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Exploring the Nexus of Sustainability and Project Success: A Proposed Framework for the Software Sector

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Abstract: In the last two decades, there have been many calls to integrate sustainability into projects. However, there are conflicting views about the relationship between sustainability and project success. Some contend that project sustainability could adversely affect project success, while others maintain the contrary. Yet, the exploration of this relationship has been insufficient thus far. Notably, no existing work specifically investigates this relationship within the software domain. Therefore, this paper aims to contribute significantly by introducing a conceptual framework that assists in inspecting the relationships between software project sustainability (SPS) and project success. The proposed framework was developed based on well-defined aspects of both concepts. The findings show that most of the relationships between the two concepts are expected to be significant and positive. Our propositions were built after analysing the best of relevant contributions. However, an empirical examination is needed, especially with the presence of control variables such as country, company size, and project complexity. This work could be an initial motion for future empirical studies and provide a significant theoretical foundation for researchers and practitioners in this domain.

Keywords: sustainability; triple bottom line (TBL); project sustainability; software project sustainability; product sustainability; process sustainability; project management; project success

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Citation: Khalifeh, A.; Al-Adwan, A.S.; Alrousan, M.K.; Yaseen, H.; Mathani, B.; Wahsheh, F.R. Exploring the Nexus of Sustainability and Project Success: A Proposed Framework for the Software Sector. *Sustainability* **2023**, *15*, 15957. https://doi.org/10.3390/su152215957

Academic Editors: Wen-Hsien Tsai, Jurgita Antucheviciene and Mohammad Khalilzadeh

Received: 22 September 2023
Revised: 11 November 2023
Accepted: 12 November 2023
Published: 15 November 2023

1. Introduction

Sustainability represents one of the most notable challenges in our current era. There are many definitions of sustainability, some of which focus on the environmental dimension, others on the social or economic dimension [1]. However, this research agrees with the triple-bottom-line (TBL) view of Elkington [2]. In short, there is a need to care for and balance the three dimensions simultaneously. This means protecting the environment and financial resources and respecting present and future human/social needs as a base to attain short- and long-term success.

Many companies are now looking seriously at integrating sustainability into their business as a new innovative methodology and tool for reducing costs and having a competitive advantage [3,4]. In this context, it should be noted that projects form around 30% of global economic activities [5]. Therefore, the potential effect of integrating sustainability into projects (or what is called project sustainability) is inconceivable, and it is a must for a more sustainable future. Likewise, various authors agree with the pressing need for project sustainability because projects are an effective tool for managing change and they have a lot of resources and intense interaction with their surroundings. In the last two decades, the literature has witnessed considerable attention being paid to project sustainability, and several contributions have created a solid foundation for supporting this intellectual orientation in managing projects [6,7].

However, some researchers debate that the long-term endeavour of sustainability may contradict the short-term endeavour or temporary nature of projects, and perhaps they are not naturally compatible. Sustainability may stretch the cost and time constraints, negatively affecting projects' success [8–10]. Others argue that integrating sustainability into projects means greater overheads [11–13], extra specifications and additional variations in design [14–16], and increased tension between stakeholders and expectations [17,18]. Such authors, as a result, deduce that project sustainability could negatively influence project success.

Conversely, authors, including Almahmoud et al. [19] and Kometa et al. [20], argue that factors related to sustainability, such as environmental performance, health, safety, and other corporate social responsibility practices, are crucial for project success. Michaelides et al. [21] maintain that sustainability is a key success factor, with major corporations like Nike, Zara, and Toyota integrating sustainability into projects to boost their reputation in the markets, leading to successful projects and increased market share. Furthermore, empirical studies [22–24] found significant positive correlations between sustainability and the success of projects. Others discovered that adopting sustainability does not inevitably result in higher budgets; and by employing optimal methods and cutting-edge technology to use resources effectively, it is possible to reduce costs and increase profitability [25–30].

Nonetheless, there are conflicting views about project sustainability, especially concerning its influence on project success. It is vital to carefully integrate sustainability into projects, as project success is vital and significantly impacts the overall success of organisations [31–33]. Project success ranks among the highest priorities, drawing significant attention in the literature on project management [34–37]. The 2016 and 2017 International Project Management Association (IPMA) conferences recently highlighted sustainability and project success as key research subjects [38]. Nevertheless, the relationship between these two subjects remains insufficiently investigated, with the sparse existing research mainly concentrating on construction and manufacturing projects [1,39].

Currently, no noted work has investigated this relationship in the software industry. Software projects are prevalent drivers of change in society, and integrating sustainability into software projects (or what we call software project sustainability) is gaining more consideration [4,40]. Recently, many notable works on software project sustainability (SPS) have been published. However, in the context of project success, the question remains, 'Does SPS support project success?'. Therefore, as a first step towards answering this question, this paper aims to contribute significantly by presenting a framework that helps examine the relationship between these two concepts.

Finally, it should be noted that a software project is defined as a group of tasks and processes that should be completed within a specific time and budget to attain a particular software product (e.g., operating systems, mobile applications, text editors, web browsers, video games, accounting systems, simulators, databases, photo and video editors, cloud services, virtual reality, social media, and other online platforms).

Besides this introduction (Section 1), this article has five more sections, as follows: Section 2 provides a literature review and theoretical background. Section 3 presents the research methodology. The proposed framework is presented in Section 4, followed by establishing relationships and research propositions in Section 5. Finally, Section 6 offers the conclusions.

2. Literature Review and Theoretical Background

2.1. Project Sustainability

Two views can be identified in project sustainability literature, namely project product sustainability and project process sustainability. Project product sustainability means the sustainability of deliverables/outcome of projects, whereas project process sustainability is defined as the sustainability of project interrelated activities and management processes [7,41,42].

However, integrating sustainability into projects is a complicated process because decisions have to be taken cautiously from both views above, based on various stakeholders, and with consideration of economic, environmental, and social interests. Decision-makers face high pressures with different needs from different parties (e.g., environmental agencies, governments, workers, communities, and consumers). These pressures should be beside the need for an acceptable return on investment with long-term viability [10,43–45]. Therefore, tools for supporting project management practitioners and other decision-makers are essential for integrating sustainability into projects [22].

In this regard, some well-known frameworks, for instance, the Indicators of Sustainable Development and the Sustainability Reporting Guidelines (SRG), are available. Companies can use these frameworks as tools to select TBL-related aspects (e.g., energy efficiency, financial benefits, green outsourcing, human rights, resource utilisation, waste, and ethical behaviour) for more sustainable business practices [42,46]. Similarly, many authors have developed TBL-related aspects as an approach for integrating sustainability into projects [44,45,47–50].

2.2. Software Project Sustainability

The origin of most of the existing works on project sustainability is the construction and manufacturing sectors. In the software sector, contributions are far fewer and need more effort. However, like the construction and manufacturing fields, two views can be noticed in the literature on the sustainability of software projects, which are: software sustainability and software process sustainability. The first view means the sustainability of software project outcomes (the sustainability of the software itself as a product), whereas the second view is the sustainability of project processes and interrelated activities when creating or developing a software product. The following two sections will discuss these two perspectives in detail.

2.2.1. Software "Product" Sustainability

Relevant software literature links sustainability to the quality characteristics of software products, considering it as a non-functional [4,51–56]. The IEEE-610 standard defines non-functional requirements as the level to which software fulfils the expectations or needs; they can be seen as the "How" of software products, such as security, maintainability, performance efficiency, and reliability, whereas functional requirements represent the software's fundamental operations to process inputs and produce outputs; they essentially address the "What of a software product" [4,53].

However, the findings show that most software sustainability research has focused on only one or two pillars rather than all three pillars of the TBL framework. For example, Jansen et al. [57] and Koziolek [58] focused on the economic pillar through non-functional quality characteristics such as compatibility, modifiability, portability, maintainability, functional suitability, evolvability, and interoperability as necessary requirements for long-living software products.

On the other hand, Koçak et al. [59] and Cabot et al. [60] concentrated on the environmental pillar—or in some cases, they call it green performance—and linked it to several non-functional quality characteristics (e.g., reliability, resource and capacity optimisation, performance efficiency, and usability). A similar concern is in the works of García-Mireles et al. [61], Roher and Richardson [62], and Taina [63].

A step further was taken by Beghoura et al. [64], Venters et al. [53], and Amsel et al. [51] by focusing on the economic and environmental pillars together. At the same time, the social pillar was the main concern of Ahmad et al. [65], Al Hinai and Chitchyan [66], Duffy [67], and Johann and Maalej [68]. Several quality characteristics are proposed for software social sustainability in their works, such as availability, security, safety, privacy, compatibility, resilience, acceptability, reliability, and accessibility. However, only a few contributions focused on the three pillars of TBL (e.g., [50,69–73]), but there is a lack, or absence of empirical evidence in considering the sustainability of software process and product at the same time.

Most non-functional requirements used for software sustainability, for instance, "Boehm's quality model", "Systemic Quality Model", "The UcSoftC Model", "Dromey's Quality Model", "ISO 9126 and 25010", "Pragmatic Quality Factor (PQF)", and "McCall's Quality Model", came from well-known quality standards and models. However, it is detected that none of these standards or models addressed or considered the sustainability of software products [7].

2.2.2. Software "Process" Sustainability

Many authors assert that project sustainability should include specific aspects related to project process sustainability besides the sustainability aspects of project products to deliver projects in a more economical, environmental, and social way [1,10,41,42,74]. Relevant software literature shares a similar perspective, endorsing an environmentally friendly process that leads to an eco-friendly product [4]. Naumann et al. [75] stressed the necessity of a software-engineering procedure that aligns with sustainability goals to produce sustainable software. Similarly, Mahmoud and Ahmad [76] posit that all the processes within a software product's life cycle must themselves embody sustainability to yield a sustainable software product. Therefore, there is a demand for frameworks and models encompassing pertinent aspects of software process sustainability [7,56,64,77].

However, few contributions are available, and unfortunately, the focus primarily was on the environmental pillar aspects (e.g., pollution, waste, and carbon footprints), not on the TBL (e.g., [63,76,78–80]).

Social and economic aspects, for instance, working conditions, health, social insurance, education, satisfaction, trust, access to services, payments, economic risks, financial performance, and asset management, should also be included for software process sustainability. Such aspects can be observed in Kern et al. [81], Dick et al. [82], and Naumann et al. [69], where the TBL was considered.

Furthermore, several related aspects (e.g., fairness, respect, honesty, human rights, compliance with the law, social welfare, ethical behaviour, accountability, transparency, and integrity) can be found in the Sustainability Checklist of the Sustainability Reporting Guidelines (SRG), the IPMA and PMI Codes of Ethics and Professional Conduct, and the ISO 26,000 standard [10,83,84]. However, software process sustainability is still in its early phases and needs more effort.

2.3. Project Success

The traditional criteria for measuring project success are cost, time, and requirements (also called specifications, scope, or quality). These criteria are called triple constraints or the "iron triangle" [85–87]. However, these criteria are subject to massive criticism when considered alone, as they only measure project management success (the success of how a project was managed, so-called project efficiency), not the project outcomes, so-called project effectiveness [1,32,36,88–90].

Nonetheless, the evolution of the literature reveals additional success criteria for evaluating project outcomes, such as aligning with business strategic goals and objectives; fostering new technology, markets, or opportunities; satisfying stakeholders; and generating positive environmental and social impacts. These criteria place greater importance on the judgments of multiple stakeholders (e.g., owners, clients or users, senior management, sponsors, project managers, and project teams) and emphasise the assessment of project outcome success or its effectiveness over time [34,91–93].

Hence, project success ought to be evaluated based on its efficiency and effectiveness, and the measurement of project success should include both project management success and project outcome success [1,94,95].

Numerous theories, models, and techniques exist for assessing project success, including Pinto and Slevin's [90] systematic method, Wateridge's [86] set of criteria, Lim and Mohamed's [96] macro and micro perspectives, Baccarini's [94] logical framework method (LFM), Atkinson's [87] square route framework, Shenhar et al.'s [97,98] multi-dimensional framework, Collins and Baccarini's [99] dual perspectives, Nelson's [100] retrospective technique, Müller and Turner's [101] success criteria, Thomas and Fernandez's [3] model, Shenhar's [93] strategic approach, and Dalcher's [85] four-tier model. In addition, widely employed tools such as the 'balanced scorecard' and 'key performance indicators' (KPIs) play a crucial role in determining project success [36,102–104]. Nevertheless, as highlighted by Silvius and Schipper [39] and Davis [105], the most frequently referenced of the 199 contributions for assessing project success are those by Shenhar and Dvir [106], Shenhar et al. [97,98], and Pinto and Slevin [90].

3. Research Methodology

The proposed framework of this paper was developed based on an extensive review of relevant literature. Our search was on published works that focus mainly on the relationship between sustainability and projects, considering relevant contributions from the software industry. Then, we searched for the best-cited works on project success. The main sources were books, academic journals, conference proceedings, and relevant official websites. Scopus and Google Scholar search engines were utilised to find relevant publications [1].

Extracting data was carried out using academic library databases (e.g., Emerald Insight, JSTOR, Science Direct, Business Source Premier, EBSCO, and some official websites [7]. To filter related data, the authors read the summaries of the selected works independently, and their references were reviewed to find more contributions. The final chosen works were read carefully, and content analysis was applied, in-depth, to ensure research originality and develop the proposed framework's variables [1,7].

It should be noted that this paper focuses on "sustainability IN software projects" NOT on "sustainability BY software projects". Briefly, "sustainability IN software projects" means making software projects 'themselves' sustainable (e.g., dealing with quality issues, using renewable and clean energy, and considering human rights). Meanwhile, "sustainability BY software projects" means attaining sustainability by managing social, environmental, and economic-related issues through projects or their products/outcomes (e.g., employing software for remote collaboration, logistics optimisation, efficient resource utilisation, and waste reduction). Therefore, our analysis has included only published works relevant to "sustainability IN software projects".

4. The Proposed Framework

After reviewing the literature intensively, SPS can be defined as demonstrating commitment and considering sustainability TBL-related aspects of economic, environmental, and social pillars in the products and processes of software projects. Based on this definition, the authors developed a conceptual framework that organises the relationships between SPS and project success using clearly defined variables. The suggested framework (Figure 1) is divided into three parts. The first part illustrates the SPS variables and their triple-bottom-line (TBL) aspects. The second part demonstrates project success with its five dimensions. The third part symbolises the suggested control variables, as discussed later in this section.

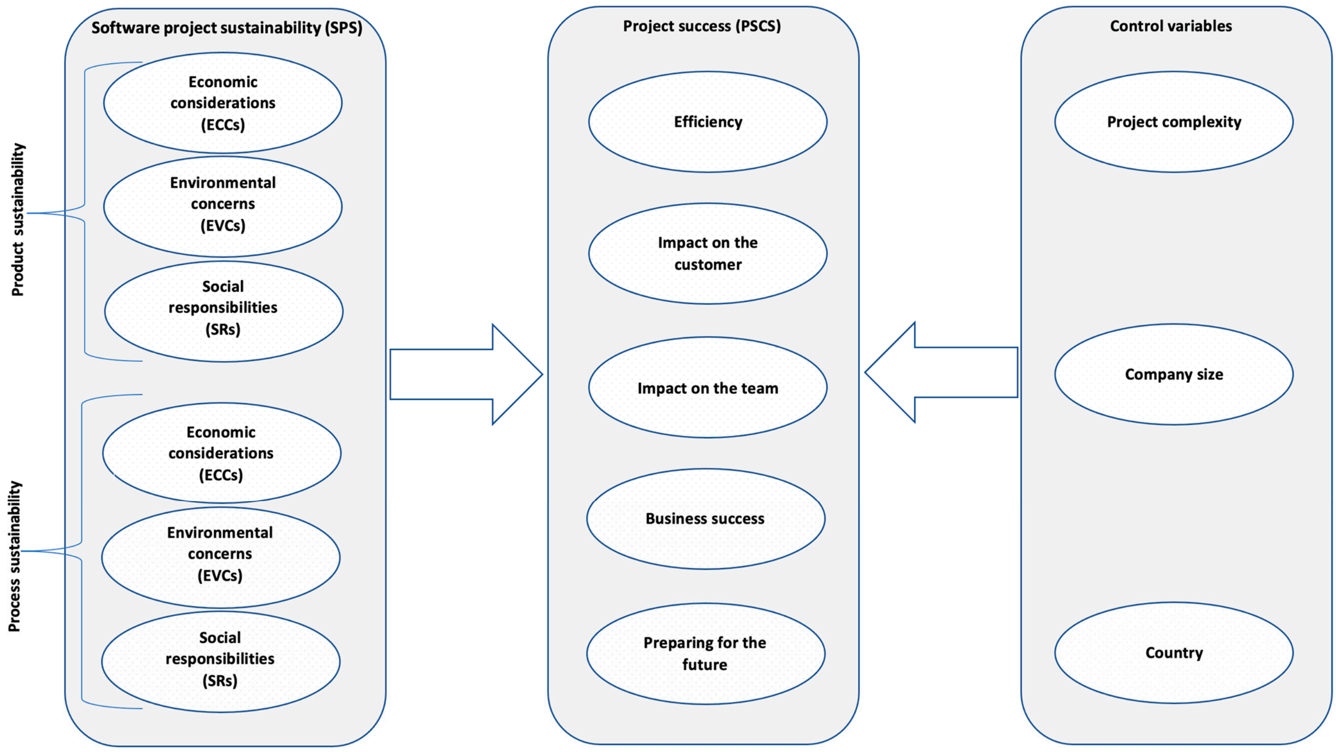

Figure 1. SPS and project success, the proposed framework.

Part one (SPS) has two sections: integrating sustainability into software project products (product sustainability) and integrating sustainability into software project processes (process sustainability). **Product sustainability** (Table 1) has three variables: economic non-functional requirements (ECN-NFRs), environmental non-functional requirements (ENV-NFRs), and social non-functional requirements (SOC-NFRs). These variables were developed based on the most researched quality/non-functional requirements (NFRs) after critically analysing the best relevant works. Then, the NFRs were summarised, synthesised, and classified based on their highest impacts on each pillar of the TBL, as follows:

- ECN-NFRs
  - Functionality: software that meets user needs and expectations by providing the required features can contribute to a company's financial success by driving sales and customer loyalty.
  - Reliability: dependable software reduces downtime and the costs associated with fixing errors or recovering from failures, which can lead to better financial performance.
- ENV-NFRs
  - Efficiency: efficient software reduces the consumption of computing resources, such as processing power and memory, which can lead to lower energy usage and a smaller environmental footprint.
  - Maintainability: software that is easy to maintain and update can have a longer lifespan, reducing the need for creating new software and, in turn, the environmental impact of software development.
  - Portability: portable software that can run on different platforms and devices can minimise the need for developing separate versions, reducing resource consumption and waste.
- SOC-NFRs
  - Usability: user-friendly and accessible software can improve people's experiences and overall satisfaction with a product or service, which contributes to social well-being.

- Security: protecting user privacy, ensuring data confidentiality, and preventing unauthorised access can help build trust and maintain the reputation of a company, thus benefiting society.
- Compatibility: software that is compatible with various systems and devices promotes inclusivity and accessibility, reducing the digital divide and ensuring that more people can use the product.

Process sustainability (Table 2) has three variables as well: economic considerations (ECCs), environmental concerns (EVCs), and social responsibilities (SRs). Likewise, each of these variables was developed using the insertion of TBL-related aspects based on the best relevant works. For instance, the variable of ECCs has two aspects; one of them is 'return on investment', which considers the direct financial benefits arising from refining and enhancing processes, cost savings, and minimising risks and use of resources. Similarly, all aspects of the SPS variables are defined in Tables 1 and 2.

On the other hand, **part two**, which represents project success (PSCS), has five dimensions: efficiency (project cost and time), impact on project teams and customers, business success, and preparing for the future (in the middle of Figure 1). These dimensions were developed based on the most frequently cited works for evaluating the success of a project, such as those by Dalcher [85], Atkinson [87], Pinto and Slevin [90], Müller and Turner [101], and Shenhar and Dvir [106].

Efficiency means completing projects within time or earlier and within or below budget. Impact on the customer refers to meeting customers' requirements and achieving their satisfaction, benefits, and loyalty. Impact on the team concerns project team satisfaction, retention, and personal growth. Business success means the economic success of projects, having positive returns on investment, increasing market share, and organisation growth. At the same time, preparing for the future involves creating new technologies, markets, business processes, and capabilities.

Finally, given the complex nature of project success, it is strongly advised to incorporate control variables (**Part three**, in the far right of Figure 1) into the framework. Numerous scholars have emphasised the importance of Fiedler's contingency theory [107], suggesting that success of projects can be negatively or positively influenced by varying contingencies tied to the project's context. The most suitable control variables that were used in relevant literature are: company size, country, and complexity [22,108–113].

Table 1. Integrating sustainability into software project products.

Variables	**Sustainability TBL-Related Aspects**	**Definitions**	**References**
Economic non-functional requirements (ECN-NFRs)	Functionality	The degree to which software provides functions that meet 'stated and implied needs' when used under particular conditions.	[4,59,61,65,114]
	Reliability	The degree to which software performs particular functions under specific conditions for a certain period of time.	[53,55,63,65,68,70,71,77,114–116]

Table 1. *Cont.*

Variables	Sustainability TBL-Related Aspects	Definitions	References
Environmental non-functional requirements (ENV-NFRs)	Efficiency	Performance with respect to the amount of resources used under stated conditions.	[52,55,59,61,73,114,117]
	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.	[4,52,53,58,59,61,63,65,71,114,118]
	Portability	The degree of efficiency and effectiveness with which software can be transferred from one usage, or other hardware or operational environment to another.	[52,53,58,61,63,65,69,71,75]
bSocial non-functional requirements (SOC-NFRs)	Usability	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.	[52,53,64–66,68,114,116,119]
	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.	[55,56,65,66,68,71,114]
	Compatibility	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.	[4,63,65,66,114]

Table 2. Integrating sustainability into software project processes.

Variables	Sustainability TBL-Related Aspects	Definitions	References
Economic consideration (ECCs)	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.	[10,22,42,44,45,48–50,65,69,72,81,120,121]
	Strategic value	Evaluating and selecting projects based on both long- and short-term strategic value.	[22,42,45,48,49,65,69,72,81,84,120–123]

Table 2. *Cont.*

Variables	Sustainability TBL-Related Aspects	Definitions	References
Environmental concerns (EVCs)	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).	[22,42,44,45,49,63,69,72,76,78–82,119,121,123]
	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).	[10,48,63,69,72,76,78,80,119,120]
	Energy	Taking into account energy consumption in the design of project processes and promoting green energy, energy saving equipment, and smart use of energy.	[10,22,42,44,49,50,63,69,72,76,78,79,119–121]
	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.	[10,22,44,45,48–50,63,69,76,78–80,119,120,124]
Social responsibilities (SRs)	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).	[10,22,42,44,45,48–50,69,72,81,84,120–123]
	Society and human rights	Applying policies for human rights and compliance with public policies (e.g., no child labour, health and welfare, freedom of association, non-discrimination, community and customer support, responsible marketing and customer awareness, and ensuring stakeholders security, safety and privacy).	[10,22,42,44,45,48,49,69,72,84,120–124]
	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.	[10,22,44,45,72,84,120–122,124,125]

5. Establishing Relationships and Research Propositions

The first variable of SPS in the framework is economic non-functional requirements (ECN-NFRs). It involves functionality and reliability, as they can highly impact the financial sustainability of a software project [4,59,63,65,68,114]. Functionality is a crucial determinant of software project success, representing the range of operations that a software product can perform. The ability of software to meet user needs and requirements directly influences its acceptance and usage. Also, if users find the software features beneficial and easy to use, their satisfaction levels increase, leading to higher adoption rates. Similarly, well-designed and intuitive features can enhance user productivity by aligning with user workflows and reducing the time and effort needed to finish tasks. Furthermore, unique and superior functionalities can provide a competitive advantage, making the software stand out among its competitors and increasing its market appeal. Reliability is critical to a software project's success as well. Software that functions reliably over time earns the trust of its users, enhancing its credibility and reputation. This trust can lead to increased user adoption, positively impacting the software's success. From a cost perspective, reliable software reduces the need for frequent bug fixes and updates, thereby controlling the associated maintenance costs. Moreover, particularly for business-critical applications, the reliability of software is paramount. Software that consistently performs as expected ensures business continuity, whereas software failures can lead to significant operational disruptions. Therefore, reliable software can be a key success factor for a software project by supporting business continuity. Accordingly, it is proposed that:

Proposition 1. *ECN-NFRs positively influence project success.*

The second variable of SPS is environmental non-functional requirements (ENV-NFRs). It includes efficiency, maintainability, and portability, as they can highly impact the environmental sustainability of a software project by minimising environmental waste, energy consumption and risks, and extending software—and hardware—lifetime [52,55,58,59,61,73,117,118].

Efficient software often leads to an enhanced user experience, providing faster response times and higher throughput. Users prefer software that delivers results quickly and smoothly, leading to higher user satisfaction and adoption rates. Furthermore, efficient use of system resources can result in lower infrastructure costs, offering economic advantages for both the development company and the end-users. Therefore, software efficiency can directly impact the project's financial success and user acceptance.

Also, software with high maintainability can better adapt to evolving user needs and technology trends, extending its useful life and enhancing its chances of long-term success. When software is easy to maintain and update, it requires less time and resources, contributing to cost savings over its lifetime. These cost savings can considerably influence the overall financial success of the software project. Thus, software maintainability is a crucial factor in both the technical and economic aspects of a project's success.

Finally, highly portable software can be accessed on various platforms, increasing its reach to a broader user base. This enhanced accessibility can lead to higher adoption rates and user satisfaction, directly contributing to project success. Moreover, as technology evolves, moving software to new platforms or systems becomes necessary. Software with high portability is easier to adapt to these new environments, helping to future-proof the product and increase its chances of long-term success. Therefore, software portability is pivotal in determining a project's adaptability, accessibility, and longevity. Therefore, we propose that:

Proposition 2. *ENV-NFRs positively influence project success.*

The third variable of SPS is social non-functional requirements (SOC-NFRs). It encompasses usability, security, and compatibility as they can highly impact the social sustainability of a software project by increasing customer satisfaction and loyalty and reducing social risks [53,56,64,66,70,71,77,116,119]. High usability allows users to effectively and efficiently achieve their goals with the software. This becomes a deciding factor in user satisfaction and user adoption. If users find the software difficult to navigate or understand, they will likely abandon it for a more user-friendly alternative. On the other hand, when software is user-friendly and easy to use, it can boost productivity by enabling users to complete tasks more efficiently. This increases user engagement and loyalty, generates positive word-of-mouth, and improves customer retention rates. Therefore, the usability of a software project plays a pivotal role in its acceptance and overall success.

In a time when cyber threats are growing, ensuring security has emerged as a paramount concern for users. Security breaches can lead to financial loss, damage to reputation, and loss of user trust. Consequently, if the software fails to address security issues adequately, it risks losing users and harming project success. Conversely, software that offers robust security measures can build user trust, enhance its reputation, and increase its chances of success. Therefore, software security is a critical factor in the project's success, impacting user trust, reputation, and financial viability.

Highly compatible software can reach a wider audience and be used across various platforms and devices. This increases accessibility and adoption rates, positively impacting the software project's success. Moreover, compatibility issues can lead to negative user experiences, causing frustration and potentially leading to software abandonment. Hence, compatibility is a significant factor in user satisfaction and the overall success of a software project. It influences the software's accessibility, user satisfaction, and market reach. Hence,

Proposition 3. *SOC-NFRs positively influence project success.*

The fourth variable of SPS involves economic considerations (ECCs), which essentially means including pertinent economic factors (such as return on investment and strategic value) in the management of software projects. These variables concentrate on choosing and assessing projects based on their long-term and short-term strategic importance, as well as taking into account the direct financial gains derived from process improvements, cost reductions, risk mitigation, and efficient resource utilisation. According to Atkinson [87] and Shenhar [93], such aspects are foundational to project success. Dalcher [85] classifies these aspects as 'critical issues'; failure to address them often leads to failure of the projects. Silvius and Schipper [39] propose that minimising risks, costs, and resource usage positively influences project success, and with the consideration of long- and short-term strategic value, assures stakeholders that their interests are being prioritised, thus promoting well-managed project execution and success. This view is corroborated by other authors (e.g., [56,126–128]) who affirm that integrating such aspects undeniably paves the way to project success. Thus, we propose that:

Proposition 4. *ECCs positively influence project success.*

The fifth variable of SPS in the suggested framework pertains to environmental concerns (EVCs). This emphasises the inclusion of environment-related aspects within the processes of software projects, including elements like green outsourcing, transportation, energy use, and waste management. Many scholars assert that consideration of such aspects positively influences success of projects. For instance, Maltzman and Shirley [15] associate waste reduction with quality, viewing it as a vital factor in the success of environmentally-conscious projects. Chan and Chan [129] categorise these aspects under environmental performance, which they believe is a critical metric for gauging project success. This classification is consistent with Atkinson's [87] Square Route framework, which included environmental impact as a significant determinant for the success of information system projects. Silvius and Schipper [39] suggest that managing waste, transportation, and energy significantly contributes to project success by reducing costs, adhering to schedule and budget, satisfying stakeholders, and preparing organizations for future challenges. Carvalho and Rabechini [22] identified a positive and significant connection between green outsourcing and project success. The empirical findings of Martens and Carvalho [126] show that the aspects of the environmental pillar were given more consideration than the social and economic pillars, and none of the organizations—in their study—waited to acknowledge the substantial influence of this pillar on project success. In the same way, Almahmoud et al. [19], Lim and Mohamed [96], and Kometa et al. [20] argue that environmental performance is a requisite for succeeding projects.

However, some researchers—from different fields—have contended that the integration of such environmental aspects into projects might negatively affect their success. They argue that integrating sustainability into projects means more coordination with different parties, a higher level of expectations, more specifications and additional requirements, more variations in design, harder planning, uncertainty in the required equipment and materials, and difficulty in selecting subcontractors. Also, greater overheads, extra waste-removal costs, more tension between stakeholders, and pressure on practitioners and decision-makers [12,13,17,18,121,123]. Therefore, in spite of a commitment to sustainability, several firms encounter challenges when trying to integrate this concept into projects because of obstacles that impede project success [7]. Regrettably, many of these studies fail to provide empirical evidence or suitable solutions. However, to our knowledge, no research in the software field either supports or contradicts this finding.

These arguments lead to the authors having unclear assumptions about the relationship type (positive or negative) between EVCs and project success, but the relationship is there. Therefore, it is proposed that:

Proposition 5. *EVCs influence project success.*

The sixth variable of SPS in the suggested framework refers to social responsibilities (SRs). This encompasses four socially related aspects within the processes of software projects: human rights, labour practices and decent work, customer and societal impact, and ethical conduct. As per Shenhar and Dvir [106] and Atkinson [87], these aspects are directly associated with the criteria used for assessing project success. Marcelino-Sádaba et al. [123] state that such aspects give a more competitive advantage to organizations in the market by establishing a strong reputation, credibility, and integrity. Likewise, Mishra et al. [125] suggest that considering social impacts and maintaining ethical standards are crucial for project success, as these elements enhance customer satisfaction and loyalty, and foster morality, brotherhood, trust, harmony, and values among the project team. They concluded that taking care of such aspects "give millions time better results". Willis et al. [130], McKenzie [131], and Valdes-Vasquez and Klotz [132] claim that the creation of a genuinely sustainable project necessitates the consideration of its social impacts on the community (such as end-users and those involved), particularly in areas like culture, education, health, well-being, and safety. They also advocate that factoring in these aspects would enhance both the project's performance and the quality of life for the people. According to Eskerod and Huemann [133], social sustainability aspects significantly contribute to stakeholder management, which is a crucial component for project success. Similarly, other researchers propose that sustainable projects have to take social responsibilities into account, as doing so will profoundly affect the community and boost project performance in both the short and long run [45,48,49,134–138]. Based on these arguments, it is proposed that:

Proposition 6. *SRs positively influence project success.*

Based on the six proposed relationships above, and the fact that the six variables above are the main components of software project sustainability (SPS), then,

Proposition 7. *SPS positively influence project success.*

Finally, as clarified earlier, control variables (country, company size, and project complexity) were applied to evaluate their influence on project success. The influence of these control variables is expected to be significant, but the type of this influence (positive or negative) is not clear and needs an empirical examination. Table 3 summaries all the expected relationships of the conceptual framework.

Table 3. Expected relationships between SPS and project success (PSCS).

Relationship	Expected Relationship Type	Relationship Possibility?
ECN-NFRs → PSCS	Positive	Yes
ENV-NFRs → PSCS	Positive	Yes
SOC-NFRs → PSCS	Positive	Yes
ECCs → PSCS	Positive	Yes
EVCs → PSCS	Unclear	Yes
SRs → PSCS	Positive	Yes
SPS → PSCS	Positive	Yes
Country → (SPS → PSCS)	Unclear	Yes
Company size → (SPS → PSCS)	Unclear	Yes
Project complexity → (SPS → PSCS)	Unclear	Yes

6. Conclusions

Project sustainability and project success are among the most prominent subjects in relevant literature nowadays. However, there are some contradictions regarding the relationship between these two concepts. Some authors argue that project sustainability may negatively affect project success, while others say the opposite. Yet, this relationship has been poorly studied until now. Currently, no recorded work puts emphasis on this relationship in the software sector. Therefore, this research contributes significantly by developing a multi-dimensional framework that helps examine this relationship based on explicit variables of both concepts.

Our findings reveal that project sustainability refers to two perspectives: project product sustainability and project process sustainability. Project product sustainability pertains to the sustainability of projects' outcomes or deliverables, whereas project process sustainability concerns the sustainability of project-interrelated activities and management processes. Also, it was found that the inclusion of TBL-related aspects was the most-used approach for integrating sustainability into projects. Accordingly, we defined software project sustainability (SPS) as demonstrating commitment and considering sustainability TBL-related aspects of economic, environmental, and social pillars in the products and processes of software projects.

The proposed framework has three parts, which were developed based on the best relevant works. The first part illustrates the SPS variables and their triple-bottom-line (TBL) aspects. The second part demonstrates project success with its five dimensions. The third part symbolises the suggested control variables.

Finally, after critically analysing the outcomes of the conducted literature review, it is expected that the relationship between both concepts will be significant and positive. However, an empirical examination is needed, especially with the presence of control variables such as country, company size, and project complexity.

6.1. Implications

The proposed framework variables give both researchers and/or practitioners (e.g., decision-makers, project managers, and project teams) better insight into how to inspect whether SPS impedes or supports the success of software projects. Additionally, the proposed expected relationships provide a solid base for hypothesis development for future empirical studies. Furthermore, since the proposed SPS variables include a unique set of (TBL-related) aspects for integrating sustainability into software project processes and products, software firms—or other relevant companies—might use the framework as an assessment instrument to assess the social and environmental impacts of their future project products and management practices. Subsequently, they may give more heed to considering sustainability in their projects.

6.2. Research Limitations and Directions for Future Contributions

This research is limited to the authors' analysis of relevant contributions. Besides, some works could not be reached due to language limitations. For these reasons, improving and enhancing the proposed framework using further resources and validating it empirically could be interesting for future works. Moreover, future research may focus on other industries, such as service sectors, telecommunications, and information systems, which have rarely been studied. This paper refers to the micro-scale since it focuses on sustainability in software projects. Therefore, studying the macro-scale could be significant for future work.

Author Contributions: Conceptualization, A.K.; Methodology, A.K.; Validation, A.K. and A.S.A.-A.; Formal analysis, A.K.; Investigation, A.S.A.-A., M.K.A., H.Y., B.M. and F.R.W.; Resources, A.S.A.-A. and M.K.A.; Data curation, A.K.; Writing—original draft, A.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflict of interest.

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