 2014; Venters et al., 2014b; Calero et al., 2015; Zakaria et al., 2016; Ahmad et al., 2018). However, it should be noted that software product sustainability has not been considered in any of these models or standards. According to Ahmad et al. (2017: 596), researchers "aimed to achieve software sustainability in their own ways based on their theories and practices, activities, opinions and experiences". This has led to misunderstanding, as researchers have adopted different characteristics from different quality models or standards to incorporate sustainability into software products. As a result, the question remains: "what a good classification framework for sustainability requirements might be?" (Raturi et al., 2014: 2). Despite substantive efforts, many authors declare that there is no consensus on a specific set of non-functional requirements, nor a unified definition for proposed quality characteristics (Dick et al., 2010; Penzenstadler and Femmer, 2013a; Al Hinai and Chitchyan, 2014; Venters et al., 2014b; Ahmad et al., 2017; Calero and Piattini, 2017; Oyedeji et al., 2017; Condori-Fernandez and Lago, 2018). For instance, Kern et al. (2013) consider the quality characteristic of "adaptability", whereas Albertao et al. (2010) do not consider it a non-functional requirement for software sustainability. Moreover, Venters et al. (2014a) consider "usability" in terms of efficiency, effectiveness, and satisfaction, while Condori-Fernandez and Lago (2018) consider it in terms of operability, learnability, appropriateness recognisability, and user error protection.

To avoid such conflicts in defining, determining, and classifying the quality requirements of software sustainability, some recent contributions such as Calero et al.

(2015), Zakaria et al. (2016), Ahmad et al. (2018), and Condori-Fernandez and Lago (2018) have adopted the widely used Product Quality Model (PQM) of the ISO/IEC 25010 standard (Table 2.4) as a theoretical base in their works. According to Calero et al. (2015: 233), the ISO/IEC 25010 PQM is "the only valid international standard related to software product quality" which has "a widely accepted set of quality characteristics that has been agreed on by consensus". It provides a standardised set of quality requirements and definitions of software products (García-Mireles, 2016). Moreover, the systematic literature reviews of Ahmad et al. (2014 and 2015) indicate that most proposed requirements for software sustainability are included in the Product Quality Model (PQM) of the ISO/IEC 25010.

Table 2. 4: Software Product Quality Model (PQM) with definitions of its characteristics and sub-characteristics
(ISO/IEC 25010:2011, 2018)

Characteristics	Sub Characteristics
Functional suitability: the degree to which software provides functions that meet 'stated and implied needs' when used under particular conditions.	**Functional completeness**: the degree to which the set of functions covers all the specified tasks and user objectives. **Functional correctness**: the degree to which software provides the correct results with the needed degree of precision. **Functional Appropriateness**: the degree to which the functions facilitate the accomplishment of specified tasks and objectives.
Performance efficiency: the performance with respect to the number of resources used under stated conditions.	**Time Behaviour:** the degree to which the response and processing times and throughput rates of software, when performing its functions, meet requirements. **Resource Utilisation:** the degree to which the amounts and types of resources used by a software, when performing its functions, meet requirements. **Capacity:** the degree to which the maximum limits of a software parameter meet requirements.
Compatibility: the degree to which software performs required functions and/or can exchange information with other components (e.g. software, systems, products) and use exchanged information, while sharing the same hardware or software environments and without detrimental impact on any other products.	**Co-existence:** the degree to which a software can perform its required functions efficiently while sharing a common environment and resources with other products, without a detrimental impact on any other product. **Interoperability**: the degree to which two or more software can exchange information and use the information that has been exchanged.

Usability: the degree to which software can be used by particular users to achieve particular goals effectively, efficiently, satisfactorily, and without risk in a specific context of use.	**Appropriateness recognisability:** the degree to which users can recognise whether the software is appropriate for their needs. **Learnability:** the degree to which a software can be used by specified users to achieve specified goals of learning to use the software with effectiveness, efficiency, freedom from risk, and satisfaction in a specified context of use. **Operability:** the degree to which software has attributes that make it easy to operate and control. **User error protection:** the degree to which software protects users against making errors. **User interface aesthetics:** the degree to which a user interface enables pleasing and satisfying interaction for the user. **Accessibility:** the degree to which a software can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.
Reliability the degree to which software performs particular functions under specific conditions for a certain period of time.	**Maturity:** the degree to which software meets needs for reliability under normal operation. **Availability:** the degree to which software is operational and accessible when required for use. **Fault tolerance:** the degree to which software operates as intended despite the presence of hardware or software faults. **Recoverability:** the degree to which, in the event of an interruption or a failure, a software can recover the data directly affected and re-establish the desired state of the system.
Security the degree to which software protects data and information so that individuals or other systems or products have appropriate data accessibility according to authorisation levels.	**Confidentiality:** the degree to which a software ensures that data are accessible only to those authorised to have access. **Integrity:** the degree to which a software prevents unauthorised access to, or modification of, computer programs or data. **Non-repudiation:** the degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later. **Accountability:** the degree to which the actions of an entity can be traced uniquely to the entity. **Authenticity:** the degree to which the identity of a subject or resource can be proved to be the one claimed.
Maintainability the degree of efficiency and effectiveness with which software can be modified to correct it, improve it, or adapt it to changes in requirements and environments.	**Modularity:** the degree to which software is composed of discrete components such that a change to one component has minimal impact on other components. **Reusability:** the degree to which a software can be used in more than one system, or in building other assets. **Analysability:** the degree of effectiveness and efficiency with which it is possible to assess the impact on a software of an intended change to one or more of its parts, or to diagnose a software for deficiencies or causes of failures, or to identify parts to be modified. **Modifiability:** the degree to which a software can be effectively and efficiently modified without introducing defects or degrading its existing quality. **Testability:** the degree of effectiveness and efficiency with which test criteria can be established for software and tests can be performed to determine whether those criteria have been met.
Portability the degree of efficiency and effectiveness with which software can be transferred from one usage, or other hardware or operational environment to another.	**Adaptability:** the degree to which a software can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments. **Installability:** the degree of effectiveness and efficiency with which a software can be successfully installed and/or uninstalled in a specified environment. **Replaceability:** the degree to which a software can replace another specified software product for the same purpose in the same environment.

2.3.3.2 Software process sustainability

It is argued that projects cannot be sustainable if sustainability is not applied to project processes (Marcelino-Sádaba et al., 2015; Silvius, 2017). According to Khalfan (2006: 42), there is a need "to incorporate and consider sustainability issues within each and every activity in the development process". Likewise, El-Haram et al. (2007) and Thomson et al. (2011) state that it is necessary to integrate sustainability in the way projects are designed, managed, maintained, and finally closed or terminated. Incorporating sustainability aspects in such processes would deliver projects in a more economical and environmentally and socially friendly manner (Khalfan, 2006; Gareis et al., 2011; Silvius, 2015b). Project sustainability is broader than simply focusing on the sustainability of project product and must include certain aspects related to the sustainability of project processes during the whole life cycle of projects (Labuschagne et al., 2005; Labuschagne and Brent, 2005 and 2006; Umeda et al., 2012; Silvius and Schipper, 2014; Carvalho and Rabechini, 2017).

Similar perspectives have been taken in the relevant literature of software projects which "defend the need for a green process that results in a green product" (Calero et al., 2015: 234). According to Mahmoud and Ahmad (2013: 58), "to obtain a sustainable software product any processes contributing to its life cycle should be sustainable themselves". Naumann et al. (2015: 197) declare, "the precondition for creating software products that meet the presented sustainability criteria is a software engineering process that meets sustainability objectives". Hence, many authors agree that there is a need for models and frameworks that contain relevant aspects of software process sustainability (e.g. Shenoy and Eeratta, 2011; Lami et al., 2012; Penzenstadler and Femmer, 2013a; Beghoura et al., 2017; Oyedeji et al., 2017; Malik and Khan, 2018).

Some relevant practices have been suggested for delivering software projects in a more sustainable way; these practices include avoiding unnecessary usage of paper and air conditioning, minimising travel, collecting requirements electronically, making use of natural lighting, green outsourcing and partnership, having long-term economic strategy, optimising resource consumption (reducing, reusing, and recycling), using new and effective communication tools, purchasing and using environmentally approved products, avoiding throw-away prototyping, writing energy-efficient codes and algorithms, deploying the virtualisation concept, avoiding frequent changes in design, reducing unnecessary activities, automating repetitive implementation tasks, incorporating project environmental impacts in feasibility studies, having effective knowledge management, avoiding long working hours, enforcing pair programming, encouraging test automation, encouraging online installation and electronic documentation, compressing data for storage, and reusing old hardware, systems, and equipment (Shenoy and Eeratta, 2011; Agarwal et al., 2012; Mahmoud and Ahmad, 2013; Penzenstadler and Femmer, 2013a; Kern et al., 2015).

However, there are only a few works related to the sustainability of software project processes, and most of them, unfortunately, focus mainly on aspects of the environmental dimension and not on the TBL. For instance, Shenoy and Eeratta (2011), Mahaux et al. (2011), Lami et al. (2012), Taina (2011), Agarwal et al. (2012), and Mahmoud and Ahmad (2013) focus on some environmental aspects such as power consumption, resource utilisation, waste, pollution, and carbon footprints in different phases of software development processes (e.g. the requirement gathering, design, implementation, maintenance, and retirement phases). On the other hand, there are also economic and social aspects that should be considered for software process sustainability, such as asset management, financial performance, economic risks, social insurance, education, health, working conditions, trust, payments, access to services, and satisfaction. These aspects can be found in studies such as Naumann et al. (2011), Dick et al. (2013), Penzenstadler and Femmer, (2013a), and Kern et al. (2015), where the three dimensions of sustainability have been considered.

Software process sustainability is still in its early stages and more work is needed (Naumann et al., 2015; Calero and Piattini, 2017). Sustainability is inherently multidisciplinary (Cabot et al., 2009; Lago et al., 2015), and in general, the methodology of managing this concept in IT projects - such as software projects - is not different from the methodology of managing it in other types of projects (Bachour and Chasteen, 2010). Therefore, relevant aspects from other disciplines could be incorporated into software project processes effectively (Becker et al., 2016). In this context, several related aspects in the ISO 26000 standard, such as transparency, accountability, ethical behaviour, social welfare, compliance with the law, labour practices, and human rights, are necessary for software process sustainability. The ISO 26000 supports corporate social responsibility (CSR) and provides all types of organisations with a comprehensive guideline for measuring and improving the environmental and social impacts of their activities - such as projects – and therefore demonstrating more sustainable practices (Ebner and Baumgartner, 2006; ISO, 2010; Silvius, 2015a). According to Marcelino-Sádaba et al. (2015: 12), “the great advantage of considering

CSR in project management is its contribution in terms of establishing values such as integrity, credibility and reputation. These values must be understood as a long-term investment that will make a company more competitive and reduce certain financial risks". Also, the Codes of Ethics and Professional Conduct of the International Project Management Association (IPMA) and the Project Management Institute (PMI) include important aspects for consideration, such as honesty, fairness, responsibility, and respect, which are related to the ethical behaviour of project managers and other stakeholders (Silvius et al., 2017; PMI, 2017). Such aspects can also be found in McDermott et al. (2002), Helgadóttir (2008), Schieg (2009), Gareis et al. (2009 and 2013), and Eskerod and Huemann (2013). Marcelino-Sádaba et al. (2015: 15) declare that "no sustainable project can exist without calling on the ethical aspect of the project manager and his team". Therefore, "the project manager should make sure that he is completing the project while keeping the ethical standards and social impact in mind" as they "give millions time better results compared to those which are non-ethical" (Mishra et al., 2011: 342).

In addition, many aspects related to project process sustainability can be observed in the influential frameworks of well-known organisations such as the Natural Step Framework of Swedish scientist Karl-Henrik Robèrt, the Measuring Impact Framework of the World Business Council for Sustainable Development (WBCSD), the Global Compact Framework of the United Nations (UN), the Indicators of Sustainable Development of the UN Commission on Sustainable Development (UNCSD), the Sustainability Reporting Guidelines (SRG) of the Global Reporting Initiative (GRI), and The Dow Jones Sustainability Indexes (DJSI) (Silvius et al., 2012; Marcelino-Sádaba et al., 2015; Silvius, 2015a).

Based on the SRG of the GRI, which is "the world's most widely used sustainability reporting framework" (Silvius et al., 2012: 11), the 2010 Expert Seminar of IPMA developed a Sustainability Checklist to translate the concept of TBL into a practically applicable tool for project management professionals (Silvius et al., 2013). This checklist can be considered a key guideline reference for developing relevant models, since it encompasses the most significant 'TBL-related' aspects (e.g. return on investment, energy, resources, waste, human rights, and ethics) that should be considered when incorporating sustainability into project management processes (Silvius and Nedeski, 2011; Michaelides et al., 2014; Daneshpour, 2015; Marnewick, 2017).

2.4 Conclusion

To translate sustainability from theory into practice and incorporate it into software projects, the findings of the conducted systematic literature review (SLR) revealed that the most efficient and effective method is by integrating TBL-related aspects into these projects. Integrating such aspects should be based on two perspectives, software product sustainability and software process sustainability. Many authors have used this approach in the relevant literature of software projects. However, the majority of these contributions have focused on either project product or project process, or on one or two dimensions of sustainability rather than the three dimensions of the TBL theory. As a result, until now there is no consensus on any specific set of TBL-related aspects for incorporating sustainability into software projects. In terms of project success, the findings revealed that measuring project success should encompass project outcome success (effectiveness) as well as project management success (efficiency). There are several models for evaluating project success. The findings agree with Davis (2014) and Silvius and Schipper (2016) that Pinto and Slevin (1988), Shenhar et al. (1997 and 2001), and Shenhar and Dvir (2007) are among the most cited works for measuring project success. However, it was found that the multidimensional model of Shenhar and Dvir (2007) has the most comprehensive criteria for evaluating project success and serves the exact purpose of this research.

Chapter 3 - The conceptual framework and hypotheses development

This chapter contributes to the third objective of this thesis by developing a conceptual framework that helps in examining the relationship between software project sustainability (SPS) and project success based on explicit constructs for both concepts. Section 3.1 introduces the development of the first segment of the conceptual framework which represents SPS. Then, Section 3.2 introduces the development of the second segment of the conceptual framework which represents project success. Section 3.3 summarises the whole framework and presents the development of the hypothesis. Finally, Section 3.4 concludes the entire chapter.

3.1 The development of the first segment: software project sustainability (SPS)

The multidisciplinary nature of this study posed a challenge for reviewing relevant contributions as there was no founded framework to guide the literature search. As in section 2.1, the author carried out an extensive bibliographic search on relevant published materials (dated before 2019) to analyse links between the two disciplines (sustainability and software projects) by means of a systematic literature review. However, the selection of studies was based on three main criteria; (i) the used language is English, (ii) the incorporation of sustainability into projects has been considered clearly, and (iii) the focus is on / or relevant to the software field. The key search terms were 'sustain project', 'sustainable project', 'project sustainability', 'project sustainable development', 'project social responsibility' or 'green project', 'sustain software', 'sustainable software', 'software sustainability', 'sustain software project', 'sustainable software project', 'software project sustainability', 'green software', and 'software social responsibility'.

The initial sample selection resulted in 407 studies, where the key search terms were detailed in some way. To filter relevant studies from the initial selection, the author read the abstracts of the initial sample independently. In total, 148 studies were classified irrelevant and were removed from the initially selected sample since they were not focusing mainly on the incorporation of sustainability into projects. Although 259 studies were selected after the first filtration, another 157 studies were then filtered out by content analysis for three main reasons. First, the content of some studies is not applicable to the projects of the software field (e.g. water, pollution, chemical waste or toxins). Second, some studies were incorporated sustainability as a critical success factor for projects among several other factors; sustainability was not the main concern and details regarding its incorporation were not sufficient. Third, some studies in the software field and other relevant contributions in IT sector focused on ‘sustainability BY projects’ not on ‘sustainability IN projects’ (discussed in section 2.3.3). The final selected sample comprised 102 studies which precisely focus on the incorporation of sustainability into projects and focus on / or relevant to the software field, thus serving the exact purpose of this study.

As discussed in section 2.3.1, the findings reveal that integrating aspects relevant to the economic, environmental, and social dimensions is the most efficient way to operationalise the TBL theory and incorporate sustainability into projects. Thus, for developing the first segment (SPS), the author will use this approach as a methodological base for incorporating sustainability into software projects as well. In sections 2.3.3.1 and 2.3.3.2, two perspectives can be recognised in the relevant literature of software project sustainability: software product sustainability and software process sustainability. Software product sustainability is about the sustainability of software ‘itself’ as a product (sustainability of project product/outcome). Meanwhile, software process sustainability is about the sustainability of managing software development and its engineering processes; it is sustainability in project interrelated activities during the development of a software product (Albertao et al., 2010; Penzenstadler, 2013; Naumann et al., 2015; Malik and Khan, 2018). Therefore, to develop the first segment of the conceptual framework which represents SPS, the methodological approach of integrating TBL-related aspects will be used to incorporate sustainability into both ‘software project product’ and ‘software project process’. To sum up, SPS is about incorporating TBL-related aspects into the product and process of a software project.

3.1.1 Incorporating sustainability into software project product (software product sustainability)

As mentioned earlier in section 2.3.3.1, in the software engineering literature sustainability is considered a non-functional requirement (Amsel et al., 2011; Calero et al., 2013b; Penzenstadler et al., 2014; Venters et al., 2014a; Alharthi et al., 2016) and has been linked to the quality characteristics of software products (Albertao et al., 2010; Naumann et al., 2015; Condori-Fernandez and Lago, 2018; Malik and Khan, 2018).

Penzenstadler et al. (2014) and Lago et al. (2015) support this perspective and confirm that sustainability should be explicitly considered as a non-functional quality requirement of software systems. According to Venters et al. (2014b: 3), "by defining software sustainability as a non-functional requirement it allows us to move away from the focus of thinking about how we sustain existing software, to understanding how we can develop sustainable software in the future". Calero et al. (2013b: 2) concludes, "software sustainability is related to non-functional requirements … as it is obvious that sustainability is a way to improve a software product, and then it must be related to the how and not to the what". Therefore, the incorporation of sustainability in the development of a software product should be in the form of non-functional requirements (Calero et al., 2013a). Similarly, many authors support this perspective for incorporating sustainability in software projects, including Cabot et al. (2009), Albertao et al. (2010), Naumann et al. (2011), Taina (2010 and 2011), Koziolek (2011), Kocak (2013), Duffy (2014), Kocak et al. (2015), Al Hinai and Chitchyan (2016), Ahmad et al. (2017), Condori-Fernandez and Lago (2018).

Most non-functional requirements (NFRs) of software sustainability are adopted from the characteristics and sub-characteristics of well-known quality models and international standards such as Boehm's quality model, McCall's Quality Model, Pragmatic Quality Factor (PQF), Systemic Quality Model, Dromey's Quality Model, the User Centric Software Certification (UcSoftC) Model, the International Organisation for Standardisation (ISO) 9126 and 25010, and the FURPS model of Functionality, Usability, Reliability, Performance, and Supportability (Raturi et al., 2014; Venters et al., 2014b; Calero et al., 2015; Zakaria et al., 2016; Ahmad et al., 2018). However, as stated in section 2.3.3.1, many authors declare that there is no consensus on a specific set of NFRs, nor is there a unified definition for their proposed quality characteristics, as researchers have adopted different characteristics from different quality models or standards based on their own perspectives (Dick et al., 2010; Penzenstadler and Femmer, 2013a; Al Hinai and Chitchyan, 2014; Raturi et al., 2014; Venters et al., 2014b; Ahmad et al., 2017; Calero and Piattini, 2017; Oyedeji et al., 2017; Condori-Fernandez and Lago, 2018). For instance, Kern et al. (2013) consider the quality characteristic of "adaptability", whereas Albertao et al. (2010) ignore it as a non-functional requirement for software sustainability. Moreover, Venters et al. (2014a) consider "usability" in terms of efficiency, effectiveness, and satisfaction, while Condori-Fernandez and Lago (2018) consider it in terms of operability, learnability, appropriateness recognisability, and user error protection. To avoid such conflicts in defining and determining the quality requirements of software sustainability, some recent contributions such as Calero et al. (2015), Zakaria et al. (2016), Ahmad et al. (2018), and Condori-Fernandez and Lago (2018) have adopted the widely used Product Quality Model (PQM) of the ISO/IEC 25010 standard as a theoretical base in their works. According to Calero et al. (2015: 233), the ISO/IEC 25010 PQM is "the only valid international standard related to software product quality" which has "a widely accepted set of quality characteristics that has been agreed on by consensus". It provides a standardised set of quality requirements and definitions of software products (García-Mireles, 2016). Furthermore, the systematic literature reviews of Ahmad et al. (2014 and 2015) indicate that most proposed requirements for software sustainability are included in the Product Quality Model (PQM) of ISO/IEC 25010.

ISO/IEC 25010 is one of the standards of the ISO/IEC 25000 family, also known as the System and Software Quality Requirements and Evaluation (SQuaRE) series. It is derived from the revised ISO/IEC 9126:1991. The standard "was last reviewed and confirmed in 2017. Therefore, this version remains current" (ISO/IEC 25010:2011, 2018). It includes the Product Quality model (PQM) which relates to "static properties of software and dynamic properties of the computer system" (ISO/IEC 25010:2011, 2018). The model consists of eight quality characteristics which are subdivided into 31 sub-characteristics (as defined in Table 2.4 in section 2.3.3.1). The main eight characteristics can be considered as sustainability-related aspects of software product, whereas the sub-characteristics are criteria for measuring the level of these aspects (Venters et al., 2014a). Based on Calero et al. (2013c), Ahmad et al. (2014, 2015, and 2018), Zakaria et al. (2016), and Condori-Fernandez and Lago (2018), most of the non-functional requirements (NFRs) which are proposed in the relevant literature for software product sustainability are related to the eight main quality characteristics of the ISO/IEC 25010 PQM (Table 3.1).

Table 3. 1: The eight main software quality characteristics of the ISO/IEC 25010 PQM

	Characteristics
PQM	Functional suitability
	Performance efficiency
	Compatibility
	Usability
	Reliability
	Security
	Maintainability
	Portability

Therefore, the author of this thesis considers sustainability as a set of NFRs of software products, and the definition of these NFRs will be based on the eight main software quality characteristics of the ISO/IEC 25010 PQM. As for incorporating sustainability into software project product, these characteristics will be linked and classified for each dimension of sustainability (as TBL-related aspects) in accordance with relevant literature, thus:

Functional suitability is the degree to which software provides functions that meet 'stated and implied needs' when used under particular conditions. It is concerned with the degree to which software functions, covering all stated tasks and objectives, providing accurate results, and facilitating the accomplishment of all tasks as required (ISO/IEC 25010:2011, 2018). Therefore, it could have a significant impact on the three dimensions of software sustainability by minimising maintenance and support costs; minimising energy consumption and environmental waste; and increasing user productivity and social interactions (Koçak et al., 2014 and 2015; Calero et al., 2015; Ahmad et al., 2018; Condori-Fernandez and Lago, 2018; García-Mireles et al., 2018).

Performance efficiency is performance with respect to the number of resources used under stated conditions. It concerns software: a) response and processing times, b) throughput rates, c) amounts and types of resources used (e.g. processor, memory, and disk space), and d) maximum capacity to meet requirements when performing functions (ISO/IEC 25010:2011, 2018). Therefore, it is proposed that efficient performance plays a significant role in the three dimensions of software sustainability, as it enhances software productivity; minimises expenditure on new hardware; minimises energy consumption through less software usage time; minimises social dependency on the newest technologies; and enhances ecological footprint by extending the lifetime of hardware and minimising e-waste, as equipment disposal and manufacturing both contribute to carbon footprints (Albertao et al., 2010, Penzenstadler, 2012; Kern et al., 2013; Penzenstadler and Femmer 2013b; Kocak, 2013; Calero et al., 2013b; Shokri and Badaruzzaman, 2014; Penzenstadler et al., 2014; Mohankumar and Kumar, 2015; García-Mireles, 2016; Condori-Fernandez and Lago, 2018; García-Mireles et al., 2018).

Compatibility is the degree to which software performs required functions and/or can exchange information with other components (e.g. software, systems, and products) and use exchanged information while sharing the same hardware or software environments and without detrimental impact on any other products (ISO/IEC 25010:2011, 2018). It is suggested that this characteristic could have a particular impact on the economic and social dimensions of software sustainability, as flexibility in exchanging information and sharing resources without harmful effects can reduce investment and development costs, reduce risks, facilitate user communication, and increase satisfaction (Taina, 2011; Calero et al., 2015; Al Hinai and Chitchyan 2016; Ahmad et al., 2018; Condori-Fernandez and Lago, 2018).

Usability is the degree to which software can be used by particular users to achieve specific goals effectively, efficiently, satisfactorily, and without risk in a particular context of use (ISO/IEC 25010:2011, 2018). It is the degree to which software: a) can be recognised as appropriate for user needs, b) can be used to achieve certain learning goals, c) is easy to operate and control, d) protects users from making mistakes, e) enables a satisfying and pleasing interface for the user, and f) can be used by people with the broadest range of capabilities and characteristics (e.g. disabled users, language, background, age, computer technology used, location) to achieve specific goals in a specific context of use (ISO/IEC 25010:2011, 2018). Therefore, this characteristic could significantly impact the economic and social dimensions of software sustainability by minimising support costs, increasing customer satisfaction and the potential market, eliminating learning barriers, and delivering technology to minorities and illiterate populations (Albertao et al., 2010; Mahaux et al., 2011; Johann and Maalej, 2013; Venters et al., 2014a; Penzenstadler, 2015; Al Hinai and Chitchyan 2016; Zakaria et al., 2016; Beghoura et al., 2017; Condori-Fernandez and Lago, 2018; Ahmad et al., 2018).

Reliability is the degree to which software performs particular functions under specific conditions for a certain period of time. It is composed of the degree to which software: a) meets needs for reliability under normal operation, b) is accessible and operational when required for use, c) operates as intended despite the presence of hardware or software faults, and d) can recover directly affected data and re-establish the desired state of the system in the event of a failure or an interruption (ISO/IEC 25010:2011, 2018). This characteristic is linked mostly to the economic and social dimensions of software sustainability, as it minimises support costs, minimises the risk of errors and failures, minimises development costs, enhances software consistency and productivity, increases the longevity of software usage, and increases user satisfaction and software reputation in markets (Bevan, 1999; Blevis, 2007; Sibisi and Van Waveren, 2007; Taina, 2011; Svensson et al., 2013; Johann and Maalej, 2013; Penzenstadler et al., 2014; Raturi et al., 2014; Venters et al., 2014a; Penzenstadler, 2015; Zakaria et al., 2016; Alelyani and Yang, 2016; Saputri and Lee, 2016; Oyedeji et al., 2017; Condori-Fernandez and Lago, 2018; Ahmad et al., 2018).

Security is the degree to which software protects data and information so that individuals or other systems or products have appropriate data accessibility according to authorisation levels. This characteristic is composed of the degree to which: a) software ensures that accessing or modifying data can only be done by authorised users, b) actions can be proven to have taken place, so that they can be traced and cannot be repudiated later, and c) the identity of a ‘subject or resource’ can be proved to be the one claimed (ISO/IEC 25010:2011, 2018). Similar to compatibility, usability, and reliability, this characteristic is linked to the economic and social dimensions of software sustainability because it reduces maintenance and support costs, minimises risks, increases user satisfaction and longevity of software usage, facilitates communication between users, and increases the trustworthiness and customer base of software (Devanbu and Stubblebine, 2000; Cysneiros and do Prado Leite, 2002; Reza and Grant, 2005; Chung et al., 2012; Penzenstadler and Femmer, 2012; Johann and Maalej, 2013; Penzenstadler et al., 2014; Raturi et al., 2014; Penzenstadler, 2015; Al Hinai and Chitchyan, 2016; Malik and Khan, 2018; Ahmad et al., 2018; Condori-Fernandez and Lago, 2018).

Maintainability is the degree of efficiency and effectiveness with which software can be modified to correct it, improve it, or adapt it to changes in requirements and environments (ISO/IEC 25010:2011, 2018). It includes the degree to which: a) a change to one component of software has minimal impact on other components, b) software can be used in more than one system, or in constructing other assets, c) the impact of change on a software can be evaluated, causes of failures or deficiencies can be diagnosed, or parts requiring modification can be identified, d) software can be efficiently and effectively modified without introducing defects or degrading quality, and e) test criteria can be efficiently and effectively established for software and tests can be carried out to determine whether these criteria have been met (ISO/IEC 25010:2011, 2018). It is proposed that maintainability influences the three dimensions of software sustainability by increasing the longevity of software usage; minimising the costs of development, maintenance, and support; accelerating time-to-market; enabling software to meet societal demands continuously; increasing customer base; and reducing the required time, risks, efforts, resources, and waste for maintaining existing software (Albertao et al., 2010; Koziolek 2011; Taina, 2011; Calero et al., 2013c; Venters et al., 2014a; Raturi et al., 2014; Calero et al., 2015; Koçak et al., 2015; Becker et al., 2015 and 2016; Ahmad et al., 2018; Condori-Fernandez and Lago, 2018; García-Mireles et al., 2018).

Portability is the degree of efficiency and effectiveness with which software can be transferred from one usage, or other hardware or operational environment, to another (ISO/IEC 25010:2011, 2018). It includes the degree to which software can be: a) adapted for different computing environments, b) installed and/or uninstalled successfully in a specified environment, and c) replaced with another specified software product for the same purpose in the same environment (ISO/IEC 25010:2011, 2018). As for functional suitability, performance efficiency, and maintainability, portability can be linked to the three dimensions of software sustainability, as it increases the software's lifetime and its potential market; extends hardware lifetime and minimises waste; increases flexibility of software usage; and increases customer satisfaction and loyalty (Albertao et al., 2010; Koziolek, 2011; Taina, 2011; Kern et al., 2013; Calero et al., 2013a; Raturi et al., 2014; Venters et al., 2014a; Naumann et al., 2011 and 2015; García-Mireles et al., 2018; Ahmad et al., 2018).

Based on the analysis of relevant contributions, it can be observed that all of the eight main characteristics of the ISO/IEC 25010 PQM are linked to the economic and social dimensions of software product sustainability. Meanwhile, only four quality characteristics (functional suitability, performance efficiency, maintainability, and portability) are linked to the environmental dimension of software product sustainability. In conclusion, it can be deduced that these eight characteristics reflect the TBL theory. Therefore, these characteristics have been grouped as TBL-related aspects for incorporating sustainability into software products (Table 3.2). It has been recommended that such quality characteristics should be considered during the early design stage of software products (Albertao et al., 2010; Naumann et al., 2011; Koziolek, 2011; Raturi et al., 2014; Saputri and Lee, 2016; Becker et al., 2016; Beghoura et al., 2017; Condori-Fernandez and Lago, 2018). However, project stakeholders may modify this set of quality characteristics by removing or adding certain characteristics based on their sustainability requirements. In all cases, any modification should also be considered at the design stage (Raturi et al., 2014; Penzenstadler, 2015; Becker et al., 2015 and 2016; Oyedeji et al., 2017).

Table 3. 2: Software product sustainability

TBL-related aspects of software products	• Functional suitability • Performance efficiency • Compatibility • Usability • Reliability • Security • Maintainability • Portability • Certain quality requirements of stakeholders

3.1.2 Incorporating sustainability into software project process (software process sustainability)

Project sustainability is broader than simply focusing on the sustainability of project product and must include certain aspects related to the sustainability of project processes during the whole life cycle of projects (Labuschagne et al., 2005; Labuschagne and Brent, 2005 and 2006; Umeda et al., 2012; Silvius and Schipper, 2014; Marcelino-Sádaba et al., 2015; Carvalho and Rabechini, 2017; Silvius, 2017). According to Khalfan (2006: 42), there is a need "to incorporate and consider sustainability issues within each and every activity in the development process". Likewise, El-Haram et al. (2007) and Thomson et al. (2011) state that it is necessary to integrate sustainability in the way projects are designed, managed, maintained, and finally closed or terminated. Gareis et al. (2011) and Silvius (2015b) conclude that incorporating sustainability aspects in such processes would deliver projects in a more economic and environmentally and socially friendly manner.

This perspective has been also taken in the relevant literature of software projects which "defend the need for a green process that results in a green product" (Calero et al., 2015: 234). According to Mahmoud and Ahmad (2013: 58), "to obtain a sustainable software product any processes contributing to its life cycle should be sustainable themselves". Naumann et al. (2015: 197) declare, "the precondition for creating software products that meet the presented sustainability criteria is a software engineering process that meets sustainability objectives". Hence, many authors agree that there is a need for models and frameworks that contain relevant aspects of software process sustainability (e.g. Shenoy and Eeratta, 2011; Lami et al., 2012; Penzenstadler and Femmer, 2013a; Beghoura et al., 2017; Oyedeji et al., 2017; Malik and Khan, 2018). However, there are only a few works related to the sustainability of software project processes, and most of them, unfortunately, focus mainly on aspects of the environmental dimension rather than the TBL. For instance, Shenoy and Eeratta (2011), Mahaux et al. (2011), Lami et al. (2012), Taina, (2011), Agarwal et al. (2012), and Mahmoud and Ahmad (2013) focus on some environmental aspects such as power consumption, resource utilisation, waste, pollution, and carbon footprints in different phases of software development processes (e.g. the requirement gathering, design, implementation, maintenance, and retirement phases). On the other hand, there are also economic and social aspects that should be considered for software process sustainability, such as asset management, financial performance, economic risks, social insurance, education, health, working conditions, trust, payments, access to services, and satisfaction. These aspects can be found in only a few studies, such as Naumann et al. (2011), Dick et al. (2013), Penzenstadler and Femmer, (2013a), and Kern et al. (2015), where the three dimensions of sustainability are considered. In conclusion, software process sustainability is still in its early stages and more work is needed (Naumann et al., 2015; Calero and Piattini, 2017).

Sustainability is inherently multidisciplinary (Cabot et al., 2009; Lago et al., 2015), and in general, the methodology of managing this concept in IT projects - such as software projects - is not different from the methodology of managing it in other types of projects (Bachour and Chasteen, 2010). Therefore, relevant aspects from other disciplines could be incorporated into software project processes effectively (Becker et al., 2016). Section 2.3.3.2 reveals several TBL-related aspects for incorporating sustainability into the software project process. In addition, many aspects related to project process sustainability can be observed in influential frameworks of well-known organisations such as the Natural Step Framework of Swedish scientist Karl-Henrik Robèrt, the Measuring Impact Framework of World Business Council for Sustainable Development (WBCSD), the Global Compact Framework of the United Nations (UN), the Indicators of Sustainable Development of the UN Commission on Sustainable Development (UNCSD), the Sustainability Reporting Guidelines (SRG) of the Global Reporting Initiative (GRI), and The Dow Jones Sustainability Indexes (DJSI) (Silvius et al., 2012; Marcelino-Sádaba et al., 2015; Silvius, 2015a).

However, particularly for project sustainability, the 2010 Expert Seminar of IPMA developed a sustainability checklist (Table 3.3) to translate the concept of TBL to a practically applicable tool for project management professionals (Silvius et al., 2013). The development of this checklist was based on the SRG of the GRI, which is "the world's most widely used sustainability reporting framework" (Silvius et al., 2012: 11). This checklist can be considered as a key guideline reference for developing relevant models, since it encompasses the most significant TBL-related aspects (e.g. return on investment, energy, resources, waste, human rights, and ethics) that should be considered when incorporating sustainability into project processes (Silvius and Nedeski, 2011; Michaelides et al., 2014; Daneshpour, 2015; Marnewick, 2017).

Table 3. 3: The Sustainability Checklist of IPMA
(Silvius et al., 2012: 41)

Sustainability dimension	Related aspects	indicators
Economic	Return on Investment	Direct financial benefits; Net Present Value
	Business Agility	Flexibility and optionality in the project; Increased business flexibility
Environmental	Transport	Local procurement; Digital communication; Traveling
	Energy	Minimise energy consumption, Emission / CO2 from energy used
	Water	Water usage; Recycling
	Waste	Recycling; Disposal
	Materials and resources	Reusability; Incorporated energy; Waste
Social	Labour Practices and Decent Work	Employment; Labour / Management relations; Health and Safety; Training and Education; Organizational learning; Diversity and Equal opportunity
	Human Rights	Non-discrimination; Freedom of association; Child labour; Forced and compulsory labour
	Society and Customers	Community support; Public policy / Compliance; Customer health and safety; Product and service labelling; Market communication and Advertising; Customer privacy
	Ethical behaviour	Investment and Procurement practices; Bribery and corruption; Anti-competition behaviour

The checklist consists of 11 TBL-related aspects with their relevant measures. These aspects were developed based upon their expected relevance for projects in general. Silvius et al. (2012) state that the selection of aspects in this checklist should be based on the type of project (e.g. construction, information technology, manufacturing, and so on). Therefore, after analysing the relevant literature, the author of this thesis summarises and defines the most used and applicable aspects in the IPMA Checklist and in other significant contributions for incorporating sustainability into software project process (Table 3.4). Some aspects such as 'Water' and 'Business Agility' have not been considered due to the nature of software projects and the scarcity of their usage in the relevant literature.

Table 3. 4: The proposed TBL-related Aspects for incorporating sustainability into software project process

Sustainability dimension	Related aspect	Definitions	References
Economic	**Return on Investment**	Taking into account the direct financial benefits originating from reducing the use of resources, cost savings, and improving processes and minimising risks.	Silvius and Nedeski (2011), Silvius et al. (2012), Yao et al. (2011), Yuan (2017), Martens and Carvalho (2017), APM (2016), Naumann et al. (2011), Penzenstadler and Femmer (2013a), Kern et al. (2015), Fiksel et al. (1999), Labuschagne et al. (2005), ISO (2010), Marcelino-Sádaba et al. (2015), UNDESA (2001), Fernández-Sánchez and Rodríguez-López (2010), Singh et al. (2007), Shen et al. (2010), Marnewick (2017), Ahmad et al. (2018).
	Strategic value	Evaluating and selecting projects based on both long- and short-term strategic value.	Knoepfel (2001), Fiksel et al. (1999), Labuschagne et al. (2005), ISO (2010), Marcelino-Sádaba et al. (2015), UNDESA (2001), Fernández-Sánchez and Rodríguez-López (2010), Singh et al. (2007), Shen et al. (2010), Marnewick (2017), Ahmad et al. (2018), Olsson (2006), Miller and Lessard (2001), Genus (1997), Chapman and Ward (2003), Lundin and Söderholm (1995), Kreiner (1995), Brennan (2000), Silvius and Nedeski (2011), Silvius et al. (2012), Yao et al. (2011), APM (2016), Naumann et al. (2011), Penzenstadler and Femmer (2013a), Kern et al. (2015), Martens and Carvalho (2017), Yuan (2017).
Environmental	**Green outsourcing (materials, resources, and suppliers)**	Taking into account environmental aspects when selecting materials, products, and equipment (e.g. energy consumption, waste and pollution they cause, reuse capabilities); and selecting suppliers based on their environmental policies, knowledge, usage of natural resources, and location (to minimise transport).	Carvalho and Rabechini (2017), Silvius et al. (2012), Martens and Carvalho (2017), Shenoy and Eeratta (2011), Agarwal et al. (2012), Mahaux et al. (2011), Mahmoud and Ahmad (2013), Marcelino-Sádaba et al. (2015), Lami et al. (2012), Taina (2011), Dick et al. (2013), Kern et al. (2015), Naumann et al. (2011), Penzenstadler and Femmer (2013a), Aarseth et al. (2017), UNDESA (2001), Fiksel et al. (1999), Fernández-Sánchez and Rodríguez-López (2010), Labuschagne et al. (2005), Singh et al. (2007), Shen et al. (2010), Yuan (2017).
	Transport	Applying travel policies and designing software project processes in a way to minimise travel, as well as actively promoting travelling alternatives (e.g. emails, mobiles and telephones, video conferencing).	Taina (2011), Silvius et al. (2012), Penzenstadler and Femmer (2013a), Naumann et al. (2011), Mahmoud and Ahmad (2013), Lami et al. (2012), Mahaux et al. (2011), Shenoy and Eeratta (2011), UNDESA (2001), Yao et al. (2011), Marnewick (2017).
	Energy	Taking into account energy consumption in the design of project processes and promoting green energy, energy saving equipment, and smart use of energy.	Taina (2011), Silvius et al. (2012), Penzenstadler and Femmer (2013a), Naumann et al. (2011), Mahmoud and Ahmad (2013), Agarwal et al. (2012), Lami et al. (2012), Mahaux et al. (2011), Shenoy and Eeratta (2011), UNDESA (2001), Fiksel et al. (1999), Fernández-Sánchez and Rodríguez-López (2010), Labuschagne et al. (2005), Singh et al. (2007), Shen et al. (2010), Marnewick (2017), Carvalho and Rabechini (2017).

	Waste	Applying policies to minimise waste such as double-sided printing and avoiding unnecessary usage of paper; optimising resource consumption (reducing, reusing, and recycling), and considering waste in the design of project processes.	Taina (2011), Penzenstadler and Femmer (2013a), Silvius et al. (2012), Naumann et al. (2011), Mahmoud and Ahmad (2013), Agarwal et al. (2012), Lami et al. (2012), Mahaux et al. (2011), Shenoy and Eeratta (2011), UNDESA (2001), Fiksel et al. (1999), Fernández-Sánchez and Rodríguez-López (2010), Yao et al. (2011), Singh et al. (2007), Shen et al. (2010), Yuan (2017), Marnewick (2017), Martens and Carvalho (2017), Carvalho and Rabechini (2017).
Social	**Labour practices and decent work**	Applying policies for occupational health and safety (e.g. hazard identification, risk assessment, determination of controls, legal requirements, incident monitoring); applying policies for diversity and equal opportunities; and taking care of working conditions, social insurance, payments, and stakeholders' development (training, and education).	Naumann et al. (2011), Carvalho and Rabechini (2017), Silvius et al. (2012), Penzenstadler and Femmer (2013a), Kern et al. (2015), Marcelino-Sádaba et al. (2015), Martens and Carvalho (2017), ISO (2010), UNDESA (2001), Knoepfel (2001), Fiksel et al. (1999), Fernández-Sánchez and Rodríguez-López (2010), Labuschagne et al. (2005), Yao et al. (2011), Singh et al. (2007), Shen et al. (2010), Yuan (2017), Marnewick (2017).
	Human rights	Applying policies for human rights (e.g. no child labour, freedom of association, and non-discrimination), and designing project processes in a way to improve human rights.	Penzenstadler and Femmer (2013a), Silvius and Nedeski (2011), Silvius et al. (2012), Carvalho and Rabechini (2017), Marcelino-Sádaba et al. (2015), Martens and Carvalho (2017), ISO (2010), UNDESA (2001), Knoepfel (2001), Fiksel et al. (1999), Labuschagne et al. (2005), Singh et al. (2007), Yuan (2017), Marnewick (2017).
	Society and customers	Compliance with public policies and having a social responsibility towards society (e.g. health and welfare; community support; customer privacy and safety; market communication and advertising; product and service labelling).	Naumann et al. (2011), ISO (2010), Penzenstadler and Femmer (2013a), Silvius and Nedeski (2011), Silvius et al. (2012), Carvalho and Rabechini (2017), Marnewick (2017), Martens and Carvalho (2016b), Marcelino-Sádaba et al. (2015), UNDESA (2001), Knoepfel (2001), Fiksel et al. (1999), Fernández-Sánchez and Rodríguez-López (2010), Labuschagne et al. (2005), Yao et al. (2011), Singh et al. (2007), Shen et al. (2010), Yuan (2017), Martens and Carvalho (2017).
	Ethical behaviour	Supporting fair trade and competition; rejecting bribery, corruption, and anti-competitive behaviour; and having well-written codes of conduct which supports principles and values such as honesty, transparency, privacy, fairness, trust, accountability, and respect.	ISO (2010), Silvius et al. (2012), Silvius and Nedeski (2011), Penzenstadler and Femmer (2013a), Marcelino-Sádaba et al. (2015), Carvalho and Rabechini (2017), Martens and Carvalho (2016b), UNDESA (2001), Knoepfel (2001), Fiksel et al. (1999), Singh et al. (2007), Yuan (2017), Marnewick (2017), Martens and Carvalho (2017), Mishra et al. (2011).

3.2 The development of the second segment: project success

The traditional criteria that were used to measure project success were cost, time, and specifications, otherwise called quality or scope (Larson and Gobeli, 1989; Joslin and Müller, 2015) and known as the “iron triangle” (Atkinson, 1999) or triple constraints (Dalcher, 2014). When considered alone, these criteria are subject to extensive criticism (De Bakker et al., 2010) because they only measure project management success, which is just project efficiency (De Wit, 1988; Atkinson, 1999; Cooke-Davies, 2002, Turner; 2014). However, the development of the literature illustrates other success criteria that should be considered for measuring the success of project outcomes - effectiveness - beside the iron triangle, such as stakeholders' satisfaction, meeting business objectives and strategic goals, creating new markets and technology, and creating social and environmental impacts. These criteria place more focus on multiple stakeholder judgments (e.g. project managers, project teams, owners, clients, users, sponsors, senior management) and on the evaluation of project outcome success over time (Pinto and Slevin, 1987; Atkinson, 1999; Turner et al., 2009; Shenhar, 2011; Turner and Zolin, 2012; Müller and Jugdev, 2012; Dalcher, 2014; Davis, 2017).

According to Davis (2014) and Silvius and Schipper (2016), the evaluation criteria of Shenhar et al. (1997 and 2001), Shenhar and Dvir (2007), and Shenhar (2011) are among the most cited criteria for measuring project success. These criteria measure project management success and project outcome success based on five dimensions, namely project efficiency, impact on the customer, impact on the team, business success, and preparation for the future. These dimensions were also used in relevant studies such as Mir and Pinnington (2014), Martens and Carvalho (2016b), and Carvalho and Rabechini (2017). Therefore, these dimensions will be used in the proposed framework for evaluating project success. Table 3.5 presents the five dimensions of project success and clarifies their evaluation criteria.

Table 3. 5: The dimensions of project success and their evaluation criteria
Based on Shenhar et al. (1997 and 2001), Shenhar and Dvir (2007), and Shenhar (2011)

Dimensions of project success	Evaluation criteria
Efficiency	Completing projects within time or earlier and within or below budget
Impact on the customer	Meeting customers' requirements and achieving their satisfaction, benefits, and loyalty
Impact on the team	Project team satisfaction, retention, and personal growth
Business success	The economic success of projects, having positive returns on investment, increasing market share, and organisation growth
Preparing for the future	Creating new technologies, new markets, new business processes, and new capabilities

3.3 The proposed framework and hypotheses

The previous analysis guided the author to develop the following conceptual framework, which systemises the relationship between software project sustainability (SPS) and project success based on explicit constructs. The proposed framework consists of two segments. The first segment represents the constructs of SPS and their TBL-related aspects (Table 3.6), whereas the second segment represents project success and its five dimensions (Table 3.7).

SPS includes two perspectives: software process sustainability and software product sustainability (Table 3.6). Software process sustainability is composed of three constructs: economic considerations (ECCs), environmental concerns (EVCs), and social responsibilities (SRs). Meanwhile, software product sustainability has one construct: incorporating TBL-related quality characteristics as non-functional requirements in software products (QRs). The proposed aspects of these four SPS constructs have been defined based on the Product

Quality model of ISO/IEC 25010 and the Sustainability Checklist of IPMA, which forms a theoretical base of widely accepted sets of related aspects agreed on by consensus. Then, these aspects were synthesised and linked to each dimension of sustainability based on the analysis of the best contributions in the relevant literature. The third column of Table 3.6 shows the TBL-related aspects of all the SPS constructs.

As indicated in section 3.1, the development of the first segment (SPS) is based on the methodological approach of integrating TBL-related aspects into both 'software project product' and 'software project process'. The proposed structure of the first segment provides a unique combination of TBL-related aspects for SPS and forms a significant part of the contribution of this thesis. This combination can be used by academics and practitioners as a checklist for incorporating sustainability into software projects.

Table 3. 6: The first segment of the framework: SPS perspectives, constructs, and TBL-related aspects

SPS perspectives	SPS constructs	TBL-related aspects
Software Process sustainability	Economic considerations (ECCs)	- Return on investment - Strategic value
	Environmental concerns (EVCs)	- Transport - Energy - Waste - Green outsourcing (materials, resources, and suppliers)
	Social responsibilities (SRs)	- Labour practices and decent work - Human rights - Society and customers - Ethical behaviour
Software Product sustainability	Incorporating TBL-related quality requirements (QRs)	- Functional suitability - Performance efficiency - Compatibility - Usability - Reliability - Security - Maintainability - Portability - Certain quality requirements of stakeholders (old and/or new)

On the other hand, the construct of project success (PSCS) has five dimensions: efficiency, impact on the customer, impact on the team, business success, and preparation for the future (Table 3.7). Following Mir and Pinnington (2014), Martens and Carvalho (2017), and Carvalho and Rabechini (2017), these dimensions are selected and defined based on the multidimensional model of Shenhar and Dvir (2007), as it includes one of the most cited criteria for measuring project success comprehensively (Davis, 2014; Silvius and Schipper, 2016).

Table 3. 7: The second segment of the framework: project success and its dimensions

	Dimensions of project success
Project success (PSCS)	- Efficiency
	- Impact on the customer
	- Impact on the team
	- Business success
	- Preparing for the future

Figure 1.1 (section 1.4) shows the proposed framework for the relationship between software project sustainability (SPS) and project success. To investigate the potential impact of SPS on project success in-depth, the potential impact of each construct of SPS on project success should be examined; then, the potential impact of all of the constructs combined on project success should be examined as well. Additionally, as found in the relevant literature, the potential impact on project success should be inspected under different levels of project complexity, (as discussed below in hypothesis six). Therefore, the following hypotheses have been developed.

In the proposed framework, the first construct of SPS is economic considerations (ECCs). It is about incorporating relevant economic aspects (return on investment and strategic value) into the processes of software projects. These aspects focus on evaluating and selecting projects based on long- and short-term strategic value, as well as considering the direct financial benefits originating from reducing the use of resources, minimising risks, reducing costs, and improving processes. Based on Atkinson (1999), Shenhar and Dvir (2007), and Shenhar (2011), such aspects can be considered as fundamentals for the success of projects. For Dalcher (2014), these aspects are categorised under 'critical issues', and neglecting them leads to project failure. Silvius and Schipper (2016: 15) state that minimising risks, cost, and use of resources relates positively to project success, and that considering both short- and long-term strategic value "is expected to reduce the risk of the project in the form of disturbances of the project by stakeholders that feel that their (long term) interests are not considered" … and therefore contributes "to a controlled execution, and thereby success, of the project". Similarly, Nidumolu et al. (2009), Adriana and Ioana-Maria (2013), Martens and Carvalho (2016a and b), and Malik and Khan (2018) confirm that considering such aspects undoubtedly leads to project success. Based on these arguments, the following hypothesis is derived:

Hypothesis 1: Incorporating economic considerations in the processes of software projects has a significant and positive relationship with project success.

The second construct of SPS in the proposed framework is environmental concerns (EVCs). It focuses on incorporating environmental-related aspects in the processes of software projects. These environmental aspects are green outsourcing, transport, energy, and waste. 'Green outsourcing' means selecting environmentally friendly materials, products, and equipment based on the waste and pollution they cause, their energy consumption, and their reuse capabilities. It also includes selecting suppliers based on their environmental policies, knowledge, location (to minimise transport), and use of natural resources. 'Transport' is about applying travel policies and designing software project processes in a way to minimise travel, as well as actively promoting travelling alternatives (e.g. emails, mobiles and telephones, video conferencing). 'Energy' is about bearing in mind energy consumption in the design of project processes and promoting green energy, energy saving equipment, and smart energy use. 'Waste' refers to applying policies to minimise waste, such as double-sided printing or avoiding unnecessary use of paper; optimising resource consumption (reducing, reusing, and recycling); and considering waste in the design of project processes. Many authors state that considering such aspects has a positive impact on project success. For example, Maltzman and Shirley (2010) link waste elimination to quality and consider it a major factor for succeeding in green projects. Silvius and Schipper (2016) state that taking care of waste, transport, and energy plays a significant role in project success in terms of reducing cost, achieving schedule and budget, achieving stakeholder satisfaction, and preparing the organisation for the future. Carvalho and Rabechini (2017) found a significant and positive relationship between green outsourcing and project success. Chan and Chan (2004) categorised such aspects under environmental performance, which they consider to be a key performance indicator for measuring project success. This categorisation was already found in the Square Route framework of Atkinson (1999), who included environmental impact as a major criterion for information systems project success. The results of Martens and Carvalho (2016b) show that the environmental dimension and its relevant aspects received higher consideration (77.17%) than the economical (75.60%) and social (74.67%) dimensions in the projects of the four investigated companies, and that none of the companies hesitated to confirm the significant influence of this dimension in achieving project success. Likewise, Kometa et al. (1995), Lim and Mohamed (1999), and Almahmoud et al. (2012) assert that environmental performance is necessary for project success. Therefore, it is hypothesised that incorporating relevant environmental aspects in the processes of software projects contributes positively to project success.

> **Hypothesis 2:** Incorporating environmental concerns in the processes of software projects has a significant and positive relationship with project success.

The third construct of SPS in the proposed framework is social responsibilities (SRs). It includes four social-related aspects for the processes of software projects: labour practices and decent work, human rights, society and customers, and ethical behaviour. 'Labour practices and decent work' concerns applying policies for occupational health and safety (e.g. hazard identification, risk assessment, determination of controls, legal requirements, and incident monitoring); applying policies for diversity and equal opportunities; and taking care of working conditions, social insurance, payments, and stakeholders' development (training, and education). 'Human rights' refers to the application of policies to ensure that human rights are met (e.g. no child labour, freedom of association, and non-discrimination) and designing project processes in a way to promote human rights. 'Society and customers' focuses on considering the expectations of stakeholders and having a social responsibility towards society (e.g. health and welfare; compliance with public policies; community support; customer privacy and safety; market communication and advertising; and product and service labelling). 'Ethical behaviour' means supporting fair trade and competition; rejecting bribery, corruption, and anti-competitive behaviour; and having well-written codes of conduct which support principles and values such as honesty, transparency, privacy, fairness, trust, accountability, and respect. Based on Atkinson (1999), Shenhar and Dvir (2007) and Shenhar (2011), these aspects are linked directly to the evaluation criteria of project success. According to Mishra et al. (2011), keeping in mind social impacts and ethical standards is essential for the success of projects, as they increase customer loyalty and satisfaction and create trust, morality, values, brotherhood, and harmony among team members. They conclude, "the project manager should make sure that he is completing the project while keeping the ethical standards and social impact in mind" as they "give millions time better results compared to those which are non-ethical" (Mishra et al., 2011: 342). Similarly, Marcelino-Sádaba et al. (2015: 12) declare that such aspects contribute to establishing integrity, credibility, and reputation, and "must be understood as a long-term investment that will make a company more competitive and reduce certain financial risks". McKenzie (2009), Willis et al. (2009), and Valdes-Vasquez and Klotz (2013) assert that designing a truly sustainable project requires considering the social impacts the project will have on the community (e.g. end-users and people involved) with regards to culture, well-being, health, safety, and education. The authors also assert that considering all of these aspects would improve project performance and people's quality of life. For Eskerod and Huemann (2013), social sustainability and its related aspects play a significant role in stakeholder management, which is a core activity for project success. Likewise, Schieg (2009), Shen et al. (2010), Yao et al. (2011), and Yuan (2017) argue that a sustainable project should consider social responsibilities, as this will have a great impact on the community and will improve the performance of projects on the short and long terms. These arguments have led the author to develop the following hypothesis:

> **Hypothesis 3:** Incorporating social responsibilities in the processes of software projects has a significant and positive relationship with project success.

The fourth construct of SPS in the proposed framework is quality requirements (QRs). It focuses on incorporating TBL-related non-functional requirements as quality characteristics in the products of software projects. These TBL-related quality requirements are functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. The proposed QRs were defined based on the Product Quality model of ISO/IEC 25010 and have been synthesised and linked to each dimension of sustainability as TBL-related aspects based on the analysis of the best contributions in the relevant literature (section 3.1.1). Based on arguments from several authors, it has been proposed that such aspects have a significant influence on project success, as they could reduce investment and development costs; minimise maintenance and support costs; minimise energy consumption and environmental waste; reduce financial, environmental, and social risks; extend software and hardware lifetime; and increase customer satisfaction and loyalty and the potential market (Albertao et al., 2010; Koziolek 2011; Mahaux et al., 2011; Taina, 2011; Naumann et al., 2011 and 2015; Penzenstadler and Femmer, 2012; Calero et al., 2013a, b, c; Johann and Maalej, 2013; Kern et al., 2013; Kocak, 2013; Penzenstadler and Femmer 2013b; Penzenstadler et al., 2014; Raturi et al., 2014; Venters et al., 2014a; Koçak et al., 2014 and 2015; Calero et al., 2015; Mohankumar and Kumar, 2015; Penzenstadler, 2015; Becker et al., 2015 and 2016; Al Hinai and Chitchyan, 2016; García-Mireles, 2016; Saputri and Lee, 2016; Zakaria et al., 2016; Beghoura et al., 2017; Oyedeji et al., 2017; Ahmad et al., 2018;

Condori-Fernandez and Lago, 2018; García-Mireles et al., 2018; Malik and Khan, 2018). Additionally, such quality aspects are among the criteria for evaluating information systems project success in the Square Route framework of Atkinson (1999). Accordingly, the following hypothesis has been developed:

> **Hypothesis 4:** Incorporating TBL-related quality requirements in the products of software projects has a significant and positive relationship with project success.

Based on the four hypotheses above, and that the four constructs above are the main components of SPS, the following hypothesis has been developed:

> **Hypothesis 5:** Software project sustainability (SPS) has a significant and positive relationship with project success.

Finally, because of the complicated nature of project success, it is essential to include control variables in the research framework (Carvalho et al., 2015). Several authors highlighted the importance of the contingency theory of Fiedler (1964) in the project management field, and that project success can be affected - positively or negatively - by different contingencies (e.g. project complexity, industry sector, and country) related to the context of the project. Therefore, in relevant contingent studies, control variables were applied to evaluate the effect of these contingencies (Shenhar, 2001; Davis, 2017; Carvalho and Rabechini, 2017). The most used control variables in project management literature are: country (Khang and Moe, 2008; Ahsan and Gunawan, 2010; Prasad et al., 2013; Carvalho et al., 2015), company size (Carvalho and Rabechini, 2015; Carvalho and Rabechini, 2017), industry sector (Ibbs and Kwak, 2000; Raz et al., 2002; Pennypacker and Grant, 2003; Zwikael and Ahn, 2011; Carvalho and Rabechini, 2017), and project complexity (Shenhar, 2001; Shenhar and Dvir, 1996; Shenhar et al., 2002; Carvalho et al., 2015; Carvalho and Rabechini, 2017). However, as the empirical testing of this research targets the key stakeholders of the internal software projects of the Jordanian public universities (discussed in section 4.11), only project complexity will be used in the framework because the other control variables are already pre-set and constant. Based on that, the following hypothesis has been developed:

> **Hypothesis 6**: Project complexity has a significant impact on project success.

The operationalisation of project complexity is discussed in section 4.8.3, measuring project complexity (low, medium, and high) is discussed in section 5.8.1, and the evaluation of its effect is discussed in section 5.8.4.

3.4 Conclusion

This chapter presents a conceptual framework that helps in the empirical examination of the relationship between software project sustainability (SPS) on project success. The proposed framework consists of six constructs which have been developed through a systematic literature review and based on the analysis of the best relevant contributions. The first four constructs, which are independent variables (IVs) and represent SPS, are economic considerations (ECCs), environmental concerns (EVCs), social responsibilities (SRs), and TBL-related quality requirements (QRs). These constructs encompass a unique combination of TBL-related aspects for incorporating sustainability into processes and products of software projects and form a significant part of the contribution of this thesis. The fifth construct, project success (PSCS), was positioned as a dependent variable (DV), and the sixth construct, project complexity, was set as a control variable in the proposed framework. The development of the framework is affiliated with the triple bottom line (TBL) theory, the ISO/IEC 25010:2011 product quality model of systems and software, the Sustainability Checklist of the International Project Management Association (IPMA), the contingency theory, and the multidimensional model of Shenhar and Dvir (2007) for measuring project success.

Chapter 4 - Research methodology and design

4.1 Introduction

The aim of this chapter is to present and explain the suitability and relevance of the methodologies utilised in this study, details of which are presented in the different sections of the chapter. The ontological and epistemological considerations are presented in section 4.2, whilst an explanation of the adopted research philosophy, positivism, is presented in section 4.3. Section 4.4 presents a comparison between inductive and deductive research approaches and justifies why the latter approach is better suited to the nature of the current study. Further, section 4.5 provides a comparison between quantitative and qualitative research choices and an explanation as to why the former choice was deemed more suitable for the current study. The utilised research strategy and the data collection technique are in section 4.6, whilst the development of the questionnaire content is presented in section 4.7. Variables operationalisation and questionnaire items are in section 4.8 and section 4.9 discusses the used method for translating the questionnaire. Section 4.10 presents the utilised methods for pre-testing the questionnaire. Sampling procedures of the main study are discussed in section 4.11. Section 4.12 presents the used criteria for verifying the quality of the questionnaire. Section 4.13 discusses the ethical considerations, and finally, section 4.14 concludes the whole chapter.

4.2 Ontological and epistemological considerations

As defined by Saunders et al. (2016: 726), research is "the systematic collection and interpretation of information with a clear purpose, to find things out". This "systematic way" in which research should be carried out refers to the process of utilising research philosophies, strategies, methods, and instruments with the aim of reaching reliable research outcomes. Reaching reliable research outcomes also requires that researchers "find out things" by answering research questions (Saunders et al., 2012). Further, the process of research design must also take into account the two main philosophical positions, ontology and epistemology (Adams et al., 2007).

4.2.1 Ontology

Ontology is the philosophical study of being. It places a particular focus on the researcher's personal views on existence and reality. Following the supposition that knowledge is existent and able to be tested, ontology is divided into two positions, objectivism and subjectivism. Objectivism maintains the view that reality is unrelated to social actors and remains unaffected by any interaction that may occur between these actors. It thus follows that, according to objectivism, efforts by the researcher to change reality will not yield any results. The latter position, subjectivism, maintains the opposing view that reality is a social phenomenon brought about by the interaction of social actors; thus, according to subjectivism, the researcher is able to influence reality (Adams et al., 2007; Saunders et al., 2016). For the purpose of the current study, an objectivist approach was taken.

4.2.2 Epistemology

Epistemology is a philosophical position which is concerned with the nature and ways of acquiring knowledge about reality, as well as the ways of testing the reliability of this knowledge (Johnson and Duberley, 2000). Epistemology can be divided into two positions, positive epistemology and anti-positive epistemology. Whilst positive epistemology derives explanations about phenomena in the social world from the causal relationships between a phenomenon's components, anti-positive epistemology derives its explanations by observing the perspectives of the social actors of a phenomenon (Saunders et al., 2012). The current study adopts the position of positive epistemology, as it attempts to examine causal relationships - between two concepts - by investigating the potential impact of software project sustainability (SPS) on project success through the medium of observable, measurable facts from which law-like generalisations about a specific social reality can be drawn (Saunders et al., 2016: 128).

4.3 Research philosophy and methodological adoptions

Saunders et al. (2012) hold the view that understanding research philosophy is fundamental for conducting research, as it allows the researcher to select the type and source of data most suitable for a given study. Collis and Hussey (2013) also add that understanding research philosophy facilitates the accomplishment of the research objectives by allowing the researcher to choose the appropriate research instruments. In an attempt to clarify the different philosophical and methodological terms and concepts related to research, Saunders et al. (2016) developed the "Research Onion", a diagram which depicts the different possible research philosophies, approaches, strategies, and methods used in the research process.

Figure 4.1 presents the “Research Onion”, with the red marked parts being the selected choices for the current study.

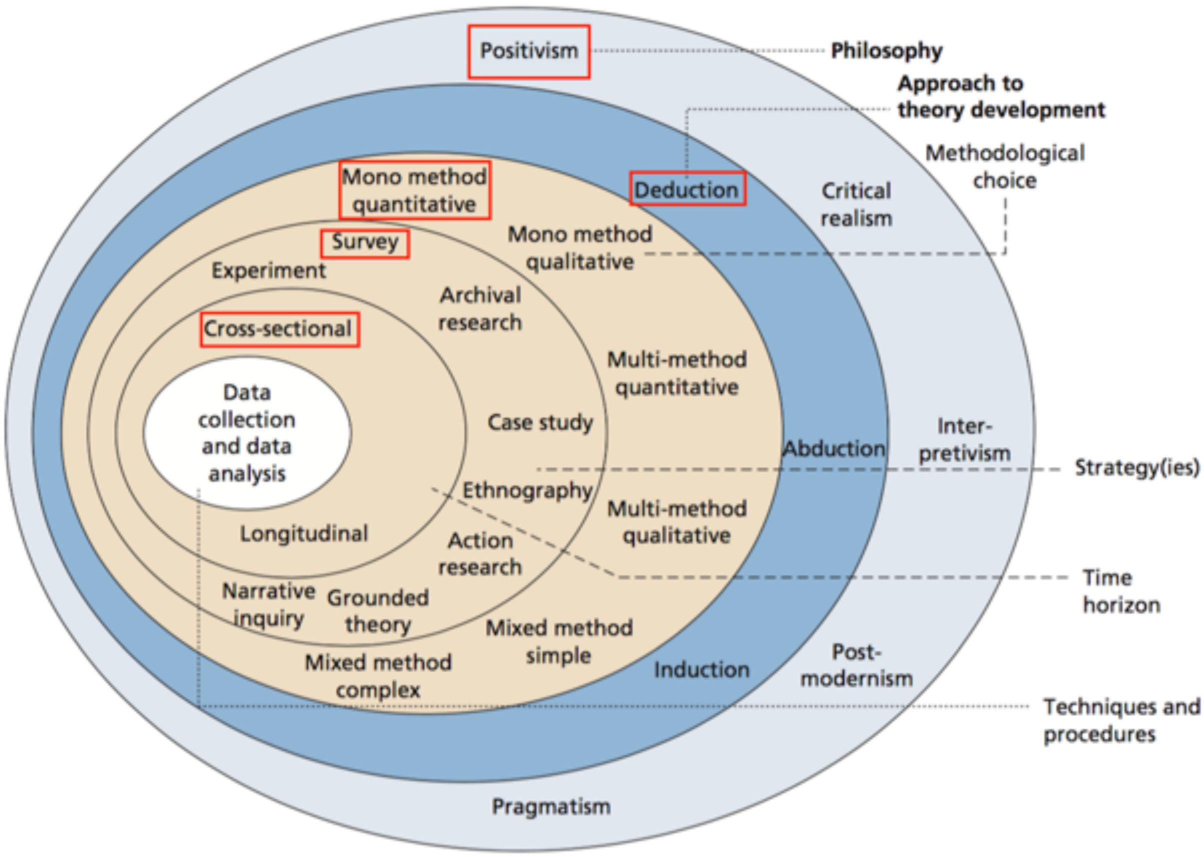

Figure 4. 1: The Research Onion and the selected choices for the current study (Saunders et al., 2016: 124)

4.3.1 Research Philosophy

The “Research Onion” presents five research philosophies: positivism, critical realism, interpretivism, postmodernism and pragmatism, all of which may be seen to reflect the kind of knowledge appropriate for the researcher and the field of research. Positivism is concerned with the philosophical stance of the natural scientist. Therefore, as with physical and natural sciences, the researcher works with an observable social reality to make law-like generalisations. Critical realism aims to go beyond that which is observed by exploring the underlying structures of reality. Therefore, critical realists utilise a range of techniques to under-take historical analyses of changing or enduring societal and organisational structures. Interpretivism, a subjectivist philosophy, states that the difference between humans and physical phenomena is that humans can create meanings. Therefore, interpretivists explore meanings in order to better understand organisational realities. From an empirical perspective, interpretivists explore individuals' lived experiences and cultural artefacts, with the aim of incorporating their own interpretations, along with the participants' interpretations, into their research. Postmodernism focuses on the ability of language and power relations in world-making. Postmodernists attempt to challenge commonly accepted views and to shed light on alternative worldviews which have been overtaken by dominant perspectives. Postmodernists aim to find contradictions by deconstructing data, and postmodernist axiology is radically reflexive. Finally, pragmatism views positivism and interpretivism as philosophies which are not mutually exclusive. Rather, depending on the research questions, a study may utilise viewpoints from both positions, and external or multiple views of reality may be adopted when answering research questions. It thus follows that the research philosophy used to guide a study and reach knowledge is selected according to the nature of the research questions and that a study may use qualitative and quantitative data collection methods in tandem (Saunders et al., 2016).

4.3.2 Selection of the positivism research philosophy

Taking into consideration the nature of the study problem and after reviewing similar studies, the positivist philosophy was deemed most suitable for the current study. Positivism supports the study of phenomena as observable and independent social realities (Saunders et al., 2012). Thus, positivists hold the view that the researcher does not influence a social reality; rather, the researcher can only measure and quantify a social reality in an objective manner (Collis and Hussey, 2013). The role of the researcher, therefore, is to unmask what already exists and find knowledge using scientific, systematic, and highly structured methods. Positivism follows a deductive methodological approach to research (Aliyu et al., 2014), whereby hypotheses are determined to model casual relationships between variables and then quantitative techniques are used to test these hypotheses and relationships, with as little intervention on behalf of the researchers as possible (Creswell, 2014). The researcher must test the hypotheses using data collected from a representative sample of a large population, which allows for the generalisation of the results. It is argued that positivist researchers are likely to adopt a quantitative methodological choice using empirical techniques (e.g. quantifiable observations, questionnaire surveys, experiments, case studies, and statistical analysis) to reach accurate and credible results and to facilitate replication (Gill and Johnson 2010; Saunders et al., 2016). Williams (2007) concludes that the fundamental elements of a positivist study are pre-determined relationships, quantifiable measures of the researched constructs, hypotheses testing, and generalisation of outcomes to the large population based on a representative sample.

The adopted positivist philosophy would allow the current study to empirically test and validate the conceptual framework and the related hypotheses. As per the recommendations of Collis and Hussey (2013), a literature review was initially carried out, followed by establishing the appropriate theory and formulating the hypotheses. Following are the main reasons as to why a positivist philosophy was considered to be most suited to the aims of this study:

- A systematic literature review was carried out prior to the development of the hypotheses. Also, it was decided that the hypotheses would be tested using a quantitative choice and strategy (Saunders et al., 2012).
- A positivist approach ensures that the study remains unaffected by the researcher's influence.
- Data can be collected from a large study sample accurately whilst also providing the researcher with a clear theoretical study focus (Creswell, 2014).

It is important to note that although a positivist philosophy was adopted for the current study, it was not the only research philosophy suitable. A pragmatist approach could have been adopted, but that would have required the conduction of interviews to investigate the research constructs (Guba and Lincoln, 1994). However, as the addressed research problem focuses mainly on contradictions in the relationship between existing constructs and not on building or discovering new constructs, interviews were seen to be unnecessary, and a pragmatist approach was therefore not adopted. In other words, this research intends to investigate the potential impact of one concept (SPS) on another (project success) based on their existing constructs that are widely accepted in the literature rather than developing new constructs through interviews. The research problem concerns the contradictions regarding the relationship between these concepts and their existing relevant constructs, and by investigating and developing new constructs - where the problem does not yet exist – the research would steer away from its aim. Further, the study objectives require an objectivist ontological approach with little intervention on behalf of the researcher. In order to ensure that the researcher had no influence on the study outcomes, realism and interpretivism were dismissed, as both philosophies follow a subjective ontological approach that advocates the influence of the researcher (Guba and Lincoln, 1994; Gray, 2013).

4.4 Research approach

The most commonly adopted approaches in the field of business studies are deductive and inductive (Saunders et al., 2016), the former of which was adapted for the current study. Using this approach, the researcher begins by testing a certain theory and then accepting, modifying, or rejecting the theory according to the test results. Thus, the research process progresses from the general to the specific. According to Saunders et al. (2012), a positivist philosophy and a deductive approach go hand in hand, as deductive researchers rely on quantitative data collection and analysis techniques whilst maintaining a positivist view to reality. A deductive study begins with a literature review in order to establish hypotheses which portray testable causal relationships between different variables and which are then tested using quantitative methods, making the results generalisable to the whole population represented by the study sample (Creswell, 2014).

On the other hand, an inductive study moves from the specific to the general, whereby the researcher begins with making observations and collecting data and progresses to establishing a theory (Collis and Hussey, 2013). Such studies rely on qualitative data collection and analysis methods (Saunders et al., 2012). One drawback to adopting an inductive approach to research is that an inductive researcher is also often an interpretivist, which may result in researcher bias and thus impact the credibility of the study. Another drawback to induction is that, unlike a deductive study, an inductive study has a small study sample, preventing the study results from being generalizable to the whole population represented by the study (Saunders et al., 2016). However, an inductive approach may be necessary in cases where there is a lack of literature on the study problem, disabling the researcher from establishing hypotheses (Krishnaswamy, 2006). The main differences between induction and deduction are presented in Table 4.1.

Table 4. 1: Deduction and induction approaches
(Saunders et al., 2016)

	Deduction	Induction
Logic	In a deductive inference, when the premises are true, the conclusion must also be true	In an inductive inference, known premises are used to generate untested conclusions
Generalisability	Generalising from the general to the specific	Generalising from the specific to the general
Use of data	Data collection is used to evaluate propositions or hypotheses related to an existing theory	Data collection is used to explore a phenomenon, identify themes and patterns, and create a conceptual framework
Theory	Theory falsification or verification	Theory generation and building

4.5 Methodological choice

There are two main methodological choices to research, a qualitative choice and a quantitative choice (Saunders et al., 2016), the latter of which was considered most suited to the aim and context of the current study. The quantitative methodological choice is in line with objectivist ontology and the deductive approach (Creswell, 2014), whilst the qualitative choice is generally associated with the inductive approach. In this context, quantitative research aims to address a particular problem and investigate the relationships between constructs using scientific procedures and statistical analysis (Bryman and Bell, 2015), whilst qualitative research relies on the circumstances behind the study problem in order to establish theories (Marschan-Piekkari and Welch, 2004; Creswell, 2014). Further, since qualitative methods reflect the participants' interpretations and subjective perceptions of social reality, results may not always be considered credible (Bryman and Bell, 2015). On the other hand, a quantitative methodological choice produces results which are arguably more credible, as it enables the researcher to test the validity of pre-established theories and related hypotheses using experimentation and accurate measurement techniques (Saunders et al., 2016). According to Creswell (2014), quantitative techniques are necessary for the validation of theoretical models in a scientific manner, as such techniques allow the researcher to test and interpret relationships statistically.

However, that is not to say that a qualitative choice is unreliable and should thus not be used. A qualitative choice may be selected for studies which aim to explore a social reality subjectively by describing and interpreting human behaviour. It may also prove necessary in cases where there is a lack of studies which explore the same variables and their relationships (Saunders et al., 2016), as such a choice allows the researcher to explore new topics (Creswell, 2014; Bryman and Bell, 2015). Following a qualitative choice, the researcher is able to study and better understand phenomena as they occur in their natural circumference, establish theories, and address related complex procedures.

In conclusion, whilst a quantitative choice was considered as generally being most suitable for the current study, a literature review was also necessary in order to formulate propositions and establish hypotheses related to the study problem (the relationship between SPS and project success). Therefore, this research also incorporates a qualitative choice with an inductive approach at the initial stage, where data from previous literature were used to develop a conceptual framework. However, based on Saunders et al. (2016), the methodological choice of this research is considered as a mono method quantitative.

4.6 Research strategy and time horizon

Experiments, surveys, archival studies, case studies, ethnographies, action research, grounded theory, and narrative inquiry are all examples of research strategies (Saunders et al. 2016). Some strategies, such as experiment and survey, are most suited to the deductive approach, whilst strategies such as ethnography and grounded theory are most suited to the inductive approach. Other strategies, such as case studies, may be used in both the inductive approach and deductive approach (Bryman and Bell, 2015; Saunders, et al., 2016). For the current study, a survey strategy was selected, as that would maintain the consistency between the research philosophy, approach, and methodological choice.

The survey strategy may be used in studies with both exploratory or explanatory research objectives (Adams et al., 2007) and in studies which require the researcher to collect large amounts of data (Saunders et al., 2012). Baruch (1999) explains that the survey strategy is a quick and efficient method of collecting large amounts of data, making it a fundamental strategy for studies in the field of social science. Further, the strategy may be seen as feasible and economic, and data collected using the survey strategy may be considered as high-quality data when the survey is properly built and managed (Creswell 2014; Saunders et al., 2016).

The survey strategy is commonly linked to a deductive research approach. It is commonly utilised in business and management research and aims to answer ‘what’, ‘who’, ‘where’, ‘how much’ and ‘how many’ questions, making it suitable for exploratory and descriptive research. The most commonly used survey strategy technique is the questionnaire, as it allows for the collection of standardised data from a sizeable population in a cost-effective manner, therefore facilitating comparison. Further, the survey strategy is generally seen to be authoritative and can be explained and understood without much effort. It is highly common for a news bulletin, news website, or newspaper to report the results of a new survey which provides insight into the opinions and behaviours of people towards a certain issue (Saunders et al., 2016). Using a questionnaire survey, the researcher can gather large amounts of empirical data on the behaviours, opinions, and attitudes of a large number of respondents towards a certain topic (Maylor and Blackmon, 2005).

However, a disadvantage of using the survey strategy is that it may limit the scope of the collected data; this is because a questionnaire should not be composed of a large number of questions, as that would lead to a low response rate. Finally, although the questionnaire was seen as the most appropriate technique for the aims of this study, the survey strategy has other data collection techniques. This includes structured observation, which is commonly used in organisation and methods (O&M) research, and structured interviews, whereby interviewees are asked a set of standardised questions (Saunders et al., 2016).

There are two commonly utilised questionnaire techniques, the self-administered questionnaire and the interviewer-administered questionnaire. The difference between the two techniques lies in the extent of the interviewer's involvement, with the former technique requiring no interference on behalf of the interviewer and the latter requiring some form of verbal interference. This interference may be in the form of a telephone interview or a structured face-to-face interview (Maylor and Blackmon 2005; Saunders et al., 2016). Both techniques have their advantages and disadvantages. The interviewer-administered questionnaire is a preferable option among researchers, as it can be used for all types of research (Maylor and Blackmon, 2005; Hair et al., 2007) and it allows the researcher to expand upon the respondent's answers by asking further questions or making comments (Bryman and Bell, 2015). Whilst the flexibility of interviews may be favoured by researchers, this survey technique is often found to be costly, time-consuming, and difficult to use with a large number of respondents or respondents in different locations. Hence, the self-administered questionnaire can be considered a more timesaving, cost-effective, and feasible option, as it can easily be distributed to a large number of respondents in different locations online or through the internet, postal, or hand-delivery (Gable, 1994; Kaplowitz et al., 2004). On the other hand, whilst some respondents may appreciate the lack of interviewer intervention in a self-administered questionnaire (Jackson, 2011; Saunders et al., 2012), respondents who require further clarification of certain questions may find this disadvantageous. Further, a self-administered questionnaire leaves no room for the researcher to ask extra questions and gather more information (Creswell, 2014; Saunders et al., 2016). Table 4.2 compares between the two questionnaire techniques based on their distribution types (the method of delivery and collection). Researchers who opt for questionnaire must take into account the type of technique they use.

Table 4. 2: Questionnaire techniques and their distribution types
Based on Gable (1994), Kaplowitz et al. (2004), Jackson (2011), and Saunders et al. (2012)

Questionnaire techniques	Interviewer-administered		Self-administered		
Distribution types	Telephone interview	Personal Interview	Postal	Hand-delivery	Internet
Cost	Medium	High	Low	High	Very Low
Response rate	Medium	High	Medium	High	Very low
Amount of Sample	Medium	Low	Large	Low	Large
Survey Length	Up to 30 minutes	Up to 2 hours	Up to 20 minutes	Up to 20 minutes	Up to 20 minutes
Training	Required	Required	Not required	Not required	Not required
Respondents' feeling of	Uncomfortable	Less comfortable	Comfortable	Comfortable	Comfortable
Missing data	Low	Low	Medium	Low	Medium
Reaching respondents	Easy	Difficult	Medium	Medium	Easy
Interviewer bias	Yes	Yes	No	No	No
Geographical coverage	Easy	Difficult	Easy	Difficult	Very Easy

A self-administered questionnaire using "hand delivery" was chosen as the data collection technique of this research. Despite the high costs and low geographical coverage, the hand-delivered self-administered questionnaire technique was selected based on the need for a relatively small sample of respondents, a high response rate, and a low rate of missing data. Also, some of the targeted participants, such as project managers and senior management, were expected to be busy and difficult to contact over the phone or to interview for more than a few minutes. Finally, training is not required for this technique and participants can respond freely, comfortably, and without bias, which adds to the accuracy and credibility of the results.

Finally, as with regards to the time frame used to conduct the study, researchers may choose between a cross-sectional study or a longitudinal study. A cross-sectional study is conducted within a limited, set time frame, whilst a longitudinal study is conducted over several periods of time (Saunders et al., 2016). Seeing as a longitudinal study can take up to several years and taking into account the time constraints facing the current study, the cross-sectional method was seen as most suited for this study.

4.7 Development of the questionnaire content

The questionnaire of this research was developed to gather data regarding the current sustainability practices in software projects and to evaluate the success of these projects. To investigate and analyse the potential impact of SPS on project success, an ex-post-facto survey design – also known as an after-the-fact study – was used. In this type of survey design, the investigation begins after the fact (the project) has occurred and without any interference from the researcher. This method was chosen in order to evaluate project success from both perspectives: project management success and project outcome success (Shenhar and Dvir, 2007; Carvalho and Rabechini, 2017). Therefore, a sentence was written inside the questionnaire notifying the respondents that when answering the relevant questions (in part two), they should refer to a project (internal software project) that had already been completed and that they had participated in.

The questionnaire consisted of two parts (Appendix C). The first part had two sections (question 1 to question 7) and included general information (demographic data) regarding the respondents and their projects (e.g. education, experience, age, project team, cost, and duration). The second part was divided into five sections and included questions regarding the framework constructs – economic considerations (ECCs) (question 8 to question 12), environmental concerns (EVCs) (question 14 to question 21, "question 13" is an attention question, discussed in section 5.7.2), social responsibilities (SRs) (question 22 to question 27), Incorporating TBL-related quality requirements (QRs) (question 28 to question 35), and project success (PSCS) (question 36 to question 44). All parts and sections included descriptions about the upcoming questions to ensure that the obtained responses would be as accurate as possible.

For the second part, several question design principles were taken into account throughout the questionnaire design process. For example, it was ensured that the questions were succinct and that they did not require too much time to answer, as this would encourage an increased response rate. Simple and comprehensible questions were adapted to allow respondents to complete the questionnaire easily and without the need for assistance. To avoid researcher bias, negative, ambiguous, or leading questions were avoided (Cooper and Schindler, 2001; Greener, 2008; Harlacher, 2016). Sekaran and Bougie (2010) suggest three points to consider when designing a questionnaire that is as least biased as possible: the choice of wording style used for the questions, the general appearance and layout, and the categorisation, scaling, and coding of the study constructs. These points were considered during the design process for the questionnaire of the current study in order to guarantee valid and reliable results. To make sure that each construct was covered accurately and sufficiently, the questionnaire items were developed using relevant questions which had been utilised in previously published works and which were adapted to suit the context of the current study (Ary et al., 2002; Creswell, 2012). Also, in order to further reduce bias on behalf of the researcher and the respondents and reduce the required response time, the closed-ended format was utilised for designing scaled-response questions. The closed-ended format facilitates the questionnaire completion by reducing the effort and thinking time needed by respondents to answer the questions (Saunders et al., 2016). Moreover, to ensure the content validity, adequacy, and comprehensibility of the questions and response options, a number of academics and practitioners from relevant fields (e.g. project management, software engineering, and sustainability) were consulted – as a face validation procedure – during the development of the questionnaire. After that, a pilot study was carried out as well.

The first part of the questionnaire used nominal data, but in the second part, scaled-response questions were utilised to obtain data on the beliefs, attitudes, and opinions of the respondents regarding the framework constructs (Alreck and Settle, 1995). Specifically, the widely used Likert scale was utilised to allow the respondents to express their level of agreement with each statement (question) through five options ranging from strongly disagree (1) to strongly agree (5). The Likert scale was developed by Rensis Likert in 1932 (Saunders et al., 2012); it is a popular option among researchers in the business field due to its efficiency and effectiveness and because it can easily be understood (Collis and Hussey, 2013; Bryman and Bell, 2015). Likert scale-type questions yield quantifiable responses relevant to mathematical and statistical analysis and allow respondents to express their undecided or neutral feelings freely, without pushing them towards a concrete yes or no response (Saunders et al., 2012; Creswell, 2014). Therefore, the Likert scale was found to be most suitable for the aims of the current study.

Finally, attached to the questionnaire was a cover letter (Appendix C) describing the aim of the research and ensuring the respondents that all data would be treated confidentially and used for academic purposes only. The respondents were thanked at the end of the questionnaire and were asked to feel free to make any further comments or recommendations. The questionnaire was translated from English into Arabic (Appendix D) as described in section 4.9. The final version consisted of 44 questions – after the modifications made in the face validation and the pilot study (section 5.6) – and required approximately 15 to 20 minutes completion time. The final version of the questionnaire is presented in Appendix C. The following section clarifies the operationalisation of the variables and the items of the second part of the questionnaire.

4.8 Variables operationalisation and questionnaire items

According to Hair et al. (2017), in order to properly examine the relationships between different concepts in a conceptual framework, the measurement model (questionnaire items) of these concepts should be carefully developed based on conceptual reasoning before data collection. In this context, Creswell (2012) states that it is easier, faster, and much better to borrow relevant constructs (variables) and indicators which have already been used or measured by previous studies. Likewise, Ary et al. (2002) assert that the proposed constructs should be developed from a variety of previous related resources and operationalised using observable indicators (questionnaire items) which represent the best meaning of these constructs and which are consistent with their theoretical definition. Therefore, the development of the proposed conceptual framework and the operationalisation of its constructs (variables) was carried out using indicators which had previously been used in the relevant literature and which were adapted as questionnaire items for these constructs. The questionnaire items of the constructs were formulated as statements, applying a five-point Likert scale (as mentioned earlier). Following are details of the operationalisation of the variables and the questionnaire items of the measurement model.

4.8.1 Independent variables (IVs)

Software project sustainability (SPS) was developed as a multidimensional concept represented by four interrelated and complementary constructs: economic considerations (ECCs), environmental concerns (EVCs), social responsibilities (SRs), and Incorporating TBL-related quality requirements (QRs). These constructs were developed as independent latent variables (IVs) and operationalised using TBL-related aspects as indicator variables – also known as manifest variables (MVs) or items – based on the analysis of a variety of the best contributions in the relevant literature. The questionnaire items of each IV were adapted from relevant empirical contributions in a way that represents the best meaning of the IV and is consistent with its theoretical definition. Details about the operationalisation of each independent variable (IV) and its questionnaire items are as below.

- **Economic considerations (ECCs)**

Economic considerations (ECCs) is the first independent variable (IV) of SPS in the proposed framework. It was operationalised using relevant economic aspects – return on investment and strategic value (as discussed in section 3.1.2, Table 3.4) – as indicator variables. Return on Investment is defined as taking into account the direct financial benefits originating from reducing the use of resources, reducing costs, improving processes, and minimising risks. Strategic value is defined as evaluating and selecting projects based on both long- and short-term strategic value. The adapted questionnaire items of ECCs, presented in Table 4.3 below, are consistent with the definitions of these aspects.

Table 4. 3: The operationalisation of economic considerations (ECCs)

Independent variable	**Aspects (Indicators)**	**Code**	**Questionnaire items** (the questions and their numbering inside the questionnaire)		**Adapted from**
Economic considerations (ECCs)	Return on Investment	ECCs01	Q8	In your chosen project, financial benefits originating from cost savings were taken into account.	APM (2016), Martens and Carvalho (2017)
		ECCs02	Q9	In your chosen project, financial benefits originating from reducing the use of resources were taken into account.	
		ECCs03	Q10	In your chosen project, financial benefits originating from improving business processes and minimising risks were taken into account.	
	Strategic value	ECCs04	Q11	The evaluation of this project was based on its short- and long-term strategic value.	Silvius et al. (2012)
		ECCs05	Q12	The selection of this project was based on its short- and long-term strategic value.	

**Please note that the first seven questions (Q1 to Q7) are for demographic data, and Q13 is for attention (discussed in section 5.7.2) in the initial and the final versions of the questionnaire, Appendix A and Appendix C, respectively.*

- Environmental concerns (EVCs)

Environmental concerns (EVCs) is the second independent variable (IV) of SPS in the proposed framework. It was operationalised using four environmental-related aspects as indicator variables; these aspects are transport, energy, waste, and green outsourcing (as discussed in section 3.1.2, Table 3.4). The adapted questionnaire items of EVCs – presented in Table 4.4 below – are consistent with the definitions of these aspects.

Table 4. 4: The operationalisation of environmental concerns (EVCs)

Independent variable	Aspects (Indicators)	Code	Questionnaire items (the questions and their numbering inside the questionnaire)*		Adapted from
Environmental concerns (EVCs)	Transport	EVCs01	Q14	Travel policies that consider environmental aspects were applied in the project.	Silvius et al. (2012)
		EVCs02	Q15	The project delivery processes were designed to minimise travelling and travelling time in the project, and the use of eco-friendly alternatives (e.g. emails, mobiles and telephones, video conferencing, emission-free travelling like walking or cycling) was actively promoted.	Taina (2011), Shenoy and Eeratta (2011), Lami et al. (2012), Silvius et al. (2012), Penzenstadler and Femmer (2013a), Mahmoud and Ahmad (2013)
	Energy	EVCs03	Q16	There were policies in the project to promote the smart use of energy, and where possible, energy-saving equipment was used.	Silvius et al. (2012)
		EVCs04	Q17	Where possible, energy consumption was actively kept to a minimum and the necessary energy used was acquired as 'green' energy.	
		EVCs05	Q18	Minimising energy consumption was one of the parameters in the design of the project delivery processes.	
	Waste	EVCs06	Q19	The project had policies to minimise waste (e.g. double-sided printing, recycling necessary waste in the project itself).	
		EVCs07	Q20	The project delivery processes were designed to minimise waste.	
	Green outsourcing	EVCs08	Q21	Project procurement took into consideration environmental aspects when selecting products (e.g. their energy consumption, the waste and pollution they cause, their reuse capabilities).	Carvalho and Rabechini (2017)
		EVCs09	Q22	The project supply chain took into consideration environmental aspects when selecting suppliers (e.g. suppliers' environmental policies and their use of natural resources, suppliers' knowledge, and their locations).	

**Please note that each item in this table has the same number in the initial version of the questionnaire (Appendix A). However, the numbering is different in the final version of the questionnaire (Appendix C), as Q18 was deleted after conducting the pilot study (as discussed in section 5.6).*

Transport refers to applying travel policies and designing software project processes in a way to minimise travel, as well as actively promoting travel alternatives (e.g. emails, mobiles and telephones, video conferencing). Energy refers to taking into account energy consumption in the design of project processes and promoting green energy, energy saving equipment, and smart use of energy. Waste refers to applying policies to minimise waste, such as promoting double-sided printing or avoiding unnecessary usage of paper; optimising resource consumption (reducing, reusing, and recycling); and considering waste in the design of project processes. Green outsourcing refers to taking into account environmental aspects when selecting materials, products, and equipment (e.g. their energy consumption, the waste and pollution they cause, their reuse capabilities). It also refers to selecting suppliers based on their environmental policies, knowledge, use of natural resources, and location (to minimise transport).

- **Social responsibilities (SRs)**

Social responsibilities (SRs) is the third independent variable (IV) of SPS in the proposed framework. It was operationalised using four social-related aspects as indicator variables: labour practices and decent work, human rights, society and customers, and ethical behaviour (as discussed in section 3.1.2, Table 3.4). Labour practices and decent work refer to applying policies for occupational health and safety (e.g. hazard identification, risk assessment, determination of controls, legal requirements, incident monitoring); applying policies for diversity and equal opportunities; and taking care of working conditions, social insurance, payments, and stakeholders' development (training and education). 'Human rights' refers to applying policies to ensure that human rights are met (e.g. no child labour, freedom of association, and non-discrimination) and designing project processes in a way to promote human rights. Society and customers refer to compliance with public policies and having a social responsibility towards society (e.g. health and welfare; community support; customer privacy and safety; market communication and advertising; product and service labelling). Ethical behaviour refers to supporting fair trade and competition; rejecting bribery, corruption, and anti-competitive behaviour; and having well-written codes of conduct which support principles and values such as honesty, transparency, privacy, fairness, trust, accountability, and respect. The adapted questionnaire items of SRs presented in Table 4.5 below, are consistent with the definitions of these aspects.

Table 4. 5: The operationalisation of social responsibilities (SRs)

Independent variable	Aspects (Indicators)	Code	Questionnaire items (the questions and their numbering inside the questionnaire)*		Adapted from
Social responsibilities (SRs)	Labour practices and decent work	SRs01	Q23	The project included training, education, and development of stakeholders.	Silvius et al. (2012)
		SRs02	Q24	The project applied policies or standards for diversity and equal opportunity in terms of gender, race, religion, etc.	
		SRs03	Q25	Aspects of occupational health and safety were considered for project staff and outsourced (e.g. hazard identification, risk assessment, determination of controls, legal requirements, incident monitoring).	Carvalho and Rabechini (2017)
	Human rights	SRs04	Q26	The project applied policies or standards for respecting and improving human rights, including non-discrimination, freedom of association and no child labour.	Silvius et al. (2012)
		SRs05	Q27	The project also required its suppliers and partners to respect and improve human rights where possible.	
	Society and customers	SRs06	Q28	The project had complied with public policies and had a social responsibility towards the society it operated in (e.g. the health and welfare of society; community support; customer health and safety; product and service labelling; market communication and advertising; customer privacy).	ISO (2010), Silvius et al. (2012), GPM (2015), Marcelino-Sádaba et al. (2015), Carvalho and Rabechini (2017)
		SRs07	Q29	The project took into account the expectations of stakeholders.	Marcelino-Sádaba et al. (2015), Carvalho and Rabechini (2017)
	Ethical behaviour	SRs08	Q30	The project rejected bribery and corruption, and had well-written codes of conduct which support principles and values such as honesty, transparency, privacy, fairness, trust, respect, and fair trade and competition.	ISO (2010), Mishra et al. (2011), APM (2016), Martens and Carvalho (2017)

**Please note that each item in this table has the same number in the initial version of the questionnaire (Appendix A). However, the numbering is different in the final version of the questionnaire (Appendix C), as Q27 and Q29 were deleted after conducting the pilot study (as discussed in section 5.6).*

- **Quality requirements (QRs)**

The fourth independent variable (IV) of SPS in the proposed framework is quality requirements (QRs). It was operationalised using the following TBL-related quality aspects as manifest variables (indicators): functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. The adapted questionnaire items of QRs, presented in Table 4.6 below, are consistent with the definitions of these aspects (discussed in section 3.1.1).

Table 4. 6: The operationalisation of quality requirements (QRs)

Independent variable	Aspects (Indicators)	Code	Questionnaire items (the questions and their numbering inside the questionnaire)*		Adapted from
Incorporating TBL-related quality requirements (QRs)	Functional suitability	QRs01	Q31	Facilitating the accomplishment of all specified tasks and objectives correctly and accurately was among the quality requirements of the software.	ISO/IEC 25010:2011 (2018)
	Performance efficiency	QRs02	Q32	Response time, processing time, throughput rates, and the maximum capacity of the software were taken into account.	
	Compatibility	QRs03	Q33	The software can perform its required functions efficiently while exchanging information and sharing a common environment and resources with other products, without any detrimental impact on any other product.	
	Usability	QRs04	Q34	The software enables people with the widest range of characteristics and capabilities to use it easily, appropriately, efficiently, effectively, satisfactorily, risk-free, and without errors.	
	Reliability	QRs05	Q35	The software was designed to be always ready when required for use, and it is capable to recover the affected data and its desired state in the event of an interruption or a failure.	
	Security	QRs06	Q36	The software prevents unauthorised access or modifications, and actions or events can be traced and proven.	
	Maintainability	QRs07	Q37	The software can be modified and used in more than one system effectively and efficiently without introducing defects.	
	Portability	QRs08	Q38	The software can be transferred effectively and efficiently from one hardware - or other operational or usage environment - to another.	
	Certain quality requirements of stakeholders	QRs09	Q39	In the design stage of the software, certain quality requirements of internal stakeholders (e.g. employees, students, higher management) were taken into account.	Developed by the author based on Raturi et al. (2014), Penzenstadler (2015), Becker et al. (2015 and 2016), and Oyedeji et al. (2017).
		QRs10	Q40	In the design stage of the software, certain quality requirements of external stakeholders (e.g. government or any other legal authority) were taken into account.	

**Please note that each item in this table has the same number in the initial version of the questionnaire (Appendix A). However, the numbering is different in the final version of the questionnaire (Appendix C), as Q39 and Q40 were deleted after conducting the pilot study (as discussed in section 5.6).*

4.8.2 Dependent variable (DV)

Project success (PSCS) was positioned as a dependent latent variable (DV) in the proposed framework. It was operationalised using five relevant dimensions as reflective indicators (manifest variables): project efficiency, impact on the customer, impact on the team, business success, and preparation for the future. These dimensions were selected and defined based on the theoretical models of Shenhar et al. (1997 and 2001), Shenhar and Dvir (2007), and Shenhar (2011), as they include one of the most cited criteria for measuring project success (Davis, 2014; Silvius and Schipper, 2016). These dimensions were also used in relevant studies such as Mir and Pinnington (2014), Martens and Carvalho (2016b), and Carvalho and Rabechini (2017). The questionnaire items of PSCS, presented in Table 4.7 below, were adapted from Shenhar and Dvir (2007) and are consistent with the definitions of these dimensions (as discussed in section 3.2, Table 3.5).

Table 4. 7: The operationalisation of project success (PSCS)

Dependent variable	Dimensions	Code		Questionnaire items (the questions and their numbering inside the questionnaire)*	Adapted from
Project success (PSCS)	Efficiency	PSCS01	Q41	The project was completed on time or earlier.	Shenhar and Dvir (2007)
		PSCS02	Q42	The project was completed within or below budget.	
	Impact on the customer	PSCS03	Q43	You were satisfied, and the software met all requirements.	
		PSCS04	Q44	The software improved your work performance.	
	Impact on the team	PSCS05	Q45	The project team was highly satisfied and motivated.	
		PSCS06	Q46	Team members experienced personal growth.	
	Business success	PSCS07	Q47	The project was an economic business success.	
		PSCS08	Q48	The project increased the organisation's market share.	
		PSCS09	Q49	The project contributed to the organisation's direct performance.	
	Preparing for the future	PSCS10	Q50	The project outcome will contribute to future projects.	
		PSCS11	Q51	The project contributed to new business processes.	

**Please note that each item in this table has the same number in the initial version of the questionnaire (Appendix A). However, the numbering is different in the final version of the questionnaire (Appendix C), as Q47 and Q48 were deleted after conducting the pilot study (as discussed in section 5.6).*

4.8.3 Control variable: project complexity

Project complexity was positioned as a control variable in the proposed framework. Several indicators are being used in literature to measure project complexity such as project cost, project duration, risk, technology, geographic dispersion, availability of resources, team multidisciplinary, pace, novelty, the size of project team, clarity and stability in requirements, political issues, number of stakeholders, level of organisational change, and others (Fitsilis, 2009; Wilson, 2014; Hass, 2016; Carvalho and Rabechini, 2017; ISTPMO, 2019). However, there is no consensus on a unified set of project complexity indicators, as it depends on the nature and context of the project (Vidal and Marle, 2008; Fitsilis and Damasiotis, 2015; Kermanshachi et al., 2016).

Among the long list of relevant indicators in literature, it can be observed that project cost, project duration, risk, clarity and stability in requirements, and the size of the project team, are the most used indicators for measuring project complexity and common between authors, and almost applicable to all types of projects. However, due to the nature of the targeted respondents and that some of them (e.g. project team, discussed in section 4.11) may not be able to give an accurate answer regarding the project cost and risk, only the size of the project team, project duration, and stability in requirements which were used in this research to measure project complexity. The adapted questionnaire items of project complexity are presented below in Table 4.8.

Table 4. 8: The operationalisation of project complexity

Control variable	**Indicators**	**Questionnaire items** (the questions and their numbering inside the questionnaire)		**Adapted from**
Project complexity	Project team size	Q5	What was the size of the project team?	Vidal and Marle (2008), Fitsilis and Damasiotis (2015), Hass (2016), ISTPMO (2019)
	Project duration	Q6	What was the project's duration?	
	Requirements clarity and stability	Q7	What was the overall level of clarity and stability in requirements?	

Measuring project complexity (low, medium, and high) is discussed in section 5.8.1, and the evaluation of its effect is discussed in section 5.8.4.

4.9 Translation of the questionnaire

Translation of the questionnaire from English into Arabic was carried out (Appendix D), as Arabic is the language of the targeted population (the key stakeholders of the internal software projects of Jordanian public universities, including project managers and senior management, discussed in section 4.11). Throughout the translation process, the researcher needed to take certain measures to ensure that meaning was not lost in translation and that the questions yielded the necessary data. Usunier (1998), cited by (Saunders et al., 2016: 464), recommends that when translating a questionnaire, a particular focus needs to be placed on:

- "Lexical meaning – the precise meaning of individual words".
- "Idiomatic meaning – the meanings of a group of words that are natural to a native speaker and not deducible from those of the individual words".
- "Experiential meaning – the equivalence of meanings of words and sentences for people in their everyday experiences".
- "Grammar and syntax – the correct use of language, including the ordering of words and phrases to create well-formed sentences".

Further, Table 4.9 presents a comparison between four techniques, developed by Usunier (1998), for the translation of a questionnaire. The technique that was found to be most suited to the aims of this study was "Back-translation" (cited by Saunders et al., 2016: 465), which included translating the questionnaire from English into Arabic and then into English again. This enabled the author to compare the original English version with the final English version, allowed him to identify any differences in meaning and therefore made the necessary adjustments to the Arabic version in order to convey the exact meaning of the source questionnaire (Saunders et al., 2016).

Table 4. 9: Translation techniques for questionnaires
(Saunders et al., 2016)

	Direct translation	Back-translation	Parallel translation	Mixed techniques
Approach	Source questionnaire to target questionnaire	Source questionnaire to target questionnaire to source questionnaire; comparison of two new source questionnaires; creation of final version	Source questionnaire to target questionnaire by two or more independent translators; comparison of two target questionnaires; creation of final version	Back-translation undertaken by two or more independent translators; comparison of two new source questionnaires; creation of the final version
Advantages	Easy to implement, relatively inexpensive	Likely to discover most problems	Leads to good wording of the target questionnaire	Ensures best match between source and target questionnaires
Disadvantages	Can lead to many discrepancies (including those relating to meaning) between source and target questionnaire	Requires two translators, one a native speaker of the source language, the other a native speaker of the target language	Cannot ensure that lexical, idiomatic, and experiential meanings are kept in the target questionnaire	Costly; requires two or more independent translators. Implies that the source questionnaire can also be changed

4.10 Pre-testing: the face validation and pilot study

Multiple testing stages and methods were carried out in order to ensure the validity and reliability of the data collection instrument (the questionnaire), in addition to a revision of the instrument by eight academics and practitioners from relevant fields. This review was carried out prior to the pilot study and aimed to ensure the content validity, readability, clarity, structure, and completeness of the designed questionnaire (Dillman, 1991). After the reviewers' recommendations were taken into account and the necessary modifications were made, the pilot study was carried out. A pilot study aims to identify any undetected errors and ambiguities before carrying out the final study, as the validation of the questionnaire during the initial stages confirms its' reliability as a data collection tool (Sekaran and Bougie, 2010). A pilot study also aims to enhance the design and the internal validity of the questionnaire and to eliminate any potential deficiencies or weaknesses in the research instrument (Zikmund, 2003). Therefore, the sequencing, wording, response rate, analysis process, and completion time of the questions are all tested out during a pilot study (Veal, 2005). Further, any major concerns or problems pertaining to the questionnaire and which may impact the research process can be identified during the piloting stage. The pilot study for the current research was carried out on a sample of 20 volunteer respondents who represented the targeted population to an accurate degree. This was in line was the recommended sample of 10 to 30 respondents (Saunders et al., 2012). Section 5.6 in the following chapter presents the results of the pilot study.

4.11 Sampling procedures

The target population of this research included the key stakeholders (project managers, project team, and senior management) of the internal software projects of Jordanian public universities. The reason behind focusing on internal projects is the possibility of having the key stakeholders in the same place, unlike external projects (Lock, 2007). Also, the reason for targeting the key stakeholders of these projects is their strong influence in evaluating project success (Davis, 2017). According to the Ministry of Higher Education and Scientific Research in Jordan, there are ten public universities in Jordan (MHESR, 2019). After conducting the pilot study and contacting the heads of relevant departments in these universities (e.g. Departments of Information Technology, Software Development, Information Systems, or Computer and the Information Technology Centre), approximately 300 key stakeholders who represent the sampling frame of whole population of respondents and from which the actual sample of this research were selected. A sufficient sample of respondents was carefully considered in order to accurately represent the targeted population and to yield reliable and generalisable statistical outcomes. The determination of the actual sample size was based on practical considerations such as the estimated response rate and the minimum sample size required for the adopted statistical technique to undertake the analysis as required.

As this research used a self-administered, hand-delivered questionnaire, the response rate was expected to be high, over 70%; in some cases, "response rates as high as 98 per cent are achievable!" (Saunders et al., 2016: 480). Accordingly, and after conducting the pilot study and receiving advice from relevant respondents from the universities, the estimated response rate was 75%. However, in terms of the minimum sample size required to undertake the analysis, this was based on the adopted statistical technique. In this context, the conceptual framework of this research proposes a number of relationships between the variables of both concepts, SPS and project success. In situations where the hypothesis of the research investigates the relationships and patterns simultaneously between different variables and investigates the strength of these relationships, 'Multivariate Regression' is seen as an appropriate analysis method. In simple words, it is a method to predict the value of the dependent variable(s) based on the value of independent variables (Ho, 2006). Structural Equation Modelling (SEM) is an effective statistical analysis technique for conducting multivariate regression for both exploratory and confirmatory studies. There are two types of analysis in SEM, the partial least squares (PLS-SEM) and the covariance-based (CB-SEM). The choice between them is determined by the nature of research and its main objectives. In causal modelling conditions where previous theory is strong and additional confirmation and testing are the main goals of research, CB-SEM is the preferred method. In situations where the research nature is exploratory, and the aim is prediction rather than theory confirmation, PLS-SEM is the more appropriate statistical methodology (Hair et al., 2011). Therefore, because this research is exploratory in nature and the primary aim is prediction, PLS-SEM is considered more appropriate. According to Hair et al. (2017: 38), "the minimum sample size shall safeguard that the results of the statistical method such as PLS-SEM have adequate statistical power". Therefore, to determine the minimum sample size required to conduct the analysis using PLS-SEM, they recommend researchers to rely either on the rule of thumb of Cohen (1992) or to use the G*Power program (Figure 4.2). The rule of thumb of Cohen (1992) works to a statistical power of 80%; however, according to Saunders et al. (2016), researchers normally work to a 95% level of certainty. Therefore, the minimum sample size required to use the PLS-SEM (multivariate analysis) was calculated using the G*Power 3.1 program. Based on this, the minimum sample size required to conduct the analysis is 129 valid questionnaires, considering four independent variables (predictors), statistical power of 95%, effect size of 0.15, and significance level of 5%.

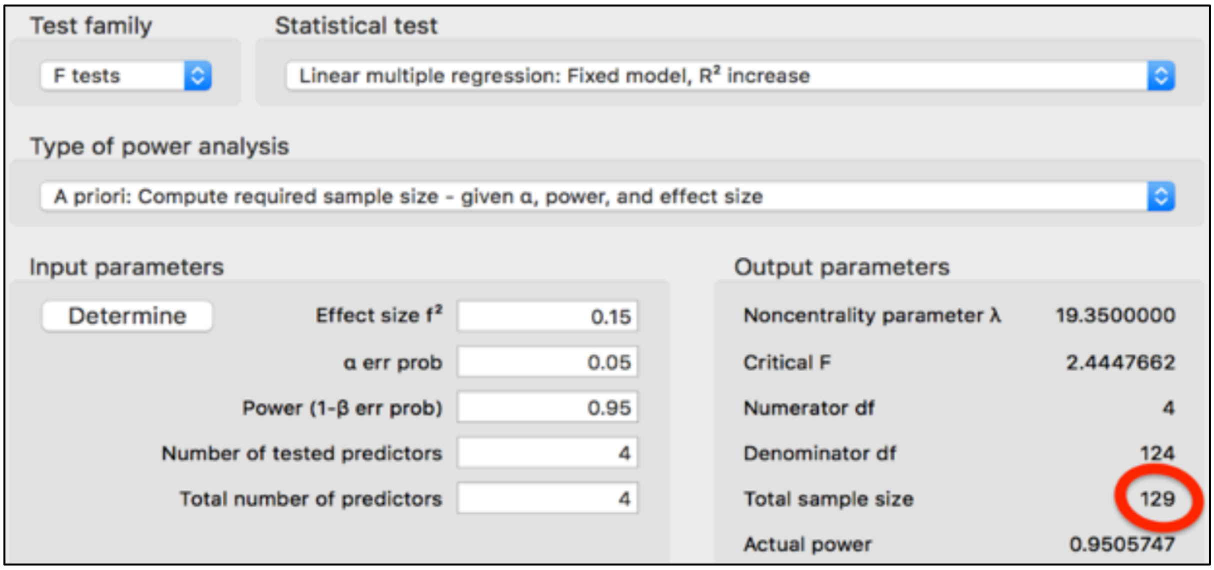

Figure 4. 2: The minimum sample size required based on the G*Power program 3.1

After estimating the likely response rate to be 75% and determining the minimum sample size required (129 valid questionnaires) to conduct the analysis, the actual sample size required was determined as 172 respondents and was calculated using the following formula (Saunders et al. 2016: 283):

$$n^a = \frac{n \times 100}{re\%}$$

where n^a is the actual sample size required,
n is the minimum sample size, and
re% is the estimated response rate expressed as a percentage.

However, whilst this research intended to use a random sampling technique in order to yield generalisable statistical outcomes, the time needed for collecting data increases markedly for hand-delivered questionnaires where the respondents are geographically dispersed. To overcome this constraint, a cluster random sampling technique was used in order to divide the target population into discrete groups (clusters) based on the university they work for. In this case, the sampling frame was the complete list of universities rather than a complete list of respondents (key stockholders) within the population. Then, a selection of clusters (universities) using simple random sampling was made until the actual sample size was reached (Saunders et al. 2016).

Based on the above, 172 questionnaires were distributed to six randomly chosen universities as a representative sample of the target population. After contacting the heads of departments related to software projects as a formal procedure required in the universities, the collection of the questionnaires was arranged to be on the same day of delivery. However, in a few cases, the collection of the questionnaires was after a few days of their delivery, depending on the availability of some respondents. Finally, a total of 153 questionnaires were returned, giving an initial response rate of almost 89%, which indicated low risk of non-response bias (Tuckman and Harper, 2012; Ary et al., 2018). However, among the returned questionnaires, 13 were unusable and excluded. Among these, nine questionnaires had suspicious response patterns (discussed in section 5.7.2) and four questionnaires had a missing data more than 15% (Saunders et al., 2016; Hair et al., 2017).

Thus, this left 140 valid questionnaires with no missing data, giving an actual response rate of 81.4%. This rate was higher than the estimated response rate (75%), and the sample was larger than the minimum sample size required for analysis (129 valid questionnaires).

4.12 Data quality (reliability and validity)

Before data analysis can be carried out and the findings can be generalised, the quality of the collected data must be verified, as this guarantees data consistency and questionnaire accuracy for measuring what is intended to measure (Farrell, 2016). The quality criteria which are considered are reliability and validity. Following are explanations of these criteria and the methods used to measure them.

4.12.1 Reliability

Reliability can be defined as "the extent to which an experiment, test, or any measurement procedure yields the same results on repeated trial" (Carmines and Zeller, 1979: 11). Therefore, the measurement scale of a data collection instrument is stable and consistent across time. It is necessary to examine reliability, as this guarantees a high rate of stability and consistency and ensures that no measurement errors take place (Golafshani, 2003).

In the current study, data reliability was checked using Cronbach's alpha technique, which is the most commonly used technique for measuring the homogeneity of scale based on multiple-items scale of the variable(s), was used in this study (Creswell, 2012; Tavakol and Dennick, 2011). Further, the reliability of the constructs was verified using the composite reliability method (Hair et al., 2017). The assessment of reliability is further discussed in the following chapter.

4.12.2 Validity

Validity refers to "the extent to which any measuring instrument measures what is intended to measure" (Carmines and Zeller, 1979: 17). Therefore, a validity test can be carried out in order to assess the extent to which the instrument measures what it is supposed to measure and to assess research quality. The current study checked for validity by assessing content validity and construct validity. Content validity refers to "the degree to which set of items, taken together, constitute an adequate operational definition of a construct" (Polit and Beck, 2006: 490). Content validity was assessed by carrying out an extensive literature review, and measurement of the questionnaire constructs was carried out by operationalising relevant aspects and indicators adopted from previous contributions. In addition, a revision of the questionnaire by eight academics and practitioners from relevant fields (a face validation procedure). Also, before conducting the pilot study, the questionnaire was translated into Arabic using "Back-translation" to ensure that translation of the questionnaire constructs would be accurate and that meaning would not be lost through translation. Then, after the pilot study was carried out, the feedback from the respondents was used to modify the wording of the questions and the questionnaire layout. On the other hand, construct validity is concerned with the degree to which the data collection instrument measures a theoretical construct. It can be divided into two subtypes, convergent and discriminate validity (discussed in detail in chapter 5). Convergent validity examines whether constructs that should be related, are related; while discriminant validity examines whether believed unrelated constructs are, in fact, unrelated (Saunders et al., 2016; Hair et al., 2017).

4.13 Ethical Considerations

Researchers must take ethical considerations into account for the integrity of the research to be preserved. Research ethics can be defined as guidelines for researchers (Saunders et al. 2012) – guidelines which aim to protect the privacy and confidentiality of participants and therefore maintain the quality of the data collection process generally and the response rate specifically (Sekaran and Bougie, 2010; Collis and Hussey, 2013). Thus, ethical considerations play an important role in protecting human rights by 1) ensuring that the participants are aware of the study purposes and objectives, 2) ensuring that voluntary consent is obtained from the participants prior to the data collection process, 3) ensuring that all information obtained from participants is kept confidential, 4) ensuring that all information obtained from participants is kept private, 5) ensuring that all information obtained from participants is utilized in a fair manner and is not misrepresented or distorted in any way, and 6) ensuring that the self-esteem and self-respect of the participants is guarded at all times during the research process (Bryman and Bell, 2015).

As per the guidelines of the Ethics Committee at the University of Bolton, the researcher in the current study ensured that each distributed questionnaire was accompanied by a cover letter which clarified to the participants that their participation was voluntary, that they had the right to withdraw from the study at any time, and that they could refuse to answer any questions if they wished. The participants were also assured that all information would be kept confidential. A copy of the questionnaire, accompanied by a copy of the cover letter, can be found in Appendix C. A copy of the ethical form is in Appendix E. The author followed the University of Bolton (UOB, 2019) ethical protocols.

4.14 Conclusion

This chapter has presented in-depth descriptions of the philosophical position and approach, methodological choice and strategy, sampling procedure, data collection technique, and ethical considerations of the current study. The chapter also explored the different philosophical positions in general and the positivist position, which was chosen for this study, in specific. Further, in accordance with the positivist position and the nature of the investigation, the deductive approach was seen to be the best-suited approach for the current study. The methodological choice was mono method quantitative with a cross-sectional time horizon. A survey strategy was chosen, and it was applied using a self-administered questionnaire technique, as that would allow the researcher to collect a large amount of high-quality empirical data quickly and effectively within a dedicated time frame. The operationalisation of the variables and the development of the questionnaire items were in accordance with previously published works and included a face validation procedure and pilot testing. Due to the nature of project success, as discussed in section 4.7, an ex-post-facto survey design was used with a closed-ended and scaled-response format. The questionnaire was translated from English into Arabic (Appendix D) as described in section 4.9. After the modifications in the face validation and the pilot study were implemented, the final version consisted of 44 questions and required approximately 15 to 20 minutes completion time. Attached to the questionnaire was a cover letter (Appendix C) which described the aim of the research, ensured the respondents that all data would be treated confidentially and used for academic purposes only, and asked the respondents to feel free to make any further comments or recommendations. The actual sample size of the study is 172 participants from the target population (the key stakeholders of the internal software projects in Jordanian public universities), and it was calculated based on scientific rules, as disscused in section 4.11. The questionnaires were distributed randomly, and they were delivered and collected by hand to guarantee a high response rate and a low rate of missing data. However, as data collection time increases markedly for hand-delivered questionnaires in cases where the samples are geographically dispersed, a cluster random sampling technique was used to overcome this constraint (section 4.11). A total of 153 questionnaires were returned; however, among the returned questionnaires, 13 were not valid and excluded to ensure accurate and credible outcomes. This left 140 valid questionnaires, resulting in a sample larger than the minimum sample size required for conducting the PLS-SEM analysis (129 valid questionnaires) and a response rate of 81.4%.

Chapter 5 - Data analysis

This chapter contributes to objective 3-B (OB3-B) of this thesis by presenting the analysis and the results of the empirical data. It consists of nine main sections. Section 5.1 and section 5.2 present the method and the technique of the adopted statistical analysis. Section 5.3 discusses modelling in the adopted analysis technique - the partial least squares structural equation modelling (PLS-SEM). Section 5.4 clarifies the adopted analysis procedure. Section 5.5 presents the utilised software for undertaking PLS-SEM. The conducted pilot study is in section 5.6. Section 5.7 presents the examination of the collected data and section 5.8 presents the results of the main empirical study. Finally, section 5.9 summarises the whole chapter.

5.1 The adopted statistical analysis method (Multivariate Regression)

The conceptual framework of this research proposes a number of relationships between the variables of both concepts, SPS and project success. In such situations where the hypothesis of the research investigates the relationships and patterns simultaneously between different variables and the strength of such relationships, 'Multivariate Regression' is seen as an appropriate analysis method. In simple words, it is a method to predict the value of dependent variable(s) based on the value of independent variables (Ho, 2006). Multivariate analysis "involves the application of statistical methods that simultaneously analyse multiple variables. The variables typically represent measurements associated with individuals, companies, events, activities, situations, and so forth. The measurements are often obtained from surveys or observations that are used to collect primary data, but they may also be obtained from databases consisting of secondary data" (Hair et al., 2017: 2).

The statistical techniques available for multivariate analysis can be classified into first-generation techniques and second-generation techniques (Fornell, 1982; Hair et al., 2017), the former class being the most common among researchers in the field of social science (Fornell, 1982). First-generation techniques adopt a range of advanced approaches, including logistical regression, multiple regression, analysis of variance, and exploratory factor analysis. Nonetheless, second-generation techniques have been increasingly gaining popularity since the early 1990s and are now used for data analysis in almost half of the empirical studies across multiple fields (Hair et al., 2017). This increasing popularity is due to first-generation techniques having several limitations, including limited techniques for dealing with complex model structures and, because first-generation techniques assume that all variables are observable, limited techniques for administering latent variables indirectly measured by first order as high order constructs (Haenlein and Kaplan, 2004; Vinzi et al., 2010). These limitations can be avoided with the use of second-generation techniques, which are otherwise called structural equation modelling (SEM) techniques and which were developed in order to address these limitations. Further, SEM techniques can be used to model complex relationships between multiple dependent and independent latent variables simultaneously, utilising exogenous and endogenous terminologies to describe independent and dependent variables (Vinzi et al., 2010; Hair et al., 2014). Thus, an SEM construct can be both dependent and independent simultaneously. Another advantage of SEM technique(s) is that they allow the researcher to use indicator variables to measure unobservable variables whilst also accounting for the measurement error for the indicator variables (Hair et al., 2017). These advantages led to the selection of SEM techniques for the current study in order to test the relationships between the multi-variables of the study models. Following is a more comprehensive description of SEM approaches in general and the approach adopted for this study in specific.

5.2 The adopted statistical analysis technique (PLS-SEM)

Structural Equation Modelling (SEM) is an effective statistical analysis technique for conducting multivariate regression for both exploratory and confirmatory studies. It provides researchers with results that could then be generalised (Hair et al., 2017). There are two types of analysis in SEM, the partial least squares (PLS-SEM) and the covariance-based (CB-SEM). The choice between them depends on the nature of research and its main objectives, and on the approach used to estimate the parameters of the developed model (Vinzi et al., 2010; Hair et al., 2017). Whilst covariance-based SEM (CB-SEM) is useful for testing the extent to which a proposed model can estimate the covariance matrix for a sample data set in order to confirm or reject a theoretical model, variance-based SEM (e.g. the partial least squares PLS-SEM) is useful for clarifying the variance in the endogenous constructs - dependent variables (DVs) - that are caused by the exogenous constructs - independent variables (IVs) - within the model.

Often, researchers may choose to use one type of method over the other based on the required functions for the empirical investigation at hand. However, that is not to say that the two types are contrasting; in some cases, results generated through PLS-SEM are similar to those generated through CB-SEM (Vinzi et al., 2010). The choice of which technique to adopt must be based on several conditions. Researchers who have chosen to use PLS-SEM over CB-SEM in previous studies have based this decision on several factors, including the normality distributional assumptions, the higher complexity of the model, the required sample size (relatively small), the nature of the investigation (e.g. exploratory study), and whether the model has formative constructs (Vinzi et al., 2010). A review by Ringle et al. (2012) studied 65 empirical studies which had been conducted between 1992 and 2011 and which had used the PLS-SEM technique. The results showed that PLS-SEM had mainly been chosen due to the small sample size in almost 36.9% of the studies (24 studies), the non-normally distributed data in 33.8% of the studies (22 studies), and the existence of formative constructs in the study model in 30.7% of the studies (20 studies). Hair et al. (2011) conclude, in causal modelling conditions where previous theory is strong and additional confirmation and testing are the main goals of research, CB-SEM is the preferred method. In situations where the research nature is exploratory, and the aim is theory development and prediction - not theory confirmation -, PLS-SEM is the more appropriate statistical methodology. Therefore, because this research is exploratory in nature and the primary aim is theory development and prediction, PLS-SEM is considered more appropriate.

5.3 Modelling in PLS-SEM and the proposed framework

Modelling in the partial least squares (PLS-SEM) has two parts, the measurement models and the structural model (Figure 5.1). The measurement models - also known as outer models in PLS-SEM - are used to evaluate the relationships between the construct - latent variable (LV) - and its indicators (also known as manifest variables (MVs), items, or questionnaire items). The structural model - or inner model - shows the paths (relationships) between the constructs - LVs such as Y1, Y2, Y3, Y4, Y5 - being evaluated (Hair et al., 2014).

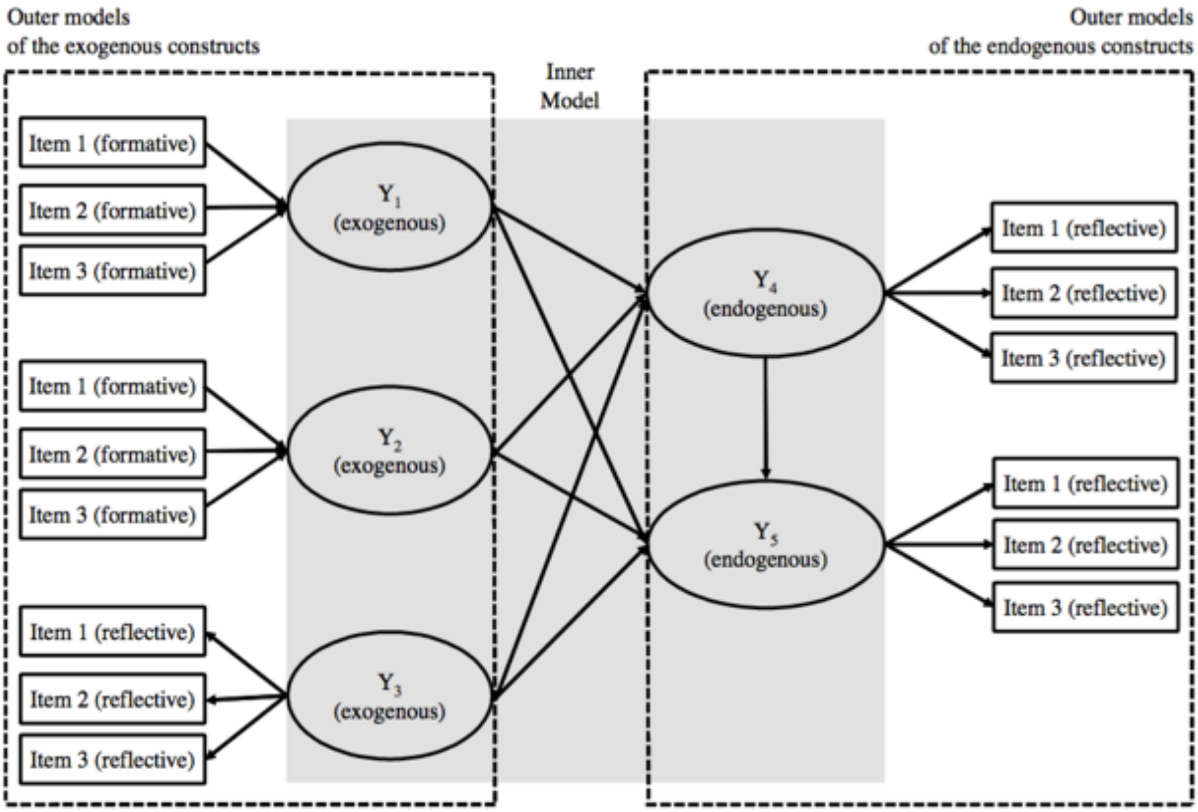

Figure 5. 1: An example of a structural equation model (SEM)
(Hair et al., 2014)

Constructs in the structural model are considered either exogenous or endogenous. Exogenous constructs (Y_1, Y_2, and Y_3) act as independent variables (IVs) and do not have an arrow pointing at them, whereas endogenous constructs (Y_4 and Y_5) usually considered as dependent variables (DVs) - have an arrow pointing at them - which are explained by other constructs. However, in their outer models, endogenous constructs may also act as independent variables as the case of Y_4. It should be noticed that multiple relationships between indicator variables (items) and constructs (latent variables) are not permitted in the PLS-SEM algorithm. Therefore, items are linked with only a single latent variable in a unidirectional relationship. Circular relationships between the constructs are not permitted as well. For example, reversing the relationship Y2→Y5 will create a circular loop as Y2 would predict Y4, Y4 would predict Y5, and Y5 would predict Y2 again (Y2→Y4 →Y5→Y2) (Hair et al., 2014). Modelling the conceptual framework of this research is presented in Figure 5.2.

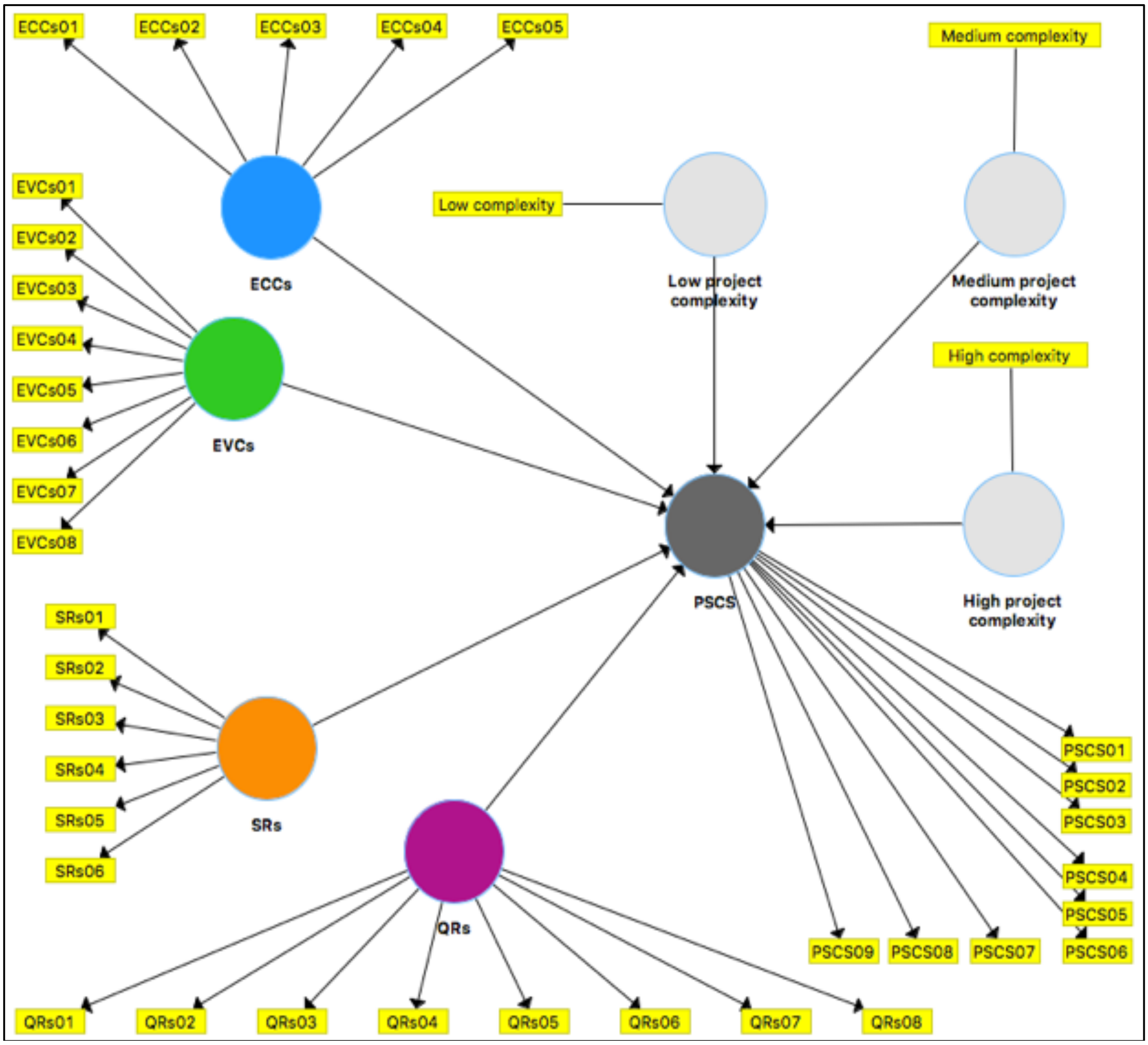

Figure 5. 2: Modelling the conceptual framework

Finally, since the logic behind each measurement model is different, it is important to differentiate between the reflective design and the formative design when developing a measurement model and its relevant variables. In the reflective design (items of Y4 and Y5), the direction of causality goes from the construct (latent variable) to its indicators (manifest variables), which are interchangeable; thus, the correlation and internal consistency are fundamental. Indicators are seen as functions of the latent construct in the reflective design, and changes in the latent construct are reflected in changes in the indicators. In contrast, in the formative design (items of Y1, Y2, and Y3), the direction of causality goes from the indicators (manifest variables) to the construct (latent variable), and indicators are assumed to cause the latent construct, and changes in the indicators determine changes in the value of the latent construct regardless that the correlation among the indicators is not necessary or desired (Hair et al., 2011; Carvalho and Rabechini, 2017). Still, "the decision as to which measurement model is appropriate has been the subject of considerable debate in a variety of disciplines and is not fully resolved" (Hair et al., 2017: 51). Hair et al. (2011: 141) conclude, "these situations are often the ones in which the measurement properties are questionable, and the results may diverge, thus requiring the researcher to make a reasoned judgment as to which approach is most appropriate". Figure 5.3 shows the reflective design of the measurement models (outer models) of the proposed framework.

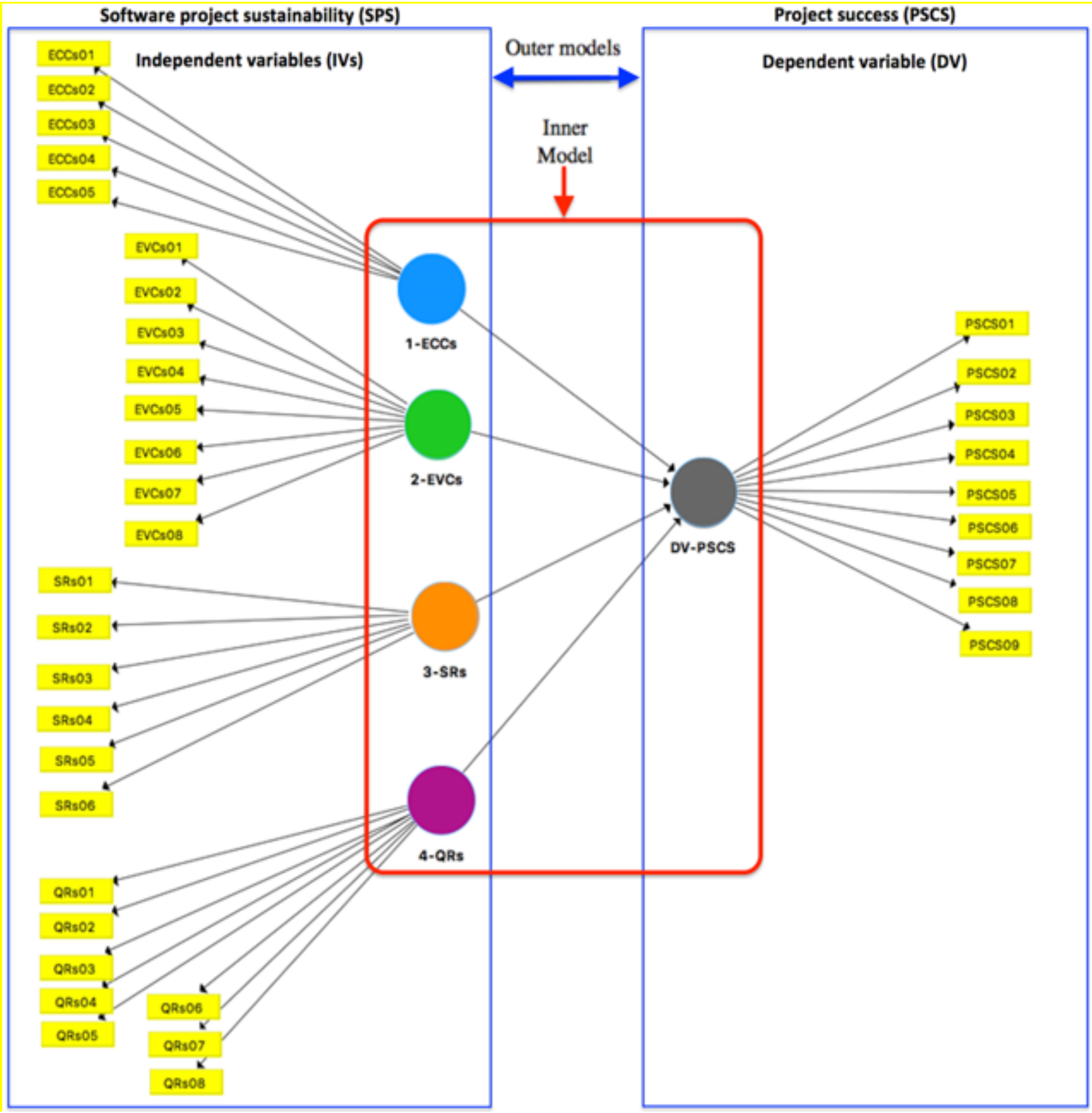

Figure 5. 3: The measurement models (outer) and the structural model (inner) of the proposed framework

As "the primary means to decide whether to specify a measurement model reflectively or formatively is by theoretical reasoning" (Hair et al., 2017: 285), the development of the proposed conceptual framework and its constructs (latent variables) was carried out using indicators (manifest variables) which had previously been used in the relevant literature. Following Jarvis et al. (2003), Hair et al. (2011), and Carvalho and Rabechini (2017), the reflective design mode was chosen for the independent variables and for the dependent variable because the indicators of each variable are seen as interchangeable functions, and changes in the variable are reflected in changes in the indicators and not vice versa. Also, dropping an indicator will not change the conceptual domain of the variable.

Software project sustainability (SPS) was developed as multidimensional concept represented by four interrelated and complementary constructs: economic considerations (ECCs), environmental concerns (EVCs), social responsibilities (SRs), and Incorporating TBL-related quality requirements (QRs). These constructs were developed as independent latent variables (IVs) and operationalised using TBL-related aspects as reflective indicators variables - also known as manifest variables (MVs) or items - based on the analysis of a variety of best contributions in the relevant literature. On the other side, project success (PSCS) was positioned as a dependent latent variable (DV) in the proposed framework. Similarly, it was designed to be measured through reflective items which are based on the theoretical models of Shenhar et al. (1997 and 2001), Shenhar and Dvir (2007), and Shenhar (2011) that include one of the most-cited criteria for measuring project success (Davis, 2014; Silvius and Schipper, 2016).

The design of the measurement models is crucial as the evaluation of reliability and validity of formatively measured constructs relies on a totally different set of criteria compared to their reflective counterparts, and misspecification in design can significantly impact the reliability and validity of the hypothesised relationships within the inner model. For example, the evaluation of formative measurement models is based on convergent validity, collinearity between indicators, and significance and relevance of outer weights. However, the evaluation of reflective measurement models is based on internal consistency (Cronbach's alpha, composite reliability), convergent validity (indicator reliability, average variance extracted), and discriminant validity. As the measurement models of the conceptual framework of this research were designed reflectively, the criteria of evaluating reliability and validity of formatively measured constructs are considered not appropriate for use in the analysis process and out of the scope of this study. The following section discusses the analysis procedure through the PLS-SEM and presents the evaluation criteria of the reflective measurement models and the evaluation criteria of the structural model as well.

5.4 The adopted analysis procedure

After setting up the framework specifications - as discussed in the previous section -, the analysis procedure of PLS-SEM involves two main stages: evaluating the outer models (measurement models) and evaluating the inner model (structural model). According to Hair et al. (2017: 105), "the most important measurement model metrics for PLS-SEM are reliability, convergent validity, and discriminant validity. For the structural model, the most important evaluation metrics are R^2 (explained variance), f^2 (effect size), Q^2 (predictive relevance), and the size and statistical significance of the structural path coefficients". However, the structural model should not be examined until the reliability and validity of the measurement models have been established. By starting with the evaluation of the measurement models, researchers can trust that the constructs (latent variables), which form the basis for evaluating the hypothesised relationships within the structural model, are accurately measured and represented. Therefore, as indicated in the previous section, researchers must differentiate between formatively and reflectively measured constructs as the two approaches to measurement need consideration of different metrics when assessing the measurement models (Hair et al., 2011; Sarstedt et al., 2014).

Figure 5.4 illustrates the two main stages of the analysis procedure in PLS-SEM. Stage 1 "examines the measurement models, with the analysis varying depending upon whether the model includes reflective measures (Stage 1.1), formative measures (Stage 1.2) or both. If the measurement model evaluation provides satisfactory results, the researcher moves on to Stage 2, which involves … determining whether the structural relationships are significant and meaningful, and testing hypotheses" (Sarstedt et al., 2014: 108). Accordingly, since constructs of the conceptual framework of this research were designed to be measured reflectively, the analysis procedure will start with stage 1.1 then moves to stage 2 if the reliability and validity of the measurement models have been established satisfactorily. Stage 1.2 is considered not appropriate for use in the analysis process and out of the scope of this study as the framework has no formative measures. The evaluation criteria of reflective measurement models (Stage 1.1) and the evaluation criteria of structural model (Stage 2) are discussed in sections 5.8.2 and 5.8.3, respectively.

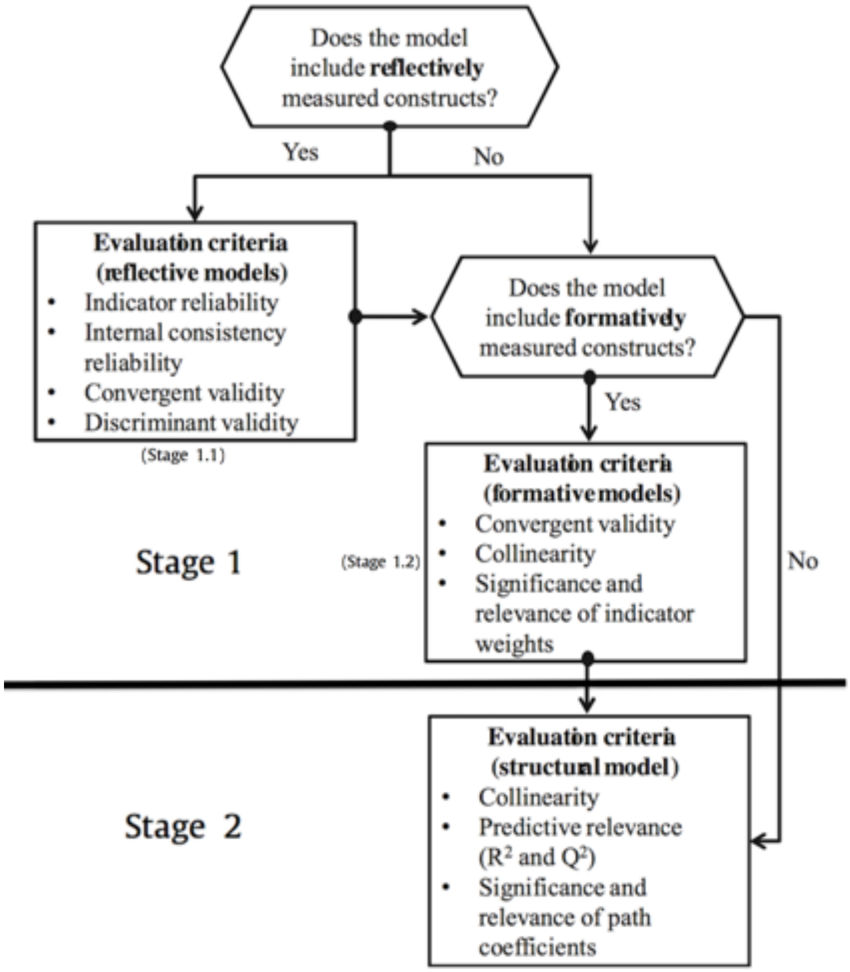

Figure 5. 4: PLS-SEM evaluation stages
Adapted from Sarstedt et al. (2014)

5.5 The utilised software for undertaking PLS-SEM

Several software packages were developed to analyse the data statistically under the PLS-SEM. These software packages include Visual-PLS, SmartPLS, PLS-GUI, PLS-Graph, and LVPLS etc. (Temme et al., 2006; Hair et al., 2017). However, SmartPLS software was used in this research because it has an easy and friendly graphical user interface (GUI) and literature are available related to the usage of the software. For example, the book of Hair et al. (2017) clearly demonstrates all actions required for the data analysis process. In addition, the availability of an online forum for all SmartPLS users to discuss and share knowledge and experience regarding any issues that could be encountered during the use of the software and the analysis process. All of these reasons make the selection of SmartPLS software more reliable to a great extent. Finally, the used version of the SmartPLS software in this research is 3.2.8. This version has been released in November 2018 (SmartPLS, 2018).

5.6 The conducted pilot study: pre-testing the reliability and validity of the questionnaire

As mentioned in the previous chapter, multiple testing stages and methods were carried out in order to ensure the validity and reliability of the data collection instrument (the questionnaire), in addition to a revision of the questionnaire by eight academics and practitioners from relevant fields. This review was carried out as a face validation procedure prior to the pilot study and aimed to ensure the content validity, readability, clarity, structure, and completeness of the designed questionnaire (Dillman, 1991). After that, the questionnaire was pilot-tested on a sample of 20 volunteer respondents working in Jordanian universities, and who represented the targeted population to an accurate degree. This was in line with the recommended sample size of 10 to 30 respondents for piloting (Bryman and Bell, 2015). The pilot study aimed to ensure the reliability and validity of the questionnaire items - including the measurement model items -, and to eliminate any potential deficiencies, weaknesses, errors, ambiguities before carrying out the final study. Also, any major concerns or problems pertaining to the questionnaire and which may impact the research process can be identified during the piloting stage by testing the sequencing, wording, response rate, analysis process, and completion time of the questions (Veal, 2005; Sekaran and Bougie, 2010; Saunders et al., 2012).

Since the items of the questionnaire (the questions) were used and tested previously in the literature, few modifications were revealed during the face validation procedure and after conducting the pilot study, and all were considered by the researcher. For example, during the face validation procedure, the reviewers advised that one question need to be rewritten and that two questions need to be deleted as they considered as a repetition to other questions. Similarly, after conducting the pilot study, the analysis of the collected data revealed that seven questions need to be deleted (Figure 5.5) because their outer loadings were far below the threshold of 0.70 as recommended by Hair et al. (2017). However, after deleting the weak outer loadings and re-ensuring individual question reliability (Table 5.1), the reliability and validity of the questionnaire were established by evaluating the Cronbach's alpha and the composite reliability (both should be above the threshold of 0.70). The analysis was conducted using the SmartPLS software version 3.2.8 (Ringle et al., 2015). The results show significant outer loading, in Table 5.1, for all indicators (questions of variables), with Cronbach's alpha and composite reliability (Table 5.2) higher than the threshold of 0.70 (Field, 2013; Hair et al., 2017).

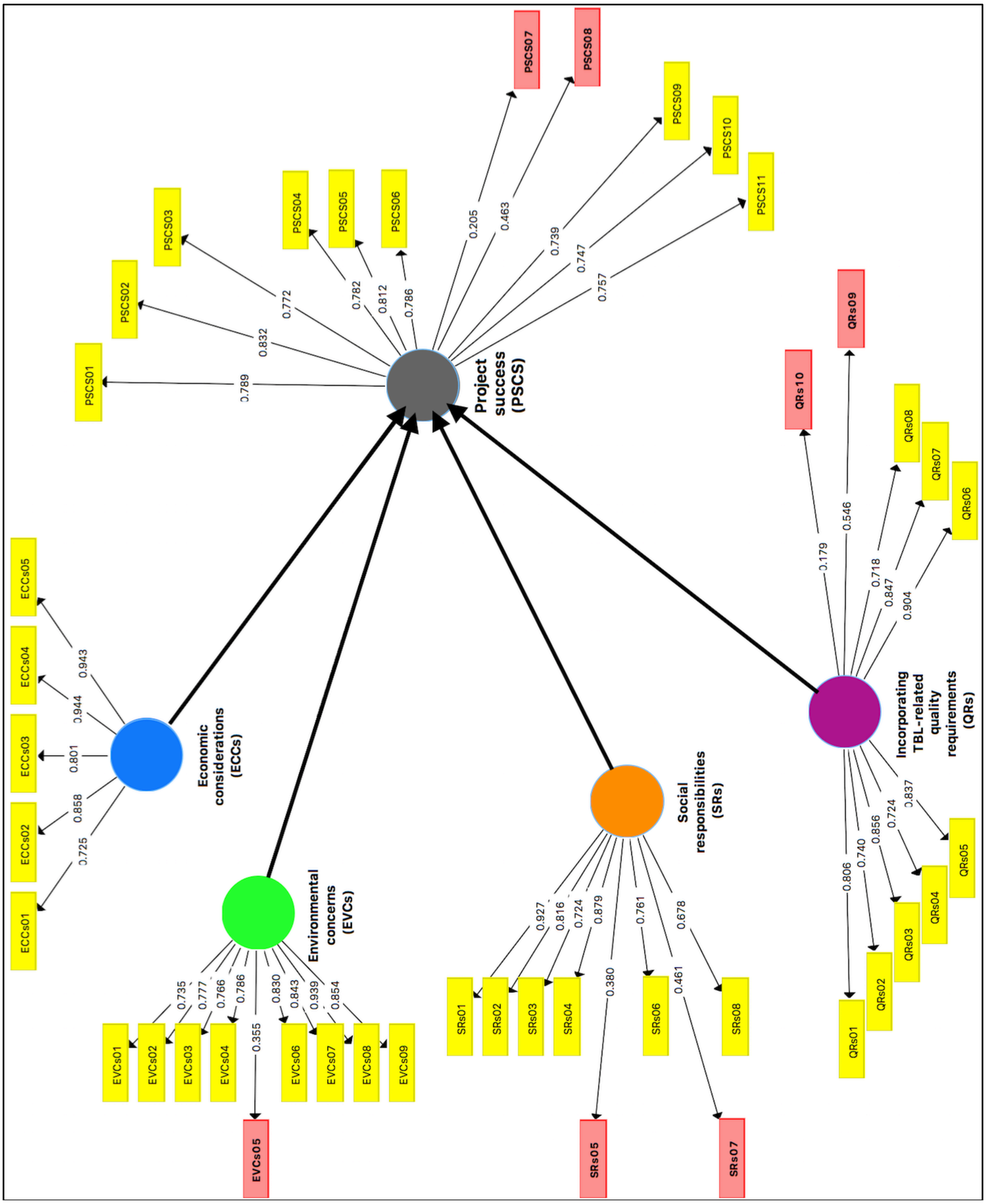

Figure 5. 5: Pilot testing - evaluating the outer loadings of variables' questions

Table 5. 1: Pilot testing - individual question reliability after deleting weak outer loadings

Indicators	ECCs	EVCs	SRs	QRs	PSCS
ECCs01	0.721				
ECCs02	0.856				
ECCs03	0.804				
ECCs04	0.945				
ECCs05	0.943				
EVCs01		0.743			
EVCs02		0.770			
EVCs03		0.767			
EVCs04		0.790			
~~EVCs05~~	-	-	-	-	-
EVCs06		0.828			
EVCs07		0.843			
EVCs08		0.941			
EVCs09		0.861			
SRs01			0.913		
SRs02			0.852		
SRs03			0.732		
SRs04			0.861		
~~SRs05~~	-	-	-	-	-
SRs06			0.749		
~~SRs07~~	-	-	-	-	-
SRs08			0.695		
QRs01				0.813	
QRs02				0.760	
QRs03				0.864	
QRs04				0.747	
QRs05				0.831	
QRs06				0.892	
QRs07				0.858	
QRs08				0.715	
~~QRs09~~	-	-	-	-	-
~~QRs10~~	-	-	-	-	-
PSCS01					0.808
PSCS02					0.844
PSCS03					0.772
PSCS04					0.775
PSCS05					0.804
PSCS06					0.797
~~PSCS07~~	-	-	-	-	-
~~PSCS08~~	-	-	-	-	-
PSCS09					0.736
PSCS10					0.744
PSCS11					0.746

Table 5. 2: Pilot testing - results of Cronbach's alpha and composite reliability

Variables	Number of questions	Cronbach's Alpha	Composite Reliability
ECCs	5	0.909	0.933
EVCs	8	0.930	0.942
SRs	6	0.889	0.916
QRs	8	0.926	0.939
PSCS	9	0.920	0.934

After deleting seven questions (out of 51) from the initial version of the questionnaire (Appendix A), the last version of the questionnaire consists of 44 questions and needs approximately 15 to 20 minutes to be completed. The final version of the questionnaire versions is presented in Appendix C.

5.7 Data collection and examination

As discussed in the previous chapter, a total of 153 questionnaires were returned out of the 172 that were distributed. In this context, examining the returned questionnaires is a very important stage in the application of PLS-SEM to have valid, reliable, and credible outcomes. The main issues that need to be examined involve missing data, suspicious response patterns, data distribution, outliers, response rate, and non-response bias. The following sub-sections briefly address each of these issues.

5.7.1 Missing data

Missing data are often a problem in social science studies, as many researchers collect data using survey strategy. Missing data may happen when a respondent either inadvertently or purposely fails to answer one or more questionnaire item(s) (questions). When the missing data on a questionnaire exceeds 15%, the observation should be removed from the data file. Indeed, "an observation may be removed from the data file even if the overall missing data on the questionnaire do not exceed 15%. For example, if a high proportion of responses are missing for a single construct, then the entire observation may have to be removed. A high proportion of missing data on a single construct is more likely to occur if the construct is measuring a sensitive topic, such as racism, sexual orientation, or even firm performance" (Hair et al., 2017: 56).

If the missing values per indicator are less than 5%, then the mean replacement method can be used. It is by replacing the missing values of a question (indicator) with the mean of its valid values. While easy to implement, the mean value replacement method "decreases the variability in the data and likely reduces the possibility of finding meaningful relationships" (Hair et al., 2017: 57). Alternatively, in the SmartPLS software, all cases that include missing values - in any of the questions - can be removed by casewise deletion (also known as listwise deletion) or pairwise deletion. In casewise deletion, the software discards all observations with missing values. However, this method is crucial as it can dramatically decrease the number of observations in the data set or omit a group of respondents who did not answer a specific question (e.g. refuse to answer questions related to income). In pairwise deletion, the software continues in calculating all valid values within the questions even if there are missing values in one or more questions. However, some researchers consider this approach unwise as it can bias the results (Ringle et al., 2015; Hair et al., 2017).

Among the 153 returned questionnaires of this research, four questionnaires were typically removed from the data set as they have a missing data more than 15% (Saunders et al., 2016; Hair et al., 2017). The remaining questionnaires have no missing data, however, as discussed in the following sections, some of them have suspicious response patterns and were removed from the data set as well.

5.7.2 Suspicious response patterns

Before analysing the collected data, suspicious response patterns such as straight lining, diagonal lining should be inspected and removed from the data set. Straight-lining means having the same answer for a high proportion of the questions (e.g. selecting all 3s in a 5-point scale or choosing only 1s or 5s). Diagonal lining means using the available answers on a scale (e.g., a 5-point scale) to answer different questions diagonally (e.g. having a diagonal line by selecting answers from 1 to 5 respectively). Also, having the same answer for all questions or inconsistency in answers should be inspected and removed from the data set (Hair et al., 2017).

Researchers may use one or more screening questions to ensure the attention of respondents and the validity of their answers. For example, asking the same question twice with a slight variation, then comparing the two answers. If there was a big difference between the two answers, this indicates that the respondent was not reading the questions carefully or simply wanted to complete the questionnaire quickly and exit the survey. Another way, which was used in this research, is to include a specific question ("attention question") to inspect the attention of respondents. In the middle of the questionnaire, the author of this research has asked the respondents in question number 13 to choose only answer number 2 on a 5-point scale before going to the next question. Therefore, any answer given other than 2, resulted in removing the whole questionnaire from the data set (Hair et al., 2017).

Finally, among the 153 returned questionnaires of this research, nine questionnaires were removed from the data set as they have suspicious response patterns. Three questionnaires have straight-lining answers, and six questionnaires have not answered the attention question carefully (question number 13) because the answers were other than the choice number 2.

5.7.3 Data distribution

PLS-SEM is a nonparametric statistical technique. It does not require normally distributed data. Still, it is significant to be sure that the data are not too far distributed from normal. Highly non-normal data distribution proves problematic in analysing the significances of relationships and generate invalid statistical results (Kline, 2011; Hair et al., 2017). Skewness and kurtosis are well-known measures for examining normality. Skewness measures the symmetry of a variable’s distribution. The distribution is characterised as skewed when responses for a variable spread toward the left or right tail of the distribution. Kurtosis measures the “flatness” and “peakedness” of a distribution; whether the distribution is too flat (with long, thin tails) or too peaked (with short, thick tails). When both skewness and kurtosis are close to zero, the data (pattern of responses) are considered normally distributed. In general, skewness values lower than -1 or greater than +1 indicate a skewed distribution. For kurtosis, values lower than -1 indicate a flat distribution, whilst values greater than +1 indicate a peaked distribution.

Values that exceed these guidelines (for skewness and/or kurtosis) are considered nonnormally distributed (Hair et al., 2017). According to Tabachnick and Fidell (2013: 83), “it is more likely that the assumption of multivariate normality is met if all the variables are normally distributed”. Based on that, the author of this research assumes that the multivariate normality is met because most of the variables’ indicators, as shown in Table 5.3, were normally distributed (values of skewness and kurtosis are within the range of ± 1). Hair et al. (2017: 62) conclude, “lack of normality in variable distributions can distort the results of multivariate analysis”. However, “this problem is much less severe with PLS-SEM, but researchers should still examine PLS-SEM results carefully when distributions deviate substantially from normal”.

Table 5. 3: Results of the normality test

Indicators	Excess Kurtosis	Skewness
ECCs01	-0.824	-0.387
ECCs02	-0.718	-0.412
ECCs03	-0.575	0.105
ECCs04	-0.714	0.101
ECCs05	-0.632	0.151
EVCs01	0.091	0.744
EVCs02	-0.933	-0.295
EVCs03	-0.402	0.206
EVCs04	-0.401	0.292
EVCs05	-0.997	0.062
EVCs06	-0.605	0.540
EVCs07	0.390	0.361
EVCs08	-0.452	-0.025
SRs01	0.400	-0.544
SRs02	0.050	-0.417
SRs03	1.317	-1.109
SRs04	-0.467	-0.373
SRs05	-0.096	-0.528
SRs06	0.144	-0.859
QRs01	-0.384	-0.448
QRs02	0.848	-0.930
QRs03	1.478	-0.665
QRs04	0.526	-0.754
QRs05	0.651	-0.667
QRs06	-0.602	-0.483
QRs07	-0.535	-0.656
QRs08	-0.451	-0.075
PSCS01	-0.814	-0.453
PSCS02	-0.796	-0.149
PSCS03	0.068	-0.683
PSCS04	-0.829	0.112
PSCS05	-0.520	-0.233
PSCS06	0.400	-0.501
PSCS07	2.663	-1.071
PSCS08	-0.124	-0.490
PSCS09	-1.151	-0.347

5.7.4 Outliers

Examining the collected data also include outliers' detection. An outlier is "a case with such an extreme value on one variable (a univariate outlier) or such a strange combination of scores on two or more variables (multivariate outlier) that it distorts statistics" (Tabachnick and Fidell, 2013: 72). According to Hair et al. (2017: 59), an outlier is "an extreme response to a particular question, or extreme responses to all questions". Outliers can influence statistical analyses (e.g. increasing error variance) and can lead to incorrect outcomes. The presence of outliers may occur for several reasons such as incorrect data entry, failure to specify codes for missing values in a data set, the existence of a case that is not related to the intended sample (should be deleted once it is detected), and the distribution of a variable in the population has more extreme values than a normal distribution (Tabachnick and Fidell, 2013). Hair et al. (2017: 60) concludes, "once the outliers are identified, the researcher must decide what to do. If there is an explanation for exceptionally high or low values, outliers are typically retained, because they represent an element of the population. However, their impact on the analysis results should be carefully evaluated. That is, one should run the analyses with and without the outliers to ensure that a very few (extreme) observations do not influence the results substantially. If the outliers are a result of data collection or entry errors, they are always deleted or corrected (e.g., the value of 77 on a 9-point scale). If there is no clear explanation for the exceptional values, outliers should be retained".

There are several ways for detecting outliers, and statistical software packages offer a multitude of numerical and graphical options which allow identifying univariate and multivariate outliers. For example, measuring kurtosis (Barnett and Lewis, 1996; DeCarlo, 1997), box plots and probability plots (EPA, 2009), histograms and inspecting Z scores (Tabachnick and Fidell, 2013), and analysing residuals in the measurement model (Garson, 2016), can be used for finding univariate outliers. For detecting multivariate outliers, using Mardia's test of multivariate kurtosis (Schwager and Margolin, 1982; DeCarlo, 1997), measuring Mahalanobis distance, leverage, influence, discrepancy (Tabachnick and Fidell, 2013), and analysing residuals in the structural model (Garson, 2016), are considered among the best methods in this regard.

However, for PLS-SEM, Garson (2016) recommends analysing residuals scores in the measurement and structural models for detecting outliers, as an outlier may be on any of the indicators or on any of the latent variables. Therefore, as the adopted statistical analysis of this research is PLS-SEM, the method of analysing residuals scores was used for outliers' detection. Since "residuals reflect the difference between observed and expected values, there is a good model fit when residuals are low". Consequently, at the significance level of .05, residuals with an absolute value greater than ±1.96 are considered outliers (Garson, 2016: 86). Based on that, Table 5.4 and Table 5.5 show the detected outliers in the data set (on the indicators' level and on the variables' level, respectively).

Table 5. 4: Outliers on the indicators' level
(considering absolute value of ±1.96)

Case ID	ECCs05	EVCs01	EVCs07	EVCs08	QRs06	QRs07	QRs08
17	0.613	2.119	-0.856	-0.778	0.002	0.005	0.269
28	2.020	-0.506	-0.551	0.293	-0.758	-0.774	0.459
36	0.186	2.308	-0.678	-0.595	-0.227	-0.233	-0.175
37	0.208	-0.162	2.545	-0.454	-0.639	0.555	0.784
64	0.849	-0.012	2.686	-0.309	0.332	1.452	-1.171
67	-0.049	-0.345	-0.400	-0.492	2.034	-0.564	-0.732
80	-0.589	-0.552	2.178	-0.834	-0.227	-0.233	-0.175
95	0.681	0.089	0.255	-0.940	0.245	-2.155	0.532
96	0.041	2.428	-0.565	-0.478	0.830	-0.481	-0.632
99	-1.968	-0.235	-0.296	0.556	0.012	-1.208	0.084
109	-0.011	-0.493	0.303	0.235	2.724	-1.138	0.015
119	-0.181	-0.052	-0.371	2.545	0.587	1.679	-0.895
128	-0.383	-0.853	-0.036	-0.116	0.654	0.585	-2.227
138	0.781	-0.646	-0.930	1.967	0.002	0.005	0.269

Table 5. 5: Outliers on the variables' level
(considering absolute value of ±1.96)

Case ID	EVCs	SRs	QRs	PSCS
7	0.138	-2.817	-0.559	-0.095
57	-1.982	1.017	1.461	1.632
87	-1.119	-0.159	-2.399	0.402
89	0.970	-1.036	-0.116	-2.324
106	2.199	-0.159	-0.356	0.632
109	0.000	0.237	-2.215	0.193
112	-2.057	0.497	-0.116	0.402
125	2.408	1.127	0.019	-0.095

After identifying the outliers, they were examined to detect the reasons behind their presence. There were no missing data or technical errors during the data entry. The outliers may exist because of the distribution of a variable in the population has more extreme values than a normal distribution (Tabachnick and Fidell, 2013). However, the detected outliers have not been removed from the data set, as it was found that their values are within the normal range of other responses (not scoring extremely low or extremely high). Also, as the sample size of the current research is larger than 80 observations (140 observations), the threshold value of residuals scores can be increased "up to 4" (Hair et al., 2013: 65) instead of 1.96. Therefore, the detected outliers were retained in the data set and considered as valid elements in the sample (there was no value greater than ±4 in both tables above).

5.7.5 Response rate and non-response bias

Non-response bias occurs when respondents (people who participated) in a study are inherently different in meaningful ways from non-respondents (people who did not participate) (Collis and Hussey, 2013; Bryman and Bell, 2015). As defined by Vogt and Johnson

(2011: 256), non-response bias is “the kind of bias that occurs when some subjects choose not to respond to particular questions and when the non-responders are different in some way from those who do respond”. Non-response bias may negatively impact the representativeness of the research sample in which the results become non-representative to the target population, not valid, and cannot be generalised (Saunders et al., 2012; Bryman and Bell, 2015). According to Malhotra and Birks (2007), there is a negative relationship between response rate and non-response bias, so that a high response rate indicates a low rate of non-response bias. However, “this is not to say that a low response rate will necessarily result in your sample being biased, just that it is more likely!”. Therefore, researchers “need to obtain as high a response rate as possible to reduce the risk of non-response bias” (Saunders et al., 2016: 281).

Based on Tuckman and Harper (2012), non-response bias should be investigated if the response rate is less than about 80%. For Ary et al. (2018), the investigation must be conducted if the response rate is less than 75%. Therefore, no further investigation required regarding non-response bias in the current study because the initial and actual response rates (89% and 81.4% respectively) are higher than the two percentages above, as mentioned previously in section 4.11.

5.8 Results

The analysis of the main collected data involves four stages: analysing the demographic data and presenting the descriptive statistics of the framework constructs, evaluating the measurement models, evaluating the structural model, and evaluating the effect of the control variable. The following sections clarify these four stages and presenting their results.

5.8.1 Demographic data and descriptive statistics of the framework constructs

The targeted population was the key stakeholders (project managers, project team, and senior management) of the internal software projects of the ten Jordanian public universities. The first part of the questionnaire included general information regarding the respondents and their projects. The analysis reveals that there are around 30 of relevant respondents work in software projects in each university. This indicated that there are approximately 300 key stakeholders who represent the sampling frame of the whole population of respondents and from which the actual sample was selected (the 172 "representative-sample" of key stakeholders who required to be invited).

The final sample of this research consisted of 140 respondents, giving an actual response rate of 81.4%. As shown in Table 5.6, 46% of the respondents have a high educational degree, 39% hold a master's degree or certification in project management, and 7% have a doctorate degree. The remaining 54% hold a bachelor's degree. Only 10% of the respondents have less than 5 years of experience in software projects, and only 15% have over 20 years of relevant experience. The experience of the majority (75%) ranges from 5 to 10 years (45%), and from 11 to 20 years (30%). In addition, 10% of the respondents are in the age range of 18 to 28 years old, 45% are in the range of 29 to 28 years of age, 35% are in the range of 40 to 50 years of age, and the remaining (10%) are above 50 years old.

Table 5. 6: Profile of surveyed respondents

***(n = 140)**

Educational degree	Percentage
Diploma or lower	0
Bachelor	54%
Master or certification in project management	39%
Doctorate	7%

Experience	Percentage
Less than 5 years	10%
5-10 Years	45%
11-20 Years	30%
Over 20 years	15%

Age	Percentage
18-28	10%
29-39	45%
40-50	35%
Above 50	10%

In terms of the chosen projects in the sample (Table 5.7), 80% had a medium team size (5 to 10 team members), 15% had a small team size (less than 5 team members), and only 5% had a large team size (more than 10 team members). 59% of the projects had a medium-term time span (duration from 6 to 12 months), 39% had a long-term duration (more than 12 months), and only 2% had a short-term duration (less than 6 months). Moreover, the results show that the overall level of clarity and stability in requirements was: medium in 70% of the projects, high in 20% of the projects, and low in the remaining 10%.

Table 5. 7: Profile of the chosen project in the sample

***(n = 140)**

Project team size	Percentage
Small (Less than 5 team members)	15%
Medium (5 to 10 team members)	80%
Large (more than 10 team members)	5%

Project duration	Percentage
Short-term (less than 6 months)	2%
Medium-term (6 to 12 months)	59%
Long-term (More than 12 months)	39%

Requirements clarity and stability	Percentage
Low	10%
Medium	70%
High	20%

Regarding the project complexity (control variable), the majority of projects in the sample (79%) have a medium complexity (Table 5.8). Project complexity was measured based on three indicators (Table 5.9): project team size, project duration, and the overall level of clarity and stability in requirements. The lowest score can be achieved for a project is three points (one point for each indicator), and the highest score can be achieved for a project is nine points (three points for each indicator). According to the scores, the projects were classified into one of three levels: low complexity, medium complexity, and high complexity. If the score was between 3 to 4 points, then the project complexity was classified as low. If the score was between 5 to 7 points, then the project complexity was classified as medium. If the score was between 8 to 9 points, then the project complexity was classified as high.

Table 5. 8: Results of project complexity levels in the sample

	Level	**Frequency (out of 140)**	**Percentage**
Project complexity *(n = 140)	Low	16	11%
	Medium	110	79%
	High	14	10%

Table 5. 9: Project complexity: indicators and measuring tool

Project complexity indicators	**Response scale**		
Project team size	Less than 5 team members	5 to 10 team members	More than 10 team members
	1 point	**2 points**	**3 points**
Project duration	Less than 6 months	6 to 12 months	More than 12 months
	1 point	**2 points**	**3 points**
Clarity and stability in requirements	High	Medium	Low
	1 point	**2 points**	**3 points**

Finally, as shown in Table 5.10, most of the mean values of IVs indicators in the sample are above the midpoint (point 3 on the Likert scale), except the indicators of EVCs. It means that the degree of usage of the software project sustainability (SPS) constructs was above the average in the sample, except the EVCs construct, which was barely used. Similarly, most of the mean values of DV indicators (Table 5.11) are above the midpoint; which indicates that most of the chosen projects in the sample were succeeded or were evaluated as successful projects.

Table 5. 10: Descriptive statistics of the IVs indicators

Indicators	Mean	Median	Min	Max	Standard Deviation
ECCs01	3.50	4	2	5	0.92
ECCs02	3.70	4	2	5	0.95
ECCs03	3.65	4	2	5	0.79
ECCs04	3.28	3	2	5	0.86
ECCs05	3.31	3	2	5	0.86
EVCs01	2.55	2	1	5	1.12
EVCs02	2.97	3	1	5	1.14
EVCs03	2.64	3	1	4	0.69
EVCs04	2.69	3	1	5	1.06
EVCs05	2.78	3	1	5	1.20
EVCs06	2.40	2	1	5	1.16
EVCs07	2.72	3	1	5	0.92
EVCs08	2.75	3	1	5	1.06
SRs01	3.74	4	2	5	0.71
SRs02	3.79	4	2	5	0.76
SRs03	3.59	4	1	5	0.94
SRs04	3.89	4	2	5	0.84
SRs05	3.94	4	2	5	0.82
SRs06	3.99	4	2	5	0.91
QRs01	3.83	4	2	5	0.87
QRs02	3.88	4	1	5	0.96
QRs03	4.04	4	2	5	0.65
QRs04	3.78	4	2	5	0.77
QRs05	3.89	4	2	5	0.74
QRs06	4.16	4	2	5	0.77
QRs07	4.19	4	2	5	0.84
QRs08	4.10	4	3	5	0.62
Indicators 'combined'	3.47	3.44	2.44	4.26	0.37

Table 5. 11: Descriptive statistics of the DV indicators

Indicators	Mean	Median	Min	Max	Standard Deviation
PSCS01	3.60	4	2	5	0.97
PSCS02	3.55	4	2	5	0.92
PSCS03	3.85	4	2	5	0.85
PSCS04	3.70	4	2	5	0.84
PSCS05	3.65	4	2	5	0.85
PSCS06	3.75	4	2	5	0.70
PSCS07	4.05	4	2	5	0.67
PSCS08	3.95	4	2	5	0.81
PSCS09	4.20	4	3	5	0.75
Indicators 'combined'	3.81	3.89	2.33	4.89	0.66

5.8.2 Evaluating the measurement models (reliability and validity)

Evaluation of reflective measurement models involves examining outer loadings to assess individual indicator reliability, Cronbach's alpha and composite reliability to assess internal consistency reliability, and average variance extracted (AVE) to examine convergent validity. The assessment also includes the Fornell-Larcker criterion and cross-loadings to evaluate discriminant validity. The following sub-sections address each of these criteria.

5.8.2.1 Indicator reliability

Indicator reliability is defined as the square of a standardised indicator's outer loading. It is referred to as the 'communality' of an indicator or the variance extracted from an indicator and represents how much of the variation in an indicator is explained by the variable. To be statistically significant at a minimum, a common rule of thumb is that the outer loadings of all indicators in the framework should be higher than the threshold value of 0.70. In social science studies, researchers often get lower outer loadings than 0.70. In such cases, when an indicator has outer loading between the value of 0.40 and the value of 0.70, it should be removed only if the deletion leads to an increase in the value of composite reliability (section 5.8.2.2) and in the value of average variance extracted (section 5.8.2.3). However, indicators with outer loadings lower than 0.40, should always be removed from the variable (Bagozzi et al., 1991; Hulland, 1999; Hair et al., 2017).

Table 5.12 shows that most of the indicators' outer loadings of the framework constructs (ECCs, EVCs, SRs, QRs, and PSCS) are well above the threshold value of 0.70, which suggests sufficient levels of individual indicator reliability. Only the outer loadings of EVCs04 (0.628) and QRs07 (0.659) which have values slightly lower than the suggested threshold value of 0.70. However, these indicators were retained on the basis of their acceptable values in this exploratory research and their contribution to content validity. Additionally, the analysis revealed that deleting them (EVCs04 and QRs07) does not significantly increase the value of composite reliability or the value of the average variance extracted (AVE).

Table 5. 12: Individual indicator reliability of the framework constructs

Indicators	ECCs	EVCs	SRs	QRs	PSCS
ECCs01	0.728				
ECCs02	0.831				
ECCs03	0.790				
ECCs04	0.761				
ECCs05	0.874				
EVCs01		0.771			
EVCs02		0.738			
EVCs03		0.734			
EVCs04		0.628			
EVCs05		0.725			
EVCs06		0.828			
EVCs07		0.725			
EVCs08		0.749			
SRs01			0.852		
SRs02			0.919		
SRs03			0.754		
SRs04			0.847		
SRs05			0.862		
SRs06			0.743		
QRs01				0.768	
QRs02				0.882	
QRs03				0.824	
QRs04				0.817	
QRs05				0.801	
QRs06				0.740	
QRs07				0.659	
QRs08				0.802	
PSCS01					0.822
PSCS02					0.865
PSCS03					0.765
PSCS04					0.827
PSCS05					0.794
PSCS06					0.822
PSCS07					0.787
PSCS08					0.826
PSCS09					0.741

5.8.2.2 Internal consistency reliability

The second criterion to be evaluated is internal consistency reliability. It is "a form of reliability used to judge the consistency of results across items on the same test. It determines whether the items measuring a construct are similar in their scores (i.e., if the correlations between the items are large)" (Hair et al., 2017: 320).

Cronbach's alpha is the traditional criterion for evaluating internal consistency reliability. It gives an estimation of the reliability based on the intercorrelations between indicators. However, Cronbach's alpha is sensitive to the number of indicators in the variable, and it supposes that all the indicators have equal outer loadings on their variables. Therefore, it is generally considered as a conservative measure that tends to underestimate the internal consistency reliability. Due to these limitations of Cronbach's alpha, composite reliability is seen as a more appropriate criterion that should be used as well (beside Cronbach's alpha) for measuring internal consistency reliability. Composite reliability unlike Cronbach′s alpha, it does not presume that all indicators have equal outer loadings on their variables, which is consistent with the principle of the PLS-SEM algorithm that prioritises the indicators based on their individual reliability. Also, Composite reliability is not sensitive to the number of indicators in the variable and enables PLS-SEM to accommodate differences in the outer loadings and tends to overestimate the internal consistency reliability (Hair et al., 2017).

Finally, values of composite reliability vary between 0 and 1 and in general, it is interpreted in the same way as Cronbach's alpha. Values below 0.60 indicate a lack of internal consistency reliability. Values should be higher than 0.70 but, in exploratory research, values above 0.60 are acceptable. However, values above 0.95 are not desirable as they indicate that all the indicators are assessing the same phenomenon and are therefore may not be a valid measure of the construct (Drolet and Morrison, 2001; Hair et al., 2011; Sarstedt et al., 2014). Hair et al. (2017: 112) concludes, "the true reliability usually lies between Cronbach's alpha (representing the lower bound) and the composite reliability (representing the upper bound)".

As shown in Table 5.13, Cronbach's alpha values for all variables of the proposed framework (IVs and DVs) are above the threshold value of 0.70. Also, the values of composite reliability for all variables are above 0.70. Therefore, all of the framework constructs of the current research have high levels of internal consistency reliability.

Table 5. 13: Internal consistency reliability of the proposed framework

Variables	Cronbach's Alpha	Composite Reliability
ECCs	0.860	0.898
EVCs	0.885	0.906
SRs	0.911	0.931
QRs	0.912	0.929
PSCS	0.933	0.943

5.8.2.3 Convergent validity

Convergent validity is defined as the extent to which an indicator correlates positively with alternative indicators of the same variable. Establishing convergent validity, in other words, means that a certain variable is represented well by its indicators. Therefore, the indicators that are measures of a specific variable should share or converge a high proportion of variance. The outer loadings of the indicators (as discussed in section 5.8.2.1) are used for establishing convergent validity on the indicators' level. However, in the constructs' level, average variance extracted (AVE) is considered as a well-accepted criterion for establishing convergent validity. AVE is defined as “the grand mean value of the squared loadings of the indicators associated with the construct (i.e., the sum of the squared loadings divided by the number of indicators). Therefore, the AVE is equivalent to the communality of a construct” (Hair et al., 2017: 114). AVE value of 0.50 or higher implies that, averagely, the variable explains more than half of the variance of its indicators. Contrariwise, an AVE value of less than 0.50 implies that, averagely, more variance remains in the error of the indicators than in the variance explained by the variable. Table 5.14 illustrates that the convergent validity of the proposed framework is established, as the AVE values of all variables are well above the required minimum level of 0.50. Thus, the indicators of these variables have high levels of convergent validity as well.

Table 5. 14: Convergent validity of the framework constructs

Variables	Average Variance Extracted (AVE)
ECCs	0.638
EVCs	0.546
SRs	0.692
QRs	0.623
PSCS	0.650

5.8.2.4 Discriminant validity

Discriminant validity is defined as the extent to which a variable is truly different from other variables by empirical standards. Consequently, establishing discriminant validity implies that a variable is unique and has phenomena not represented by other variables in the model. Examining discriminant validity has the same meaning as examining collinearity. However, the term of “collinearity” may be more used for formative measurement models. Collinearity defined as a state of very high inter-associations or intercorrelations or among the predictor constructs. It arises when two or more of independent variables in the inner model are highly correlated. High levels of collinearity may bias the path coefficients (discussed in section 5.8.3.1) and can cause problems when fitting the model and interpreting the results, as independent variables supposed to be distinct in predicting and exploring the dependent variable(s) (Hair et al., 2017).

In reflective measurement models, researchers are relied on two approaches for evaluating discriminant validity: examining the cross-loadings and examining the Fornell-Larcker criterion. Establishing discriminant validity by the cross-loadings means that the outer loading of an indicator on the associated variable should be greater than any of its cross-loadings - its correlation - on other variables. Whereas, establishing discriminant validity by the Fornell-Larcker criterion requires that the square root of the average variance extracted (AVE) of each variable to be greater than its highest correlation with any other variable (Sarstedt et al., 2014; Hair et al., 2014). According to Hair et al. (2017), the idea behind Fornell-Larcker method is that a variable shares more variance with its associated indicators than with any other variable.

The analysis of cross-loadings and the Fornell-Larcker criterion reveals that the discriminant validity of the research framework has been established. Table 5.15 shows the analysis of the five latent variables of the research framework (ECCs, EVCs, SRs, QRs, and PSCS), each measured by different indicators. It can be seen that the outer loadings of the variables' indicators always exceed the cross-loadings on other variables. For example, ECCs02 loads high on its corresponding variable ECCs (0.831) but much lower on variables EVCs (-0.291), SRs (0.083), QRs (0.194), and PSCS (0.263). Table 5.16 shows the results of the Fornell-Larcker criterion evaluation with the square root of the AVE of the variables on the diagonal and the correlations between the variables in the off-diagonal position. The correlations should be considered in both the column and row. For example, the square root value of the AVE of SRs (0.832) is higher than all correlation values in the row of SRs and in the column of SRs. Similarly, the square roots of the AVEs for all variables are all higher than their correlations with other variables, which indicates that all variables are valid measures of unique concepts. Overall, the Fornell-Larcker criterion, as well as cross-loadings, provide evidence for the discriminant validity of the research framework.

Table 5. 15: The outer loadings and the cross-loadings of the indicators

Indicators	ECCs	EVCs	SRs	QRs	PSCS
ECCs01	0.728	-0.174	0.080	-0.008	0.141
ECCs02	0.831	-0.291	0.083	0.194	0.263
ECCs03	0.790	-0.205	0.252	0.165	0.306
ECCs04	0.761	-0.120	0.039	0.193	0.152
ECCs05	0.874	-0.247	0.048	0.102	0.274
EVCs01	-0.127	0.771	0.074	-0.030	-0.242
EVCs02	-0.293	0.738	-0.004	-0.051	-0.308
EVCs03	-0.264	0.734	-0.114	-0.221	-0.349
EVCs04	-0.183	0.628	0.033	-0.129	-0.128
EVCs05	-0.134	0.725	0.062	0.039	-0.255
EVCs06	-0.172	0.828	0.131	0.064	-0.100
EVCs07	-0.149	0.725	0.063	-0.041	-0.164
EVCs08	-0.195	0.749	0.025	0.000	-0.302
SRs01	0.160	0.068	0.852	0.137	0.218
SRs02	0.079	-0.005	0.919	0.099	0.224
SRs03	0.098	0.129	0.754	0.120	0.101
SRs04	0.205	0.012	0.847	0.073	0.210
SRs05	0.052	-0.006	0.862	0.145	0.214
SRs06	0.105	-0.051	0.743	0.145	0.172
QRs01	0.076	-0.035	0.061	0.768	0.199
QRs02	0.094	-0.071	0.069	0.882	0.228
QRs03	0.148	-0.027	0.130	0.824	0.228
QRs04	0.131	-0.004	0.182	0.817	0.250
QRs05	0.194	-0.072	0.123	0.801	0.229
QRs06	0.027	-0.090	0.182	0.740	0.204
QRs07	0.117	-0.029	0.214	0.659	0.198
QRs08	0.252	-0.149	-0.029	0.802	0.278
PSCS01	0.312	-0.372	0.251	0.269	0.822
PSCS02	0.289	-0.303	0.143	0.171	0.865
PSCS03	0.167	-0.273	0.262	0.335	0.765
PSCS04	0.224	-0.208	0.126	0.220	0.827
PSCS05	0.089	-0.235	0.115	0.215	0.794
PSCS06	0.361	-0.374	0.150	0.220	0.822
PSCS07	0.262	-0.268	0.175	0.241	0.787
PSCS08	0.261	-0.318	0.208	0.252	0.826
PSCS09	0.142	-0.091	0.274	0.119	0.741

Table 5. 16: Fornell-Larcker criterion

Variables	ECCs	EVCs	SRs	QRs	PSCS
ECCs	0.799				
EVCs	-0.272	0.739			
SRs	0.141	0.02	0.832		
QRs	0.172	-0.078	0.141	0.789	
PSCS	0.306	-0.356	0.237	0.291	0.806

5.8.3 Evaluating the structural model (predictivity, relationships and hypotheses testing)

Once the reliability and validity of the measurement models (outer models) are recognised and accepted, researchers need to take several steps to evaluate the structural model (inner model) and the hypothesised relationships between the constructs (variables). This includes, as shown in Figure 5.6 below, examining: the significance and relevance of the inner model hypothesised relationships (Path Coefficients), the level of coefficient of determination (R^2), the effect size (f^2), and the predictive relevance (Q^2) of the inner model (Sarstedt et al., 2014; Hair et al., 2014). The following sub-sections address each of these steps.

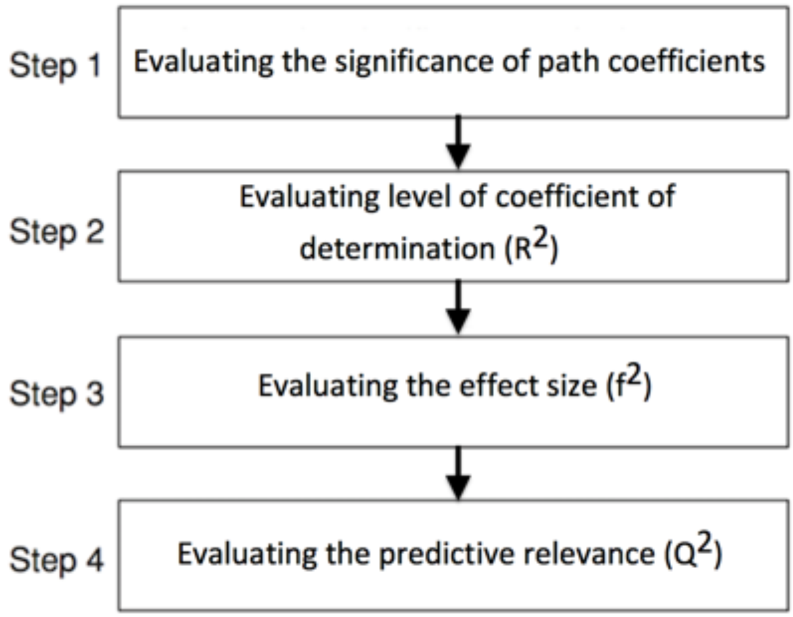

Figure 5. 6: The assessment procedure of the inner model
Adapted from Hair et al. (2014, 2017)

5.8.3.1 Evaluating the significance of path coefficients (Hypotheses Testing)

Path coefficients represent the hypothesised relationships between variables in the structural model. Researchers usually use P-values to evaluate the significance of path coefficients. In the context of evaluating the structural model, the P-value (or calculated probability) is the probability of finding the observed results assuming the null hypothesis (H_0) is true. As indicated in the previous chapter, assuming a significance level of 5% (and level of confidence or statistical power of 95%), the P-value should be smaller than 0.05 (for a certain coefficient) to conclude that the relationship is significant. Also, to observe the level and the type of relationships between variables in the structural model, the standardised values of the path coefficients (β) should be evaluated. The standardised values range (approximately) from -1 to +1. Values near to +1 represent strong positive relationships and values close to -1 represent strong negative relationships. Values closer to 0 represent weaker relationships (Sarstedt et al., 2014; Hair et al., 2017). Figure 5.7 shows independent and dependent variables (IVs and DVs) in the research framework, and Table 5.17 shows its six hypotheses. Table 5.18 illustrates the statistical results of the first five hypotheses of the research framework. The results of hypothesis six (H6) is presented in section 5.8.4.

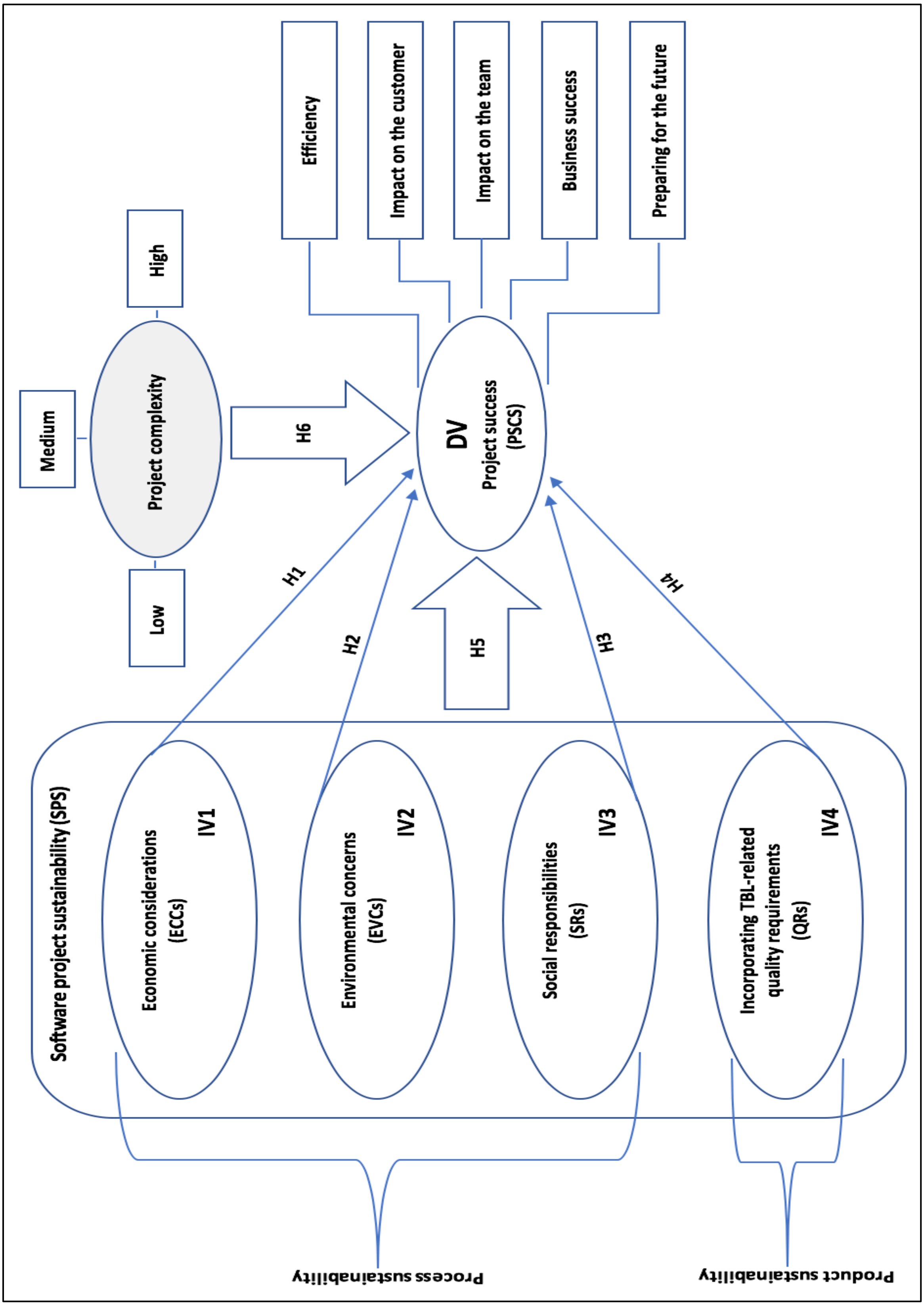

Figure 5. 7: Independent and dependent variables (IVs and DVs) in the research framework

Table 5. 17: Independent and dependent variables (IVs and DVs) in the research hypotheses

Hypotheses	
H1	Incorporating economic considerations in the processes of software projects (**IV1**) has a significant and positive relationship with project success (**DV**).
H2	Incorporating environmental concerns in the processes of software projects (**IV2**) has a significant and positive relationship with project success (**DV**).
H3	Incorporating social responsibilities in the processes of software projects (**IV3**) has a significant and positive relationship with project success (**DV**).
H4	Incorporating TBL-related quality requirements in the products of software projects (**IV4**) has a significant and positive relationship with project success (**DV**).
H5	Software project sustainability (**All IVs combined**) has a significant and positive relationship with project success (**DV**).
H6	Project complexity has a significant impact on project success (**DV**).

For the first four hypotheses (H1, H2, H3, and H4), as shown in Table 5.18, the four independent variables (IVs) of the research framework have a significant relationship with the project success (PSCS) - the dependent variable (DV) - as the P-values of the relationships always smaller than the threshold (0.05). Figure 5.8 displays the significance of the relationships (P-values) in the structural model of the research framework. However, the relationship with project success is not positive for all IVs. The results of the third column in Table 5.18 show that the 'environmental concerns' (EVCs) has a negative relationship with project success, as the value of its path coefficients (β) is negative (-0.299). This indicates that focusing only on environmental-related aspects when incorporating sustainability into the processes of software project may impact negatively project success.

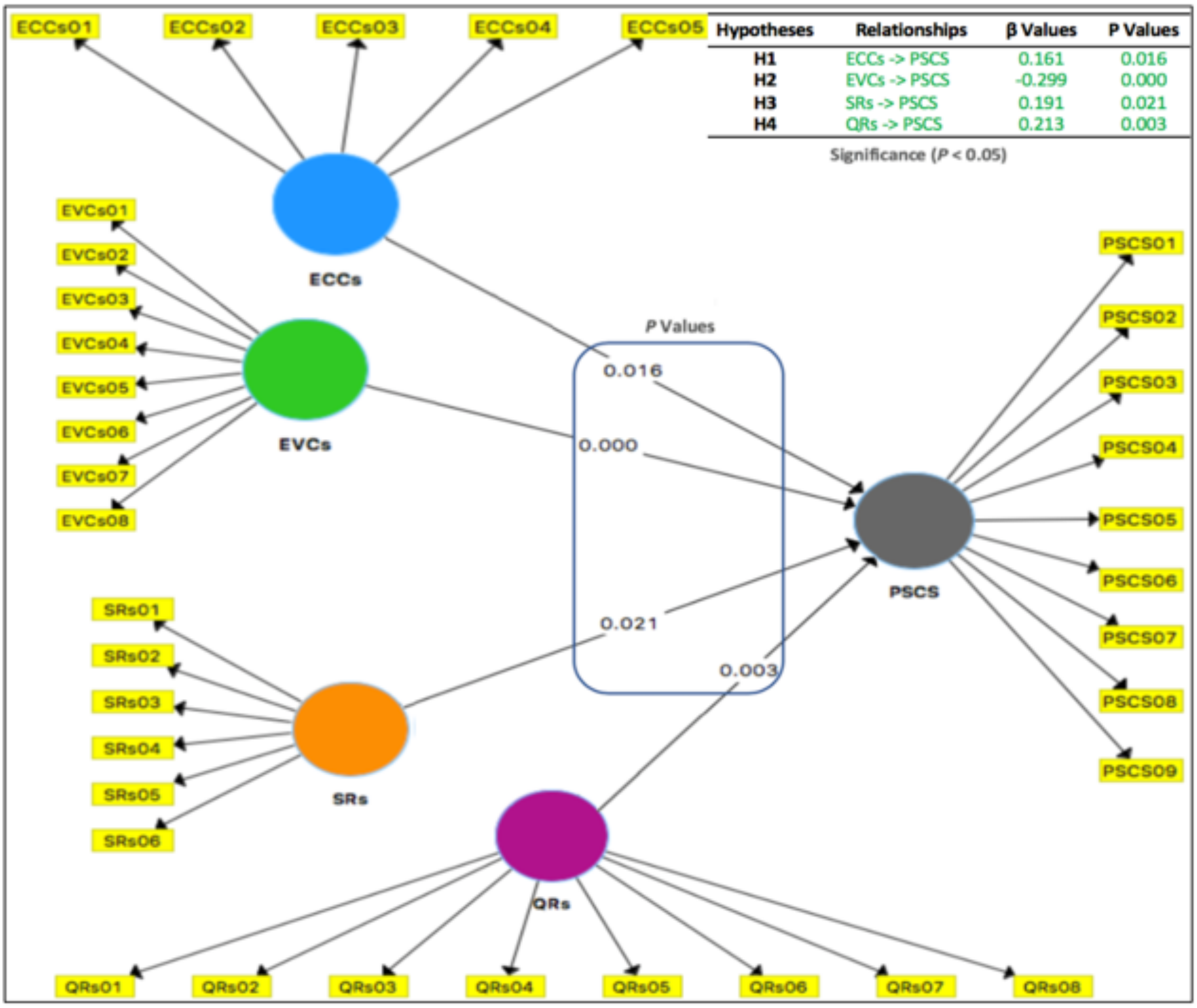

Figure 5. 8: The significance of the relationships between the IVs and the DV (P-values)

Table 5. 18: The statistical results of the first five hypotheses

Hypotheses	Relationships	β-Values	P-Values	Significance ($p < 0.05$)?	Relationships type
H1	ECCs -> PSCS	0.161	0.016	Yes	Positive
H2	EVCs -> PSCS	-0.299	0.000	Yes	Negative
H3	SRs -> PSCS	0.191	0.021	Yes	Positive
H4	QRs -> PSCS	0.213	0.003	Yes	Positive
H5	SPS -> PSCS	0.479	0.000	Yes	Positive

The results of the first four hypotheses in Table 5.18 indicate that software project sustainability (SPS) has a significant relationship with project success (H5), as the four constructs of SPS (IVs) have a significant relationship with project success. However, to evaluate the significance of path coefficient (P-value), and the level and the type of the relationship (β-value) of H5, a higher-order model design (Hair et al., 2017) was applied. In this model design (Figure 5.9), SPS is considered as a multidimensional second-order independent variable represented by the four IVs as a system of important and interrelated first-order latent variables. As shown in Figure 5.9, the analysis reveals that SPS has a significant and positive relationship with project success (P-value =0.000, β = 0.479).

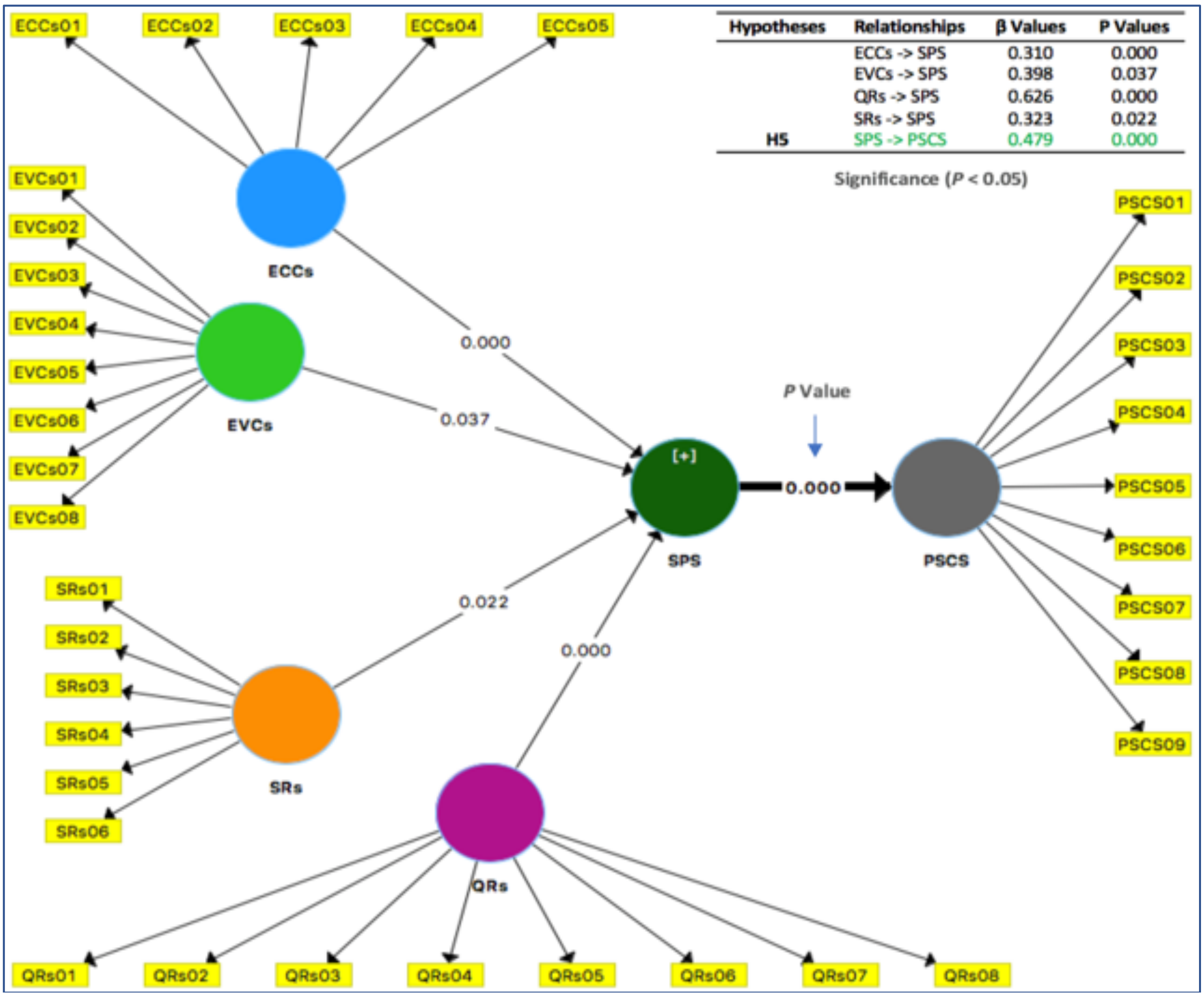

Figure 5. 9: The significance of the relationship between SPS and project success

Based on the results above, it can be concluded that the first four hypotheses (Table 5.17) are not rejected, except that there is a contradiction regarding the relationship type of the second hypothesis because the analysis revealed that it is a negative relationship, not positive as hypothesised. However, the analysis of the fifth hypothesis (H5) reveals that the overall relationship of all IVs' with project success - which represented by applying SPS as a second-order independent variable – is significant and positive.

To sum up:

- For H1, there is a significant positive relationship between economic considerations (ECCs) and project success.
- For H2, there is a significant negative relationship between environmental concerns (EVCs) and project success.

- For H3, there is a significant positive relationship between social responsibilities (SRs) and project success.
- For H4, there is a significant positive relationship between TBL-related quality requirements (QRs) and project success.
- For H5, there is a significant positive relationship between Software project sustainability (SPS) and project success.

Therefore, software project sustainability (SPS) can be seen as a net of the four IVs' relationships that are significant for project success, and not the solo relationship of each. The sixth hypothesis (H6) will be discussed in section 5.8.4.

5.8.3.2 Evaluating the level of coefficient of determination (R^2)

The coefficient of determination (R^2) is the most commonly used measure in assessing structural models. It is the predictive accuracy of the structural model, and it is calculated as the squared correlation between the actual and predicted values of a specific dependent variable. Also, it represents the combined effect of independent variables on the dependent variable(s). The effect of R^2 ranges between 0 and 1; values close to 1 representing high predictive power. However, "it is difficult to provide rules of thumb for acceptable R^2 values as this depends on the model complexity and the research discipline" (Hair et al. 2017: 199). For example, in scholarly marketing research or in explanatory studies that focus on explaining the loyalty and satisfaction of consumers, R^2 values of 0.75, 0.50, 0.25, respectively, representing high, moderate, and weak levels of predictive power or accuracy. However, in studies that focus on exploring customers perception and behaviour, R^2 values of 0.20 are considered high (Henseler et al., 2009; Hair et al., 2011, 2017). For example, in Cohen (1992) and in Jabbour et al. (2015), R^2 values of 0.02, 0.13, 0.26, respectively, representing weak, moderate, and high levels of predictive power or accuracy.

Although R^2 is a valuable tool in evaluating the quality of a structural model, too much reliance on it can be problematic. The reason is that R^2 will increase even if a researcher added a non-significant yet slightly correlated variable to the model. As a result, a researcher may improve the R^2 by adding additional independent variable(s) even if the relationship(s) is not meaningful. Rather, to avoid bias, the evaluation for a structural model should be also based on the adjusted coefficient of determination (R^2 adj) which penalises increasing complexity of the model by reducing the R^2 when adding extra variables to the model (Hair et al. 2017). The adjusted R^2 is calculated by the following equation:

$$R^2_{\text{adj}} = 1 - (1 - R^2) \cdot \frac{n-1}{n-k-1},$$

where n is the sample size and k is the number of independent variables used to predict the dependent variable under consideration (Hair et al., 2017). The evaluation of R^2 and adjusted R^2 was conducted two times. The first time by applying a first-order model design (Figure 5.10) and the second time by applying a second-order model design (Figure 5.11). The analysis results were close in both cases, particularly for adjusted R^2 (in the 1st time = 0.241, and in the 2nd time = 0.224). Based on Cohen (1992) Henseler et al. (2009), Hair et al. (2011), Jabbour et al. (2015), and Hair et al. (2017), and by considering the exploratory nature of the current research, it can be concluded that the proposed framework has a moderate level of predictive power or accuracy. Also, the combined effect of the independent variables (SPS) on the dependent variable (project success) can be considered as a moderate.

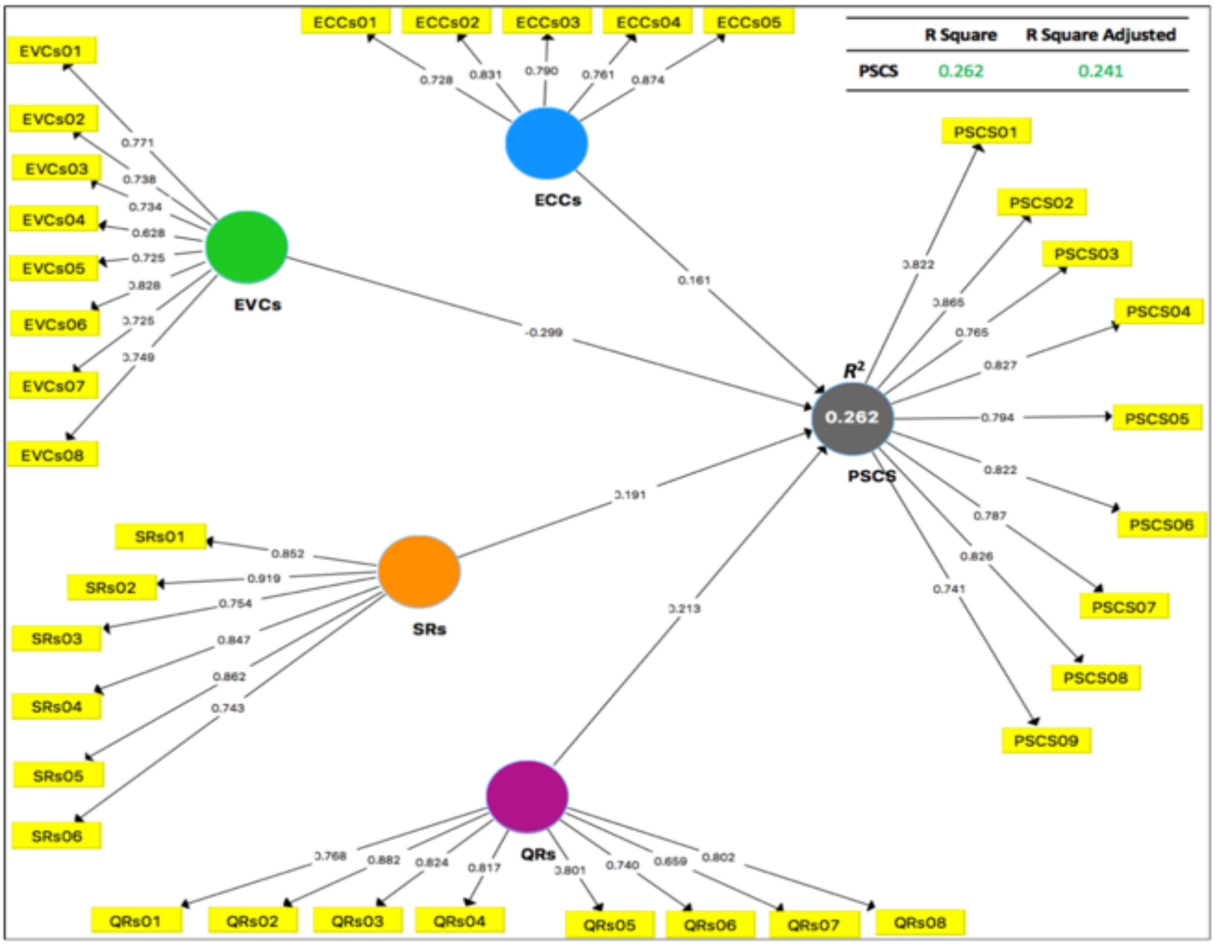

Figure 5. 10: R^2 results of the first-order model design

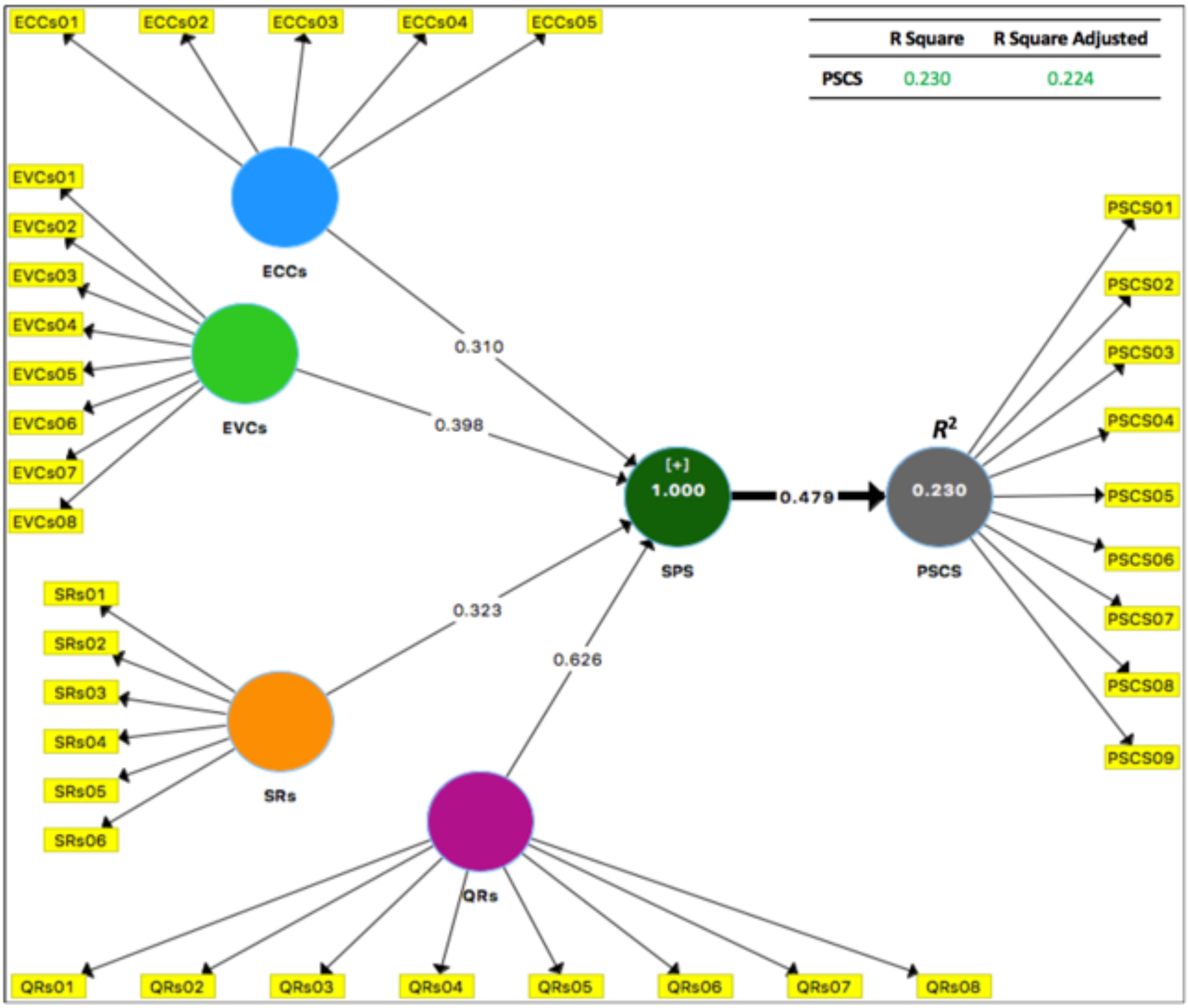

Figure 5. 11: R^2 results of the second-order model design

5.8.3.3 Evaluating the effect size (f^2)

The f^2 effect size is a measure used to evaluate the relative impact of an independent variable (a predictor construct) on a dependent variable (an endogenous construct). The effect size (f^2) is calculated by noticing the change in the coefficient of determination (R^2) when a specific variable is removed from the model. Based on the value of f^2, the effect size of the removed variable for a particular dependent variable can be determined. Values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively (Cohen, 1992; Hair et al., 2014). The effect size can be calculated as

$$f^2 = \frac{R^2_{\text{included}} - R^2_{\text{excluded}}}{1 - R^2_{\text{included}}},$$

where R^2_{included} and R^2_{excluded} are the R^2 values of the dependent variable when a selected independent is included or excluded from the model (Hair et al., 2017). As shown in Table

5.19, the first four values of f^2 indicate that all of the four IVs (ECCs, EVCs, SRs, and QRs) have a small effect size on project success. However, when applying a second-order model design (as discussed in section 5.8.3.1), the combined effect of IVs which represented by SPS, is medium. These results re-confirm that SPS has to be seen as a net of the four IVs' relationships that are significant for project success, and not the solo relationship of each.

Table 5. 19: The statistical results of the effect size (f^2)

Model design	Independent variables (IVs)	f^2 value	Effect size
First-order	ECCs	0.031	Small
	EVCs	0.112	Small
	SRs	0.047	Small
	QRs	0.059	Small
Second-order	SPS	0.299	Medium

5.8.3.4 Evaluating the predictive relevance (Q^2)

The Q^2 is a means for evaluating the predictive relevance of the structural model of a framework. It evaluates whether a model accurately predicts data not used in the assessment of model parameters. The measure builds on "a sample re-use technique, which omits a part of the data matrix, estimates the model parameters and predicts the omitted part using the estimates. The smaller the difference between predicted and original values the greater the Q^2 and thus the model's predictive accuracy". Specifically, a Q^2 value larger than zero (0) indicates that the IVs have predictive relevance for the DV(s) (Hair et al., 2014: 113).

Table 5. 20: The predictive relevance of the structural model (Q^2)

Variables	SSO	SSE	Q^2 (=1-SSE/SSO)
ECCs	700	700	
EVCs	1,120.00	1,120.00	
SRs	840	840	
QRs	1,120.00	1,120.00	
PSCS	1,260.00	1,088.67	0.136

The analysis results in Table 5.20 provide clear support for the predictive relevance of the current research framework regarding the dependent variable, as the Q^2 value of project success (PSCS) is considerably above zero (0.136). SSO column shows the sum of the squared observations, while SSE column shows the sum of the squared prediction errors. The Q^2 value in the last column is the result of 1 – SSE(PSCS)/SSO(PSCS).

5.8.4 Evaluating the effect of the control variable: project complexity

The final step in the analysis was evaluating the effect of the project complexity within the structural model. To evaluate the effect of the project complexity, the projects in the sample were classified into one of three levels: low complexity, medium complexity, and high complexity (as discussed in section 5.8.1). Following Falk and Miller (1992) and Carvalho and Rabechini (2017), these levels of project complexity were operationalised as dummy control variables in the structural model by attributing a value equal to one (1) to the projects that belonged to the same level and zero (0) to all other levels. Table 5.21 displays a fraction of the sample as an illustrative example. After that, the analysis was performed for each level separately, starting by low project complexity, then medium project complexity, after that high project complexity, as shown in Figures 5.12, 5.13, and 5.14, respectively. The statistical results of each level (low, medium, and high) are presented in Tables 5.22, 5.23, 5.24, respectively. The analysis revealed that project complexity has no effect within the structural model. The P-value of each level shows no significant relationship with project success (PSCS), as it is always higher than the threshold of 0.05; and there was no significant effect on the relationships between the IVs and the DV (PSCS) in each level as well (as shown in Tables 5.22, 5.23, 5.24). Also, there was no significant effect on the value of R^2 in each level as shown in Figures 5.12, 5.13, and 5.14, respectively.

Table 5. 21: Operationalising project complexity in the model (illustrative example)

Response (6 out of 140)	Complexity level	Dummy control variables		
		Low complexity	Medium complexity	High complexity
1	MEDIUM	0	1	0
2	MEDIUM	0	1	0
3	LOW	1	0	0
4	MEDIUM	0	1	0
5	HIGH	0	0	1
6	HIGH	0	0	1

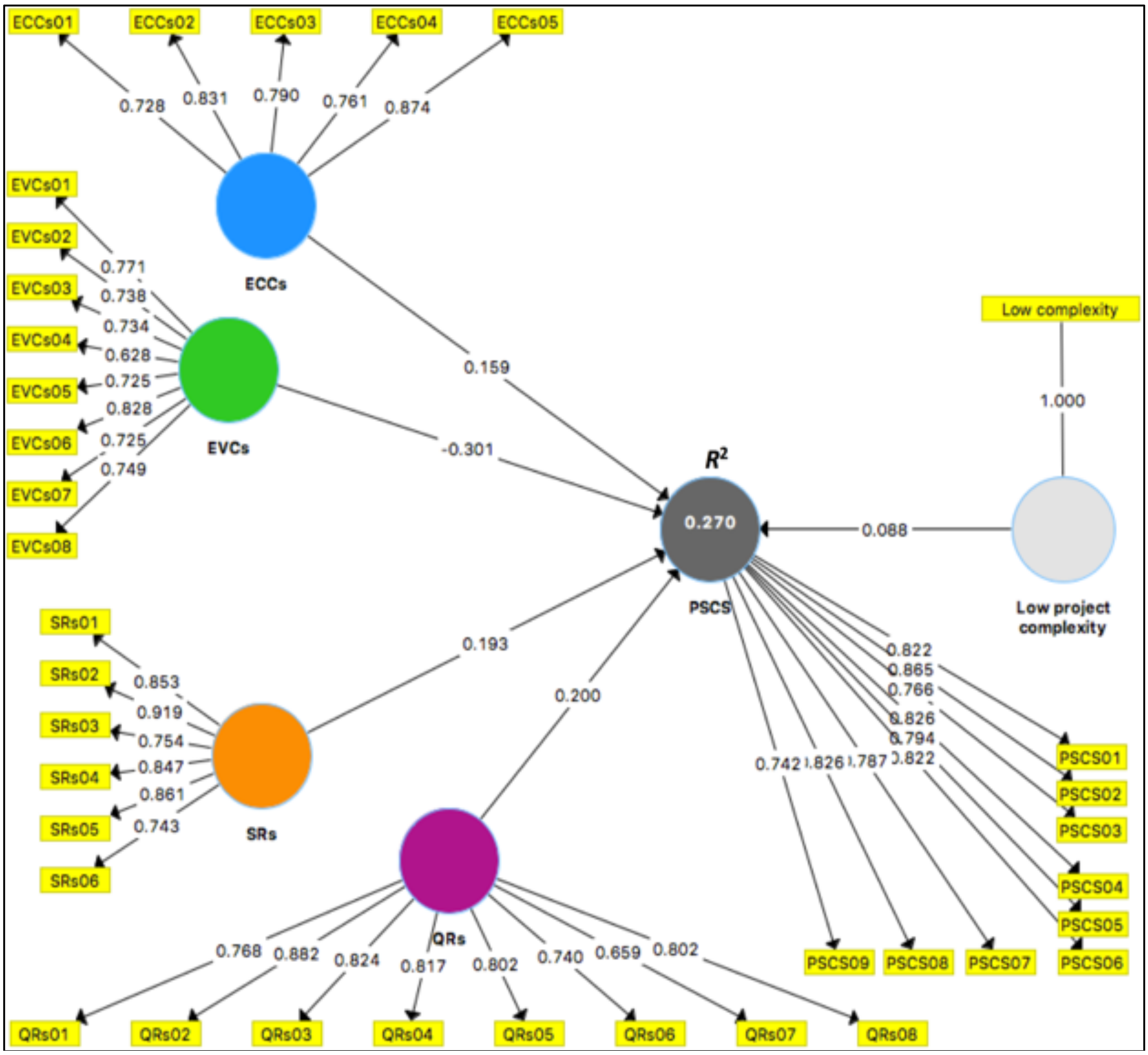

Figure 5. 12: The effect of low project complexity on R^2

Table 5. 22: The statistical results of low project complexity

Relationships	β-Values	P-Values	Significance (p < 0.05)?	Relationships type
ECCs -> PSCS	0.159	0.028	Yes	Positive
EVCs -> PSCS	-0.301	0.000	Yes	Negative
Low project complexity -> PSCS	0.088	0.156	No	Positive
QRs -> PSCS	0.200	0.003	Yes	Positive
SRs -> PSCS	0.193	0.019	Yes	Positive

*(n=16 out of 140, 11%)

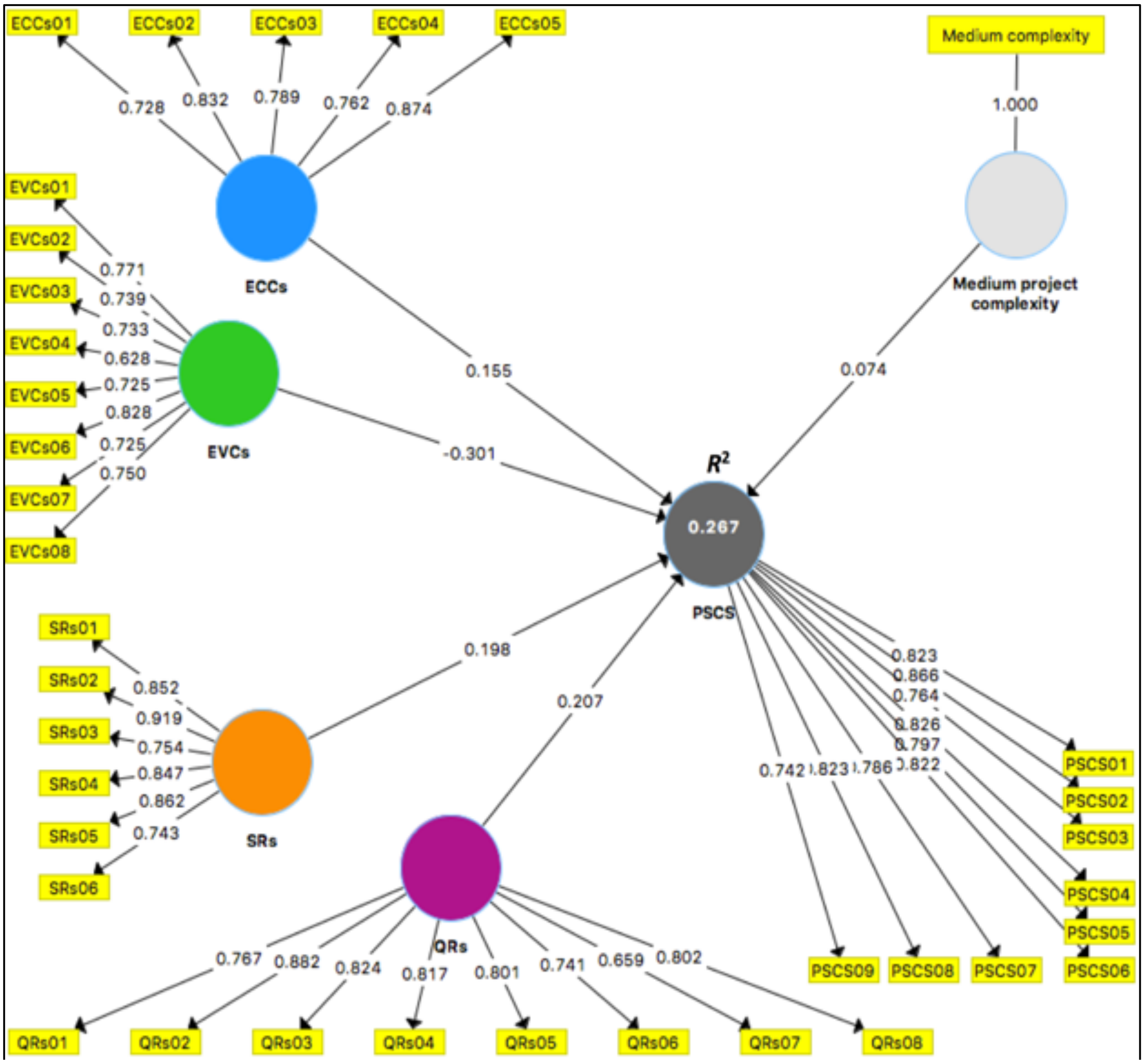

Figure 5. 13: The effect of medium project complexity on R^2

Table 5. 23: The statistical results of medium project complexity

Relationships	β-Values	P-Values	Significance (p < 0.05)?	Relationships type
ECCs -> PSCS	0.155	0.024	Yes	Positive
EVCs -> PSCS	-0.301	0.000	Yes	Negative
Medium project complexity -> PSCS	0.074	0.336	No	Positive
QRs -> PSCS	0.207	0.006	Yes	Positive
SRs -> PSCS	0.198	0.02	Yes	Positive

*(n=110 out of 140, 79%)

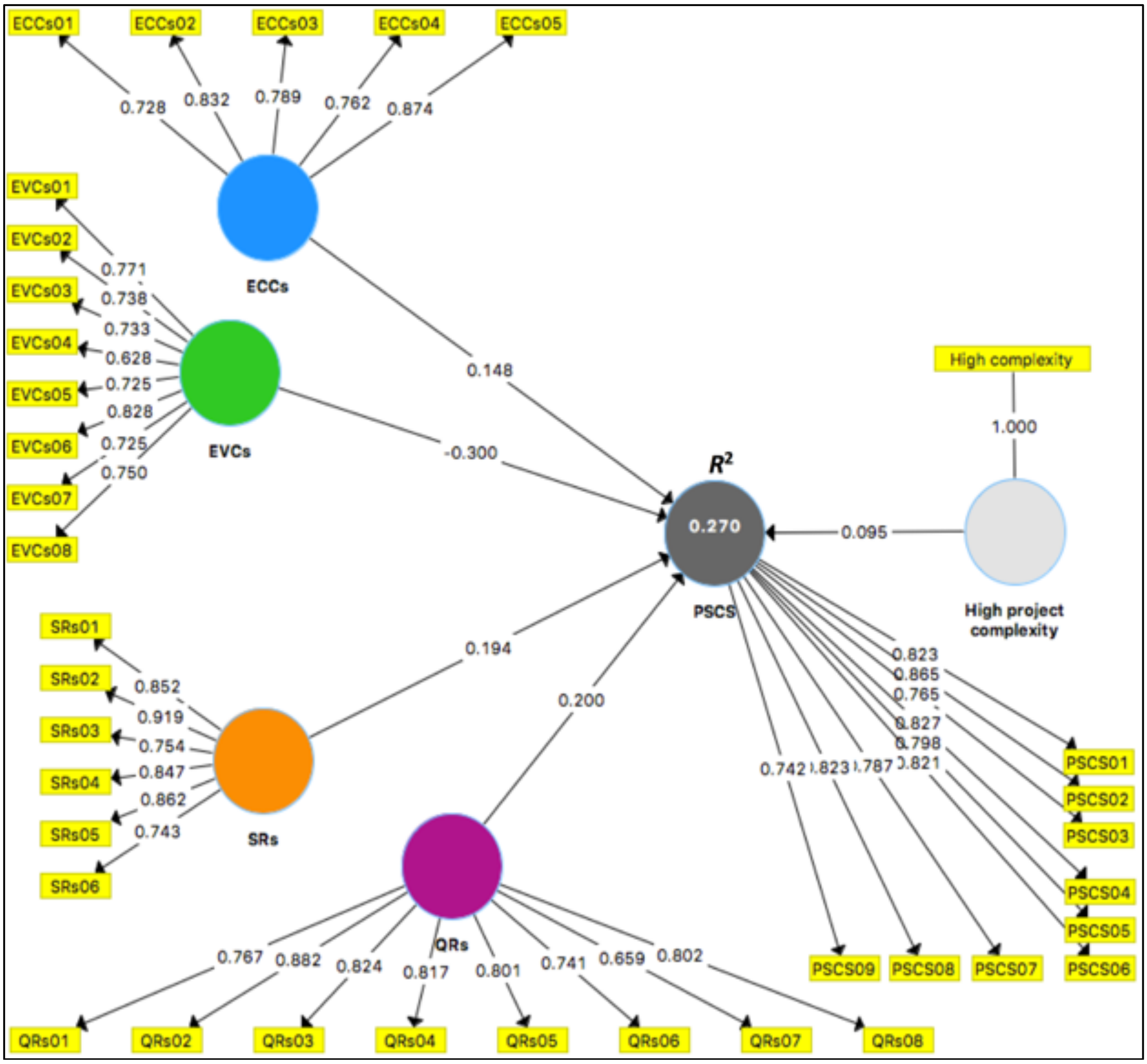

Figure 5. 14: The effect of high project complexity on R^2

Table 5. 24: The statistical results of high project complexity

Relationships	β-Values	P-Values	Significance (p < 0.05)?	Relationships type
ECCs -> PSCS	0.148	0.051	Yes	Positive
EVCs -> PSCS	-0.300	0.000	Yes	Negative
High project complexity -> PSCS	0.095	0.234	No	Positive
QRs -> PSCS	0.200	0.006	Yes	Positive
SRs -> PSCS	0.194	0.014	Yes	Positive

*(n=14 out of 140, 10%)

5.9 Summary

The adopted statistical analysis technique of the empirical data in this thesis was the partial least squares structural equation modelling (PLS-SEM). The conceptual framework was validated as a model by establishing the internal consistency reliability (Cronbach's alpha and composite reliability), the convergent validity (indicator reliability and average variance extracted), and the discriminant validity (Fornell-Larcker criterion and cross-loadings). The results show a good commitment toward the economic and social aspects of SPS in the surveyed sample, while environmental aspects were barely considered. The analysis revealed a significant relationship between the four constructs of SPS and project success. The relationship with project success was positive for the ECCs, the SRs, and the QRs, while for the EVCs, this relationship was negative. However, it was found that the overall relationship of all constructs "combined" with project success is significant and positive. Also, the analysis revealed that project complexity has no significant effect on the relationship between SPS and project success. Therefore, it was concluded that SPS can impact project success significantly and positively, especially if SPS is considered as a net of the four constructs' relationships with project success, and not the solo relationship of each.

Chapter 6 - Discussion and conclusion

This chapter discusses and concludes the main findings of the thesis. It consists of three main sections. Section 6.1 reiterates the research problem, aim, and objectives; and discusses the major findings. Section 6.2 presents the significant contributions of the thesis with the academic and practical implications. Finally, section 6.3 acknowledges the research limitations and makes suggestions for future research.

6.1 Reiterating the research problem and aim, and discussing the major findings

Over the last decade, there has been growing attention to the incorporation of sustainability into projects (project sustainability). The link between sustainability and projects has been built on 'achieving the required change'. In essence, sustainability is concerned with generating beneficial change, and projects are the ideal tools that can significantly help in achieving this change. However, there are some criticisms regarding the incorporation of sustainability into projects, and one of the most important criticisms is that this incorporation may have a negative impact on project success (as discussed in detail in section 1.2), which is crucial and directly linked to the success of organisations as a whole. Project success remains among the top priorities and at the heart of project management (Müller and Jugdev, 2012).

However, the conducted systematic literature review (section 2.1) revealed that the relationship between project sustainability and project success has been inadequately researched until now, and more studies should be carried in both developed and developing countries. There is an evident lack of research on this relationship in the developing countries of the Arab world in particular. Further, it has been found that most of the few relevant contributions are conceptual in nature and focus mainly on manufacturing and construction projects. There is a lack of research which explores this relationship in some important projects such as information systems, information technology, services, and telecommunications projects. Currently, there is no recorded contribution which focuses on the relationship between project sustainability (PS) and project success in the software industry. This gap in the literature was the main basis of the current thesis. Software systems are considered as pervasive drivers of change in society (Calero and Piattini, 2017; Penzenstadler et al., 2018), and incorporating sustainability into software projects - software project sustainability (SPS) - is gaining importance. Many notable contributions on SPS have recently been made. However, in terms of the relationship with project success, the question that remains is **'does software project sustainability (SPS) support project success?'**. This research has worked on this question and **aimed to investigate the potential impact of software project sustainability (SPS) on project success.** To achieve this aim, this thesis sought to answer the following three questions.

- **Research question 1 (RQ1):** how has the concept of sustainability been translated from theory into practice and incorporated into software projects?
- **Research question 2 (RQ2):** how is project success being evaluated in relevant literature?
- **Research question 3 (RQ3):** can software project sustainability (SPS) support project success?

These three questions have been answered by achieving the four objectives below, which are discussed in the following subsections. The first objective (OB1) was set to answer RQ1, the second objective (OB2) was set to answer RQ2, while objective 3-A and objective 3-B (OB3-A and OB3-B) were set to answer RQ3.

6.1.1 Research objective one (OB1)

To explore how the concept of sustainability can be translated from theory into practice and incorporated into software projects.

The conducted systematic literature review (in section 3.1) disclosed that most existing contributions in the literature regarding incorporating sustainability into projects have focused on the manufacturing and construction projects. The findings revealed that most of these contributions used the triple bottom line (TBL) as a dominant theory in defining the concept of sustainability. The main idea behind the TBL theory is about balancing or harmonising economic, environmental, and social interests; and that none of these dimensions can be developed without considering and affecting the other two dimensions (Elkington, 1998 and 2013; Savitz, 2013). In summary, the economic dimension focuses mainly on financial aspects and business strategic value. The environmental dimension focuses on protecting the environment (e.g. reducing waste, environmental accidents, pollution, toxic, and harmful materials) and its natural resources (e.g. air, land, water, raw materials, and minerals). The social dimension focuses on the relationships between individuals and groups, and concerns with providing equal opportunities and responsible governance structure, and ensuring the quality of life.

Some contributions relevant to SPS (as discussed in section 2.2.4) have tried to add more dimensions to the TBL such as human or individual dimension, cultural dimension, and political dimension. However, in the opinion of the author, these proposed dimensions are considered to be already included in the TBL. For instance, the individual dimension can be included in the social dimension. Therefore, the author of the current research agrees with Silvius et al. (2017) that there is no consensus on any other dimensions. In addition, most of the "related works" in section 2.1, particularly the empirical studies, have used the TBL as a theoretical base for project sustainability. Therefore, this research focuses only on the TBL theory, as it is widely accepted (Keating, 1994) and as it "captures the essence of sustainability" (Savitz, 2013: 5). Based on that, sustainability is defined as the consideration of environmental and social needs besides the economic interest to achieve short- and long-term success (Elkington, 1998, Kleindorfer et al., 2005; Baumgartner and Ebner, 2010; Thomas and Lamm, 2012; Silvius and Schipper, 2014; Khalifeh et al., 2019).

To translate sustainability from theory into practice and incorporate it into software projects, it was found that the most efficient and effective method is by integrating TBL-related aspects into these projects. Integrating such aspects should be based on two perspectives, software product sustainability and software process sustainability. Software product sustainability concerns the sustainability of software 'itself' as a product (sustainability of project outcomes). Meanwhile, software process sustainability concerns the sustainability of managing software development and its engineering processes; it can be defined as the sustainability in project interrelated activities during the development of a software product (Khalifeh et al., 2020).

Many authors have used this approach such as Cabot et al. (2009), Albertao et al. (2010), Naumann et al. (2011), Koziolek (2011), Shenoy and Eeratta (2011), Lami et al. (2012), Penzenstadler and Femmer (2013a), Mahmoud and Ahmad (2013), Raturi et al. (2014), Venters et al. (2014a), Kocak et al. (2015), Calero et al. (2015), Al Hinai and Chitchyan (2016), and Oyedeji et al. (2017). However, the majority of these contributions have focused on either project product or project process, or on one or two dimensions of sustainability rather than the three dimensions of the TBL theory. As a result, until now there is no consensus on any specific set of TBL-related aspects for incorporating sustainability into software projects.

In conclusion, the current research has applied the same approach - integrating TBL-related aspects - for incorporating sustainability into software projects. However, the proposed framework has gone beyond the previous works of software sustainability and contributed significantly by presenting a new set of aspects that consider all three TBL dimensions (economic, environmental, and social) in the processes and products of software projects (as discussed in detail in section 3.1). Finally, as discussed in section 2.3.3, software project sustainability (SPS) can encompass two different perspectives - 'sustainability BY software project' and 'sustainability IN software project'. In brief, sustainability BY software project, which is out of the scope of this study, is about achieving sustainability by solving economic, environmental, and social-related problems through software projects or their outcomes/products (e.g. using software in process automation and logistics optimisation, telepresence, cloud management, remote collaboration, measuring carbon footprints, reducing waste and greenhouse gas emissions, efficient resources utilisation). Meanwhile, sustainability IN software project, where this study is focused, is about making software projects "themselves" sustainable. For instance, using clean and renewable energy, using co-location services, considering human rights and ethical behaviour, dealing with unwanted equipment and materials in an environmentally friendly manner.

Based on these two perspectives, it should be noted that current research focuses particularly on sustainability "IN" software projects and defines software project sustainability (SPS) as the consideration of the three dimensions of sustainability (economic, environmental, and social) in processes and products of software projects.

6.1.2 Research objective two (OB2)

To investigate how project success is being evaluated in the relevant literature.

Considerable works have been conducted, over the past 40 years, on the evaluation of project success. The traditional criteria that were used to measure project success were cost, time, and specifications (otherwise called quality or scope), and known as the "iron triangle" (Atkinson, 1999) or triple constraints (Dalcher, 2014). These criteria, when considered alone, are subject to extensive criticism, as they only measure project management success (project efficiency) and ignore project outcome success (project effectiveness). Project management success is mainly related to the success of project processes and how a project was managed within time, cost and specifications constraints.

Meanwhile, project outcome success refers to the strategic success of deliverables, which means meeting initial project objectives and other benefits gained for all stakeholders over time (e.g. impact on the project team and customer, and creating new markets).

The findings revealed that measuring project success should encompass project outcome success as well as project management success. The development of the literature illustrates other criteria that should be considered for measuring the success of project outcomes besides the iron triangle, such as stakeholders' satisfaction, meeting business objectives and strategic goals, creating new markets and technology, and creating social and environmental impacts. These criteria place more focus on multiple stakeholder judgments (e.g. project managers, project teams, owners, clients, users, sponsors, senior management) and on the evaluation of project outcome success over time.

In this context, relevant empirical studies which were found in section 2.1.2 have sufficiently considered the two types of project success - project management success and project outcome success - depending on different models. Martens and Carvalho (2016a and 2016b) measure the two types of project success based on six sub-dimensions, namely project efficiency (meeting the criteria of time, cost, and scope), impact on clients, impact on staff, business success, future preparation, and social and environmental impact (or sustainability impact). The first five sub-dimensions are based on Shenhar and Dvir (2007), whereas the sixth sub-dimension is based on others such as Atkinson (1999); Lim and Mohamed (1999); Elattar (2009); Kumaraswamy and Thorpe (1996); Kometa et al. (1995); Almahmoud et al., (2012); Chan and Chan (2004); and Carvalho and Rabechini (2015). Similarly, Carvalho and Rabechini (2017) measure the two types of project success based on the five sub-dimensions of Shenhar and Dvir (2007), but without considering the sixth dimension, sustainability impact. On the other hand, the study by Adriana and Ioana-Maria (2013) depends on the six sub-dimensions of DeLone and McLean (2003) for measuring the two types of project success. The six sub-dimensions are meeting time and cost with initial objectives, ensuring quality standards of procedures, engagement with stakeholders, compliance with strategic business objectives, understanding user needs, and stakeholders' participation in products. Finally, the study by Khalilzadeh et al. (2016) measures the two types of project success using six sub-dimensions developed by Silvius and Schipper (2016). These sub-dimensions are project execution in a controlled way, project deliverables fit for purpose, the satisfaction of project stakeholders, completion of agreed deliverables within budget and time, the realisation of project business objectives, and future preparation. Knowing how each study considered project success is necessary to determine whether the evaluation was done comprehensively (based on project efficiency and effectiveness) or not.

In conclusion, project success should be evaluated by its efficiency and effectiveness. Efficiency "focuses on optimisation of the available resources by doing things right, while effectiveness revolves around the fulfilment of objectives and the contribution to achieving organisational goals by doing the right things" (Dalcher, 2014: 14). Therefore, evaluating project success should include criteria for project outcome success besides the traditional criteria of project management success.

The conducted systematic literature review (SLR) revealed several models for evaluating project success. The findings agree with Davis (2014) and Silvius and Schipper (2016) that Pinto and Slevin (1988), Shenhar et al. (1997 and 2001), and Shenhar and Dvir (2007) are among the most cited works for measuring project success. However, it was found that the multidimensional model of Shenhar and Dvir (2007) has the most comprehensive criteria for evaluating project success and serves the exact purpose of this research. The model includes criteria for evaluating project management success (project efficiency) and criteria for evaluating project outcome success (project effectiveness). Based on this model, project success is defined as completing a project within time or earlier, within or below budget, meeting customers' requirements and having their satisfaction, and achieving business goals. Also, this model was used in relevant empirical studies such as Mir and Pinnington (2014), Martens and Carvalho (2016b), and Carvalho and Rabechini (2017). Therefore, it was used in the current research. Consequently, the evaluation criteria of project success included project efficiency and effectiveness based on five dimensions, which are: project efficiency, impact on the customer, impact on the team, business success, and preparing for the future.

6.1.3 Research objective 3-A (OB3-A)

To develop and validate a model that helps in examining the relationship between SPS and project success based on explicit constructs for both concepts.

To achieve this objective, the first step was to develop a conceptual framework (using SLR methodology as discussed in detail in chapter 3) that helps in the empirical examination of the relationship between these two concepts. The proposed framework (Figure 1.1) consists of six constructs which were developed based on the analysis of the best contributions in the relevant literature and correspond with the findings of OB1 and OB2. The first four constructs, which are independent variables (IVs) and represent SPS (Table 3.6), are economic considerations (ECCs), environmental concerns (EVCs), social responsibilities (SRs), and TBL-related quality requirements (QRs). These constructs encompass a unique combination of TBL-related aspects for incorporating sustainability into the processes and products of software projects and form a significant part of the contribution of this thesis. The fifth construct represents project success (PSCS) and its five dimensions (Table 3.7), which was positioned as a dependent variable (DV). The sixth construct is project complexity, which was set as a control variable in the proposed framework (as discussed in detail in sections 3.3 and 4.8.3). The development of the framework is affiliated with the triple bottom line (TBL) theory of sustainability (Elkington, 1998), the Product Quality model of systems and software (ISO/IEC 25010:2011, 2018), the Sustainability Checklist of the International Project Management Association (IPMA) (Silvius et al., 2012), the contingency theory (Fiedler, 1964), and the multidimensional model of Shenhar and Dvir (2007) for measuring project success.

The proposed framework was operationalised using observable indicators (questionnaire items), which had previously been used or examined by relevant studies, and which represent the best meaning of the framework variables and consistent with their theoretical definition. After that, a face validation assessment with a pilot study were carried out to ensure the validity and reliability of the framework and its questionnaire items and to eliminate any potential deficiencies, weaknesses, errors, ambiguities before conducting the final empirical study. Also, any major concerns or problems pertaining to the questionnaire and which may impact the research process can be identified during the piloting stage by testing the sequencing, wording, response rate, analysis process, and completion time of the questions. Finally, the main empirical study was carried out using a self-administered questionnaire and targeted the key stakeholders of the internal software projects of the ten Jordanian public universities. The collected data were examined and analysed using the partial least squares structural equation modelling (PLS-SEM). Based on the analysis of 140 valid questionnaires, the framework was validated as a model (discussed in detail in section 5.8.2) by establishing the internal consistency reliability (Cronbach's alpha and composite reliability), the convergent validity (indicator reliability and average variance extracted), and the discriminant validity (Fornell-Larcker criterion and cross-loadings) (Sarstedt et al., 2014; Hair et al., 2017).

6.1.4 Research objective 3-B (OB3-B)

To examine the potential impact of SPS on project success empirically.

To investigate the potential impact of SPS on project success in-depth, the potential impact of each construct of SPS on project success was examined; then, the potential impact of all of the constructs "combined" on project success was examined as well. Additionally, because it has been argued in the relevant literature that project success can be affected - positively or negatively - by project complexity (discussed in detail in sections 3.3 and 4.8.3), the potential impact on project success was inspected under different levels of project complexity (low, medium, and high). Based on the above, the following six research hypotheses were developed.

- **H1:** Incorporating economic considerations (ECCs) in the processes of software projects has a significant and positive relationship with project success.
- **H2:** Incorporating environmental concerns (EVCs) in the processes of software projects has a significant and positive relationship with project success.
- **H3:** Incorporating social responsibilities (SRs) in the processes of software projects has a significant and positive relationship with project success.
- **H4:** Incorporating TBL-related quality requirements (QRs) in the products of software projects has a significant and positive relationship with project success.
- **H5:** Software project sustainability (SPS) has a significant and positive relationship with project success.
- **H6:** Project complexity has a significant impact on project success.

The statistical results of the first four hypotheses (H1, H2, H3, and H4) show a significant relationship between the four constructs of SPS and project success. The relationship with project success was positive for ECCs, SRs, and QRs, while it was negative for EVCs. This indicates that focusing only on environmental-related aspects when incorporating sustainability into the processes of a software project may impact negatively project success. A possible justification for this result is that incorporating the environmental-related aspects of sustainability (which were defined in Table 3.4, section 3.1.2) requires more coordination with different parties; put more pressure on project managers, practitioners, and decision-makers; makes planning harder; causes more variations in design; and causes greater overheads and difficulty in selecting subcontractors, materials, and equipment. This finding regarding EVCs was not surprising. Many authors - from other fields - have argued that incorporating environmental aspects into projects may have a negative impact on project success. For example, Pujari (2006), Taylor (2010), Plouffe et al. (2011), Hwang and Ng (2013), and Marcelino-Sádaba et al. (2015). However, most of these studies do not give empirical evidence and/or proper solutions. A key issue may be to use digital technologies and enlightened thinking, to ensure that doing more on the environment comes simultaneously with lower cost and other success measures. Clients are becoming increasingly aware that they should only engage with other companies, that have high environmental standards, otherwise they own reputation may be damaged. Consequently, that can lead to business growth for those who are implementing best practice, and potentially greater profitability. Therefore, in future research, focusing on problems of incorporating environmental-related aspects into projects and giving proper solutions empirically, may support project success significantly.

However, the analysis revealed that the overall relationship of the four constructs "combined" with project success is significant and positive (H5). Also, it was found that the combined effect of the four constructs of SPS on project success is moderate. Finally, the analysis revealed that project complexity has no significant effect on the relationship between SPS and project success (H6). Table 6.1 summarises the main results of OB3-B.

Table 6. 1: The main statistical results of the hypothesised relationships

Hypotheses	Relationships	Significance ($p < 0.05$)?	Relationships type	Effect on project success (R^2)	Hypotheses final assessment
H1	ECCs -> PSCS	**Yes**	**Positive**	Moderate	**Supported**
H2	EVCs -> PSCS	**Yes**	**Negative**		**Contradicted***
H3	SRs -> PSCS	**Yes**	**Positive**		**Supported**
H4	QRs -> PSCS	**Yes**	**Positive**		**Supported**
H5	SPS -> PSCS	**Yes**	**Positive**	Moderate	**Supported**
H6	Project complexity -> PSCS	**No**	**Positive**	**No Effect**	**Rejected**

*Contradicted: the relationship is significant (as hypothesised) but negative (not positive as hypothesised).

Based on these results, it is concluded that SPS can impact project success significantly and positively regardless of the level of project complexity; and particularly if SPS is considered as a net of the four constructs' relationships with project success, and not the solo relationship of each. The findings of this thesis may reflect actual reality, as most of the essential criteria required for examining the relationship between SPS and project success comprehensively were sufficiently considered. The two types of incorporation of SPS (project process sustainability and project product sustainability) with their TBL-related aspects were considered, and the two types of project success (project management success and project outcome success) were considered as well. Also, the collected data set was examined for missing entries, suspicious response patterns, data distribution, outliers, response rate, and non-response bias. In addition, the results showed a reasonable level of commitment to the TBL-related aspects of SPS in the surveyed sample. Furthermore, the analysis results provide clear support for the predictive relevance of the model (Q^2) regarding project success. Finally, the results of this thesis agree with the findings of the majority of relevant empirical studies in section 2.1.2. Three studies (out of five) found a significant relationship between project sustainability (PS) and project success, and a positive impact was observed. According to Carvalho and Rabechini (2017: 1120), there is “a significant and positive relation between project sustainability management and project success”. Likewise, Khalilzadeh et al. (2016: 352) conclude that PS has “a positive and significant relationship” with project success. Martens and Carvalho (2016b: 37) state that “there is a strong relationship between the main constructs of the framework” and PS “promoting” project success. However, these studies differ with regards to the impact level of PS on project success. Both Khalilzadeh et al. (2016) and Martens and Carvalho (2016b) show a high level of positive impact on project success, while the level of impact in the study by Carvalho and Rabechini (2017) was found to be moderate. A possible justification for this variation in the level of impact is that the level of sustainability incorporation in projects varied between the surveyed companies in each study. Another justification may be due to the use of different models, dimensions and measures by each study in testing the impact of PS on project success. Also, the difference in the type of industries, respondents, or countries targeted in each study could be another reason. On the other hand, the other two studies, Adriana and Ioana-Maria (2013) and Martens and Carvalho (2016a), reached no definitive results on the relationship between project sustainability (PS) and project success. Nevertheless, the authors of these two studies conclude that PS has the potential to increase the success of projects and improve the satisfaction of stakeholders. The results of the Adriana and Ioana-Maria (2013) study are controversial. The authors found cases when “sustainable practice did not lead to success” (Adriana and Ioana-Maria, 2013: 20) and found that “the success of projects is not always connected to sustainability inclusion” (Adriana and Ioana-Maria, 2013: 1). According to their study, “sometimes 100% sustainability integration generates only 67% or 83% successful outcomes. Similarly, 86%, 71%, and even 57% sustainability levels lead to 100% success" (Adriana and Ioana-Maria, 2013: 15). However, they claim, "in the majority of cases, we obtained a direct impact from sustainability. Therefore, there is evidence that sustainability may induce success in project management, even though there could be other factors of influence" (Adriana and Ioana-Maria, 2013: 1). The possible reason behind these controversies may be the fact that their study was based on reports, not on samples of respondents like other studies, and the information in these reports – as they claimed – was "confusing" or "not presented properly". In addition, their concern about the incorporation of sustainability in the project process only maybe another reason for controversy. Similarly, the study of Martens and Carvalho (2016a) produced no conclusive results about the importance of the relationship between the two concepts, as it was based solely on the exploration of the potential impact type (positive or negative) of PS on project success. However, they declare that "addressing the impacts of sustainability in project management on project success has the potential to increase the efficacy and efficiency of projects as well as improve stakeholders' satisfaction" (Martens and Carvalho, 2016a: 37).

6.2 Contribution and implications

This thesis contributes to project sustainability research by providing empirical evidence regarding the potential impact of software project sustainability (SPS) on project success. This is considered significant due to the present contradictions in the literature regarding the incorporation of sustainability into projects and its impact on project success. Some authors argue that project sustainability (PS) has a negative impact on project success, while others say the opposite. These contradictions frustrate and impede moving towards a more sustainable orientation in projects, which make up about a third of the organisations' activity worldwide. The relationship between project sustainability (PS) and project success remains among the top priorities and of significant concern for researchers and practitioners. Unfortunately, this relationship has been inadequately researched until now and most of the few relevant contributions are conceptual studies and focus mainly on manufacturing and construction projects. Currently, there is no recorded contribution which focuses on this relationship in the field of software projects and within the context of Arab countries. Therefore, by focusing on this gap, this thesis contributes significantly to knowledge, and the empirical findings may relief the contradictions regarding the incorporation of sustainability and push towards a more sustainable orientation in projects.

Another significant contribution is the development and validation of a model that systemises this relationship based on explicit constructs and helps in examining the potential impact of SPS on project success. Until now, there is no theoretical model for examining this relationship in the relevant literature. The constructs of the model provide a unique combination of variables that may give researchers and practitioners (e.g. project managers and decision-makers) a better understanding of how to examine whether incorporating sustainability in software projects supports or impedes the success of these projects. Also, it can be argued that the approach of the thesis in developing the conceptual framework for the relationship between SPS and project success will add value to the relevant literature.

In addition, the proposed model provides business leaders, decision-makers, project managers, software engineers, and consultants with useful guidance on how to incorporate, enhance, and monitor sustainability in their software projects. Further, the model allows practitioners to identify changes in priorities as a result of the consideration of project success. It may also enhance current sustainability practices and help identify stakeholders' priorities and manage their expectations throughout the project. This is considered significant, as the majority of these practitioners "recognise the need for sustainability but underestimate what needs to be done" (Marnewick, 2017: 1153). This may have a negative impact on project success, as it may lead to major losses in time and budget, demotivate the project team, create an unproductive and unsatisfactory work environment, and result in project failure.

Furthermore, whilst the current literature has some notable contributions regarding the incorporation of sustainability into software projects, these contributions have mostly focused on either project product or project process, or on one or two dimensions of sustainability rather than the three dimensions of the TBL theory. This study goes beyond previous research of software sustainability and contributes significantly by presenting a new set of TBL-related aspects for incorporating sustainability into the processes and products of software projects. Therefore, software companies - or other relevant organisations - may use the proposed model as a measurement tool to evaluate the environmental and social impacts of their current products and project management practices. Consequently, these organisations may pay more attention to incorporating sustainability into their project management practices.

Finally, the outcomes of this study will add a valuable contribution to the existing body of knowledge related to project sustainability in general, as it can be applied in other sectors and may benefit all involved stakeholders across different disciplines. Despite the need for more research in this potential paradigm shift in project management, this study may facilitate decision-making by considering sustainability as a new school of thought in project management and providing a good basis for testing the impact on project success empirically in future research. It is hoped that this study can expedite the adoption of sustainability in software projects to contribute towards a more sustainable orientation and success of organisations and society at large.

6.3 Limitations and recommendations for future research

Although this thesis contributes significantly to project sustainability and its relationship with project success, some limitations should be noted for future research. Initially, this thesis focuses only on software projects and the empirical results are limited to one developing country of the Arab world (Jordan). Jordan indeed forms part of the Arab world but it is not one of those countries that have earned a lot of wealth through their oil deposits. While there are aspects of Jordanian culture that are very similar to what is found in other Arab countries, Jordan cannot be seen as representing the totality, either for Arab countries or for developing nations. Therefore, future research may focus on different types of projects (e.g. information systems, telecommunications, and service sectors) and within the context of other countries. Generally, there is a need for further research in this topic area in both developed and developing countries, and the findings show that there is an obvious lack of empirical contributions. In the opinion of the author, future research should be based on surveys more than case studies, since surveys are suitable for testing insights and hypotheses to develop new knowledge. Alternatively, case studies are suitable for exploring and developing hypotheses and less suited to testing them.

The above are limitations and recommendations are for future research in general. However, for future research that focuses on software project sustainability and its relationship with project success, there are some specific limitations and recommendations that should be considered. **First**, the development of the conceptual framework constructs was based only on the analysis of relevant literature and some publications could not be accessed due to linguistic limitations. Therefore, in future works, improving the proposed framework through additional resources or by conducting semi-structured interviews, then validating the findings empirically could be interesting research issues. **Second**, for collecting the empirical data, this thesis has only employed a quantitative methodology that was based on a self-administered cross-sectional questionnaire survey. Despite the questionnaires are based on robust theoretical literature and were dispersed to the surveyed sample randomly and carefully, using a solely quantitative methodology may limit the ability to have an in-depth view of the subject matter under investigation, which is usually found in qualitative research. Also, using a cross-sectional survey (which is considered cheap, practical and quick) only reflects the beliefs and perceptions of respondents at one point in time. However, these beliefs and perceptions may change over time which necessitates conducting a longitudinal survey in future research to provide more robust evidence and give further validation to the proposed framework of this study. **Third**, the survey sample of this thesis is limited to the internal software projects of Jordanian public universities. This could potentially bias the results as all surveyed key-stakeholders are working in the same place and under governmental responsibility. Therefore, to expand the generalisability of the results, it would be desirable in future studies to focus on external projects of private organisations, where key-stakeholders are distributed between the executing company and the project owner (unlike internal projects).

Finally, the empirical findings revealed that focusing only on environmental-related aspects (without considering economic and social aspects) when incorporating sustainability into the processes of a software project may impact negatively project success. Unfortunately, to the author's knowledge, there is no research to support or oppose this result in software field until now. The relationship between the environmental sustainability of software projects and project success is still absent in the literature. This omission is an important gap in knowledge and could be significant research for future contributions; particularly, if the impact on project efficiency (project management success) and project effectiveness (project product/outcome success) was examined separately (as two dependent variables).

References

- Aaltonen, K. and Kujala, J., 2010. A project lifecycle perspective on stakeholder influence strategies in global projects. *Scandinavian Journal of Management*, *26*(4), pp.381-397.
- Aarseth, W., Ahola, T., Aaltonen, K., Økland, A. and Andersen, B., 2017. Project sustainability strategies: A systematic literature review. *International Journal of Project Management*, *35*(6), pp.1071-1083.
- Abdali, R.A. and Mohammad, O., 2005. Software industry in Jordan the Prospects and Hopes. In *The 2nd International Conference* (pp. 3-5).
- Abidin, N.Z. and Pasquire, C.L., 2007. Revolutionize value management: A mode towards sustainability. *International Journal of Project Management*, *25*(3), pp.275-282.
- Acar, H., 2017. *Software development methodology in a Green IT environment* (Doctoral dissertation, Université de Lyon).
- Achterkamp, M.C. and Vos, J.F., 2006. A framework for making sense of sustainable innovation through stakeholder involvement. *International journal of environmental technology and management*, *6*(6), pp.525-538.
- Adams, J., Khan, H.T., Raeside, R. and White, D.I., 2007. *Research methods for graduate business and social science students*. SAGE publications India.
- Adriana, T.T. and Ioana-Maria, D., 2013. Project Success by Integrating Sustainability in Project Management. *Sustainability Integration for Effective Project Management*, *106*.
- Agarwal, S., Nath, A. and Chowdhury, D., 2012. Sustainable approaches and good practices in green software engineering. *International Journal of Research and Reviews in Computer Science (IJRRCS)*, *3*(1), pp.1425-1428.
- Ahmad, R., Baharom, F. and Hussain, A., 2014, August. A systematic literature review on sustainability studies in software engineering. In *Proceedings of the KMICe Knowledge Management International Conference (KMICe)*.
- Ahmad, R., Baharom, F. and Hussain, A., 2017. SOFTWARE SUSTAINABILITY DEVELOPMENT: IMPACTIBILITY CHARACTERISTIC FOCUSES ON SOCIAL APPROACH.

In *Proceedings of International Conference on Computing and Informatics* (pp. 595-600). Kuala Lumpur. Universiti Utara Malaysia.

- Ahmad, R., Hussain, A. and Baharom, F., 2015. A Systematic Review on Characteristic and Sub-Characteristic for Software Development towards Software Sustainability. *Environment*, *20*, p.34.
- Ahmad, R., Hussain, A. and Baharom, F., 2018. Integrated-Software Sustainability Evaluation Model (i-SSEM) Development. *Journal of Telecommunication, Electronic and Computer Engineering (JTEC)*, *10*(1-11), pp.39-46.
- Ahsan, K. and Gunawan, I., 2010. Analysis of cost and schedule performance of international development projects. *International journal of project management*, *28*(1), pp.68-78.
- Akadiri, P.O., Olomolaiye, P.O. and Chinyio, E.A., 2013. Multi-criteria evaluation model for the selection of sustainable materials for building projects. *Automation in Construction*, *30*, pp.113-125.
- Al Hinai, M. and Chitchyan, R., 2014. Social sustainability indicators for software: Initial review.
- Al Hinai, M. and Chitchyan, R., 2015, August. Building social sustainability into software: Case of equality. In *2015 IEEE Fifth International Workshop on Requirements Patterns (RePa)* (pp. 32-38). IEEE.
- Al Hinai, M. and Chitchyan, R., 2016. Engineering requirements for social sustainability.
- Al-Khaffaf, M., 2011. E-Readiness in Jordan Public Shareholding Companies. *Jordan Journal of Business Administration*, *153*(3148), pp.1-17.
- Albert, M., Balve, P. and Spang, K., 2017. Evaluation of project success: a structured literature review. *International Journal of Managing Projects in Business*, *10*(4), pp.796-821.
- Albertao, F., Xiao, J., Tian, C., Lu, Y., Zhang, K.Q. and Liu, C., 2010, November. Measuring the sustainability performance of software projects. In *2010 IEEE 7th International Conference on E-Business Engineering* (pp. 369-373). IEEE.

- Alelyani, T. and Yang, Y., 2016, November. Software crowdsourcing reliability: an empirical study on developers behavior. In *Proceedings of the 2nd International Workshop on Software Analytics* (pp. 36-42). ACM.
- Alharthi, A.D., Spichkova, M. and Hamilton, M., 2016. Sustainability Profiling of Long-living Software Systems. In *QuASoQ/TDA@ APSEC* (pp. 12-19).
- Aliyu, A.A., Bello, M.U., Kasim, R. and Martin, D., 2014. Positivist and non-positivist paradigm in social science research: Conflicting paradigms or perfect partners. *J. Mgmt. & Sustainability*, *4*, p.79.
- Almahmoud, E.S., Doloi, H.K. and Panuwatwanich, K., 2012. Linking project health to project performance indicators: Multiple case studies of construction projects in Saudi Arabia. *International Journal of Project Management*, *30*(3), pp.296-307.
- Alreck, P. L. and Settle, R. B., 1995. *The survey research handbook.* 2nd ed. Irwin.
- Alrousan, M.K., 2015. *E-commerce adoption by travel agencies in Jordan* (Doctoral dissertation, Cardiff Metropolitan University).
- AlWaer, H., Sibley, M. and Lewis, J., 2008. Different stakeholder perceptions of sustainability assessment. *Architectural Science Review*, *51*(1), pp.48-59.
- Alwi, S.R.W., Manan, Z.A., Klemeš, J.J. and Huisingh, D., 2014. Sustainability engineering for the future. *Journal of Cleaner Production*, (71), pp.1-10.
- Amsel, N., Ibrahim, Z., Malik, A. and Tomlinson, B., 2011, May. Toward sustainable software engineering: NIER track. In *2011 33rd International Conference on Software Engineering (ICSE)* (pp. 976-979). IEEE.
- Anbari, F.T., 1985. A systems approach to project evaluation. *Project Management Institute,* 16 (3), pp.21-26.
- Anbari, F.T., Khilkhanova, E., Romanova, M. and Umpleby, S., 2004. Managing cultural differences in international projects. *Journal of International Business and Economics*, *2*(1), pp.267-274.
- Antonova, A., 2015. How Can ICTs Contribute Towards a More Sustainable Future?. In *Handbook of Research on Sustainable Development and Economics* (pp. 404-417). IGI Global.

- APM, Association for project management, 2014, *The APM body of knowledge, 5th edition*. Available at: https://www.apm.org.uk/sites/default/files/bok%205%20 definitions.pdf [Accessed 20 Jan. 2018].
- APM, Association for project management, 2016. Project managers and sustainability. Available at: https://www.apm.org.uk/news/project-managers-and-sustainability/ [Accessed 9 Dec. 2018].
- Archibald, R.D. and Villoria, R.L., 1967. *Network-based management systems (PERT/CPM)*, New York: Wiley.
- Ary, D., Jacobs, L., Razavieh, A. and Sorensen, C., 2002. *Introduction to research in education*. 6th ed. Belmont, CA: Wadsworth.
- Ary, D., Jacobs, L.C., Irvine, C.K.S. and Walker, D., 2018. *Introduction to research in education*. Cengage Learning.
- Atkinson, R., 1999. Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International journal of project management*, *17*(6), pp.337-342.
- Atkinson, R., 2006. Excellence in teaching and learning for project management. *International Journal of Project Management*, *3*(24), pp.185-186.
- Azapagic, A., 2004. Developing a framework for sustainable development indicators for the mining and minerals industry. *Journal of cleaner production*, *12*(6), pp.639-662.
- Baccarini, D., 1999. The logical framework method for defining project success. *Project management journal*, *30*, pp.25-32.
- Bachour, N. and Chasteen, L., 2010, April. Optimizing the value of green it projects within organizations. In *2010 IEEE Green Technologies Conference* (pp. 1-10). IEEE.
- Bagozzi, R.P., Yi, Y. and Phillips, L.W., 1991. Assessing construct validity in organizational research. *Administrative Science Quarterly*, *36*, pp.421-458.
- Ballantine, J., Bonner, M., Levy, M. and Martin, A., 1996. The 3-D model of information systems success: the search for the dependent variable continues. *Information Resources Management Journal*, *9*(4), p.5.
- Barclay, C. and Osei-Bryson, K.M., 2010. Project performance development framework: An approach for developing performance criteria & measures for

information systems (IS) projects. *International Journal of Production Economics*, *124*(1), pp.272-292.

- Barnes, M., 1983. How to allocate risks in construction contracts. *International Journal of Project Management*, *1*(1), pp.24-28.
- Barnett, V., and Lewis, T., 1996. *Outliers in statistical data*, 3rd edn, New York: Wiley.
- Baruch, Y., 1999. Response rate in academic studies-A comparative analysis. *Human relations*, *52*(4), pp.421-438.
- Bauer, M.W., 2007. Content Analysis. An Introduction to its Methodology–By Klaus Krippendorff From Words to Numbers. Narrative, Data and Social Science–By Roberto Franzosi. *The British Journal of Sociology*, *58*(2), pp.329-331.
- Baumgartner, R.J. and Ebner, D., 2010. Corporate sustainability strategies: sustainability profiles and maturity levels. *Sustainable Development*, *18*(2), pp.76-89.
- Becker, C., Betz, S., Chitchyan, R., Duboc, L., Easterbrook, S.M., Penzenstadler, B., Seyff, N. and Venters, C.C., 2016. Requirements: The key to sustainability. *IEEE Software*, *33*(1), pp.56-65.
- Becker, C., Chitchyan, R., Duboc, L., Easterbrook, S., Penzenstadler, B., Seyff, N. and Venters, C.C., 2015, May. Sustainability design and software: The karlskrona manifesto. In *Proceedings of the 37th International Conference on Software Engineering-Volume 2* (pp. 467-476). IEEE Press.
- Beghoura, M.A., Boubetra, A. and Boukerram, A., 2017. Green software requirements and measurement: random decision forests-based software energy consumption profiling. *Requirements Engineering*, *22*(1), pp.27-40.
- Bell, S. and Morse, S., 2013. *Measuring sustainability: Learning from doing*. Routledge.
- Belout, A., 1998. Effects of human resource management on project effectiveness and success: toward a new conceptual framework. *International Journal of Project Management*, *16*(1), pp.21-26.
- Bevan, N., 1999. Quality in use: Meeting user needs for quality. *Journal of systems and software*, *49*(1), pp.89-96.
- Bhamra, T.A. and Evans, S., 1999. The next step in ecodesign: service-oriented life cycle design. In *Proceedings of the 1999 IEEE International Symposium on Electronics and the Environment (Cat. No. 99CH36357)* (pp. 263-267). IEEE.

- Biedenbach, T. and Müller, R., 2011. Paradigms in project management research: examples from 15 years of IRNOP conferences. *International Journal of Managing Projects in Business*, *4*(1), pp.82-104.
- Blengini, G.A., Garbarino, E., Šolar, S., Shields, D.J., Hámor, T., Vinai, R. and Agioutantis, Z., 2012. Life Cycle Assessment guidelines for the sustainable production and recycling of aggregates: the Sustainable Aggregates Resource Management project (SARMa). *Journal of Cleaner Production*, *27*, pp.177-181.
- Blevis, E., 2007, April. Sustainable interaction design: invention & disposal, renewal & reuse. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 503-512). ACM.
- Bond, A., Morrison-Saunders, A. and Pope, J., 2012. Sustainability assessment: the state of the art. *Impact Assessment and Project Appraisal*, *30*(1), pp.53-62.
- Bonvoisin, J., Lelah, A., Mathieux, F. and Brissaud, D., 2014. An integrated method for environmental assessment and ecodesign of ICT-based optimization services. *Journal of cleaner production*, *68*, pp.144-154.
- Borchardt, M., Wendt, M.H., Pereira, G.M. and Sellitto, M.A., 2011. Redesign of a component based on ecodesign practices: environmental impact and cost reduction achievements. *Journal of Cleaner Production*, *19*(1), pp.49-57.
- Bovea, M. and Pérez-Belis, V., 2012. A taxonomy of ecodesign tools for integrating environmental requirements into the product design process. *Journal of Cleaner Production*, *20*(1), pp.61-71.
- Brandoni, C. and Polonara, F., 2012. The role of municipal energy planning in the regional energy-planning process. *Energy*, *48*(1), pp.323-338.
- Bredillet, C.N., 2010. Mapping the dynamics of the project management field: Project management in action (part 5). *Project Management Journal*, *41*(1), pp.2-4.
- Brennan, M.J., 2000. Project flexibility, agency, and competition. *New Developments in the Theory and Application of Real Options.*
- Briner, W., Hastings, C., and Geddes, M., 1996. *Project leadership* (2nd ed.), Aldershott: Gower.
- Brones, F. and Carvalho, M.M., 2015. From 50 to 1: integrating literature toward a systemic ecodesign model. *Journal of Cleaner Production*, *96*, pp.44-57.

- Brones, F., de Carvalho, M.M. and de Senzi Zancul, E., 2014. Ecodesign in project management: a missing link for the integration of sustainability in product development?. *Journal of Cleaner Production*, *80*, pp.106-118.
- Brooks Jr, F.P., 1995. *The mythical man-month*, 20th anniversary edition, Boston, MA: Addison Wesley.
- Brundtland, G.H., 1987. *Report of the World Commission on environment and development:" our common future."*. United Nations.
- Bryman, A. and Bell, E., 2015. *Business research methods.* 4th ed. Oxford, UK: Oxford University Press.
- Bryman, A. and Cramer, D., 1997. *Quantitative data analysis with SPSS for Windows: A guide for social scientists*. London: Routledge.
- Cabot, J., Easterbrook, S., Horkoff, J., Lessard, L., Liaskos, S. and Mazón, J.N., 2009, May. Integrating sustainability in decision-making processes: A modelling strategy. In *2009 31st International Conference on Software Engineering-Companion Volume* (pp. 207-210). IEEE.
- Calero, C. and Piattini, M., 2015. Introduction to green in software engineering. In *Green in Software Engineering* (pp. 3-27). Springer, Cham.
- Calero, C. and Piattini, M., 2017. Puzzling out software sustainability. *Sustainable Computing: Informatics and Systems*, *16*, pp.117-124.
- Calero, C., Bertoa, M.F. and Moraga, M.Á., 2013b, July. Sustainability and Quality: Icing on the Cake. In *RE4SuSy@ RE*.
- Calero, C., Bertoa, M.F. and Moraga, M.Á., 2013c, May. A systematic literature review for software sustainability measures. In *Proceedings of the 2nd International Workshop on Green and Sustainable Software* (pp. 46-53). IEEE Press.
- Calero, C., Moraga, M. and Bertoa, M.F., 2013a. Towards a software product sustainability model. *arXiv preprint arXiv:1309.1640*.
- Calero, C., Moraga, M.Á., Bertoa, M.F. and Duboc, L., 2015. Green software and software quality. In *Green in Software Engineering* (pp. 231-260). Springer, Cham.
- Carmines, E.G. and Zeller, R.A., 1979. *Reliability and validity assessment* (Vol. 17). Newbury Park, CA: Sage publications.

- Carvalho, M.M. and Rabechini, R., 2017. Can project sustainability management impact project success? An empirical study applying a contingent approach. *International Journal of Project Management*, *35*(6), pp.1120-1132.
- Carvalho, M.M., Patah, L.A. and de Souza Bido, D., 2015. Project management and its effects on project success: Cross-country and cross-industry comparisons. *International Journal of Project Management*, *33*(7), pp.1509-1522.
- Carvalho, M.M.D. and Rabechini Junior, R., 2015. Impact of risk management on project performance: the importance of soft skills. *International Journal of Production Research*, *53*(2), pp.321-340.
- Cazier, J.A. and Hopkins, B.E., 2011. Doing the right thing for the environment just got easier with a little help from information systems.
- Chan, A.P. and Chan, A.P., 2004. Key performance indicators for measuring construction success. *Benchmarking: an international journal*, *11*(2), pp.203-221.
- Chapman, C. and Ward, S., 2003. Project risk management: processes, techniques and insights. John Wiley.
- Checkland, P.B., 1972. Towards a systems-based methodology for real-world problem solving. *Journal of Systems Engineering*, *3*(2), pp.87-116.
- Chung, L., Nixon, B.A., Yu, E. and Mylopoulos, J., 2012. *Non-functional requirements in software engineering* (Vol. 5). Springer Science & Business Media.
- Cohen, J., 1992. A power primer. *Psychological bulletin*, *112*(1), pp. 155–159.
- Collins, A. and Baccarini, D., 2004. Project success—a survey. *Journal of Construction Research*, *5*(02), pp.211-231.
- Collins, Collins dictionary, 2019. Definition of sustainability. Available at: http://www.collinsdictionary.com/ [Accessed 18 Mar. 2019].
- Collis, J. and Hussey, R., 2013. *Business research: A practical guide for undergraduate and postgraduate students*. 3rd ed. Palgrave Macmillan.
- Condori-Fernandez, N. and Lago, P., 2018. Characterizing the contribution of quality requirements to software sustainability. *Journal of Systems and Software*, *137*, pp.289-305.
- Cooke-Davies, T., 2002. The "real" success factors on projects. *International journal of project management*, *20*(3), pp.185-190.

- Cooper, D. R. and Schindler, P. S., 2001. *Business research methods.* 7th ed. Irwin/McGraw-Hill.
- Craddock, W.T., 2013. How business excellence models contribute to project sustainability and project success. In *Sustainability integration for effective project management* (pp. 1-19). IGI Global.
- Crawford, L. H., Hobbs, J. B., and Turner, J. R., 2005. *Project categorization systems: Aligning capability with strategy for better results*, Newtown Square: Project Management Institute.
- Crawford, L., Hobbs, B. and Turner, J.R., 2006. Aligning capability with strategy: Categorizing projects to do the right projects and to do them right. *Project Management Journal*, *37*(2), pp.38-50.
- Creswell, J.W., 2012. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research.* 4th ed. Boston: Pearson.
- Creswell, J.W., 2014. *Research design: Qualitative, quantitative, and mixed methods approaches*. 4th ed. London: SAGE Publications Ltd.
- Cysneiros, L.M. and do Prado Leite, J.C.S., 2002, May. Non-functional requirements: from elicitation to modelling languages. In *Proceedings of the 24th international conference on Software engineering* (pp. 699-700). ACM.
- Dalcher, D., 2014. Rethinking success in software projects: looking beyond the failure factors. In *Software project management in a changing world* (pp. 27-49). Springer, Berlin, Heidelberg.
- Dalkmann, H., Herrera, R.J. and Bongardt, D., 2004. Analytical strategic environmental assessment (ANSEA) developing a new approach to SEA. *Environmental Impact Assessment Review*, *24*(4), pp.385-402.
- Daneshpour, H., 2015. Integrating Sustainability into Management of Project. *International Journal of Environmental Science and Development*, *6*(4), p.321.
- Darnall, N., Gallagher, D.R. and Andrews, R.N., 2001. ISO 14001: greening management systems. In *Greener Manufacturing and Operations* (pp. 178-190). Greenleaf Publishing.
- Davis, K., 2014. Different stakeholder groups and their perceptions of project success. *International journal of project management*, *32*(2), pp.189-201.

- Davis, K., 2017. An empirical investigation into different stakeholder groups perception of project success. *International Journal of Project Management*, *35*(4), pp.604-617.
- De Bakker, K., Boonstra, A. and Wortmann, H., 2010. Does risk management contribute to IT project success? A meta-analysis of empirical evidence. *International Journal of Project Management*, *28*(5), pp.493-503.
- De Brucker, K., Macharis, C. and Verbeke, A., 2013. Multi-criteria analysis and the resolution of sustainable development dilemmas: A stakeholder management approach. *European Journal of Operational Research*, *224*(1), pp.122-131.
- De Wit, A., 1988. Measurement of project success. *International journal of project management*, *6*(3), pp.164-170.
- DeCarlo, L.T., 1997. On the meaning and use of kurtosis. *Psychological methods*, *2*(3), p.292.
- Delisle, C.L., 2004. Contemporary views on shaping, developing, and managing teams. *The Wiley guide to managing projects*, pp.983-1013.
- Delone, W.H. and McLean, E.R., 2003. The DeLone and McLean model of information systems success: a ten-year update. *Journal of management information systems*, *19*(4), pp.9-30.
- Devanbu, P.T. and Stubblebine, S., 2000, May. Software engineering for security: a roadmap. In *Proceedings of the Conference on the Future of Software Engineering* (pp. 227-239). ACM.
- Díaz Aguado, M.B. and Nicieza, C.G., 2008. An empirical index to evaluate the sustainability of mining projects. *International Journal of Environment and Pollution*, *33*(2-3), pp.336-359.
- Dick, M., Drangmeister, J., Kern, E. and Naumann, S., 2013, May. Green software engineering with agile methods. In *2013 2nd International Workshop on Green and Sustainable Software (GREENS)* (pp. 78-85). IEEE.
- Dick, M., Naumann, S. and Kuhn, N., 2010. A model and selected instances of green and sustainable software. In *What Kind of Information Society? Governance, Virtuality, Surveillance, Sustainability, Resilience* (pp. 248-259). Springer, Berlin, Heidelberg.

- Dillman, D.A., 1991. The design and administration of mail surveys. *Annual review of sociology*, *17*(1), pp.225-249.
- Dobrovolskienė, N. and Tamošiūnienė, R., 2016. Sustainability-oriented financial resource allocation in a project portfolio through multi-criteria decision-making. *Sustainability*, *8*(5), p.485.
- Donnellan, B., Sheridan, C. and Curry, E., 2011. A capability maturity framework for sustainable information and communication technology. *IT professional*, *13*(1), pp.33-40.
- Drolet, A.L. and Morrison, D.G., 2001. Do we really need multiple-item measures in service research?. *Journal of service research*, *3*(3), pp.196-204.
- Duffy, V.G., 2014, June. Improving sustainability through usability. In *International Conference of Design, User Experience, and Usability* (pp. 507-519). Springer, Cham.
- Duriau, V.J., Reger, R.K. and Pfarrer, M.D., 2007. A content analysis of the content analysis literature in organisation studies: Research themes, data sources, and methodological refinements. *Organizational research methods*, *10*(1), pp.5-34.
- Ebner, D. and Baumgartner, R.J., 2006, September. The relationship between sustainable development and corporate social responsibility. In *Corporate Responsibility Research Conference* (Vol. 4, No. 5.9, p. 2006). Queens University, Belfast Dublin.
- Eckes, G., 2002. *Six Sigma team dynamics: The elusive key to project success*, New York: Wiley.
- Edum-Fotwe, F.T. and Price, A.D., 2009. A social ontology for appraising sustainability of construction projects and developments. *International Journal of Project Management*, *27*(4), pp.313-322.
- Eid, M., 2009. Sustainable development & project management. *Cologne: Lambert Academic Publishing*, *176*.
- El-Haram, M., Walton, J., Horner, M., Hardcastle, C., Price, A., Bebbington, J., Thomson, C. and Atkin-Wright, T., 2007, June. Development of an integrated sustainability assessment toolkit. In *Conference Proceedings, International Conference on Whole life Urban Sustainability and its Assessment*.

- Elattar, S.M.S., 2009. Towards developing an improved methodology for evaluating performance and achieving success in construction projects. *Scientific Research and Essays*, *4*(6), pp.549-554.
- Elkington, J., 1998. Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management*, *8*(1), pp.37-51.
- Elkington, J., 2013. Enter the triple bottom line. In *The triple bottom line* (pp. 23-38). Routledge.
- EPA, M., 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. *United States Environmental Protection Agency (USEPA), EPA*, *530*, pp.09-007.
- Erdelyi, K., 2013, September. Special factors of development of green software supporting eco sustainability. In *2013 IEEE 11th International Symposium on Intelligent Systems and Informatics (SISY)* (pp. 337-340). IEEE.
- Eskerod, P. and Huemann, M., 2013. Sustainable development and project stakeholder management: What standards say. *International Journal of Managing Projects in Business*, *6*(1), pp.36-50.
- Falk, R.F. and Miller, N.B., 1992. *A primer for soft modeling*. University of Akron Press. Ohio.
- Fangel, M. Ed., 1987*. Handbook of project start-up: How to launch projects effectively*, Zurich: International Project Management Association.
- Farrell, P., 2016. *Writing Built Environment Dissertations and Projects: Practical Guidance and Examples*. John Wiley & Sons.
- Faucheux, S. and Nicolaï, I., 2011. IT for green and green IT: A proposed typology of eco-innovation. *Ecological Economics*, *70*(11), pp.2020-2027.
- Fernández-Sánchez, G. and Rodríguez-López, F., 2010. A methodology to identify sustainability indicators in construction project management—Application to infrastructure projects in Spain. *Ecological Indicators*, *10*(6), pp.1193-1201.
- Fiedler, F.E., 1964. A contingency model of leadership effectiveness. *Advances in experimental social psychology, Vol.* 1, pp.149-190.
- Field, A., 2013. *Discovering statistics using IBM SPSS statistics.* 4th ed. London: SAGE Publications Ltd.

- Fiksel, J., McDaniel, J. and Mendenhall, C., 1999, November. Measuring progress towards sustainability principles, process, and best practices. In *Greening of Industry Network Conference Best Practice Proceedings 199*9, p.1-25.
- Fink, A., 2017. *How to conduct surveys: A step-by-step guide*. 6th edition, Thousand Oaks, CA: SAGE Publications.
- Finkbeiner, M. and Hoffmann, R., 2006. Application of life cycle assessment for the environmental certificate of the Mercedes-Benz S-Class (7 pp). *The International Journal of Life Cycle Assessment*, *11*(4), pp.240-246.
- Fitsilis, P. and Damasiotis, V., 2015. Software project's complexity measurement: A case study. *Journal of Software Engineering and Applications*, *8*(10), p.549.
- Fitsilis, P., 2009, March. Measuring the complexity of software projects. In *2009 WRI World Congress on Computer Science and Information Engineering* (Vol. 7, pp. 644-648). IEEE.
- Fornell, C., 1982. *A second generation of multivariate analysis: methods.* Vol. 1 ed. New York, USA: Praeger.
- Fuentes-Ardeo, L., Otegi-Olaso, J.R. and Aguilar-Fernandez, M.E., 2017, September. How the project knowledge management and the sustainability in project management affect the project success. In *2017 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*(Vol. 2, pp. 884-887). IEEE.
- Gable, G.G., 1994. Integrating case study and survey research methods: an example in information systems. *European journal of information systems*, *3*(2), pp.112-126.
- Galbraith, J. R., 1973. *Designing complex organizations*, Boston: Addison-Wesley Longman.
- García-Mireles, G.A. and Villa-Martínez, H.A., 2017, October. Practices for Addressing Environmental Sustainability through Requirements Processes. In *International Conference on Software Process Improvement* (pp. 61-70). Springer, Cham.
- García-Mireles, G.A., 2016. Identifying relevant product quality characteristics in the context of very small organizations. *Computer Science and Information Systems*, *13*(3), pp.875-900.

- García-Mireles, G.A., Moraga, M.Á., García, F., Calero, C. and Piattini, M., 2018. Interactions between environmental sustainability goals and software product quality: A mapping study. *Information and Software Technology*, *95*, pp.108-129.
- Gareis, R. and Huemann, M., 2007. Maturity Models for the project-oriented Company. *The Gower Handbook of Project Management, Turner JR (ed), Gower, Aldershot*.
- Gareis, R., 2006. *Happy projects!*. Editura ASE.
- Gareis, R., Heumann, M. and Martinuzzi, A., 2009. Relating sustainable development and project management. *IRNOP IX, Berlin*, *52*.
- Gareis, R., Huemann, M., Martinuzzi, A., Weninger, C. and Sedlacko, M., 2013, April. Project management and sustainable development principles. *Project Management Institute.*
- Gareis, R., Huemann, M., Martinuzzi, R.A., Sedlacko, M. and Weninger, C., 2011. The SustPM Matrix: Relating sustainability principles to project assignment and project management. *EURAM11, Talinn*.
- Garson, G.D., 2016. *Partial least squares: Regression and structural equation models*. Asheboro, NC: Statistical Associates Publishers.
- Gasparatos, A., El-Haram, M. and Horner, M., 2009, September. The argument against a reductionist approach for measuring sustainable development performance and the need for methodological pluralism. In *Accounting Forum* (Vol. 33, No. 3, pp. 245-256). Elsevier.
- Gass, S.I. and Assad, A.A., 2005. *An annotated timeline of operations research: An informal history* (Vol. 75). Springer Science & Business Media.
- Gazeley, I., 2008. Women's pay in British industry during the Second World War. *The Economic History Review*, *61*(3), pp.651-671.
- Genus, A., 1997. Managing large-scale technology and inter-organizational relations: the case of the Channel Tunnel. *Research Policy*, *26*(2), pp.169-189.
- Gill, J. and Johnson, P., 2010. *Research Methods for Managers.* 4th ed. London: Sage.
- Gimenez, C., Sierra, V. and Rodon, J., 2012. Sustainable operations: Their impact on the triple bottom line. *International Journal of Production Economics*, *140*(1), pp.149-159.

- Gladwin, T.N., Kennelly, J.J. and Krause, T.S., 1995. Shifting paradigms for sustainable development: Implications for management theory and research. *Academy of management Review*, *20*(4), pp.874-907.
- Glavič, P. and Lukman, R., 2007. Review of sustainability terms and their definitions. *Journal of cleaner production*, *15*(18), pp.1875-1885.
- Glenn, J.C. and Florescu, E., 2015. The Millennium Project Team, 2015-16 State of the Future. *Millennium Project, Washington DC*.
- Glenn, J.C. and Gordon, T.J. eds., 1997. *State of the Future*. Washington, DC, USA: American Council for the United Nations University.
- Glenn, J.C., Gordon, T.J. and Florescu, E., 2009. 2009 State of the Future. Washington, DC, USA: American Council for the United Nations University.
- Gluch, P. and Baumann, H., 2004. The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. *Building and environment*, *39*(5), pp.571-580.
- Golafshani, N., 2003. Understanding reliability and validity in qualitative research. *The qualitative report*, *8*(4), pp.597-606.
- Gordon, J., Skinner, A. and Button, A., 2009. Green Technology: Driving Economic and Environmental Benefits from ICT. In *World Economic Forum*.
- GPM, Green Project Management, 2015. The GPM® P5™ Standard for Sustainability in Project Management.
- Graham, R. J., 1989. *Project management as if people mattered*, Bala Cynwyd: Primavera Press.
- Gray, D.E., 2013. *Doing research in the real world*. 3rd ed. Sage Publications.
- Greener, D. S., 2008. *Business research methods.* ISBN 978-87-7681-421-2 ed. DR. Sue Greener & Ventus Publishing Aps.
- Guba, E.G. and Lincoln, Y.S., 1994. Competing paradigms in qualitative research. *Handbook of qualitative research*, *2*(163-194), p.105.
- Haenlein, M. and Kaplan, A. M., 2004. A beginner's guide to partial least squares analysis. *Understanding Statistics,* 3(4), p. 283–297.

- Hair Jr, J., Sarstedt, M., Hopkins, L. and G. Kuppelwieser, V., 2014. Partial least squares structural equation modeling (PLS-SEM) An emerging tool in business research. *European Business Review*, *26*(2), pp.106-121.
- Hair Jr, J.F., Hult, G.T.M., Ringle, C. and Sarstedt, M., 2017. *A primer on partial least squares structural equation modeling (PLS-SEM)*, 2nd edition, Thousand Oaks, CA: SAGE Publications.
- Hair, J. F., Money, A. H., Samouel, P. and Page, M., 2007. *Research methods for business.* West Sussex: John Wiley & Sons Ltd.
- Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E., 2013. *Multivariate data analysis: Pearson new international edition*. Edinburgh: Pearson Higher Ed.
- Hair, J.F., Ringle, C.M. and Sarstedt, M., 2011. PLS-SEM: Indeed a silver bullet. *Journal of Marketing theory and Practice*, *19*(2), pp.139-152.
- Hallstedt, S.I., Thompson, A.W. and Lindahl, P., 2013. Key elements for implementing a strategic sustainability perspective in the product innovation process. *Journal of Cleaner Production*, *51*, pp.277-288.
- Harlacher, J., 2016. An Educator’s Guide to Questionnaire Development. (REL 2016–108). Washington, DC: US Department of Education, Institute of Education Sciences. *National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Central*, *25*.
- Hass, K.B., 2016. Introducing the new project complexity model part I. *PMtimes*. Available at: https://www.projecttimes.com/articles/introducing-the-new-project-complexity-model-part-i.html [Accessed 20 May. 2019].
- Hedman, J. and Henningsson, S., 2011. Three strategies for green IT. *IT Professional*, *13*(1), pp.54-57.
- Helgadóttir, H., 2008. The ethical dimension of project management. *International Journal of Project Management*, *26*(7), pp.743-748.
- Heller, M.C. and Keoleian, G.A., 2003. Assessing the sustainability of the US food system: a life cycle perspective. *Agricultural systems*, *76*(3), pp.1007-1041.
- Hilty, L.M. and Lohmann, W., 2011. The five most neglected issues in “Green IT”. *CEPIS UPGRADE*, *12*(4), pp.11-15.

- Ho, R., 2006. *Handbook of univariate and multivariate data analysis and interpretation with SPSS*. CRC Press, NW, USA.
- Hobbs, B. and Besner, C., 2016. Projects with internal vs. external customers: An empirical investigation of variation in practice. *International Journal of Project Management*, *34*(4), pp.675-687.
- Hsieh, H.F. and Shannon, S.E., 2005. Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), pp.1277-1288.
- Huemann, M. and Silvius, G., 2017. Projects to create the future: Managing projects meets sustainable development. *International Journal of Project Management*, 35 (6), pp.1066-1070.
- Huemann, M., Keegan, A. and Turner, J.R., 2007. Human resource management in the project-oriented company: A review. *International Journal of Project Management*, *25*(3), pp.315-323.
- Hulland, J., 1999. Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic management journal*, *20*(2), pp.195-204.
- Hwang, B.G. and Ng, W.J., 2013. Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management*, *31*(2), pp.272-284.
- Ibbs, C.W. and Kwak, Y.H., 2000. Assessing project management maturity. *Project management journal*, *31*(1), pp.32-43.
- IDC, International Data Corporation, 2009. Aid to recovery: the economic impact of IT, software, and the Microsoft ecosystem on the global economy. Available at: https://slideplayer.com/slide/5699454/ [Accessed 14 June. 2019].
- Ika, L.A., 2009. Project success as a topic in project management journals. *Project Management Journal*, *40*(4), pp.6-19.
- INTAJ, The Information and Communications Technology Association of Jordan, 2018. JORDAN ICT & ITES SECTOR STATISTICS 2018. Available at: http://intaj.net/wp-content/Studies/2018.pdf [Accessed 12 June. 2019].
- ISO, I., 2010. 26000 Guidance on social responsibility. *Ginebra: ISO*.

- ISO/IEC 25010:2011, International Organization for Standardization, 2018. System and software quality models. Available at: https://www.iso.org/standard/35733.html [Accessed 9 Dec. 2018].
- ISTPMO, Information Systems and Technology Project Management Office, 2019. Project sizing and complexity. *University of Waterloo*. Available at: https://uwaterloo.ca/ist-project-management-office/methodologies/project-sizing-and-complexity [Accessed 20 May. 2019].
- Jabbour, C.J.C., Jugend, D., de Sousa Jabbour, A.B.L., Gunasekaran, A. and Latan, H., 2015. Green product development and performance of Brazilian firms: measuring the role of human and technical aspects. *Journal of Cleaner Production*, *87*, pp.442-451.
- Jackson, S.L., 2011. Research methods and statistics a critical thinking approach 4th edition. *Wadsworth: Cengage Learning*.
- Jansen, A., Wall, A. and Weiss, R., 2011, August. Techsure-a method for assessing technology sustainability in long lived software intensive systems. In *2011 37th EUROMICRO Conference on Software Engineering and Advanced Applications* (pp. 426-434). IEEE.
- Jarvis, C.B., MacKenzie, S.B. and Podsakoff, P.M., 2003. A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of consumer research*, *30*(2), pp.199-218.
- Johann, T. and Maalej, W., 2013, July. Position paper: The social dimension of sustainability in requirements engineering. In *Proceedings of the 2nd International Workshop on Requirements Engineering for Sustainable Systems*.
- Johnson, P. and Duberley, J., 2000. *Understanding management research: An introduction to epistemology*. 1st ed. London: SAGE Publications Ltd.
- Jones, S., Tefe, M. and Appiah-Opoku, S., 2013. Proposed framework for sustainability screening of urban transport projects in developing countries: A case study of Accra, Ghana. *Transportation Research Part A: Policy and Practice*, *49*, pp.21-34.
- Joslin, R. and Müller, R., 2015. Relationships between a project management methodology and project success in different project governance contexts. *International Journal of Project Management*, *33*(6), pp.1377-1392.

- Jugdev, K. and Müller, R., 2005. A retrospective look at our evolving understanding of project success. *Project management journal*, *36*(4), pp.19-31.
- Kaplowitz, M.D., Hadlock, T.D. and Levine, R., 2004. A comparison of web and mail survey response rates. *Public opinion quarterly*, *68*(1), pp.94-101.
- Kaysi, S., 2013. Sustainability; A New Element of Project Success"“From whose point of view is Velodrome Park and Wind Turbine projects considered a success or failure?. Available at: https://mpra.ub.uni-muenchen.de/62357/1/MPRA_paper_62357.pdf [Accessed 17 Oct. 2018].
- Keating, M., 1994. The Earth Summits agenda for change: a plain language version of Agenda 21 and the other Rio agreements.
- Keeble, J.J., Topiol, S. and Berkeley, S., 2003. Using indicators to measure sustainability performance at a corporate and project level. *Journal of Business Ethics*, *44*(2-3), pp.149-158.
- Kengpol, A. and Boonkanit, P., 2011. The decision support framework for developing Ecodesign at conceptual phase based upon ISO/TR 14062. *International Journal of Production Economics*, *131*(1), pp.4-14.
- Kermanshachi, S., Dao, B., Shane, J. and Anderson, S., 2016. Project complexity indicators and management strategies–a Delphi study. *Procedia Engineering*, *145*, pp.587-594.
- Kern, E., Dick, M., Naumann, S., Guldner, A. and Johann, T., 2013. Green software and green software engineering–definitions, measurements, and quality aspects. *Hilty et al. (2013)*, pp.87-94.
- Kern, E., Naumann, S. and Dick, M., 2015. Processes for green and sustainable software engineering processes for green and sustainable software engineering. In *Green in Software Engineering* (pp. 61-81). Springer, Cham.
- Kerzner, H., 2004. *Advanced project management: Best practices on implementation*. John Wiley & Sons.
- Khalfan, M.M., 2006. Managing sustainability within construction projects. *Journal of Environmental Assessment Policy and Management*, *8*(01), pp.41-60.
- Khalifeh, A., Farrell, P., Al-edenat, M., 2019. The impact of project sustainability management (PSM) on project success: A systematic literature review. *Journal of*

Management Development. Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JMD-02-2019-0045. Emerald Publishing Limited.

- Khalifeh, A., Farrell, P., Alrousan, M., Alwardat, S. and Faisal, M. 2020. Incorporating sustainability into software projects: a conceptual framework. *International Journal of Managing Projects in Business*, Vol. 13 No. 6, pp. 1339-1361. https://doi.org/10.1108/IJMPB-12-2019-0289. Emerald Publishing Limited.
- Khalili-Damghani, K., Sadi-Nezhad, S., Lotfi, F.H. and Tavana, M., 2013. A hybrid fuzzy rule-based multi-criteria framework for sustainable project portfolio selection. *Information Sciences*, *220*, pp.442-462.
- Khalilzadeh, M., Akbari, H. and Foroughi, A., 2016. Investigating the Relationship of Sustainability Factors with Project Management Success. *Industrial Engineering & Management Systems*, *15*(4), pp.345-353.
- Khan, F.I., Sadiq, R. and Veitch, B., 2004. Life cycle iNdeX (LInX): a new indexing procedure for process and product design and decision-making. *Journal of Cleaner Production*, *12*(1), pp.59-76.
- Khang, D.B. and Moe, T.L., 2008. Success criteria and factors for international development projects: A life-cycle-based framework. *Project Management Journal*, *39*(1), pp.72-84.
- Kitchenham, B. and Pfleeger, S.L., 2002. Principles of survey research: part 5: populations and samples. *ACM SIGSOFT Software Engineering Notes*, *27*(5), pp.17-20.
- Kitchin, R. and Dodge, M., 2011. *Code/space: Software and everyday life*. Mit Press.
- Kivilä, J., Martinsuo, M. and Vuorinen, L., 2017. Sustainable project management through project control in infrastructure projects. *International Journal of Project Management*, *35*(6), pp.1167-1183.
- Klakegg, O.J. and Haavaldsen, T., 2011. Governance of major public investment projects: in pursuit of relevance and sustainability. *International Journal of Managing Projects in Business*, *4*(1), pp.157-167.
- Kleindorfer, P.R., Singhal, K. and Wassenhove, L.N., 2005. Sustainable operations management. *Production and operations management*, *14*(4), pp.482-492.
- Kline, R. B., 2011. *Principles and practice of structural equation modeling,* 3rd ed, New York: The Guilford Press.

- Knight, P. and Jenkins, J.O., 2009. Adopting and applying eco-design techniques: a practitioners perspective. *Journal of cleaner production*, *17*(5), pp.549-558.
- Knoepfel, I., 2001. Dow Jones sustainability group index: A global benchmark for corporate sustainability. *Corporate Environmental Strategy*, *8*(1), pp.6-15.
- Kocak, S.A., 2013, October. Green software development and design for environmental sustainability. In *11th International Doctoral Symposium an Empirical Software Engineering (IDOESE 2013). Baltimore, Maryland* (Vol. 9).
- Koçak, S.A., Alptekin, G.I. and Bener, A., 2014. Evaluation of Software Product Quality Attributes and Environmental Attributes using ANP Decision Framework. In *RE4SuSy@ RE*(pp. 37-44).
- Koçak, S.A., Alptekin, G.I. and Bener, A.B., 2015. Integrating Environmental Sustainability in Software Product Quality. In *RE4SuSy@ RE* (pp. 17-24).
- Kolltveit, B.J., Karlsen, J.T. and Grønhaug, K., 2007. Perspectives on project management. *International Journal of Project Management*, *25*(1), pp.3-9.
- Kometa, S.T., Olomolaiye, P.O. and Harris, F.C., 1995. An evaluation of clients' needs and responsibilities in the construction process. *Engineering, construction and Architectural management*, *2*(1), pp.57-76.
- Koziolek, H., 2011, June. Sustainability evaluation of software architectures: a systematic review. In *Proceedings of the joint ACM SIGSOFT conference--QoSA and ACM SIGSOFT symposium--ISARCS on Quality of software architectures--QoSA and architecting critical systems--ISARCS* (pp. 3-12). ACM.
- Kreiner, K., 1995. In search of relevance: project management in drifting environments. *Scandinavian Journal of Management*, *11*(4), pp.335-346.
- Krippendorff, K., 2018. *Content analysis: An introduction to its methodology*. Sage publications.
- Krishnaswamy, K.N., 2006. *Management Research Methodlogy: Integration of Principles, Medthods and Techniques*. 1st ed. India: Pearson Education.
- Kumar, D. and Katoch, S.S., 2014. Sustainability indicators for run of the river (RoR) hydropower projects in hydro rich regions of India. *Renewable and Sustainable Energy Reviews*, *35*, pp.101-108.

- Kumaraswamy, M.M. and Thorpe, A., 1996. Systematizing construction project evaluations. *Journal of Management in Engineering*, *12*(1), pp.34-39.
- Kurczewski, P. and Lewandowska, A., 2010. ISO 14062 in theory and practice—ecodesign procedure. Part 2: practical application. *The International Journal of Life Cycle Assessment*, *15*(8), pp.777-784.
- Kwak, Y.H. and Anbari, F.T., 2009. Analyzing project management research: Perspectives from top management journals. *International Journal of Project Management*, *27*(5), pp.435-446.
- LaBrosse, M., 2007. The evolution of project management. *Employment Relations Today*, *34*(1), pp.97-104.
- Labuschagne, C. and Brent, A.C., 2005. Sustainable project life cycle management: the need to integrate life cycles in the manufacturing sector. *International Journal of Project Management*, *23*(2), pp.159-168.
- Labuschagne, C. and 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. *Journal of Cleaner Production*, *16*(3), pp.253-262.
- Labuschagne, C., and Brent, A., 2006. Social indicators for sustainable project and technology life cycle management in the process industry (13 pp+ 4). *The International Journal of Life Cycle Assessment*, *11*(1), pp.3-15.
- Labuschagne, C., Brent, A.C. and Van Erck, R.P., 2005. Assessing the sustainability performances of industries. *Journal of Cleaner Production*, *13*(4), pp.373-385.
- Lago, P., Aklini Kocak, S., Crnkovic, I. and Penzensradler, B., 2015. Framing Sustainability as a Property of Software Quality. *Communications of the ACM*, *58*(10), pp.70-78.
- Lami, G., Fabbrini, F. and Fusani, M., 2012, June. Software sustainability from a process-centric perspective. In *European Conference on Software Process Improvement* (pp. 97-108). Springer, Berlin, Heidelberg.
- Larson, E.W. and Gobeli, D.H., 1989. Significance of project management structure on development success. *IEEE transactions on engineering management*, *36*(2), pp.119-125.

- Lehmann, O.F., 2018. *Project Business Management*. NW: CRC Press.
- Lewandowska, A. and Kurczewski, P., 2010. ISO 14062 in theory and practice—ecodesign procedure. Part 1: structure and theory. *The international journal of life cycle assessment*, *15*(8), pp.769-776.
- Lim, C.S. and Mohamed, M.Z., 1999. Criteria of project success: an exploratory re-examination. *International journal of project management*, *17*(4), pp.243-248.
- Littell, J.H., Corcoran, J. and Pillai, V., 2008. *Systematic reviews and meta-analysis*. Oxford University Press.
- Liu, J., Zuo, J., Sun, Z., Zillante, G. and Chen, X., 2013. Sustainability in hydropower development—A case study. *Renewable and Sustainable Energy Reviews*, *19*, pp.230-237.
- Lock, D., 2007. Project management 9th ed. *Surrey, UK: Gower Publication*.
- Lundin, R.A. and Söderholm, A., 1995. A theory of the temporary organization. *Scandinavian Journal of management*, *11*(4), pp.437-455.
- MacGillivray, A. and Zadek, S., 1995. *Accounting for change: indicators for sustainable development*. New Economics Foundation.
- Madlener, R., Robledo, C., Muys, B. and Freja, J.T.B., 2006. A sustainability framework for enhancing the long-term success of LULUCF projects. *Climatic change*, *75*(1-2), pp.241-271.
- Mahaux, M., Heymans, P. and Saval, G., 2011, March. Discovering sustainability requirements: an experience report. In *International Working Conference on Requirements Engineering: Foundation for Software Quality* (pp. 19-33). Springer, Berlin, Heidelberg.
- Mahmoud, S.S. and Ahmad, I., 2013. A green model for sustainable software engineering. *International Journal of Software Engineering and Its Applications*, *7*(4), pp.55-74.
- Malhotra, N. and Birks, D., 2007. *Marketing Research: an applied approach: 3rd European Edition*, Harlow, UK, Pearson education.
- Malik, M.N. and Khan, H.H., 2018. Investigating Software Standards: A Lens of Sustainability for Software Crowdsourcing. *IEEE Access*, *6*, pp.5139-5150.
- Maltzman, R. and Shirley, D., 2010. *Green project management*. NW: CRC Press.

- Manik, Y., Leahy, J. and Halog, A., 2013. Social life cycle assessment of palm oil biodiesel: a case study in Jambi Province of Indonesia. *The International Journal of Life Cycle Assessment*, *18*(7), pp.1386-1392.
- Marcelino-Sádaba, S., González-Jaen, L.F. and Pérez-Ezcurdia, A., 2015. Using project management as a way to sustainability. From a comprehensive review to a framework definition. *Journal of Cleaner Production*, *99*, pp.1-16.
- Marnewick, C., 2017. Information system project's sustainability capabality levels. *International Journal of Project Management*, *35*(6), pp.1151-1166.
- Marschan-Piekkari, R. and Welch, C. eds., 2004. *Handbook of qualitative research methods for international business*. Massachusetts USA: Edward Elgar Publishing.
- Martens, M.L. and Carvalho, M.M., 2014. A conceptual framework of sustainability in project management. Project Management Institute.
- Martens, M.L. and Carvalho, M.M., 2016a. Sustainability and success variables in the project management context: an expert panel. *Project Management Journal*, *47*(6), pp.24-43.
- Martens, M.L. and Carvalho, M.M., 2016b. The challenge of introducing sustainability into project management function: multiple-case studies. *Journal of Cleaner Production*, *117*, pp.29-40.
- Martens, M.L. and Carvalho, M.M., 2017. Key factors of sustainability in project management context: A survey exploring the project managers' perspective. *International Journal of Project Management*, *35*(6), pp.1084-1102.
- Martínez-Perales, S., Ortiz-Marcos, I., Juan Ruiz, J. and Lázaro, F., 2018. Using Certification as a Tool to Develop Sustainability in Project Management. *Sustainability*, *10*(5), p.1408.
- Massey, A.P., Montoya-Weiss, M.M. and Hung, Y.T., 2003. Because time matters: Temporal coordination in global virtual project teams. *Journal of management information systems*, *19*(4), pp.129-155.
- Maylor, H. and Blackmon, K., 2005. *Researching business and management: a roadmap for success.* Palgrave Macmillan.

- McDermott, T., Stainer, A. and Stainer, L., 2002. Environmental sustainability and capital investment appraisal. *International Journal of Environmental Technology and Management*, *2*(4), pp.328-343.
- McKenzie, S., 2009. Adult and Vocational Education for Social Sustainability: A New Concept for TVET for Sustainable Development. In *Work, Learning and Sustainable Development* (pp. 177-186). Springer, Dordrecht.
- Meadows, D. and Randers, J., 2012. *The limits to growth: the 30-year update*. London: Routledge.
- Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W., 1972. *The limits to growth.* New York: Universe Books.
- MHESR, Ministry of Higher Education and Scientific Research, 2019. Public Jordanian universities. Available at: http://www.mohe.gov.jo/en/Pages/StateUniversities.aspx [Accessed 20 July. 2019].
- Michaelides, R., Bryde, D. and Ohaeri, U., 2014. Sustainability From a Project Management Perspective: Are Oil and Gas Supply Chains Ready to Embed Sustainability in Their Projects?. I*n Project Management Institute Research and Education Conference* 2014, pp.1-28.
- Miles, M.P. and Russell, G.R., 1997. ISO 14000 total quality environmental management: the integration of environmental marketing, total quality management, and corporate environmental policy. *Journal of Quality Management*, *2*(1), pp.151-168.
- Miller, R. and Lessard, D.R., 2001. *The strategic management of large engineering projects: Shaping institutions, risks, and governance*. MIT press. USA.
- Ministry of Information and Communications Technology, 2007. National e-commerce Strategy: Policies and Strategies Directorate. Available at: http://moict.gov.jo/uploads/Policies-and-Strategies-Directorate/Strategies/National-E-Commerce-Strategy.pdf [Accessed 17 June. 2019].
- Mir, F.A. and Pinnington, A.H., 2014. Exploring the value of project management: linking project management performance and project success. *International Journal of Project Management*, *32*(2), pp.202-217.

- Mireles, G.A.G., Moraga, M.Á., García, F. and Piattini, M., 2017, June. A classification approach of sustainability aware requirements methods. In *2017 12th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1-6). IEEE.
- Mishra, P., Dangayach, G.S. and Mittal, M.L., 2011. An Ethical approach towards sustainable project Success. *Procedia-social and behavioral sciences*, *25*, pp.338-344.
- Mohammed, A.B., 2011. Jordan Software Industry: Investigating the Role of Human Capital. *International Journal of Business and Management*, *6*(5), p.217.
- Mohan, K., Ramesh, B., Cao, L. and Sarkar, S., 2012. Managing disruptive and sustaining innovations in Green IT. *IT Professional*, *14*(6), pp.22-29.
- Mohankumar, M. and KUMAR, D.M.A., 2015, February. Empirical study on green and sustainable software engineering. In *Proceedings of the 14th International Conference on Software Engineering, Parallel and Distributed Systems (SEPADS'15), Dubai, UAE* (pp. 22-24).
- Morris, P.W. and Hough, G.H., 1987. The anatomy of major projects: A study of the reality of project management. Chichester: Wiley.
- Morris, P.W., 1997. *The management of projects*, 2nd edition, Thomas Telford, London.
- Mulcahy, R., 2018. *PMP® Exam Prep: Accelerated Learning to Pass the Project Management Professional (PMP) Exam*. RMC Publications, Incorporated.
- Mulder, J. and Brent, A.C., 2006. Selection of sustainable rural agriculture projects in South Africa: Case studies in the LandCare programme. *Journal of Sustainable Agriculture*, *28*(2), pp.55-84.
- Müller, R. and Jugdev, K., 2012. Critical success factors in projects: Pinto, Slevin, and Prescott–the elucidation of project success. *International Journal of Managing Projects in Business*, *5*(4), pp.757-775.
- Müller, R. and Turner, J.R., 2005. The impact of principal–agent relationship and contract type on communication between project owner and manager. *International Journal of Project Management*, *23*(5), pp.398-403.
- Müller, R. and Turner, J.R., 2007b. Matching the project manager's leadership style to project type. *International journal of project management*, *25*(1), pp.21-32.

- Müller, R. and Turner, R., 2007a. The influence of project managers on project success criteria and project success by type of project. *European management journal*, *25*(4), pp.298-309.
- Murray, D. and Sandford, N., 2013. Software engineering project management. *London: University of London*.
- Murugesan, S., 2008. Harnessing green IT: Principles and practices. *IT professional*, *10*(1), pp.24-33.
- Naumann, S., Dick, M., Kern, E. and Johann, T., 2011. The greensoft model: A reference model for green and sustainable software and its engineering. *Sustainable Computing: Informatics and Systems*, *1*(4), pp.294-304.
- Naumann, S., Kern, E., Dick, M. and Johann, T., 2015. Sustainable software engineering: Process and quality models, life cycle, and social aspects. In *ICT Innovations for Sustainability* (pp. 191-205). Springer, Cham.
- Neal, R.A., 1995. Project definition: the soft-systems approach. *International Journal of Project Management*, *13*(1), pp.5-9.
- Nelson, R.R., 2008. Project retrospectives: Evaluating project success, failure, and everything in between. *MIS Quarterly Executive*, *4*(3), p.5.
- Ness, B., Urbel-Piirsalu, E., Anderberg, S. and Olsson, L., 2007. Categorising tools for sustainability assessment. *Ecological economics*, *60*(3), pp.498-508.
- Neves, F.G., Borgman, H. and Heier, H., 2016, January. Success Lies in the Eye of the Beholder: The Mismatch Between Perceived and Real IT Project Management Performance. In *System Sciences (HICSS), 2016 49th Hawaii International Conference on* (pp. 5878-5887). IEEE.
- Nidumolu, R., Prahalad, C.K. and Rangaswami, M.R., 2009. Why sustainability is now the key driver of innovation. *Harvard business review*, *87*(9), pp.56-64.
- Oanda, 2019. Currency Converter. Available at: https://www1.oanda.com/currency/converter/ [Accessed 7 Aug. 2019].
- OECD, Organisation for Economic Cooperation and Development, 2013. OECD Investment Policy Reviews: Jordan 2013. Available at: https://www.oecd-ilibrary.org/finance-and-investment/oecd-investment-policy-reviews-jordan-2013_9789264202276-en [Accessed 19 June. 2019].

- Økland, A., 2015. Gap analysis for incorporating sustainability in project management. *Procedia Computer Science*, *64*, pp.103-109.
- Olsson, N.O., 2006. Management of flexibility in projects. *International Journal of Project Management*, *24*(1), pp.66-74.
- Oyedeji, S., Seffah, A. and Penzenstadler, B., 2017. Sustainability quantification in requirements informing design. *6th Int. Work. Requir. Eng. Sustain. Syst*, *1*.
- Packard Foundation., 2002. *Building for sustainability report: Six scenarios for the David and Lucile Packard foundation Los Altos project*. Los Altos: The David and Lucile Packard Foundation.
- Pade-Khene, C., Mallinson, B. and Sewry, D., 2011. Sustainable rural ICT project management practice for developing countries: investigating the Dwesa and RUMEP projects. *Information Technology for Development*, *17*(3), pp.187-212.
- Pasian, B. and Silvius, A.G., 2016. A Review of Project Management Research in IRNOP and PMI Conferences from 2009 to 2014 to Identify Emerging Perspectives. In *the Proceedings of European Academy of Management Conference, "Manageable Cooperation", June* (Vol. 1, p. 19).
- Pearce, A.R., 2008. Sustainable capital projects: leapfrogging the first cost barrier. *Civil Engineering and Environmental Systems*, *25*(4), pp.291-300.
- Pennypacker, J.S. and Grant, K.P., 2003. Project management maturity: An industry benchmark. *Project Management Journal*, *34*(1), pp.4-11.
- Penzenstadler, B. and Femmer, H., 2012. A generic model for sustainability. Technical University of Munich, Germany.
- Penzenstadler, B. and Femmer, H., 2013a, March. A generic model for sustainability with process- and product-specific instances. In *Proceedings of the 2013 workshop on Green in/by software engineering* (pp. 3-8). ACM.
- Penzenstadler, B. and Femmer, H., 2013b. Re@ 21: Time to sustain!. In *RE4SuSy@ RE*.
- Penzenstadler, B. and Fleischmann, A., 2011, May. Teach sustainability in software engineering?. In *2011 24th IEEE-CS Conference on Software Engineering Education and Training (CSEE&T)* (pp. 454-458). IEEE.
- Penzenstadler, B., 2012. Supporting sustainability aspects in software engineering. In *3rd international conference on computational sustainability (CompSust)*.

- Penzenstadler, B., 2013, February. What does Sustainability mean in and for Software Engineering. In *Proceedings of the 1st International Conference on ICT for Sustainability (ICT4S)*.
- Penzenstadler, B., 2015. From requirements engineering to green requirements engineering. In *Green in Software Engineering* (pp. 157-186). Springer, Cham.
- Penzenstadler, B., Duboc, L., Venters, C.C., Betz, S., Seyff, N., Wnuk, K., Chitchyan, R., Easterbrook, S.M. and Becker, C., 2018. Software Engineering for Sustainability: Find the Leverage Points!. *IEEE Software*, *35*(4), pp.22-33.
- Penzenstadler, B., Raturi, A., Richardson, D. and Tomlinson, B., 2014. Safety, security, now sustainability: The nonfunctional requirement for the 21st century. *IEEE software*, *31*(3), pp.40-47.
- Peter, M. and Ashley, J., 2004, January. Translating corporate strategy into project strategy: realizing corporate strategy through project management. Project Management Institute.
- Pinto, J. K. and Slevin, D. P., 1988. Project success: definitions and measurement techniques. *Project Management Journal, 19*(1), pp.67–72.
- Pinto, J. K., 1996. *Power and politics on projects*, Newtown Square: Project Management Institute.
- Pinto, J. K., and Trailer, J. W., 1998. *Leadership skills for project managers*, Newtown Square: Project Management Institute.
- Pinto, J.K. and Slevin, D.P., 1987. Critical factors in successful project implementation. *IEEE transactions on engineering management*, (1), pp.22-27.
- Plouffe, S., Lanoie, P., Berneman, C. and Vernier, M.F., 2011. Economic benefits tied to ecodesign. *Journal of Cleaner Production*, *19*(6-7), pp.573-579.
- PMI, Project Management Institute, 2011. The Bottom Line on Sustainability. Available at: https://www.pmi.org/-/media/pmi/documents/public/pdf/white-papers/the-bottom-line-on-sustanability.pdf [Accessed 13 Mar. 2019].
- PMI, Project Management Institute, 2017, *A guide to the project management body of knowledge (PMBOK guide)*, 6th edition, Project Management Institute, Inc., Newtown Square, Pennsylvania.

- Polit, D., Beck, C., 2006. *Essentials of Nursing Research: Methods, Appraisal and Utilization.* 6th ed. Lippincott Williams and Wilkins, Philadelphia.
- Porter, M. and Van der Linde, C., 1995. Green and competitive: ending the stalemate. *The Dynamics of the eco-efficient economy: environmental regulation and competitive advantage*, *33*.
- Prabhakar, G. P., 2008. What is project success: A literature review. *International Journal of Business and Management*, 3(9), pp. 3-10.
- Prasad, S., Tata, J., Herlache, L. and McCarthy, E., 2013. Developmental project management in emerging countries. *Operations Management Research*, *6*(1-2), pp.53-73.
- Pujari, D., 2006. Eco-innovation and new product development: understanding the influences on market performance. *Technovation*, *26*(1), pp.76-85.
- Pulaski, M.H. and Horman, M.J., 2005. Continuous value enhancement process. *Journal of Construction Engineering and Management*, *131*(12), pp.1274-1282.
- Raturi, A., Penzenstadler, B., Tomlinson, B. and Richardson, D., 2014, June. Developing a sustainability non-functional requirements framework. In *Proceedings of the 3rd International Workshop on Green and Sustainable Software*(pp. 1-8). ACM.
- Raz, T., Shenhar, A.J. and Dvir, D., 2002. Risk management, project success, and technological uncertainty. *R&D Management*, *32*(2), pp.101-109.
- Reza, H. and Grant, E., 2005, April. Quality-oriented software architecture. In *International Conference on Information Technology: Coding and Computing (ITCC'05)-Volume II* (Vol. 1, pp. 140-145). IEEE.
- Ringle, C.M., Sarstedt, M. and Straub, D.W., 2012. A critical look at the use of PLS-SEM in MIS Quarterly. *MIS Quarterly*, *36*(1), pp.iii-xiv.
- Ringle, C.M., Wende, S. and Becker, J.M., 2015. SmartPLS 3. *Boenningstedt: SmartPLS GmbH*, (http://www.smartpls.com).
- Rivoire, S., Shah, M.A., Ranganathan, P., Kozyrakis, C. and Meza, J., 2007. Models and metrics to enable energy-efficiency optimizations. *Computer*, *40*(12), pp.39-48.
- Rocheska, S., Angeleski, M. and Mancheski, G., 2015. A New Methodological Approach for Designing the Software Industry Value Chain. *Ecoforum Journal*, *4*(2 (7)), pp.87-94.

- Roher, K. and Richardson, D., 2013, May. A proposed recommender system for eliciting software sustainability requirements. In *2013 2nd International Workshop on User Evaluations for Software Engineering Researchers (USER)*(pp. 16-19). IEEE.
- Rolstadås, A., Tommelein, I., Morten Schiefloe, P. and Ballard, G., 2014. Understanding project success through analysis of project management approach. *International journal of managing projects in business*, *7*(4), pp.638-660.
- Saarinen, T., 1990. System development methodology and project success: An assessment of situational approaches. *Information & Management*, *19*(3), pp.183-193.
- Salameen, R.M.D., 2015. Investigating factors affecting software maintenance in e-commerce companies in Jordan (Doctoral dissertation, University of Salford).
- Sánchez, M.A., 2015. Integrating sustainability issues into project management. *Journal of Cleaner Production*, *96*, pp.319-330.
- Saputri, T.R.D. and Lee, S.W., 2016, November. Incorporating sustainability design in requirements engineering process: A preliminary study. In *Asia Pacific Requirements Engineering Conference* (pp. 53-67). Springer, Singapore.
- Sarkis, J., Meade, L.M. and Presley, A.R., 2012. Incorporating sustainability into contractor evaluation and team formation in the built environment. *Journal of Cleaner Production*, *31*, pp.40-53.
- Sarstedt, M., Ringle, C.M., Smith, D., Reams, R. and Hair Jr, J.F., 2014. Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers. *Journal of Family Business Strategy*, *5*(1), pp.105-115.
- Saunders, M., Lewis, P., and Thornhill, A., 2012. *Research Methods for Business Students*, 6th edition. Edinburgh: Pearson Education.
- Saunders, M., Lewis, P., and Thornhill, A., 2016. *Research Methods for Business Students*, 7th edition. Edinburgh: Pearson Education.
- Savitz, A., 2013. *The triple bottom line: how today's best-run companies are achieving economic, social and environmental success-and how you can too*. San Francisco, CA: John Wiley & Sons.
- Schieg, M., 2009. The model of corporate social responsibility in project management. *Business: theory and practice*, *10*(4), pp.315-321.

- Schmidt, W.P. and Taylor, A., 2006, May. Ford of Europe’s product sustainability index. In *Proceedings of 13th CIRP International Conference on Life Cycle Engineering. Leuven May 31st–June 2nd* (pp. 5-10).
- Schrettle, S., Hinz, A., Scherrer-Rathje, M. and Friedli, T., 2014. Turning sustainability into action: Explaining firms' sustainability efforts and their impact on firm performance. *International Journal of Production Economics*, *147(PART A)*, pp.73-84.
- Schwager, S.J. and Margolin, B.H., 1982. Detection of multivariate normal outliers. *The annals of statistics*, *10*(3), pp.943-954.
- Sekaran, U. and Bougie, R., 2010. *Research methods for business a skill building approach.* 5th ed. West Sussex: John Wiley & Sons Ltd.
- Sekaran, U. and Bougie, R., 2016. *Research methods for business: A skill building approach*. West Sussex: John Wiley & Sons.
- Shannon, S., 2002. Critical appraisal of systematic reviews. *Canadian Association of Radiologists Journal*, *53*(4), pp.195-198.
- Shen, L.Y., Tam, V.W., Tam, L. and Ji, Y.B., 2010. Project feasibility study: the key to successful implementation of sustainable and socially responsible construction management practice. *Journal of Cleaner Production*, *18*(3), pp.254-259.
- Shen, L.Y., Wu, Y.Z., Chan, E.H.W. and Hao, J.L., 2005. Application of system dynamics for assessment of sustainable performance of construction projects. *Journal of Zhejiang University-Science A*, *6*(4), pp.339-349.
- Shenhar, A., 2011. Meeting Time, Cost, and Money-making Goals with Strategic Project Leadership®. *Project Management Institute*.
- Shenhar, A.J. and Dvir, D., 1996. Toward a typological theory of project management. *Research policy*, *25*(4), pp.607-632.
- Shenhar, A.J. and Dvir, D., 2007. *Reinventing project management: the diamond approach to successful growth and innovation*. Harvard Business Review Press.
- Shenhar, A.J., 2001. One size does not fit all projects: Exploring classical contingency domains. *Management science*, *47*(3), pp.394-414.
- Shenhar, A.J., Dvir, D., 2004. How projects differ and what to do about it. *The Wiley guide to project, program and portfolio management*, pp.1265-1286.

- Shenhar, A.J., Dvir, D., Levy, O. and Maltz, A.C., 2001. Project success: a multidimensional strategic concept. *Long range planning*, *34*(6), pp.699-725.
- Shenhar, A.J., Levy, O. and Dvir, D., 1997. Mapping the dimensions of project success. *Project management journal*, *28*(2), pp.5-13.
- Shenhar, A.J., Tishler, A., Dvir, D., Lipovetsky, S. and Lechler, T., 2002. Refining the search for project success factors: a multivariate, typological approach. *R&d Management*, *32*(2), pp.111-126.
- Shenoy, S.S. and Eeratta, R., 2011, December. Green software development model: An approach towards sustainable software development. In *2011 Annual IEEE India Conference* (pp. 1-6). IEEE.
- Shokri, S.M. and Badaruzzaman, W., 2014. A Problem Based Sustainability Education Approach in Integrated Design Project Course. In *International Conference on Education and Educational (EET'14)*.
- Sibisi, M. and Van Waveren, C.C., 2007, September. A process framework for customising software quality models. In *AFRICON 2007* (pp. 1-8). IEEE.
- Silvius, A.G. and Schipper, R., 2016. Exploring the relationship between sustainability and project success-conceptual model and expected relationships. *SciKA-Association for Promotion and Dissemination of Scientific Knowledge*, *4*(3), pp.5-22.
- Silvius, A.G., Kampinga, M., Paniagua, S. and Mooi, H., 2017. Considering sustainability in project management decision making; An investigation using Q-methodology. *International Journal of Project Management*, *35*(6), pp.1133-1150.
- Silvius, A.J. and Nedeski, S., 2011. Sustainability in IS projects: A case study. *Communications of the IIMA*, *11*(4), p.1.
- Silvius, A.J. and Schipper, R.P., 2014. Sustainability in project management: A literature review and impact analysis. *Social Business*, *4*(1), pp.63-96.
- Silvius, A.J.G., Schipper, R., Nedeski, S., 2013. Sustainability in project management: reality bites 1. *PM World Journal*, 2 (2), pp.1–14.
- Silvius, G. and Schipper, R., 2015. Developing a maturity model for assessing sustainable project management. *The Journal of Modern Project Management*, *3*(1), pp.16-27.

- Silvius, G., 2012. Change the Game: Sustainability in Projects and Project Management. In *Green Business Process Management* (pp. 161-177). Springer Berlin Heidelberg.
- Silvius, G., 2015a. Sustainability Evaluation of IT/IS Projects. *International Journal of Green Computing (IJGC)*, *6*(2), pp.1-15.
- Silvius, G., 2015b. Considering Sustainability in Project Management Processes. In *Handbook of Research on Sustainable Development and Economics* (pp. 311-334). IGI Global.
- Silvius, G., 2017. Sustainability as a new school of thought in project management. *Journal of Cleaner Production*, *166*, pp.1479-1493.
- Silvius, G., Schipper, R., Van Den Brink, J. and Planko, J., 2012. *Sustainability in project management*. Surrey: Gower Publishing, Ltd.
- Singh, R.K., Murty, H.R., Gupta, S.K. and Dikshit, A.K., 2007. Development of composite sustainability performance index for steel industry. *Ecological Indicators*, *7*(3), pp.565-588.
- Singh, R.K., Murty, H.R., Gupta, S.K. and Dikshit, A.K., 2012. An overview of sustainability assessment methodologies. *Ecological indicators*, *15*(1), pp.281-299.
- SmartPLS, 2018. SmartPLS is here!. Available at: https://www.smartpls.com [Accessed 12 Dec. 2018].
- Söderlund, J., 2002. On the development of project management research: schools of thought and critique. *International Project management journal*, *8*(1), pp.20-31.
- Stroustrup, B., 2012. Software development for infrastructure. *IEEE Computer*, *45*(1), pp.47-58.
- Svensson, R.B., Olsson, T. and Regnell, B., 2013. An investigation of how quality requirements are specified in industrial practice. *Information and Software Technology*, *55*(7), pp.1224-1236.
- Sverdrup, H. and Svensson, M.G., 2004. Defining the concept of sustainability-a matter of systems thinking and applied systems analysis. In *Systems approaches and their application* (pp. 143-164). Springer, Dordrecht.
- Tabachnick, B.G. and Fidell, L.S., 2013. *Using multivariate statistics*, 6th edn, Boston. *Ma: Pearson*.

- Taina, J., 2010, June. How green is your software?. In *International Conference of Software Business* (pp. 151-162). Springer, Berlin, Heidelberg.
- Taina, J., 2011. Good, bad, and beautiful software-In search of green software quality factors. *Cepis Upgrade*, *12*(4), pp.22-27.
- Talbot, J. and Venkataraman, R., 2011. Integration of sustainability principles into project baselines using a comprehensive indicator set. *International Business & Economics Research Journal (IBER)*, *10*(9), pp.29-40.
- Tam, G.C., 2015. Managing Project Sustainability: A Tool for Project Managers. In *Handbook of Research on Sustainable Development and Economics* (pp. 335-358). IGI Global.
- Tam, V.W., Shen, L.Y., Yau, R.M. and Tam, C.M., 2007. On using a communication-mapping model for environmental management (CMEM) to improve environmental performance in project development processes. *Building and environment*, *42*(8), pp.3093-3107.
- Tavakol, M. and Dennick, R., 2011. Making sense of Cronbach's alpha. *International journal of medical education*, Vol. 2, pp. 53-55.
- Taylor, T., 2010. Sustainability Interventions - for managers of projects and programmes. *Centre for Education in the Built Environment*, *University of Salford,* Greater Manchester.
- Tchertchian, N., Yvars, P.A. and Millet, D., 2013. Benefits and limits of a Constraint Satisfaction Problem/Life Cycle Assessment approach for the ecodesign of complex systems: a case applied to a hybrid passenger ferry. *Journal of cleaner production*, *42*, pp.1-18.
- Temme, D., Kreis, H. and Hildebrandt, L., 2006. *PLS Path Modeling–A Software Review*. SFB 649, Humboldt University, Berlin, Germany.
- Thabrew, L., Wiek, A. and Ries, R., 2009. Environmental decision making in multi-stakeholder contexts: applicability of life cycle thinking in development planning and implementation. *Journal of Cleaner Production*, *17*(1), pp.67-76.
- Thamhain, H.J. and Wilemon, D.L., 1975. Conflict management in project life cycles. *Sloan Management Review (pre-1986)*, *16*(3), p.31.

* Thamhain, H.J., 2004. Linkages of project environment to performance: lessons for team leadership. *International Journal of project management*, *22*(7), pp.533-544.
* Tharp, J., 2012. Project management and global sustainability. *Paper presented at PMI® Global Congress 2012—EMEA, Marsailles, France*. Newtown Square, PA: Project Management Institute.
* The World Bank, 2020. World Bank Country and Lending Groups. Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups [Accessed 16 April. 2020].
* Thomas, G. and Fernández, W., 2008. Success in IT projects: A matter of definition?. *International journal of project management*, *26*(7), pp.733-742.
* Thomas, T.E. and Lamm, E., 2012. Legitimacy and organizational sustainability. *Journal of business ethics*, *110*(2), pp.191-203.
* Thomson, C.S., El-Haram, M.A. and Emmanuel, R., 2011, June. Mapping sustainability assessment with the project life cycle. In *Proceedings of the Institution of Civil Engineers-Engineering Sustainability* (Vol. 164, No. 2, pp. 143-157). Thomas Telford Ltd.
* Toor, S. and Ogunlana, S. O., 2010. Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. *International journal of project management*, *28*(3), pp.228-236.
* Tranfield, D., Denyer, D. and Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*(3), pp.207-222.
* Tsai, C.Y. and Chang, A.S., 2012. Framework for developing construction sustainability items: the example of highway design. *Journal of Cleaner Production*, *20*(1), pp.127-136.
* Tuckman, B.W. and Harper, B.E., 2012. *Conducting educational research*. Plymouth: Rowman & Littlefield Publishers.
* Turner, J. R., 2009. *The handbook of project-based management* (3rd ed.), New York: McGraw-Hill.
* Turner, J. R., Huemann, M., and Keegan, A. E., 2007. *Human resource management in the project-oriented organization*, Newtown Square: Project Management Institute.

- Turner, J.R. and Cochrane, R.A., 1993. Goals-and-methods matrix: coping with projects with ill defined goals and/or methods of achieving them. *International Journal of project management*, *11*(2), pp.93-102.
- Turner, J.R. and Keegan, A., 2001. Mechanisms of governance in the project-based organization: Roles of the broker and steward. *European management journal*, *19*(3), pp.254-267.
- Turner, J.R. and Müller, R., 2003. On the nature of the project as a temporary organization. *International journal of project management*, *21*(1), pp.1-8.
- Turner, J.R. ed., 2007. *Gower Handbook of Project Management*. New York: Gower Publishing, Ltd.
- Turner, J.R. ed., 2014. *Gower Handbook of Project Management*. New York: Gower Publishing Ltd.
- Turner, J.R., 2004. Farsighted project contract management: incomplete in its entirety. *Construction Management and Economics*, *22*(1), pp.75-83.
- Turner, J.R., 2010. Evolution of project management research as evidenced by papers published in the International Journal of Project Management. *International Journal of Project Management*, *1*(28), pp.1-6.
- Turner, J.R., Anbari, F. and Bredillet, C., 2013. Perspectives on research in project management: the nine schools. *Global Business Perspectives*, *1*(1), pp.3-28.
- Turner, R. and Zolin, R., 2012. Forecasting success on large projects: developing reliable scales to predict multiple perspectives by multiple stakeholders over multiple time frames. *Project Management Journal*, *43*(5), pp.87-99.
- Turner, R., Zolin, R. and Remington, K., 2009. Monitoring the performance of complex projects from multiple perspectives over multiple time frames. In *Proceedings of the 9th International Research Network of Project Management Conference*. IRNOP.
- Turner, R.J., Huemann, M., Anbari, F.T. and Bredillet, C.N., 2010. *Perspectives on projects*. New York: Routledge.
- Ugwu, O.O., Kumaraswamy, M.M., Wong, A. and Ng, S.T., 2006. Sustainability appraisal in infrastructure projects (SUSAIP): Part 1. Development of indicators and computational methods. *Automation in construction*, *15*(2), pp.239-251.

- Umeda, Y., Takata, S., Kimura, F., Tomiyama, T., Sutherland, J.W., Kara, S., Herrmann, C. and Duflou, J.R., 2012. Toward integrated product and process life cycle planning—An environmental perspective. *CIRP annals*, *61*(2), pp.681-702.
- Umpleby, S. and Anbari, F.T., 2004. Strengthening the global university system and enhancing projects management education. *Review of Business Research*, *4*(1), pp.237-44.
- UNDESA, United Nations Department of Economic and Social Affairs, 2001. *Indicators of sustainable development: Guidelines and methodologies*. United Nations Publications.
- Unhelkar, B., 2016. *Green IT strategies and applications: using environmental intelligence*. Boca Raton: CRC Press.
- University of Texas Libraries, 2019. Jordan Maps. Available at: https://legacy.lib.utexas.edu/maps/middle_east_and_asia/jordan_physio-2004.jpg [Accessed 8 Jul. 2019].
- UOB, The University of Bolton, 2019. Research Ethics Framework. Available at: https://www.bolton.ac.uk/join-us/research-programmes/research-policies-and-documents/research-ethics-framework/ [Accessed 10 Aprile. 2019].
- Valdes-Vasquez, R. and Klotz, L.E., 2012. Social sustainability considerations during planning and design: Framework of processes for construction projects. *Journal of construction engineering and management*, *139*(1), pp.80-89.
- Van den Brink, J., Silvius, G.G. and Köhler, A., 2012. The impact of sustainability on project management. *The Project as a Social System: Asia-Pacific Perspectives on Project Management*, pp.183-200.
- Var, I., 1998. Multivariate data analysis. *vectors*, *8*(2), pp.125-136.
- Veal, A. J., 2005. *Business research methods: a managerial approach.* 2nd ed. London: Addison-Wesley Longman.
- Venters, C., Jay, C., Lau, L., Griffiths, M.K., Holmes, V., Ward, R., Austin, J., Dibsdale, C.E. and Xu, J., 2014b. Software sustainability: The modern tower of babel. In *Proceedings of the Third International Workshop on Requirements Engineering for Sustainable Systems co-located with 22nd International Conference on Requirements Engineering (RE 2014)* (Vol. 1216). RWTH Aachen University.

- Venters, C., Lau, L., Griffiths, M., Holmes, V., Ward, R., Jay, C., Dibsdale, C. and Xu, J., 2014a. The blind men and the elephant: Towards an empirical evaluation framework for software sustainability. *Journal of Open Research Software*, *2*(1).
- Vidal, L.A. and Marle, F., 2008. Understanding project complexity: implications on project management. *Kybernetes*, *37*(8), pp.1094-1110.
- Vinzi, V. E., Chin, W. W., Henseler, J. and Wang, H., 2010. *Handbook of partial least squares concepts, methods and applications.* London: Springer.
- Vittinghoff, E. and McCulloch, C.E., 2007. Relaxing the rule of ten events per variable in logistic and Cox regression. *American journal of epidemiology*, *165*(6), pp.710-718.
- Vogt, W.P., and Johnson, B., 2011. *Dictionary of statistics and methodology: A nontechnical guide for the social sciences*, 4th ed., Thousand Oaks, CA: Sage.
- Wang, N., Wei, K. and Sun, H., 2013. Whole life project management approach to sustainability. *Journal of Management in Engineering*, *30*(2), pp.246-255.
- Wateridge, J., 1998. How can IS/IT projects be measured for success?. *International journal of project management*, *16*(1), pp.59-63.
- Watson, R.T., Boudreau, M.C. and Chen, A.J., 2010. Information systems and environmentally sustainable development: Energy informatics and new directions for the IS community. *MIS quarterly*, *34*(1), pp.23-38.
- Weninger, C. and Huemann, M., 2015. Project initiation: investment analysis for sustainable development. In *Banking, Finance, and Accounting: Concepts, Methodologies, Tools, and Applications* (pp. 1-17). IGI Global.
- Westkämper, E., 2002. Platform for the integration of assembly, disassembly and life cycle management. *CIRP Annals*, *51*(1), pp.33-36.
- Westkämper, E., 2003. Assembly and disassembly processes in product life cycle perspectives. *CIRP Annals*, *52*(2), pp.579-588.
- Wilemon, D.L., 1973. Managing conflict in temporary management systems. *Journal of Management studies*, *10*(3), pp.282-296.
- Williams, C., 2007. Research methods. *Journal of Business & Economics Research* (JBER), 5(3), pp. 65-72.
- Williams, T., 2002. *Modelling complex projects*, Chichester: Wiley.

- Willis, P., McKenzie, S. and Harris, R., 2009. Introduction: Challenges in adult and vocational education for social sustainability. In *Rethinking Work and Learning* (pp. 1-9). Springer, Dordrecht.
- Wilson, E., 2014. Project Sizing Guidelines. *Edith Cowan University.* Available at: https://intranet.ecu.edu.au/__data/assets/pdf_file/0017/670400/ITSC_Project_Sizing_Guidelines.pdf [Accessed 18 March. 2019].
- Winch, G., 2004, July. Rethinking project management: project organizations as information processing systems. In *Proceedings of the PMI research conference*.
- WorldAtlas, 2017. Jordan. Available at: https://www.worldatlas.com/webimage/countrys/asia/jo.htm [Accessed 16 April. 2020].
- World Health Organisation, 2013. Country Cooperation Strategy for WHO and Jordan 2008–2013. Available at: https://www.who.int/country-cooperation/what-who-does/strategies-and-briefs/en/ [Accessed 16 June. 2019].
- Xing, Y., Horner, R.M.W., El-Haram, M.A. and Bebbington, J., 2009, September. A framework model for assessing sustainability impacts of urban development. In *Accounting forum*, Vol. 33, No. 3, pp. 209-224.
- Yao, H., Shen, L., Tan, Y. and Hao, J., 2011. Simulating the impacts of policy scenarios on the sustainability performance of infrastructure projects. *Automation in Construction*, *20*(8), pp.1060-1069.
- Yeo, K.T., 1993. Systems thinking and project management—time to reunite. *International journal of project management*, *11*(2), pp.111-117.
- Youker, R., 1977. Organization alternatives for project managers. *Management Review*, *66*(11), pp.46-53.
- Yuan, H., 2013. Key indicators for assessing the effectiveness of waste management in construction projects. *Ecological Indicators*, *24*, pp.476-484.
- Yuan, H., 2017. Achieving Sustainability in Railway Projects: Major Stakeholder Concerns. *Project Management Journal*, *48*(5), pp.115-132.
- Zakaria, N.Z.H., Hamdan, A.R., Yahaya, J. and Deraman, A., 2016. User Centric Software Quality Model For Sustainability: A Review. *Lecture Notes on Software Engineering*, *4*(3), pp.199-204.

- Zhang, X., Wu, Y., Shen, L. and Skitmore, M., 2014. A prototype system dynamic model for assessing the sustainability of construction projects. *International Journal of Project Management*, *32*(1), pp.66-76.
- Zikmund, W., 2003. *Business research methods.* 7th ed. Ohio: Thomson South Western.
- Zwikael, O. and Ahn, M., 2011. The effectiveness of risk management: an analysis of project risk planning across industries and countries. *Risk Analysis: An International Journal*, *31*(1), pp.25-37.

APPENDICES

Appendix A

The initial cover letter in English

Dear participant,

I am writing to request that you complete the enclosed questionnaire, which is part of my PhD research in software project sustainability at the University of Bolton in England. The aim of the research is to investigate the potential impact of software project sustainability on project success. This research is considered one of the first studies in this field and may help in the development of the software industry and in the move towards more sustainable orientation, locally and globally.

However, the completion of this research will not be possible without the contribution of those with expertise in this field. Therefore, I would be grateful if you could spare approximately 15 minutes of your valuable time to complete the enclosed questionnaire.

Your participation is voluntary, and your identity will remain anonymous. You are free to withdraw at any time without providing any reasons. There are no right or wrong answers, as your answers represent your opinion. All answers will be dealt with in a strictly confidential manner and used for scientific purposes only. Filling out this questionnaire is considered consent to participation.

Thank you for your cooperation.

Yours sincerely,

Amin Yasin Khalifeh, PhD student
University of Bolton
England, UK
Email: AYK1RES@BOLTON.AC.UK
Mobile, England: 004447801106039
Mobile, Jordan: 00962776559979

The initial version of the questionnaire in English

Part 1: General information

Section A. Please complete this section by selecting one of the response options.					
1	What is the highest educational degree you hold?	Diploma or lower	Bachelor's degree	Master or certification in project management	Doctorate
2	How many years of experience do you have in software projects?	Less than 5 years	5 to 10 Years	11 to 20 Years	Over 20 years
3	How many employees work in software projects in your department?	1 to 9	10 to 49	50 to 249	250 and above
4	What is your age?	18 to 28	29 to 39	40 to 50	Above 50

Section B. Please choose one internal software project that already finished recently, and you took part in it. Please answer the following questions by selecting one of the response options.				
5	What was the size of the project team?	Less than 5 team members	5 to 10 team members	More than 10 team members
6	What was the project's duration?	Less than 6 months	6 to 12 months	More than 12 months
7	What was the overall level of clarity and stability in requirements?	High	Medium	Low

Part 2: Based on the internal software project that you have chosen in the previous section, please indicate to what extent you agree or disagree with the below statements in each section, ranging from strongly disagree (1) to strongly agree (5).

Section A. The following statements are about the consideration of economic aspects in the processes of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
8	In your chosen project, financial benefits originating from cost savings were taken into account.	1	2	3	4	5
9	In your chosen project, financial benefits originating from reducing the use of resources were taken into account.	1	2	3	4	5
10	In your chosen project, financial benefits originating from improving business processes and minimising risks were taken into account.	1	2	3	4	5
11	The evaluation of this project was based on its short- and long-term strategic value.	1	2	3	4	5
12	The selection of this project was based on its short- and long-term strategic value.	1	2	3	4	5
13	Please select the answer number two only, then go to the next question.	1	2	3	4	5

Section B. The following statements focus on environmental concerns during the management of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
14	Travel policies that consider environmental aspects were applied in the project.	1	2	3	4	5
15	The project delivery processes were designed to minimise travelling and travelling time in the project, and the use of eco-friendly alternatives (e.g. emails, mobiles and telephones, video conferencing, emission-free travelling like walking or cycling) was actively promoted.	1	2	3	4	5
16	There were policies in the project to promote the smart use of energy, and where possible, energy-saving equipment was used.	1	2	3	4	5
17	Where possible, energy consumption was actively kept to a minimum and the necessary energy used was acquired as 'green' energy.	1	2	3	4	5
18	Minimising energy consumption was one of the parameters in the design of the project delivery processes.	1	2	3	4	5
19	The project had policies to minimise waste (e.g. double-sided printing, recycling necessary waste in the project itself).	1	2	3	4	5
20	The project delivery processes were designed to minimise waste.	1	2	3	4	5
21	Project procurement took into consideration environmental aspects when selecting products (e.g. their energy consumption, the waste and pollution they cause, their reuse capabilities).	1	2	3	4	5
22	The project supply chain took into consideration environmental aspects when selecting suppliers (e.g. suppliers' environmental policies and their use of natural resources, suppliers' knowledge, and their locations).	1	2	3	4	5

Section C. The following statements focus on social responsibility during the management of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
23	The project included training, education, and development of stakeholders.	1	2	3	4	5
24	The project applied policies or standards for diversity and equal opportunity in terms of gender, race, religion, etc.	1	2	3	4	5
25	Aspects of occupational health and safety were considered for project staff and outsourced (e.g. hazard identification, risk assessment, determination of controls, legal requirements, incident monitoring).	1	2	3	4	5
26	The project applied policies or standards for respecting and improving human rights, including non-discrimination, freedom of association and no child labour.	1	2	3	4	5
27	The project also required its suppliers and partners to respect and improve human rights where possible.	1	2	3	4	5
28	The project had complied with public policies and had a social responsibility towards the society it operated in (e.g. the health and welfare of society; community support; customer health and safety; product and service labelling; market communication and advertising; customer privacy).	1	2	3	4	5
29	The project took into account the expectations of stakeholders.	1	2	3	4	5
30	The project rejected bribery and corruption, and had well-written codes of conduct which support principles and values such as honesty, transparency, privacy, fairness, trust, respect, and fair trade and competition.	1	2	3	4	5

Section D. The following statements focus on the software quality requirements in your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
31	Facilitating the accomplishment of all specified tasks and objectives correctly and accurately was among the quality requirements of the software.	1	2	3	4	5
32	Response time, processing time, throughput rates, and the maximum capacity of the software were taken into account.	1	2	3	4	5
33	The software can perform its required functions efficiently while exchanging information and sharing a common environment and resources with other products, without any detrimental impact on any other product.	1	2	3	4	5
34	The software enables people with the widest range of characteristics and capabilities to use it easily, appropriately, efficiently, effectively, satisfactorily, risk-free, and without errors.	1	2	3	4	5
35	The software was designed to be always ready when required for use, and it is capable to recover the affected data and its desired state in the event of an interruption or a failure.	1	2	3	4	5
36	The software prevents unauthorised access or modifications, and actions or events can be traced and proven.	1	2	3	4	5
37	The software can be modified and used in more than one system effectively and efficiently without introducing defects.	1	2	3	4	5
38	The software can be transferred effectively and efficiently from one hardware - or other operational or usage environment - to another.	1	2	3	4	5
39	In the design stage of the software, certain quality requirements of internal stakeholders (e.g. employees, students, higher management) were taken into account.	1	2	3	4	5
40	In the design stage of the software, certain quality requirements of external stakeholders (e.g. government or any other legal authority) were taken into account.	1	2	3	4	5

Section E. The following statements focus on the evaluation of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
41	The project was completed on time or earlier.	1	2	3	4	5
42	The project was completed within or below budget.	1	2	3	4	5
43	You were satisfied, and the software met all requirements.	1	2	3	4	5
44	The software improved your work performance.	1	2	3	4	5
45	The project team was highly satisfied and motivated.	1	2	3	4	5
46	Team members experienced personal growth.	1	2	3	4	5
47	The project was an economic business success.	1	2	3	4	5
48	The project increased the organisation's market share.	1	2	3	4	5
49	The project contributed to the organisation's direct performance.	1	2	3	4	5
50	The project outcome will contribute to future projects.	1	2	3	4	5
51	The project contributed to new business processes.	1	2	3	4	5

Thank you…

Please, feel free to make any further comments or recommendations.

Appendix B

The initial cover letter in Arabic

نموذج موافقة على المساهمة في استبيان

عزيزي المشارك

نأمل منكم المساهمة في تعبئة الاستبانة المرفقة والتي هي جزء من البحث الخاص بي في جامعة بولتون في إنجلترا (University of Bolton)، وذلك للحصول على درجة الدكتوراه في تخصص ادارة الاستدامة في مشاريع البرمجيات. الهدف من البحث هو دراسة كيفية ادراج الاستدامة في مشاريع البرمجيات وفحص أثرها المحتمل على نجاح المشروع. يعتبر هذا البحث من أوائل الدراسات المهتمة في هذا المجال، وقد يساعد في تطوير مشاريع البرمجيات وإدارتها بشكل مستدام محليا وعالميا.

وعليه، فان انجاز هذا البحث لن يكون ممكنا بدون مساهمة ذوي الخبرة في هذا المجال. لذلك نأمل منكم تخصيص جزء بسيط من وقتكم الثمين والذي يقارب ١٥ دقيقة للإكمال الاستبانة المرفقة.

إن مشاركتك تطوعية وهويتك ستبقى غير معروفة، ولك حرية الانسحاب في أي وقت دون إبداء اية اسباب. لا يوجد إجابات صحيحة او خاطئة، وإجابتك هي رأيك، وسيتم التعامل بها بسرية تامة ولأغراض البث العلمي فقط. ان تعبئه هذا الاستبيان ستكون موافقه على مشاركتكم.

شكراً لتعاونكم، وتفضلوا بقبول فائق الاحترام...

امين ياسين خليفة، طالب دكتوراه

جامعة بولتون

إنجلترا، المملكة المتحدة

البريد الإلكتروني: AYK1RES@BOLTON.AC.UK

موبايل، انجلترا: ٠٠٤٤٧٣٨٠١٠٦٠٣٩

موبايل، الأردن: ٠٠٩٦٢٧٨٦٢٥٩٩٧٩

The initial version of the questionnaire in Arabic

الجزء الاول: معلومات عامة

القسم أ. يرجى الإجابة على الاسئلة أدناه من خلال اختيار أحد الإجابات					
1	ما هي أعلى درجة علمية حصلت عليها؟	دبلوم أو أقل	بكالوريوس	ماجيستير او شهادة عليا في إدارة المشاريع	دكتوراه
2	كم سنة من الخبرة لديك في مشاريع البرمجيات؟	اقل من 5 سنوات	من 5 الى 10 سنوات	من 11 الى 20 سنة	أكثر من 20 سنة
3	كم عدد الموظفين العاملين في مشاريع البرمجيات في قسمك؟	من 1 الى 9	من 10 الى 49	من 50 الى 249	أكثر من 250
4	كم عمرك؟	من 18 الى 28	من 29 الى 39	من 40 الى 50	فوق 50 سنة

القسم ب. الرجاء اختيار مشروع برنامج(software) داخلي انتهى مؤخرا، وشاركت فيه .يرجى اختيار أحد الاجابات أدناه.				
5	ما هو حجم فريق المشروع؟	أقل من 5 أعضاء	من 5 الى 10 اعضاء	أكثر من 10 أعضاء
6	ما هي مدة المشروع؟	أقل من 6 أشهر	من 6 الى 12 شهر	أكثر من 12 شهرا
7	ما هو المستوى العام للوضوح والاستقرار في المتطلبات؟	مرتفع	متوسط	منخفض

الجزء الثاني: بناء على المشروع الذي اخترته **في القسم السابق**، يرجى الإشارة إلى أي مدى توافق أو لا توافق على العبارات أدناه في كل قسم، وذلك باختيار احد الاجابات التي تتراوح من لا أوافق بشدة (1) إلى أوافق بشدة (5).

	القسم أ. العبارات التالية تتعلق بدراسة الجوانب الاقتصادية في عمليات المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
8	في المشروع الذي اخترته تم الاخذ بعين الاعتبار الفوائد المالية الناتجة عن التوفير في التكلفة.	1	2	3	4	**5**
9	تم الاخذ بعين الاعتبار الفوائد المالية الناتجة عن التقليل في استخدام الموارد.	1	2	3	4	**5**
10	تم الأخذ بعين الاعتبار الفوائد المالية الناتجة عن التحسين في آلية العمل وتقليل المخاطر.	1	2	3	4	**5**
11	التقييم لهذا المشروع كان مبنيا على قيمته الاستراتيجية قصيرة الامد وطويلة الأمد.	1	2	3	4	**5**
12	الاختيار لهذا المشروع كان مبنيا على قيمته الاستراتيجية قصيرة الامد وطويلة الأمد.	1	2	3	4	**5**
13	الرجاء اختيار الاجابه رقم اثنان فقط، ثم انتقل الى السؤال التالي.	1	2	3	4	**5**

	القسم ب. تركز العبارات التالية على الاهتمامات البيئية أثناء إدارة المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
14	تم تطبيق سياسات سفر في المشروع تراعي الجوانب البيئية.	1	2	3	4	**5**
15	تم تصميم عمليات المشروع بحيث تقلل من السفر ووقت السفر في المشروع، وتشجع على استخدام بدائل صديقة للبيئة (مثل رسائل البريد الإلكتروني، الهواتف المحمولة والارضية، عقد المؤتمرات عبر الفيديو، المشي أو ركوب الدراجات).	1	2	3	4	**5**
16	كانت هناك سياسات في المشروع تحث على الاستخدام الذكي للطاقة، وتم استخدام المعدات الموفرة للطاقة حيثما أمكن ذلك.	1	2	3	4	**5**
17	حيثما أمكن، تم تقليل استهلاك الطاقة إلى الحد الأدنى وتم الحصول على الطاقة اللازمة للاستخدام كطاقة "خضراء" (أي من مصادر صديقة للبيئة).	1	2	3	4	**5**
18	كان تقليل استهلاك الطاقة أحد المعايير في تصميم عمليات تسليم المشروع.	1	2	3	4	**5**
19	كان للمشروع سياسات للتقليل من النفايات (مثل الطباعة على الوجهين للورق المستخدم، وإعادة تدوير النفايات في المشروع نفسه).	1	2	3	4	**5**
20	تم تصميم عمليات المشروع بطريقة تقلل من النفايات.	1	2	3	4	**5**
21	عمليات الشراء في المشروع أَخَذت بعين الاعتبار الجوانب البيئية عند اختيار المنتجات (مثل استهلاك الطاقة، والنفايات، والتلوث التي تسببها، وامكانية إعادة استخدام).	1	2	3	4	**5**
22	أخَذَت سلسلة التزويدات في المشروع بعين الاعتبار الجوانب البيئية عند اختيار الموردين (مثل السياسات البيئية للموردين واستخدامهم للموارد الطبيعية، قدراتهم المعرفية، ومواقعهم لتقليل النقل إلى الحد الأدنى).	1	2	3	4	**5**

	القسم ج. تركز العبارات التالية على المسؤولية الاجتماعية أثناء إدارة المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
23	تضمن المشروع التدريب والتعليم وتطوير أصحاب المصلحة.	1	2	3	4	**5**
24	طَبَّقَ المشروع سياسات او معايير للتنوع وتكافؤ الفرص من حيث الجنس، العرق، الدين، إلخ.	1	2	3	4	**5**
25	تم الاخذ بعين الاعتبار جوانب الصحة والسلامة المهنية لموظفي المشروع وللمصادر الخارجية (مثل تحديد وتقييم المخاطر، تحديد الضوابط والمتطلبات القانونية، ومراقبة الحوادث).	1	2	3	4	**5**
26	طَبّق المشروع سياسات أو معايير لاحترام حقوق الإنسان وتحسينها (مثل عدم التميز، حرية الصداقة وتكوين الجمعيات، وعدم تشغيل الأطفال).	1	2	3	4	**5**
27	طالب المشروع ورديه وشركائه باحترام وتحسين حقوق الإنسان حيثما أمكن ذلك.	1	2	3	4	**5**
28	إِمتَثَل المشروع للقانون المعمول به وتَحَمَّل مسؤولية اجتماعية تجاه المجتمع الذي عمل فيه (مثل صحة ورفاهية المجتمع، دعم المجتمع، صحة العملاء وسلامتهم، تصنيف المنتجات والخدمات، اتصالات السوق والإعلان، خصوصية العميل).	1	2	3	4	**5**
29	.أخذ المشروع في الاعتبار توقعات أصحاب المصلحة	1	2	3	4	**5**
30	رَفَضَ المشروع الرشوة والفساد وكان له مدونات سلوك مكتوبة بشكل جيد والتي تدعم المبادئ والقيم مثل الأمانة، الشفافية، الخصوصية، الإنصاف، الثقة، الاحترام، والتجارة والمنافسة العادلة.	1	2	3	4	**5**

	القسم د. تركز العبارات التالية على متطلبات الجودة للبرنامج (software) في المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
31	كان تسهيل إنجاز جميع المهام والأهداف المحددة بشكل صحيح ودقيق من بين متطلبات الجودة للبرنامج.	1	2	3	4	**5**
32	تم الاخذ بعين الاعتبار وقت الاستجابة، وقت المعالجة، معدلات الإنتاجية، والحد الأقصى لسعة البرنامج.	1	2	3	4	**5**
33	يُمْكِن للبرنامج أداء وظائفه المطلوبة بكفاءة أثناء تبادل ومشاركة المعلومات مع منتجات أخرى، دون أي تأثير ضار على أي منتج آخر.	1	2	3	4	**5**
34	يُمَكّن البرنامج اشخاص بمختلف القدرات من استخدامه بسهولة، بشكل مناسب، بكفاءة، بفاعلية، بشكل مرضٍ وخالي من المخاطر، وبدون أخطاء.	1	2	3	4	**5**
35	تم تصميم البرنامج ليكون جاهزا بشكل دائم عند الحاجة للاستخدام، وهو قادر على استرداد البيانات في حال حدوث انقطاع أو عطل.	1	2	3	4	**5**
36	يَمنَع البرنامج الوصول أو التعديلات غير المصرح بها، ومن الممكن تتبع الإجراءات أو الأحداث وإثباتها.	1	2	3	4	**5**
37	يُمْكِن تعديل البرنامج واستخدامه في أكثر من نظام بفعالية وكفاءة دون تقديم أي عيوب.	1	2	3	4	**5**
38	يُمْكِن نقل البرنامج بفعالية وكفاءة من جهاز أو بيئة تشغيل أو استخدام إلى أخرى.	1	2	3	4	**5**
39	في مرحلة تصميم البرنامج ، تم مراعاة بعض متطلبات الجودة لأصحاب المصلحة الداخليين (مثل الموظفين والطلاب والإدارة العليا).	1	2	3	4	**5**
40	في مرحلة تصميم البرنامج ، تم مراعاة بعض متطلبات الجودة لأصحاب المصلحة الخارجيين (مثل الحكومة أو أي سلطة قانونية أخرى).	1	2	3	4	**5**

	القسم هـ. تركز العبارات التالية على تقييم المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
41	تم الانتهاء من المشروع في الوقت المحدد أو قبل ذلك.	1	2	3	4	**5**
42	تم الانتهاء من المشروع ضمن الميزانية أو أقل.	1	2	3	4	**5**
43	كنت راضيا عن المشروع وحقق البرنامج المتطلبات المرجوة منه.	1	2	3	4	**5**
44	حَسَّنَ البرنامج من ادائك في العمل.	1	2	3	4	**5**
45	كان فريق العمل بالمشروع يشعر بالرضا ومتحمس.	1	2	3	4	**5**
46	شَهِدَ فريق العمل تطورا على المستوى الشخصي من المشروع.	1	2	3	4	**5**
47	كان المشروع ناجحًا في الأعمال الاقتصادية.	1	2	3	4	**5**
48	زاد المشروع من حصة المنظمة في السوق.	1	2	3	4	**5**
49	ساهم المشروع في اداء المنظمة (الجامعة) بشكل مباشر.	1	2	3	4	**5**
50	سوف تساهم نتائج المشروع في المشاريع المستقبلية.	1	2	3	4	**5**
51	ساهم المشروع في عمليات تجارية جديدة.	1	2	3	4	**5**

شكرا لمشاركتك

من فضلك، لا تتردد في تقديم أي تعليقات أو توصيات أخرى.

....

Appendix C

The final cover letter in English

Dear participant,

I am writing to request that you complete the enclosed questionnaire, which is part of my PhD research in software project sustainability at the University of Bolton in England. The aim of the research is to investigate the potential impact of software project sustainability on project success. This research is considered one of the first studies in this field and may help in the development of the software industry and in the move towards more sustainable orientation, locally and globally.

However, the completion of this research will not be possible without the contribution of those with expertise in this field. Therefore, I would be grateful if you could spare approximately 15 minutes of your valuable time to complete the enclosed questionnaire.

Your participation is voluntary, and your identity will remain anonymous. You are free to withdraw at any time without providing any reasons. There are no right or wrong answers, as your answers represent your opinion. All answers will be dealt with in a strictly confidential manner and used for scientific purposes only. Filling out this questionnaire is considered consent to participation.

Thank you for your cooperation.

Yours sincerely,

Amin Yasin Khalifeh, PhD student
University of Bolton
England, UK
Email: AYK1RES@BOLTON.AC.UK
Mobile, England: 004447801106039
Mobile, Jordan: 00962776559979

The final version of the questionnaire in English

Part 1: General information

Section A. Please complete this section by selecting one of the response options.					
1	What is the highest educational degree you hold?	Diploma or lower	Bachelor's degree	Master or certification in project management	Doctorate
2	How many years of experience do you have in software projects?	Less than 5 years	5 to 10 Years	11 to 20 Years	Over 20 years
3	How many employees work in software projects in your department?	1 to 9	10 to 49	50 to 249	250 and above
4	What is your age?	18 to 28	29 to 39	40 to 50	Above 50

Section B. Please choose one internal software project that already finished recently, and you took part in it. Please answer the following questions by selecting one of the response options.				
5	What was the size of the project team?	Less than 5 team members	5 to 10 team members	More than 10 team members
6	What was the project's duration?	Less than 6 months	6 to 12 months	More than 12 months
7	What was the overall level of clarity and stability in requirements?	High	Medium	Low

Part 2: Based on the internal software project that you have chosen in the previous section, please indicate to what extent you agree or disagree with the below statements in each section, ranging from strongly disagree (1) to strongly agree (5).

Section A. The following statements are about the consideration of economic aspects in the processes of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
8	In your chosen project, financial benefits originating from cost savings were taken into account.	1	2	3	4	5
9	In your chosen project, financial benefits originating from reducing the use of resources were taken into account.	1	2	3	4	5
10	In your chosen project, financial benefits originating from improving business processes and minimising risks were taken into account.	1	2	3	4	5
11	The evaluation of this project was based on its short- and long-term strategic value.	1	2	3	4	5
12	The selection of this project was based on its short- and long-term strategic value.	1	2	3	4	5
13	Please select the answer number two only, then go to the next question.	1	2	3	4	5

Section B. The following statements focus on environmental concerns during the management of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
14	Travel policies that consider environmental aspects were applied in the project.	1	2	3	4	5
15	The project delivery processes were designed to minimise travelling and travelling time in the project, and the use of eco-friendly alternatives (e.g. emails, mobiles and telephones, video conferencing, emission-free travelling like walking or cycling) was actively promoted.	1	2	3	4	5
16	There were policies in the project to promote the smart use of energy, and where possible, energy-saving equipment was used.	1	2	3	4	5
17	Where possible, energy consumption was actively kept to a minimum and the necessary energy used was acquired as ‘green’ energy.	1	2	3	4	5
18	The project had policies to minimise waste (e.g. double-sided printing, recycling necessary waste in the project itself).	1	2	3	4	5
19	The project delivery processes were designed to minimise waste.	1	2	3	4	5
20	Project procurement took into consideration environmental aspects when selecting products (e.g. their energy consumption, the waste and pollution they cause, their reuse capabilities).	1	2	3	4	5
21	The project supply chain took into consideration environmental aspects when selecting suppliers (e.g. suppliers’ environmental policies and their use of natural resources, suppliers’ knowledge, and their locations).	1	2	3	4	5

Section C. The following statements focus on social responsibility during the management of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
22	The project included training, education, and development of stakeholders.	1	2	3	4	5
23	The project applied policies or standards for diversity and equal opportunity in terms of gender, race, religion, etc.	1	2	3	4	5
24	Aspects of occupational health and safety were considered for project staff and outsourced (e.g. hazard identification, risk assessment, determination of controls, legal requirements, incident monitoring).	1	2	3	4	5
25	The project applied policies or standards for respecting and improving human rights, including non-discrimination, freedom of association and no child labour.	1	2	3	4	5
26	The project had complied with public policies and had a social responsibility towards the society it operated in (e.g. the health and welfare of society; community support; customer health and safety; product and service labelling; market communication and advertising; customer privacy).	1	2	3	4	5
27	The project rejected bribery and corruption, and had well-written codes of conduct which support principles and values such as honesty, transparency, privacy, fairness, trust, respect, and fair trade and competition.	1	2	3	4	5

Section D. The following statements focus on the software quality requirements in your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
28	Facilitating the accomplishment of all specified tasks and objectives correctly and accurately was among the quality requirements of the software.	1	2	3	4	5
29	Response time, processing time, throughput rates, and the maximum capacity of the software were taken into account.	1	2	3	4	5
30	The software can perform its required functions efficiently while exchanging information and sharing a common environment and resources with other products, without any detrimental impact on any other product.	1	2	3	4	5
31	The software enables people with the widest range of characteristics and capabilities to use it easily, appropriately, efficiently, effectively, satisfactorily, risk-free, and without errors.	1	2	3	4	5
32	The software was designed to be always ready when required for use, and it is capable to recover the affected data and its desired state in the event of an interruption or a failure.	1	2	3	4	5
33	The software prevents unauthorised access or modifications, and actions or events can be traced and proven.	1	2	3	4	5
34	The software can be modified and used in more than one system effectively and efficiently without introducing defects.	1	2	3	4	5
35	The software can be transferred effectively and efficiently from one hardware - or other operational or usage environment - to another.	1	2	3	4	5

Section E. The following statements focus on the evaluation of your chosen project. Please indicate your level of agreement with each statement by selecting one of the response options, ranging from strongly disagree (1) to strongly agree (5).		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
36	The project was completed on time or earlier.	1	2	3	4	5
37	The project was completed within or below budget.	1	2	3	4	5
38	You were satisfied, and the software met all requirements.	1	2	3	4	5
39	The software improved your work performance.	1	2	3	4	5
40	The project team was highly satisfied and motivated.	1	2	3	4	5
41	Team members experienced personal growth.	1	2	3	4	5
42	The project contributed to the organisation's direct performance.	1	2	3	4	5
43	The project outcome will contribute to future projects.	1	2	3	4	5
44	The project contributed to new business processes.	1	2	3	4	5

Thank you…

Please, feel free to make any further comments or recommendations.

………

Appendix D

The final cover letter in Arabic

نموذج موافقة على المساهمة في استبيان

عزيزي المشارك

نأمل منكم المساهمة في تعبئة الاستبانة المرفقة والتي هي جزء من البحث الخاص بي في جامعة بولتون في إنجلترا (University of Bolton)، وذلك للحصول على درجة الدكتوراه في تخصص ادارة الاستدامة في مشاريع البرمجيات. الهدف من البحث هو دراسة كيفية ادراج الاستدامة في مشاريع البرمجيات وفحص أثرها المحتمل على نجاح المشروع. يعتبر هذا البحث من أوائل الدراسات المهتمة في هذا المجال، وقد يساعد في تطوير مشاريع البرمجيات وإدارتها بشكل مستدام محليا وعالميا.

وعليه، فان انجاز هذا البحث لن يكون ممكنا بدون مساهمة ذوي الخبرة في هذا المجال. لذلك نأمل منكم تخصيص جزء بسيط من وقتكم الثمين والذي يقارب ١٥ دقيقة للإكمال الاستبانة المرفقة.

إن مشاركتك تطوعية وهويتك ستبقى غير معروفة، ولك حرية الانسحاب في أي وقت دون إبداء اية اسباب. لا يوجد إجابات صحيحة او خاطئة، وإجابتك هي رأيك، وسيتم التعامل بها بسرية تامة ولأغراض البث العلمي فقط. ان تعبئه هذا الاستبيان ستكون موافقه على مشاركتكم.

شكراً لتعاونكم، وتفضلوا بقبول فائق الاحترام...

امين ياسين خليفة، طالب دكتوراه

جامعة بولتون

إنجلترا، المملكة المتحدة

البريد الإلكتروني: AYK1RES@BOLTON.AC.UK

موبايل، انجلترا: ٠٠٤٤٧٣٨٠١٠٦٠٣٩

موبايل، الأردن: ٠٠٩٦٢٧٨٦٢٥٩٩٧٩

The final version of the questionnaire in Arabic

الجزء الاول: معلومات عامة

القسم أ. يرجى الإجابة على الاسئلة أدناه من خلال اختيار أحد الإجابات					
1	ما هي أعلى درجة علمية حصلت عليها؟	دبلوم أو أقل	بكالوريوس	ماجيستير او شهادة عليا في إدارة المشاريع	دكتوراه
2	كم سنة من الخبرة لديك في مشاريع البرمجيات؟	اقل من 5 سنوات	من 5 الى 10 سنوات	من 11 الى 20 سنة	أكثر من 20 سنة
3	كم عدد الموظفين العاملين في مشاريع البرمجيات في قسمك؟	من 1 الى 9	من 10 الى 49	من 50 الى 249	أكثر من 250
4	كم عمرك؟	من 18 الى 28	من 29 الى 39	من 40 الى 50	فوق 50 سنة

القسم ب. الرجاء اختيار مشروع برنامج(software) داخلي انتهى مؤخرا، وشاركت فيه .يرجى اختيار أحد الاجابات أدناه.				
5	ما هو حجم فريق المشروع؟	أقل من 5 أعضاء	من 5 الى 10 اعضاء	أكثر من 10 أعضاء
6	ما هي مدة المشروع؟	أقل من 6 أشهر	من 6 الى 12 شهر	أكثر من 12 شهرا
7	ما هو المستوى العام للوضوح والاستقرار في المتطلبات؟	مرتفع	متوسط	منخفض

الجزء الثاني: بناء على المشروع الذي اخترته **في القسم السابق**، يرجى الإشارة إلى أي مدى توافق أو لا توافق على العبارات أدناه في كل قسم، وذلك باختيار احد الاجابات التي تتراوح من لا أوافق بشدة (1) إلى أوافق بشدة (5).

	القسم أ. العبارات التالية تتعلق بدراسة الجوانب الاقتصادية في عمليات المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
8	فى المشروع الذي اخترته تم الاخذ بعين الاعتبار الفوائد المالية الناتجة عن التوفير في التكلفة.	1	2	3	4	**5**
9	تم الاخذ بعين الاعتبار الفوائد المالية الناتجة عن التقليل في استخدام الموارد.	1	2	3	4	**5**
10	تم الأخذ بعين الاعتبار الفوائد المالية الناتجة عن التحسين في آلية العمل وتقليل المخاطر.	1	2	3	4	**5**
11	التقييم لهذا المشروع كان مبنيا على قيمته الاستراتيجية قصيرة الامد وطويلة الأمد.	1	2	3	4	**5**
12	الاختيار لهذا المشروع كان مبنيا على قيمته الاستراتيجية قصيرة الامد وطويلة الأمد.	1	2	3	4	**5**
13	الرجاء اختيار الاجابه رقم اثنان فقط، ثم انتقل الى السؤال التالي.	1	2	3	4	**5**

	القسم ب. تركز العبارات التالية على الاهتمامات البيئية أثناء إدارة المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
14	تم تطبيق سياسات سفر في المشروع تراعي الجوانب البيئية.	1	2	3	4	**5**
15	تم تصميم عمليات المشروع بحيث تقلل من السفر ووقت السفر في المشروع، وتشجع على استخدام بدائل صديقة للبيئة (مثل رسائل البريد الإلكتروني، الهواتف المحمولة والارضية، عقد المؤتمرات عبر الفيديو، المشي أو ركوب الدراجات).	1	2	3	4	**5**
16	كانت هناك سياسات في المشروع تحث على الاستخدام الذكي للطاقة، وتم استخدام المعدات الموفرة للطاقة حيثما أمكن ذلك.	1	2	3	4	**5**
17	حيثما أمكن، تم تقليل استهلاك الطاقة إلى الحد الأدنى وتم الحصول على الطاقة اللازمة للاستخدام كطاقة "خضراء" (أي من مصادر صديقة للبيئة).	1	2	3	4	**5**
18	كان للمشروع سياسات للتقليل من النفايات (مثل الطباعة على الوجهين للورق المستخدم، وإعادة تدوير النفايات في المشروع نفسه).	1	2	3	4	**5**
19	تم تصميم عمليات المشروع بطريقة تقلل من النفايات.	1	2	3	4	**5**
20	عمليات الشراء في المشروع أَخَذت بعين الاعتبار الجوانب البيئية عند اختيار المنتجات (مثل استهلاك الطاقة، والنفايات والتلوث التي تسببها، وامكانية إعادة استخدام).	1	2	3	4	**5**
21	أَخَذَت سلسلة التزويدات في المشروع بعين الاعتبار الجوانب البيئية عند اختيار الموردين (مثل السياسات البيئية للموردين واستخدامهم للموارد الطبيعية، قدراتهم المعرفية، ومواقعهم لتقليل النقل إلى الحد الأدنى).	1	2	3	4	**5**

	القسم ج. تركز العبارات التالية على المسؤولية الاجتماعية أثناء إدارة المشروع الذي اخترته.	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
22	تضمن المشروع التدريب والتعليم وتطوير أصحاب المصلحة.	1	2	3	4	**5**
23	طَبَّقَ المشروع سياسات او معايير للتنوع وتكافؤ الفرص من حيث الجنس، العرق، الدين، إلخ.	1	2	3	4	**5**
24	تم الاخذ بعين الاعتبار جوانب الصحة والسلامة المهنية لموظفي المشروع وللمصادر الخارجية (مثل تحديد وتقييم المخاطر، تحديد الضوابط والمتطلبات القانونية، ومراقبة الحوادث).	1	2	3	4	**5**
25	طَبّق المشروع سياسات أو معايير لاحترام حقوق الإنسان وتحسينها (مثل عدم التمييز، حرية الصداقة وتكوين الجمعيات، وعدم تشغيل الأطفال).	1	2	3	4	**5**
26	اِمتَثَل المشروع للقانون المعمول به وتَحَمّل مسؤولية اجتماعية تجاه المجتمع الذي عمل فيه (مثل صحة ورفاهية المجتمع، دعم المجتمع، صحة العملاء وسلامتهم، تصنيف المنتجات والخدمات، اتصالات السوق والإعلان، خصوصية العميل).	1	2	3	4	**5**
27	رَفَضَ المشروع الرشوة والفساد وكان له مدونات سلوك مكتوبة بشكل جيد والتي تدعم المبادئ والقيم مثل الأمانة، الشفافية، الخصوصية، الإنصاف، الثقة، الاحترام، والتجارة والمنافسة العادلة.	1	2	3	4	**5**

القسم د. تركز العبارات التالية على متطلبات الجودة للبرنامج (software) في المشروع الذي اخترته.		لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
28	كان تسهيل إنجاز جميع المهام والأهداف المحددة بشكل صحيح ودقيق من بين متطلبات الجودة للبرنامج.	1	2	3	4	**5**
29	تم الاخذ بعين الاعتبار وقت الاستجابة، وقت المعالجة، معدلات الإنتاجية، والحد الأقصى لسعة البرنامج.	1	2	3	4	**5**
30	يُمْكِن للبرنامج أداء وظائفه المطلوبة بكفاءة أثناء تبادل ومشاركة المعلومات مع منتجات أخرى، دون أي تأثير ضار على أي منتج آخر.	1	2	3	4	**5**
31	يُمَكِّن البرنامج اشخاص بمختلف القدرات من استخدامه بسهولة، بشكل مناسب، بكفاءة، بفاعلية، بشكل مرضٍ وخالي من المخاطر، وبدون أخطاء.	1	2	3	4	**5**
32	تم تصميم البرنامج ليكون جاهزا بشكل دائم عند الحاجة للاستخدام، وهو قادر على استرداد البيانات في حال حدوث انقطاع أو عطل.	1	2	3	4	**5**
33	يَمنَع البرنامج الوصول أو التعديلات غير المصرح بها، ومن الممكن تتبع الإجراءات أو الأحداث وإثباتها.	1	2	3	4	**5**
34	يُمْكِن تعديل البرنامج واستخدامه في أكثر من نظام بفعالية وكفاءة دون تقديم أي عيوب.	1	2	3	4	**5**
35	يُمْكِن نقل البرنامج بفعالية وكفاءة من جهاز أو بيئة تشغيل أو استخدام إلى أخرى.	1	2	3	4	**5**

القسم هـ. تركز العبارات التالية على تقييم المشروع الذي اخترته.		لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
36	تم الانتهاء من المشروع في الوقت المحدد أو قبل ذلك.	1	2	3	4	**5**
37	تم الانتهاء من المشروع ضمن الميزانية أو أقل.	1	2	3	4	**5**
38	كنت راضيا عن المشروع وحقق البرنامج المتطلبات المرجوة منه.	1	2	3	4	**5**
39	حَسَّنَ البرنامج من ادائك في العمل.	1	2	3	4	**5**
40	كان فريق العمل بالمشروع يشعر بالرضا ومتحمس.	1	2	3	4	**5**
41	شَهِدَ فريق العمل تطورا على المستوى الشخصي من المشروع.	1	2	3	4	**5**
42	ساهم المشروع في اداء المنظمة (الجامعة) بشكل مباشر.	1	2	3	4	**5**
43	سوف تساهم نتائج المشروع في المشاريع المستقبلية.	1	2	3	4	**5**
44	ساهم المشروع في عمليات تجارية جديدة.	1	2	3	4	**5**

شكرا لمشاركتك

من فضلك، لا تتردد في تقديم أي تعليقات أو توصيات أخرى.

....