

# Project Management for Sustainable Buildings: A Comprehensive Insight into the Relationship to Project Success

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**Purpose:** The paper aims to identify core components for managing sustainability in construction-building projects and to understand how these components support each other to achieve project success. It proposes a model for Sustainable Project Management to achieve Sustainable Project Success.

**Methodology:** The research utilised structural equation modelling to empirically test the conceptual model and the hypotheses associated to the 35 project-management related success factors and 24 performance criteria identified in literature review. Data was collected through 143 questionnaires carried out with construction professionals who has minimum two years' experience in sustainable building projects across the UK. Mediation analysis was used to identify the inter-relationships between the variables and components in the model.

**Findings:** The paper developed a model for Sustainable Project Management which consists of five components: (1) sustainability goal definition, (2) project team enhancement toward sustainability, (3) planning for sustainability, (4) sustainability assessment, and (5) stakeholder management. Stakeholder management and sustainability goal definition were found to have a significant and direct impact to the achievement of sustainable project success. The other three were found to generate an indirect but important impact on the sustainable project success. The results showed that attention should be paid to all five components to fully support the development of sustainability in projects.

**Limitations:** Regarding the research approach, the generalisation of this research's findings is limited to the construction industry in the UK and similar developed countries.

**Originality/value:** This paper provides a further understanding of the inter-related effects of sustainable project management and their impact on sustainable project success.

## 1 Introduction

The construction industry has to address new challenges that appeared with the sustainable buildings and their new higher requirements. For instance, the new Living Building Challenge put more rigorous standards for green buildings than popular green building rating systems like LEED or BREEAM (Kibert, 2016). Besides the high-performance green buildings, zero-carbon buildings or net-zero buildings have stricter principles in reducing negative environmental impacts. Changes in the industry also included the fast adoption of more and more green solutions like photovoltaics, green roofs, and environmental-friendly materials. All these efforts are to lead the construction industry to sustainability,

which aims to achieve both long and short-term goals of the current and future generations' needs, and of social, environmental, and economic life-cycle impacts.

Regardless of the critical call for sustainability and sustainable development in the construction industry, the link between sustainability and project management seems rather tenuous. Sustainability is not addressed as an important target in the widely used project management standards, including PMI, IPMA, AIPM, APM, PRINCE2, or ENAA (Martens and Carvalho, 2016a). These standards led to the current project management practice in which the focus is mostly on financial goals and is driven by the interest of project investors mostly without any further complexity beyond the time, budget, and scope constraints. CIOB and BS 6079:2019, two of the most used project management standards in the UK, also provide a minimal guide about sustainability. Focus on profit perspective has been much broader than people (social) and planet (environmental) perspectives in projects in construction and other industries (Silvius *et al.*, 2013). The limited integration of sustainability into project management could also be a reason for the dismantling of the zero-carbon-housing plan of the UK government and other ambitious future efforts toward sustainability. A practical plan for mainstreaming sustainability innovation requires a grand transformation toward sustainability (O'Neill and Gibbs, 2020); a sustainability project management approach should be one of the most important means to achieve that plan in the future.

Despite a very high interest in sustainability integration in project management, there is no clear method on how project management can support the sustainability achievement of projects (Marcelino-Sádaba *et al.*, 2015). Integrating sustainability into project management practice is necessary and urgent as the buildings would not be truly sustainable without a proper management process inclusive of sustainability angle. Recognising this gap in knowledge, this study aims to identify the core components for managing sustainability in construction-building projects and to understand how they support each other to achieve project success.

## **2 Research background**

### **2.1 Integrating Sustainability into Project Management**

Several approaches have been developed to achieve sustainable buildings and to meet sustainable construction targets in project management. The most straightforward of these approaches is the use of checklists or reference lists for sustainability, such as those demonstrated by RIBA (2013) or Silvius (2010). Research findings that identify critical success factors for sustainability management could be used as reference lists, such as ones in Stanitsas, Kirytopoulos, and Leopoulos (2021) or Gunduz and Almuajebh (2020). A wide range of green building rating systems (for example, BREEAM, LEED, or CASBEE) targets the assessment and assurance of a building with features of sustainability (Lazar and Chithra, 2020). Furthermore, Life-Cycle-Costing Life-Cycle-Assessment, or the new combination of them, Life-Cycle-Sustainability-Assessment (Keller *et al.*, 2015), are tools used to evaluate all the three economic, social, and environmental impacts of the products.

The approaches discussed above focus on defining the sustainability features, which are considered as requirements to be fulfilled by the quality management approach or quality assessment standards (Sim and Putuhena, 2015). Their focus is heavily on defining and measuring the sustainable features of final products; and there is a very little attempt, if any, in guiding project management practice to initiate and to deliver sustainable projects. In order to achieve a higher level of sustainability integration and higher success, the principles and processes of project management should change (Carvalho and Junior, 2015; Marcelino-Sádaba *et al.*, 2015). Continuing with the traditional management approach together with the application of tools/techniques for supporting sustainability might not be sufficient. Changing the principles of traditional project management to sustainable project management was proposed in recent research: such as Silviu and Schipper's (2014) suggestion of shifting the project scope, paradigm, and project manager's mind; Sertyesilisik (2016) attempted to come up with a future definition of management in regenerative construction projects.

Carboni *et al.*, (2013) has developed the projects integrating sustainable method (PRiSM) to balance the limited project resources, fulfill social responsibility, and achieve green outcomes for the project. PRiSM might inspire the project-based construction industry provided solutions can be found for dealing with a large number of stakeholders; integrating a multi-disciplinary team, and embedding specific technical parts of construction (like commissioning, procurement route, communication, and collaboration). Besides, models should also consider the human-related barriers such as the lack of stakeholders' awareness and gaps in their knowledge (Goel *et al.*, 2019), limited skills of employees, lack of collaborative working, resistance to change, poor competencies of the project team (Heffernan *et al.*, 2015), and failure in information transparency among stakeholders (Misopoulos *et al.*, 2019).

## **2.2 Sustainability Project Management (SPM) and Project Success**

Integration of sustainability into project management has resulted in concerns about whether SPM can support project success. Using analytic hierarchy process (AHP) technique, Martens & Carvalho (2016b) detected a potential positive relationship between SPM and project success. From a multi-sector analysis, Carvalhol & Rabechini (2017) confirmed that this relationship is significant but has a weak effect magnitude. However, this result might not be generalised as every industry has a unique set of criteria and management activities. Furthermore, using a multi-sector survey could result in a low degree of use for most variables on the survey. Therefore, the link between SPM and project success needs more research with empirical contribution (Khalifeh *et al.*, 2020), from each industry separately. In the construction industry, the relationship between SPM and project success remains an unanswered question, except Yu *et al.*, (2018) - who aimed to understand the support of sustainable project planning to project success. However, the link between other aspects of SPM and project success has not been addressed empirically at all.

## **3 Research approach**

This study is in the same school of thought with the efforts that highlight the importance of the project managers and project management approach in influencing the sustainability of the projects. With the

ultimate aim of improving sustainability, it looks into project management and attempts to understand how project management should be changed. In order to achieve the aim, the research approach demonstrated in Figure 1 was followed.

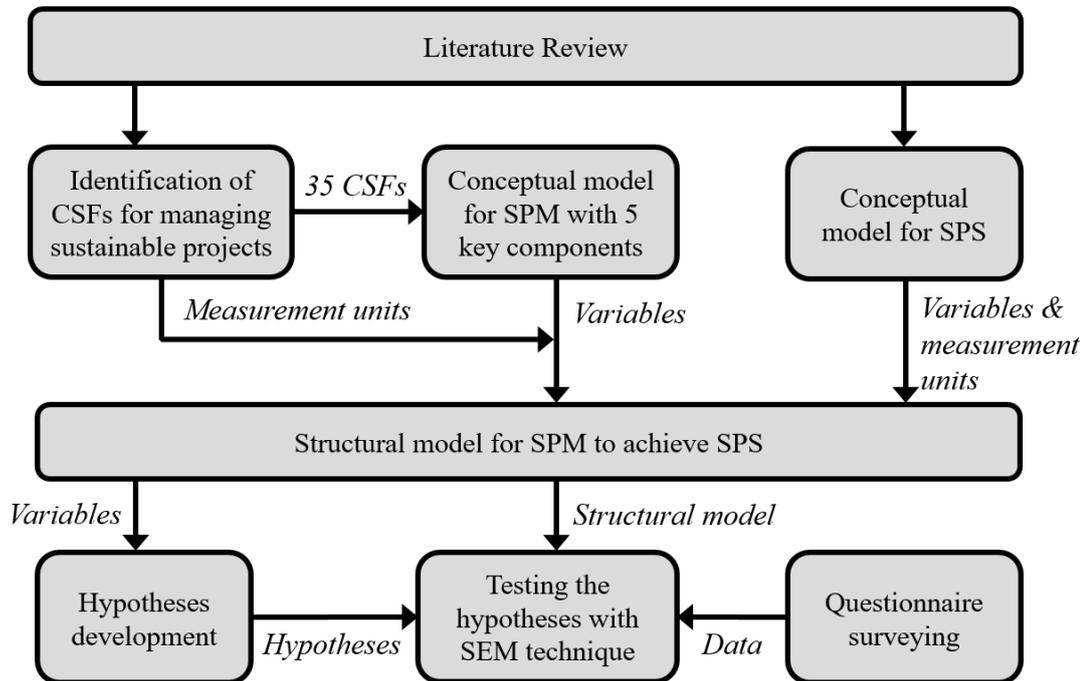


Figure 1. Research Approach

This research started with an intensive literature review on sustainable construction projects and the critical success factors. The review led to the identification of 35 Critical Success Factors for the success of sustainable construction projects (CSFs), which were clustered under five groups forming the conceptual model for SPM. Following the same approach, the literature review focusing on the project success and sustainability led to the development of the conceptual model of Sustainable Project Success (SPS) with four latent variables and their measurement indicators as the target of SPM.

The two conceptual models of SPM and SPS, their variables, and measurement units formed the structural model for SPM to achieve SPS. After forming the structural model for SPM, hypotheses for the inter-relationships between variables were developed to understand direct and indirect effects among the network of variables. In order to test the hypotheses, the structural equation modelling (SEM) technique was utilised using the quantitative data collected from a questionnaire survey. Each of these research steps is explained in detail in the following sections of this paper.

#### 4 Structural model for SPM to achieve SPS

The structural model for SPM to achieve SPS in this study includes two parts: the conceptual model of SPM (the left part of Figure 2) and the conceptual model of SPS (the right part of Figure 2). This section explains the development of these two conceptual models and their theoretical background.

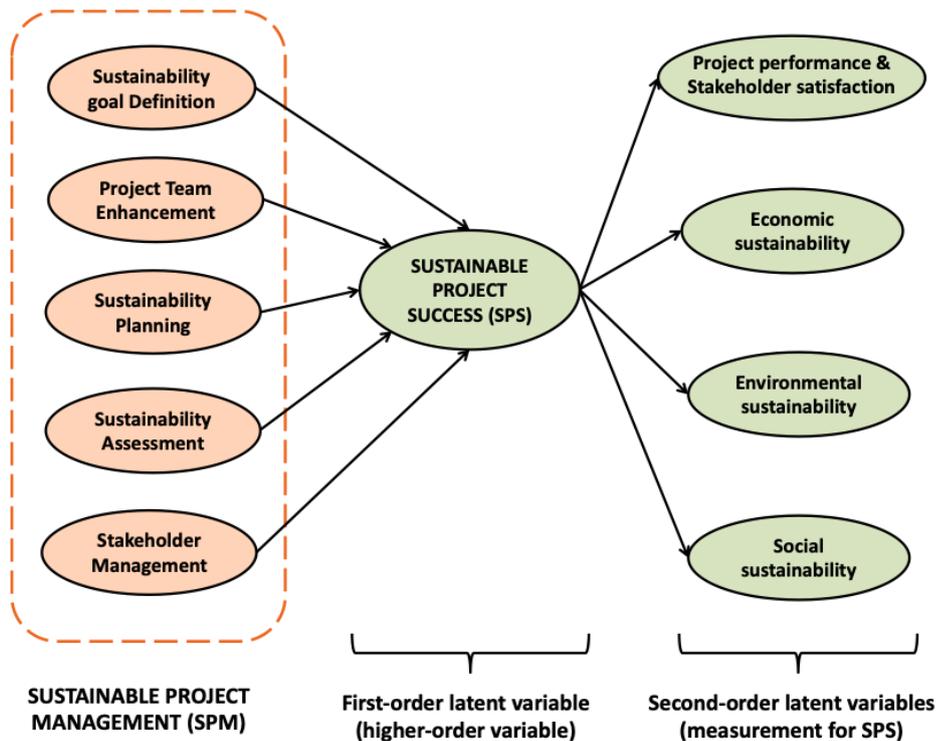


Figure 2. Conceptual models for SPM and SPS

#### 4.1 Conceptual model for Sustainable Project Management (SPM)

Modelling SPM relies on project-management-related success factors for achieving sustainability in building projects (from now on called success factors or CSFs). Four main search engines were employed to support the identification, including Google Scholar, Web of Knowledge, construction information service (CIS), and Scopus. To avoid missing important CSFs, the search was conducted in various keywords, and not only in project management theme or building projects but also in general projects and covered research carried out globally. The CSFs for sustainable success at organisational level were also examined. The search was stopped when no new factors were identified, and the final result was a list of 35 CSFs for the study.

These factors were then clustered under five groups: project team enhancement, stakeholder management, sustainability goals definition, sustainability planning, and sustainability assessment (the complete list of 35 success factors, their classification, and contributors are demonstrated in Table 1). Goals definition, sustainability assessment, and planning were mentioned in the literature before; however, the factors associated with them were not as extensive. The other two categories were identified in this study by clustering the factors identified in the literature review. The categorisation of these factors was supported by confirmatory factor analysis and assessment of reflective measurement model in the latter stages. These five groups are then accepted as five key constructs of SPM.

Table 1. Constructs and indicators for modelling Sustainable Project Management Conceptual

Code	Critical success factors	Sources / Contributors
<b>GOAL</b>	<b>Sustainability goal definition</b>	
Goal_1	Promotion of stakeholders' awareness, knowledge and commitment to invest in sustainability	Banihashemi et al. (2017), Saleh, Mohammed & Abdullah (2015), Swarup, Korkmaz & Riley (2011), Vink et al. (2010)
Goal_2	A sustainability ambition is created among project team members at the beginning of the project	Silvius, Neuvonen & Eerola (2017), Volker (2011)
Goal_3	A declaration of the owner on sustainability goals is announced to all relevant stakeholders	RIBA (2013)
Goal_4	A sustainability mission statement with tangible objectives in project brief or project plan	Banihashemi et al. (2017), Wang N. et al. (2015), Vink et al. (2010), Khalfan (2006), FIDIC (2004)
<b>ENHA</b>	<b>Project team enhancement toward sustainability</b>	
Enha_1	Responsibility and power for project team members to do their jobs	Low, Gao & Tay (2014)
Enha_2	Innovative solutions from project team members proposed (and discussed)	Shen, Tang et al. (2017), Sim & Putuhena (2015), Vink et al. (2010),
Enha_3	Workers' health, safety and working conditions in a construction site	Gudiene et al. (2014), Zou & Moon (2014), Glavinich (2008),
Enha_4	Project team's skills and knowledge in executing project activities	Banihashemi et al. (2017), Shen, Tang et al. (2017), Saleh, Mohammed & Abdullah (2015), Gudiene et al. (2014)
Enha_5	Project managers' competences and experience about sustainability in construction projects	Shen, Tang et al. (2017), Banihashemi et al. (2017), Saleh, Mohammed & Abdullah (2015), Gudiene et al. (2014)
Enha_6	Collaboration and communication among project team members	Wang N. et al. (2015)
Enha_7	Information transparency among project team members	Wai (2012), Klotz (2008), Kaatz (2006), Zutshi & Sohal (2004), Jackson et al. (2015)
Enha_8	Special advisors' involvement in a project to support for achieving sustainability targets/goals	Thomson et al. (2011)
Enha_9	Project team members are motivated towards sustainability at the beginning of the project	Shen, Tang et al. (2017), Gudiene et al. (2014)
Enha_10	The continuous learning process is implemented among the project team	Low, Gao & Tay (2014), FIDIC (2004)
<b>PLAN</b>	<b>Planning for sustainability</b>	
Plan_1	Identification, assessment and planning of sustainability-related risks	Gudiene (2014), Wai (2012), Wang N. (2015), Saleh (2015), Pojasek (2012)
Plan_2	Identification and prioritization of sustainability issues	Khalfan (2006), FIDIC (2004), Perrott (2015), Pojasek (2012)
Plan_3	Considering sustainability achievement when selecting the project delivery method	Wai (2012), Volker (2011), Kibert (Kibert, 2013), Swarup et al. (2011), Mallaoglu-Korkmaz et al. (2013)

Plan_4	Waste reduction, reuse and recycle in the project is considered in the project plan	Yunus (2012), Shami (2008), Zaini & Endut (2014), Kalutara et al. (2017)
Plan_5	Natural environment conservation is considered in the project plan	Yunus (2012), Wang N. (2015), Banihashemi (2017), Al-Yami & Price (2006), Berardi (2012), Kalutara et al. (2017)
Plan_6	Planning a realistic schedule	Wai (2012), Disterheft (2015), Wang N. (2015), Zaini & Endut (2014), Low, Gao & Tay (2014)
Plan_7	Effectiveness in allocating project resources	Wai (2012), Zutshi & Sohal (2004), Jackson et al. (2015), Kalutara et al. (2017), Low, Gao & Tay (2014)
Plan_8	Efficient and environmental-friendly technologies and materials are used	Gudiene (2014), Glavinich (2008), Kibert (2013), Spiegel & Meadows (2012), Kalutara et al. (2017)
Plan_9	Proposing and prioritising sustainability-related activities	Verboven & Vanherck (2015)
<b>ASSE Sustainability assessment</b>		
Asse_1	Targeting green building or energy performance certificates	Gudiene et al. (2014), Vink et al. (2010)
Asse_2	The application of sustainability-related standards	Zaini & Endut (2014)
Asse_3	Understand of regulations and legislative forces about sustainable development	Kalutara et al. (2017), Gudiene et al. (2014), FIDIC (2004)
Asse_4	Environmental, economic and social impacts assessment in design and early stages	Curran (2012), Lapinski, Horman & Riley. (2006)
Asse_5	Monitor and measurement of sustainability performance/progress	Banihashemi et al. (2017), Perrott (2015), FIDIC (2004)
Asse_6	Adequacy of building commissioning	Robichaud & Anantamula (2010), Stum (2000), Tseng (2005), Djuric & Novakovic (2009), Xiao & Wang (2009), Enck (2010), RSMMeans (2011)
Asse_7	Adequacy of post-occupancy evaluation (POE)	Saleh, Mohammed & Abdullah (2015), Halliday (2008)
<b>STAK Stakeholder management</b>		
Stak_1	Long-term value creation by all stakeholders is fully considered	Vink et al. (2010)
Stak_2	Key stakeholders' vision, strategies & objectives are determined to align them with project goals	Verboven & Vanherck (2015), FIDIC (2004)
Stak_3	Engagement of internal and external stakeholder to project activities	Marcelino-Sádaba, González-Jaen & Pérez-Ezcurdia (2015)
Stak_4	Effective communication with clients and other stakeholders	Shen, Tang et al. (2017), Wang N. et al. (2015), Saleh, Mohammed & Abdullah (2015), Gudiene et al. (2014), Low, Gao & Tay (2014), Volker (2011)
Stak_5	Stakeholders are involved in the early stages of projects	Kalutara et al. (2017), Shen, Tang et al. (2017), Robichaud & Anantamula (Robichaud & Anantamula, 2010)

## 4.2 model for Sustainable Project Success (SPS)

The modelling of SPS is based on 24 indicators from a research on identifying the relationship between sustainability and project success by Phung *et al.* (2019). This research saw the sustainable success of building projects as the achievement of traditional project success (i.e., project performance and stakeholder satisfaction - PPSP) and the targets of economic (EcS), environmental (EnS), and social sustainability (SoS) under the triple-bottom-line model. In this study, sustainable project success (SPS) was modelled as a second-order variable, and it was represented by four first-order variables. The four latent variables of SPS and 24 indicators in Figure 3 were accepted as measurement model for the construction SPS.

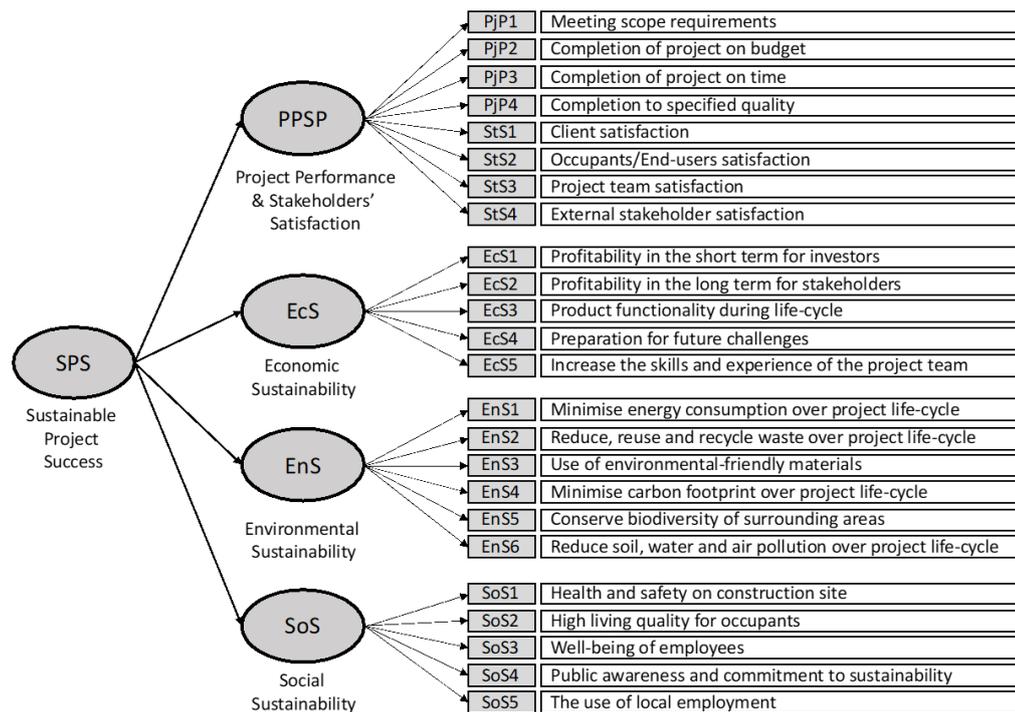


Figure 3. Constructs and indicators for modelling Sustainable Project Success (Phung *et al.*, 2019)

### Hypotheses development

After SPM and SPS were conceptualised, the study came up with questions related to the inter-relationships among the five key components of sustainable project management as well as a hypothesised question about the impact of these components on Sustainable Project Success (SPS). Given the background on various components of the model, the five following hypotheses were stated and tested in this study about the inter-relationships among the five key components of SPM.

This study focused on the inter-relationship as a network among the variables of the structural model to understand the direct and indirect effects among them and their final impacts on the achievement of SPS. Therefore, the hypotheses were developed as one-way directions toward the SPS variable. The hierarchical sequence in hypotheses follows the order by the time that these independent variables appear in the project life: starting with project goal in strategic definition; the participant of project teams

and planning activities in project preparation stage; stakeholder management and assessment of outcomes in project implementation.

- **Hypothesis 1:** The definition of sustainability goals supports the enhancement of the project team toward sustainability (h1a), the planning for sustainability (h1b), the assessment of sustainability (h1c), and the implementation of stakeholder management (h1d);
- **Hypothesis 2:** The enhancement of the project team toward sustainability supports the planning for sustainability (h2a), the assessment of sustainability (h2b), and the implementation of stakeholder management (h2c);
- **Hypothesis 3:** The planning for sustainability supports the assessment of sustainability (h3a) and the implementation of stakeholder management (h3b);
- **Hypothesis 4:** The assessment of sustainability supports the implementation of stakeholder management (h4);
- **Hypothesis 5:** Sustainable project success is supported by the definition of sustainability goals (h5a), the enhancement of project team toward sustainability (h5b), the planning for sustainability (h5c), the assessment of sustainability (h5d), and the implementation of stakeholder management (h5e).

## 6 Testing the structural model and the hypotheses

### 6.1 Data collection

An online questionnaire was carried out in order to evaluate the success factors of sustainable project management (Table 1) and sustainable project success (Figure 3), and to test the hypotheses developed. It was decided the target respondents should have at least two years experience in building projects with sustainability features; sustainable certificates as green building, energy performance, or low-carbon in the UK, in order to be able to answer the questions that require expertise in both project management and sustainability. Using the linear multiple regression approach, with an expected medium effect size of 0.15, alpha error probability at 5%, power of 0.80, and a maximum of five predictors in the model, the minimum sample size was calculated as 92.

The questionnaire included 71 close-ended questions utilising a 5-point Likert scale in order to elicit the level of agreement (1 = strongly disagree/very low, and 5 = strongly agree/very high) with the statements provided. It was delivered to participants through the LinkedIn social network, and 143 valid answers were obtained, which exceeded the minimum sample size requirement of 92.

86.2% of respondents had more than five years, and 67.4% had more than ten years of experience. 47.9% of respondents were project managers, 35.4% were construction managers, and 16.7% were unit managers or senior members of the project management team. Building projects referred by respondents were across the whole of the UK and were diverse in building purpose (commercial, residential, educational, medical, and governmental) and types of construction (new-built, refurbishment, and

renovation). Therefore, the data provided a good representation of the population and was deemed adequate for the SEM analysis.

## **6.2 Structural Equation Modelling (SEM)**

The Partial Least Square Structural Equation Modelling (PLS-SEM), a multivariate method in analysing the cause-effect relationships between latent variables, was employed as the primary data analysis technique in this study. It can solve complex models and can analyse uncompleted, non-normal data set; identify relationships between variables; and solve all hypotheses in a single model using the network of variables. Besides, SEM can explain the mediation effect between them, which is not available in other correlation-testing techniques (i.e., Chi-Square, ANOVA, Pearson, Kendall, or Spearman).

Some components in this model might have two-way impacts on each other, for example, ASSE and STAK, but SEM is unable to examine the mutual relationship between them. This technique examines all hypothesised relationships between variables in a one-way network. On the other hand, this method can help to understand the hidden effects between them with mediation analysis.

### **6.2.1 Assessing reflective measurement model**

Internal consistency reliability, individual indicator validity and reliability, convergent validity, and discriminant validity are the most critical metrics in SEM to determine the quality of the model (Hair *et al.*, 2021). During the analysis, the measurement model was modified as appropriate to increase the quality, such as merging Plan1 and Plan2, Enha6 and Enha7 using factor score obtained by factor analysis in SPSS where all the new combined indicators could explain more than 80% variance of data. These combinations of indicators also increased Cronbach's alpha (CA), composite reliability (CR), and average variance extracted (AVE), enhanced the validity and reliability of the measurement model. The final results of the measurement model satisfied all the requirements (all outer loadings > 0.5, CA > 0.7, CR > 0.7, and AVE > 0.5).

### **6.2.2 Assessing the structural model**

The structural model was assessed for collinearity issues and predictive power. Collinearity, measured by a variance inflation factor (VIF), represents the very high correlations between variables when they share a very high similarity in their variance. As all the inner VIF values (ranged from 1.0 to 3.6) were less than the threshold of 5, the whole model was considered free of a potential collinearity problem.

The model's predictive power is evaluated through two ratios: coefficient of determination ( $R^2$ ) and Stone-Geisser's  $Q^2$  value (Hair *et al.*, 2021). All  $R^2$  values for endogenous variables were in the range from 37.6% to 72.1%. In social research, an  $R^2$  value above 26% is considered substantial (Cohen, 1998). Coupled with all calculated  $Q^2$  values exceeding zero, the model had a high predictive relevance.

In brief, the model was relevant and accurate for understanding the relationships between the latent variables. These results mean the conceptualisation of SPM with the five key components and the SPS with four representative variables were successful.

## 7 Research results

### 7.1 Hypotheses testing

Using the PLS-SEM and the bootstrapping procedure, it was found that 10 out of 15 sub-hypotheses were fully supported at a significance level of 0.1%, as shown in Figure 4. The result illustrates an interrelationship among the five components of SPM. The coefficient paths in Figure 4 show that GOAL supports the implementation of other components, including ENHA, PLAN, ASSE, and STAK (h1a, h1b, h1c, and h1d are supported). Also, enhancement of the project team toward sustainability (ENHA) was found with positive impacts on the implementation of PLAN, ASSE, and STAK (h2a, h2b, and h2c are supported). Furthermore, the higher effort on PLAN was made, the more facilitation ASSE can have (h3a is supported); however, the connection between PLAN and STAK was not proven by the data (h3b is not supported). Similarly, the link between sustainability assessment was not found as a supporting variable to the management of stakeholders (h4 is not supported).

Of the five variables, two significant relationships were found, including STAK and ASSE, with significant and direct impacts on the achievement of SPS. This finding implies that a higher level of stakeholder management and sustainability assessment was associated with the achievement of sustainable project success (h5d and h5e are supported). Three other sub-hypotheses, h5a, h5b, and h5c, were found insignificant, revealing that GOAL, ENHA, and PLAN do not have direct relationships with SPS. However, on the grounds of high correlations among these variables (GOAL, ENHA, and PLAN) to STAKE and ASSE, they can potentially support the achievement of sustainable results indirectly. Within a complex interrelationship network among variables, complementary mediation effects appear and enhance the strength of the relationship with indirect effects.

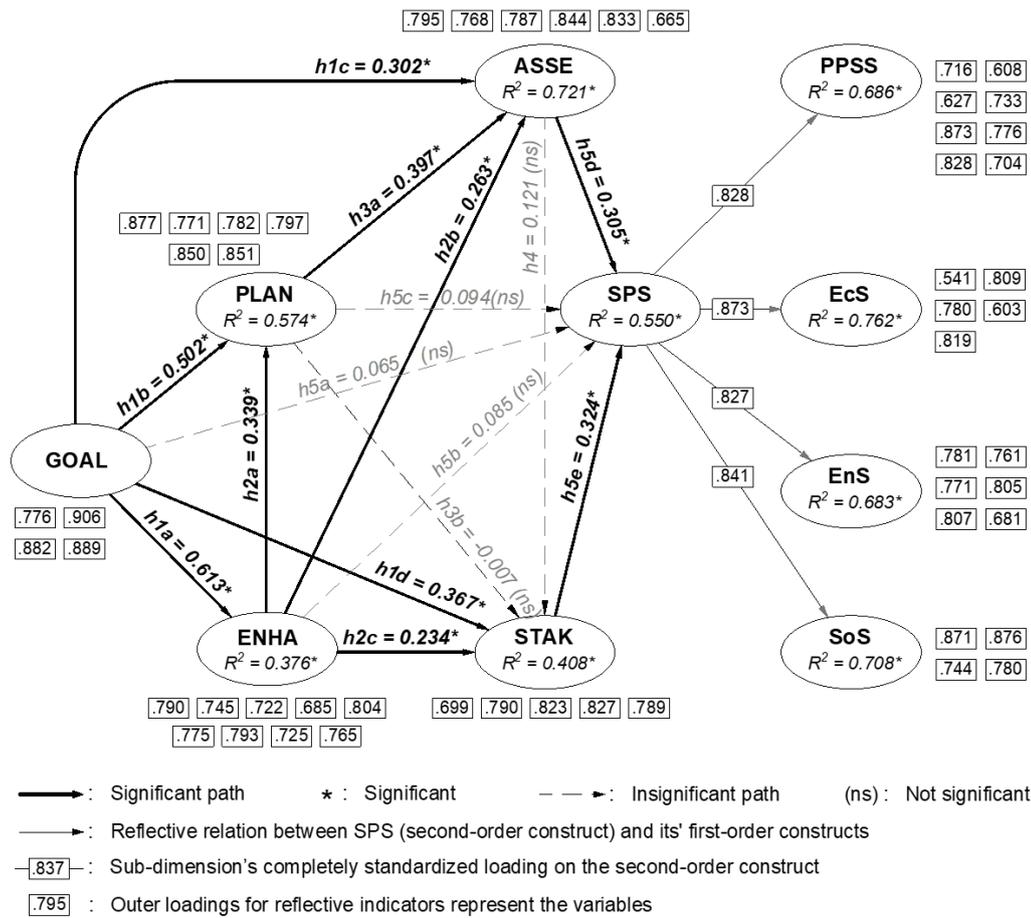


Figure 4. Types of relationships among latent variables of the testing model

## 7.2 Mediation analysis

Mediation effect happens when a third variable (mediator) intervenes between two other variables and enhances or reduces the relationship between these two variables (Hair *et al.*, 2021). After removing the insignificant paths from the original model, the bootstrapping procedure and the SmartPLS function were carried out to calculate the significance of all the indirect effects between latent variables in pairs and the total effects (Table 2).

Mediation analysis showed the role of GOAL was crucial due to its remarkable indirect impact on other variables of SPM, including PLAN, ASSE, and STAK ( $p^{\text{indirect}}=0.209, 0.442, \text{ and } 0.170$  in  $h1b, h1c, \text{ and } h1d$ , respectively). With both direct and indirect impact, the total effects of the GOAL to ENHA, PLAN, ASSE, and STAKE ( $h1$ ) are all substantial (from 0.596 to 0.746), showing this a vital component of SPM. Similarly, ENHA also has some indirect effects, particularly on ASSE ( $h2b$  with  $p^{\text{indirect}}=0.126$ ), to make its total impact on this variable to a remarkable level as high as 0.393.

Interestingly, in the hypothesis testing, the relationship between GOAL/ENHA/PLAN and SPS were found unsupported; however, the results of mediation analysis revealed that these relationships actually exist, but they are full-mediated, i.e., bearing only indirect effect ( $p=0.565, 0.283, \text{ and } 0.183$  in  $h5a, h5b \text{ and } h5c$ ).

In conclusion, the finding of meditation analysis emphasized the crucial role of GOAL and ENHA in enabling processes of STAK, PLAN, and ASSE more effectively. Through the action of boosting up these variables, GOAL and ENHA can affect the achievement of SPS, indirectly but remarkably.

Table 2. Direct effect, indirect effect, and total effects (only significance counted) of all relationship hypotheses

Hypotheses	Relationships	Direct effect (Figure 4)	Indirect effect**	Total effect	Types of meditation effect
h1a	GOAL→ENHA	0.615*		0.615*	<b>No-mediation</b>
h1b	GOAL→PLAN	0.502*	0.209*	0.711*	<i>Partial-mediation</i>
h1c	GOAL→ASSE	0.305*	0.442*	0.746*	<i>Partial-mediation</i>
h1d	GOAL→STAK	0.425*	0.170*	0.596*	<i>Partial-mediation</i>
h2a	ENHA→PLAN	0.340*		0.340*	<b>No-mediation</b>
h2b	ENHA→ASSE	0.257*	0.136*	0.393*	<i>Partial-mediation</i>
h2c	ENHA→STAK	0.277*		0.277*	<b>No-mediation</b>
h3a	PLAN→ASSE	0.399*		0.399*	<b>No-mediation</b>
h3b	PLAN→STAK				<b>No-relationship</b>
h4	ASSE→STAK				<b>No-relationship</b>
h5a	GOAL→SPS		0.565*	0.565*	<b>Full-mediation</b>
h5b	ENHA→SPS		0.283*	0.283*	<b>Full-mediation</b>
h5c	PLAN→SPS		0.183*	0.183*	<b>Full-mediation</b>
h5d	ASSE→SPS	0.460*		0.460*	<b>No-mediation</b>
h5e	STAK→SPS	0.372*		0.372*	<b>No-mediation</b>

\* Significance at <0.1%; \*\* For variables with multiple mediation effect, all specific indirect effects among paths were also found significant

## 8 Discussion

The research findings empirically proved that SPM supported the achievement of SPS. This validated the positive and significant impact of SPM and project success suggested in Martens and Carvalho's study using AHP (2016b). Furthermore, together with the findings of Khalilzadeh *et al.*, (2016) in the oil and gas industry, this research is additional evidence that the relationship between SPM and project success could be more robust when examined in a specific sector, which was only found with weak correlation in the multi-sector study of Carvalho and Rabechini (2017).

This study not only investigated the relationship between SPM and SPS but also provided an empirical contribution to the impacts of core components of SPM on SPS in sustainable construction projects. Among these key components, results show that sustainability assessment (ASSE) and stakeholder management (STAK) directly and positively influence the achievement of Sustainable Project Success (SPS). The positive relation between sustainability assessment and SPS is not surprising because the assessment criteria is designed to ensure that final targets are met. However, it was found that stakeholder management has a slightly stronger influence on SPS than ASSE has. This finding is critical as it might be possible to bring the social sustainability pillar back into the sustainable buildings by

focusing more on stakeholder management and introducing more assessment factors associated with social sustainability.

Two components of SPM in project initiation - sustainability goals definition (GOAL) and project team enhancement (ENHA) - are found to have a positive and remarkable influence on all the three other components of SPM; and on the grounds of this influence, they also have remarkable indirect impacts on SPS (full-mediation effect). The sustainability goals definition has the most considerable total effect on all variables of the SPM and SPS. The definition of sustainability is a crucial starting point of a sustainable project. It enables the employment of a competent project team and also acts as a light to show direction for all project activities. Then, a project team with rich experience, high motivation, innovative thinking, learning ability, and collaboration can contribute to the success of sustainable projects. In many projects, project managers are often restricted with traditional project constraints (mainly for cost, budget, and time) as well as limited power to contribute to the achievement of SPS fully. Therefore, an explicit goal of sustainability can free them to use all of their potential ability to manage stakeholders and in planning projects toward sustainability.

However, it is important to note that impacts of GOAL/ENHA to SPS are fully mediated through PLAN/STAK/ASSE – which means that they have less meaning without the appearance of a well-performed delivery process with suitable sustainability planning, assessment, and stakeholder management. The early part of this discussion highlighted the impacts of GOAL and ENHA on PLAN/STAK/ASSE and that they do need the early definition of goals and a competent team to enhance the performance. The five components of SPM are strongly interrelated; therefore, the impact and performance of SPM to the common targets of sustainability would be reduced if lacking any of the five key components. This finding also proves that the sole use of sustainability assessment as a means to sustainability in many projects will be insufficient to achieve sustainability in the project. The project managers should consider all the components in adopting a sustainability management approach in their projects diligently.

Finally, the significant relationship identified between PLAN and ASSE (hypothesis h3a) suggests that the sustainability assessment requires a sustainability management plan that provides further direction to activities in the project's delivery process. Although the findings show that sustainability planning does not directly relate to SPS (a drop of h5c); by the full-mediation through sustainability assessment, This suggests that practitioners recognise the value of sustainability planning, but its importance is underestimated. The indirect effect in this finding could result from the fact that almost none of the participants in this research use an official and separated sustainability management plan. In fact, using a separated/specific sustainability management plan is not widespread in construction projects. Sustainability planning may have been integrated into a regular project management plan, which might put sustainability targets behind the targets of financial benefits (like saving initial investment and reducing backpack time) from the investors' point of view on the traditional approach. Therefore, it is

believed that the sustainability of building projects can be emphasized if a sustainability management plan is made separately as an official plan before the project plan/project management plan is created.

## **9 Conclusion**

### **9.1 Theoretical contribution**

This study introduced a new theoretical model for SPM in building projects, which consists of five components that should be considered as a whole: (1) sustainability goal definition, (2) project team enhancement toward sustainability, (3) planning for sustainability, (4) sustainability assessment, and (5) stakeholder management. The model was also tested with the structural equation modelling technique to understand the inter-relation impacts of the five components and how they can support project success. These relationships are the main contribution of this study to knowledge. The testing results reveal that SPM can support the achievement of project success in building projects. Still, this study is specifically focused on the construction industry with the final product as buildings. The building projects are known as complex, unique, multi-disciplinary, multi-stakeholder involvement, and time-consuming products. Therefore, the conceptualisation of SPM in this study is different from previous research.

The most interesting results are practical value from identified inter-relationship between the components of this model. Previous research had considered that the initiation process is more important than the project delivery process to achieve sustainability, and sustainability planning was at the core of the initiation process. This study identified two more critical enablers in the initiation process of a sustainable project: official sustainable goals and project team competency enhancement. Both of these enablers were found to have a significant impact on the SPS. Defining sustainable goals serves as a fundamental ground for sustainability to be developed and embedded in the project. That goal can only be delivered by a project team with sufficient knowledge and skills in sustainability, working in a highly collaborative environment to deliver that goal. The high-skilled, experienced, and multi-disciplinary project team would help prevent/reduce risk, waste, and errors, leading to a good return on investment for clients and users, including the sustainability value/benefits.

### **9.2 Implications for practice**

Practitioners tend to rely significantly on sustainability assessment in their projects, typically a green building rating system or energy performance system. Testing the model found that not only sustainability assessment but also stakeholder management are found to have a significant positive impact on sustainable project success. However, the results also identified the inter-relationships between the five key variables/components of SPM, and they explained how these components support each other in achieving sustainable project success. Therefore, although sustainability assessment has an important value, to achieve sustainable project success, all five components of SPM should be paid attention. Stakeholder management is particularly important due to its role in balancing the three pillars of sustainability and providing support to social sustainability. It leads to enhancement of the working

condition of employees, the living condition of occupants/end-users, and community commitment to sustainability.

### 9.3 Limitation and generalisation

The data was collected from participants working in the UK; hence the research's findings represent the construction sector in the UK. The contingent effect of the country can impact the standards, legislation, social benefits, and environmental behaviour, which later influence the behaviour of participants as well as their understanding of project success. Therefore, although the conclusions are made on the UK-specific data, the findings can be generalised to all developed countries with a sustainability agenda.

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