Exploring the Management Approaches Influencing the Sustainable Practices Adoption in UK Construction Organizations: A Green Technology Perspective

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Abstract

The construction sector makes a significant contribution to the establishment of sustainable development. In the past few decades, the industry has shifted towards a more sustainable strategy by embracing advanced technology and renewable materials. The purpose of this study was to determine the influence of project management practises on sustainable building development in UK. A quantitative questionnaire survey was employed to collect the data to test the research framework. Snowball sampling was used to recruit 205 participants among professionals who have worked or currently work in construction organisations in UK. In order to establish the interrelationships among project management methodologies, green technology, and sustainable construction methods, the responses were tested using correlation, confirmatory factor analysis, and structural equation modelling. According to the data findings, good quality project management practices can pave the way for sustainable construction implantation in UK and this relationship can be strengthened by the combination of digital green technology. Instead, it may be controlled by providing training programmes and improving communication channels. Overall, this study provides significant data for industry professionals and governments interested in encouraging sustainable construction practises in UK.

Keywords: Green technology; sustainable construction; project management practices; sustainability; UK

1 Introduction

During the past few decades, the environmental quality is decreasing due to rapid growth of population, industrialization, over usage of natural resources and unsustainable waste management. Around the world, construction organizations have been heavily focused on certain aspects including communication and stakeholder management and there has not been proper discussion of the impact of unsustainable construction practices. The building sector significantly encourages unsustainable development and its economic and environmental consequences (Son *et al.*, 2011). It was argued by Misopoulos *et al.* (2021) that construction activities in the UK consumed 50% of the country's energy and generated 19% of total waste (Wang *et al.*, 2014). As there has been a rise in global demand for energy efficiency and high-quality buildings in construction development, the market of sustainable and green buildings is presumed to expand in UK.

Therefore, the UK construction sector is forced to modify both its sustainability initiatives and existing conventional practices. Besides, the lack of a common knowledge of sustainability concept and strategies is preventing this from being converted into action, posing a challenge for organisations (Renukappa *et al.*, 2012). Compared to the past, there is now a higher knowledge and awareness of the detrimental effects of the entire construction on sustainability. Given these considerations, construction organisations have made an effort to execute sustainable construction projects by incorporating good project management practises and techniques (Silvius *et al.*, 2017). Management skills are important for the successful implementation in the construction sector since the efficient planning of activities both on-site and off-site is heavily dependent on project managers in construction projects (Salem *et al.*, 2005).

In the modern competitive industries, construction organizations must develop best practice and improve their performance. Chan (2000) claimed that construction sites are a main cause of air pollution. In order to address the concerns, green building is a better and more sustainable alternative to traditional construction. During the past few years, sustainability becomes a trend topic among the construction organizations. The previous studies have been identified a number of challenges and drivers in order to implement and practice sustainability and ‘best practice’ management effectively. Some of these challenges include an inadequate understanding of the concept of sustainability, and the impact of project

management practices and green technologies (Bashir *et al.*, 2010, Zainudeen and Perera, 2020).

The aim of this research is to investigate the impact of project management practices towards adopting sustainable practices in UK construction organizations. The following objectives are decided in order to obtain the aim of the research.

1. To explore the concepts of sustainability in the building industry in UK.
2. To investigate the implications of project management practices on sustainable construction.
3. To verify the impact of green technology on sustainable construction practices.

Compared to previous studies, this research has a few significant differences. Research presented in this paper provides a comprehensive overview of sustainable practices in the construction industry, particularly in the UK. The theoretical framework (Figure 1) developed by the researcher gives a systematic approach to understanding the role of project management practises in enabling the adoption of sustainable practises in construction organisations, as well as identifying constraints to adoption. The interrelationships between key factors are examined in this study applying both qualitative and quantitative approaches. Applying a variety of data analysis approaches, such as correlation, hierarchical multiple regression, confirmatory factor analysis, structural equation modelling, and interpretative structural modelling, strengthens the validity and dependability of the results. The previous studies (Alwan, Jones and Holgate, 2017, Armenia *et al.*, 2019, Maqbool *et al.*, 2022) have some limitations such as their limit of data analysis and findings, specific geographical location and sampling bias.

2 Literature Study

2.1 Sustainability Practices in Construction Industry

Sustainability is a broad concept and a complex issue to tackle. Since the Brundtland Commission's 1987 report on the world's environment and development, there has been a greater interest developed on sustainability (Redclift, 2005). According to Brundtland Commission (1987) sustainability refers to “meeting the needs of the present without compromising the ability of future generations to meet their own needs”. Likewise, the UK government defined a sustainable development as a plan to make it possible for everyone in

the world to meet their basic requirements and have a higher quality of life without jeopardizing that of future generations (DEFRA, 2005).

Meanwhile, sustainability was described by Maqbool *et al.* (2022) in terms of the Triple-P, which refers to people, plant, and profit. As described by Brandon and Lombardi (2011, p. 21), sustainability development is a process that is aimed to establish an environment that allows humans to behave harmoniously and to improve the quality of life for current and future generations. Embracing sustainability practices is addressing the equal balance between the environment, social development, and economic growth which is also known as the triple bottom line (TBL) (Little, 2014). In other words, it means improving economic and social quality of life while keeping environmental impact to a minimum. Yet, many researches are mainly concerned on bio-physical environmental issues while human dimensions have been neglected resulting in an imbalance in sustainable development (Maqbool *et al.*, 2022).

Table 1: Summary Table for Sustainability Practices in Constriction Industry

Source	**Factor(s)**	**Location of Study**	**Methodology**	**Description**
Redclift (2005)	Sustainable Development	United Kingdom	N/A	The paper examines the conceptual history of sustainable development.
DEFRA (2005)	Sustainable development strategy	United Kingdom	N/A	The report highlighted the UK sustainable development strategy.
Maqbool *et al.* (2022)	Industrial attitudes and behaviours	United Kingdom	Questionnaire Survey	It was decided on the project management practices and integrated approaches to sustainable building.
Brandon and Lombardi (2011)	Sustainable Development	United Kingdom	N/A	The environmental perspective of sustainable development was explored.
Little (2014)	Sustainability definitions	University of Kentucky	N/A	The paper reviewed a multiple definitions and frameworks of sustainability.

HOC Library (2019)	Statistics and policy	United Kingdom	N/A	The report highlighted the policy for the UK construction industry.
Hussin, Rahmon and Memon (2013)	Issues and challenges	Malaysia	N/A	The paper reviewed the challenges that the construction industry faced in Malaysia.
Cabinet Office (2011)	Government construction strategy	United Kingdom	N/A	The paper reported the UK government construction strategy.
Dahl *et al.* (2005)	Operation and maintenance	United States of America	N/A	The paper explored the operation and maintenance knowledge of sustainability.
Opoku, Ahmed and Cruickshank (2015)	Leadership, sustainable construction	United Kingdom	Surveys and interviews	The paper investigated different leadership style within the UK construction industry.
Cruz, Gaspar and de Brito (2019)	Sustainable construction	University of Lisbon	N/A	The issues faced by the building sector in terms of sustainable development were examined in the study.
Alkhaddar et al. (2012)	Deep Learning	United Kingdom	Questionnaire Survey	The study investigated at how deep learning has affected the construction sector.
Misopoulos et al. (2019)	Social and environmental sustainability	United Kingdom	Systematic literature review	The authors conducted systematic review on sustainable construction.
Alhaddi (2015)	Triple bottom line of sustainability	Lawrence Technological University	N/A	Triple bottom line of sustainability was reviewed in the literature.
Almahmoud and Doloi (2015)	Social sustainability	The University of Melbourne	Dynamic assessment model	The paper assessed the social perspective of sustainable construction.
Abidin (2010)	Awareness and application of sustainable construction	Malaysia	Surveys and interviews	The paper studied the understanding and knowledge of sustainable practices.

2.2 Implementing Green Buildings Technology

Green building can also be described as “sustainable building”, or “high-performance building” and it is responsible for utilizing structures and procedures that are resource-efficient throughout the project life cycle (Environmental Protection Agency, 2012). It has become increasingly practical to design green buildings using Building Information Modelling (BIM), a technology that enables the generation of 3D models of buildings and the management of information throughout the lifespan of the structure (Lu *et al.*, 2017). The technology has been applied to support green building practices and Ansah *et al.* (2019) referred it as “Green BIM”. The integration of advanced building design is to minimize energy and natural resources consumption as well as to lower environmental impact.

2.2.1 Sustainable Design with BIM

BIM is a significant revolutionary technology that offers various advantages to the industry, as the construction sector is an important contributor to the negative impact on the environment. Unlike traditional design, BIM allows for a single-source model where building components may be drawn or updated in a single location where all data can be shared more extensively and efficiently, and any changes to a component inside the model are immediately updated throughout the entire project in all views (Krygiel and Nies, 2008). Developing a sustainable built environment requires integrating social, economic, and environmental aspects at the same time and it can be accomplished through BIM (Zhabrinna *et al.*, 2018).

The integration of BIM technology and sustainable design approaches has the potential to create a more efficient and high-level functioning design for a built environment. According to a study by Chong, Lee, and Wang (2017), BIM can help improve social sustainability by encouraging alternative methods for managing data exchange and communication among all stakeholders, contributing to a more collaborative approach. In considering the absence of information where the green economy is growing, measuring economic sustainability is therefore a little more difficult (Gibbs and O'Neill, 2014). However, the early implementation of BIM in a project will reduce the variation costs and the project can be accommodated more easily (Holzer, 2009). In addition, BIM is an essential tool to support a better environmental sustainability, analysing potential environmental impacts, airflow circulation, an ecosystem within a building, and conducting energy simulations (Zhabrinna *et al.*, 2018).

2.2.2 Lean Construction

Investing in lean construction can be highly beneficial for the UK construction industry but Bashir *et al.* (2010) argued that it is not generally practiced among UK construction organizations. Lean construction is described by Lim (2008) as a balance use between people, materials and resources. The fundamental aim of the lean concept is to enhance economic level by eliminating any expenditures on resources that do not provide value to the end user (Čiarnienė and Vienažindienė, 2015). Despite the fact that Lean construction and sustainable construction practices can be considered as two distinct initiatives (Khalfan *et al.*, 2001, Koranda *et al.*, 2012), their incorporation can lead to significant benefits such as better cost savings, waste reduction and environmental impact elimination (Scherrer-Rathje, Boyle and Deflorin, 2009). This is further acknowledged by Nahmens and Ikuma (2012) that using Lean construction provides the construction industry with a strategy to enhance sustainability by increasing resource usage, human safety and reducing waste with standard practices.

The core principle behind Lean construction is to reduce non-value-added flow activities while improving value-added activities (Pandithawatta, Zainudeen and Perera, 2020). Lean construction develops the product and process simultaneously and implements production control with the goal of maximising performance for the client at the project level throughout the life of the product from design to delivery (Sarhan and Fox, 2013). As a result of lean construction, clients are provided with high benefit with cost reduction maximising revenues (Pandithawatta, Zainudeen and Perera, 2020).

Table 0: Summary Table for Implementing Green Building Technology

Source	Factor(s)	Location of Study	Methodology	Description
Lu *et al.* (2017)	BIM technology	China	Critical review	The paper highlighted both academic research and industrial practices of BIM development.
Ansah *et al.* (2019)	BIM application	Hong Kong Polytechnic University	Systematic literature review	The study developed a through and systematic review on integration of BIM with green

				building assessment.
Krygiel and Nies (2008)	Green BIM	N/A	N/A	The implementation of BIM to develop successful sustainable construction was explored.
Zhabrinna *et al.* (2018)	BIM adoption	Indonesia	Questionnaire survey	The paper highlighted the awareness of BIM adoption towards sustainable construction.
Bashir *et al.* (2010)	Lean construction	United Kingdom	Interviews and questionnaire survey	The difficulties in implementing lean construction sustainably have been identified and explored.
Chong, Lee, and Wang (2017)	BIM adoption	Kyung Hee University	Systematic literature review	A systematic review approach was adopted to analyse BIM standards and guidelines; and peer-reviewed academic publications.
Gibbs and O'Neill (2014)	Green technology	Boston	Case study	The study focused on the green economy development in the Boston region.
Holzer (2009)	Sense-making across collaborating	RMIT University	Qualitative and quantitative research	In the preliminary stages of architectural design, sense-making across cooperating disciplines was examined.
Lim (2008)	Lean construction	Malaysia	Questionnaire survey	The paper investigated the application of lean construction into Malaysia construction industry.

Čiarnienė and Vienažindienė (2015)	Lean concept	Kaunas University of Technology	Questionnaire survey	The study examined multidimensional Lean concept was applied in Lithuanian businesses.
Khalfan *et al.* (2001)	Concurrent engineering	Loughborough University	N/A	The paper addressed the effectiveness of concurrent engineering within construction industry.
Koranda *et al.* (2012)	Lean construction, sustainability	United States of America	Case study	The study investigated the factors hindering the integration of sustainability and lean concept.
Scherrer-Rathje, Boyle and Deflorin (2009)	Lean implementation	St. Francis Xavier University	N/A	The paper highlighted a number of lessons learned to help improve lean implementation.
Nahmens and Ikuma (2012)	Lean construction	United States of America	Case study	The case studies demonstrated how lean has an impact on sustainability's triple bottom line in the construction of modular homes.
Pandithawatta, Zainudeen and Perera (2020)	Lean-Green construction	Sri Lankan	Interviews	The application of integrating Lean and Green ideas in the construction sector was examined in the article.
Sarhan and Fox (2013)	Lean construction	United Kingdom	Semi-structured interviews and questionnaire survey	The research focused on the challenges on the introduction of lean construction.

2.3 Project Management Practices

The application of project management practises is critical for the effective adoption of sustainable practises in the construction sector. Project managers can increase the success

of a project; hence, they must be qualified to handle the project effectively (Hwang and Ng, 2013). The project management techniques used in organisations are well adapted to accomplishing sustainable practises since they are already focused on cutting costs, expanding value, and preserving insufficient resources (Maltzman and Shirley, 2010). The application of green practices and technology requires competent professionals to design and construct, manage and maintain them. Also, sustainable principles have to be incorporated throughout a project's whole life cycle, from design to construction and operation and it is believed that a proper adoption of sustainable construction would not be possible without the support of top management (Sarhan and Fox, 2013).

It is also reiterated by Edum-Fotwe and McCaffer (2000) that additional extensive management knowledge and skills is essential for current project management practices, go far beyond the boundaries set by certification requirements (Hwang and Ng, 2013).

Table 3: Summary Table

Source	Factor(s)	Location of Study	Methodology	Description
Hwang and Ng (2013)	Project management challenges	Singapore	Questionnaire survey	The paper identified challenges faced by project managers and established the knowledge and skills for them.
Maltzman and Shirley (2010)	Green project management	United States of America	N/A	The book explored more on going “green” projects.
Silvius (2013)	Project management, sustainability	United States of America	N/A	The integration of project management and sustainability was identified.
Khalfan (2006)	Sustainability, construction project management	University of Salford	Interviews	The paper identified the effective project management practices to support sustainable construction adoption.
Peansupap and Walker (2005)	ICT diffusion	RMIT University	Survey	The paper addressed the critical issues of the ICT adoption into construction organizations.
Sarhan and Fox (2013)	Lean construction	United Kingdom	Semi-structured interviews and questionnaire survey	The research focused on the challenges on the implementation of lean construction.

Edum-Fotwe and McCaffer (2000)	Construction project management	Loughborough University	Interviews and questionnaire survey	The knowledge and skills required for professional project managers was explored in the paper.

2.4 Conceptual Framework

By summarizing existing theories and relevant concept, a conceptual framework is proposed shown in Figure 1. In this research, the framework describes the influence of project management practices on the sustainable practices in the construction industry. The underlying hypothesis is that the employment of green technology will have a positive effect on the sustainable construction resulting in a greater advantage. Thus, improvement of sustainable construction practices and their relationships can be further discussed in detail in the following section.

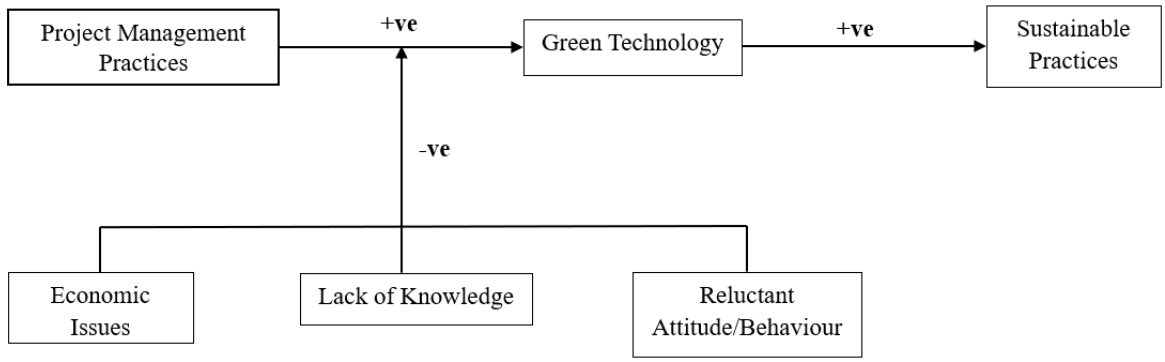

Figure 1: Conceptual Framework

The framework was developed with six variables as shown in Figure 1. Sustainable practices were designated as a dependent variable whereas project management practices were assigned as an independent variable in this research. Whereas the green technology is acting as the mediating variable in between the project management and sustainable construction practices.

3 Methodology

3.1 Research Design

Based on the research onion, this study employs the 'pragmatism' philosophy to provide the research design with reliable and applicable data (Saunders and Tosey, 2013). Quantitative research relies on formal equipment and systematic processes for data collection and this research is applicable for this study as the considered samples of the population are large (Queirós, Faria and Almeida, 2017).

3.2 Quantitative Research Approach: Questionnaire Survey

As the first approach, a questionnaire survey is used to gather expert opinion about how the construction professionals perform sustainable principles in their construction projects. A survey is used as a tool to gather data because it allows for direct access to project participants via a series of questions arranged in a certain order (Queirós, Faria and Almeida, 2017). Moreover, it is mentioned by Queirós, Faria and Almeida (2017) that the surveys have been a prominent way to investigate professional viewpoints regarding a topic due to their benefits of being highly representative of the population and comparatively low cost compared to other methods.

3.2.1 Questionnaire Development

The questionnaire is made up of two segments with close ended questions as shown in Table 4. When collecting the survey, it was ensured that the respondents have worked or are currently working for construction organizations in the United Kingdom.

Table 4: Questions and Adopted Sources

Factors	Themes	No. of Questions	Adopted Sources
Project Management Practices	Knowledge and technical expertise, commitment, leadership and guidance, innovative and sustainable practices, PM standards, information management system	7	Walker and Brammer (2009), Wang and Ng, (2013), Fathalizadeh *et al.* (2022), Maqbool *et al.* (2022)
Green Technology	BIM-based approach, cost and time saving, lean principles, on-site accidents, material waste disposal, energy usage and process variability, machineries efficiency	10	Azhar and Brown (2009), Pandithawatta, Zainudeen and Perera (2020)
Sustainable Practices	Environmental assessment, environment, social and economic factors, top management, project teams and stakeholders, government policy and support	8	Walker and Brammer (2009), Yin *et al.* (2018), Maqbool *et al.* (2022)

In the next stage, the survey is delivered and collected through online platform. The questions are prepared according to variables, namely project management practices, green technology and sustainable practices, provided by theoretical framework in Figure 1.

3.2.2 Type of Respondents

According to Bryman (2016), a representative sample is determined when the total population that is eligible for the research is considerably large. In this research, the data was collected from the professionals who have previously worked or are currently working in the construction organizations in UK and the targeted participants are selected through snowball sampling. In fact, the initial respondents who are relevant to the study's topics were selected through purposive sampling, and the sample was then expanded through their contacts in a snowballing approach. (Bryman, 2016). In other words, the additional respondents were recruited using their social networks (Rose, McKinley and Baffoe-Djan, 2019) and the process is repeated with each new participant recommending more volunteers for the study until the desired sample size is achieved.

4 Results

The questionnaire survey was conducted between 20.03.2023 and 09.04.2023. During this period, a total of 250 participants were requested to participate in the online survey and 205 completed questionnaires were received.

4.1.1 Reliability Analysis by Cronbach's Alpha

According to reports, Cronbach's coefficient alpha is the most frequent technique for determining reliability (Helms *et al.*, 2006) and an estimate of reliability can be decided for a single administration of the test using Cronbach's alpha (Gliem and Gliem, 2003). In other words, Cronbach's alpha determines the degree of internal consistency of respondents' responses to several Likert scale questions (Hajjar, 2018). According to Gliem & Gliem (2003), the typical range of the Cronbach's alpha reliability coefficient is 0 to 1. The reliability value of 0.70 and higher is regarded acceptable (Hair, 2013). Likewise, Hinton *et al.*, (2004) defined the reliability cut-off values as excellent (> 0.90), high (0.70-0.90), moderate (0.50-0.70) and low (< 0.50).

Table 5: Cronbach's alpha, Skewness and Kurtosis Results

Description	Cronbach's Alpha	Skewness	Kurtosis

Green Technology (GT)	0.851	-1.090	3.619
Project Management Practices (PMP)	0.912	-1.8554	4.644
Sustainable Practices (SP)	0.740	-1.110	2.646

Table 5 presents a summary of reliability values, and the results met all the satisfied requirements. According to the proposed criteria by Hinton *et al.* (2004), the alpha values of all variables are highly consistent and reliable. Among the variables, Cronbach's alpha of PMP which is greater than 0.90 implies that the items on the scale have strong internal consistency. Hence, the whole data can be considered to be reliable across the measurement of variables.

Additionally, skewness and kurtosis values from Table 5 implies that the collected data are distributed in an acceptable range. According to Bryne (2013), the data are considered acceptable if skewness and kurtosis are between the range of 2 to +2 and 7 to +7, respectively.

4.1.2 Validity Analysis

Validity is alternative indicator of the test accuracy and consistency of a questionnaire survey, and the validity analysis was performed to assess whether the obtained data involved the actual research area (Ghauri, Grønhaug and Strange, 2020). In fact, there are several types of validity, including construct validity, convergent validity, content validity, and discriminant validity, face validity and criterion validity (Taherdoost, 2016).

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.915
Bartlett's Test of Sphericity	Approx. Chi-Square	6451.761
	df	1081
	Sig.	.000

In this research, Table 6 shows that the value of KMO was 0.915 which was higher than the threshold value of 0.6 (Hair *et al.*, 2019) and Bartlett's test of sphericity was statistically significant ($p < 0.001$), indicating that the data was sufficient to proceed for further analysis.

4.1.3 Correlation Analysis

After checking the reliability and validity of the data, the researcher performed correlation analysis which is the measurement of the relationship between two variables in order to

determine whether they are negatively or positively correlated (Obilor and Amadi, 2018). As specified by Kafle (2019), value of correlation coefficients varies from -1 and +1 where a correlation value of + 1 implies an ideal positive relationship while a negative correlation is presented by a value of - 1. Additionally, correlation coefficient with < ± 0.40 is considered low, between ± 0.40 and ± 0.60 is moderate, and > ± 0.60 is high (Obilor and Amadi, 2018).

Table 7: Pearson Correlation Results

		GREEN	PMP	SP
GREEN	Pearson Correlation	1	.627**	.692**
PMP	Pearson Correlation	.627**	1	.749**
SP	Pearson Correlation	.692**	.749**	1

** Correlation is significant at the 0.01 level (2-tailed)

Table 7 displays a set of correlation data of six variables derived from SPSS. According to the results, both the correlation coefficient between PMP and GREEN and between SP and GREEN is 0.627 and 0.692, respectively indicating a moderate degree of correlation. In contrast, there is a strong positive correlation between SP and PMP with a correlation coefficient of 0.749.

4.1.4 Confirmatory Factor Analysis

As another analysis, Confirmatory Factor Analysis (CFA) was utilised to establish a test instrument's latent structure and statistically investigate the relationship between the observed and latent variables (Brown and Moore, 2012). As KMO and Bartlett's test of sphericity were considered acceptable, the data is suitable for the Confirmatory Factor Analysis (CFA). CFA was carried out using SPSS Amos software to verify the compatibility of the relevant factors. According to Mustafa, Nordin and Razzaq (2020), the proposed loading factor value should be ≥ 0.5.

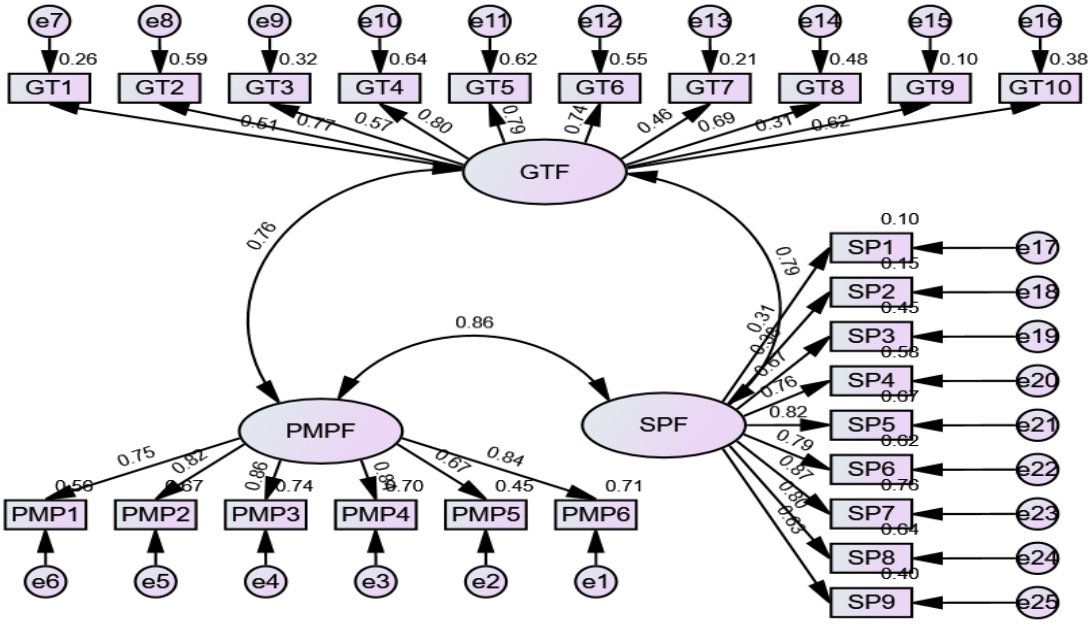

Figure 2: Original CFA Model

Figure 2 presents the original model of the analysis showing the correlation between project management practices, green technology and sustiainable construction practice. The modified model is provided in Figure 3 after removing the loading variables of less than 0.5.

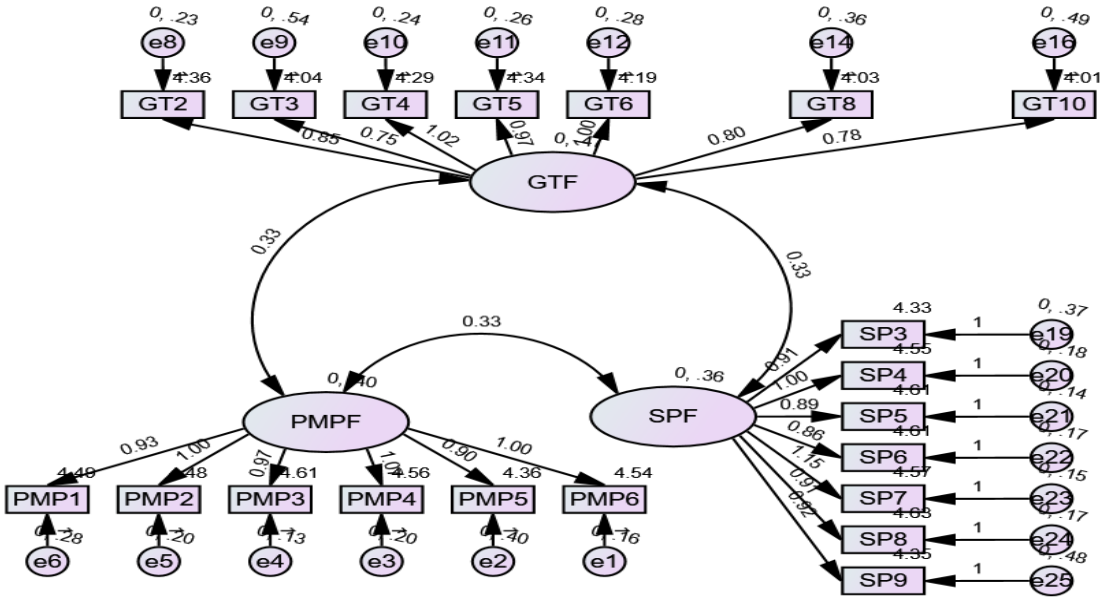

Figure 3: Modified CFA Model

Table 8 presents the recommended value of CMIN/DF, CFI and RMSEA for the analysis.

Table 8: Recommended Values for Confirmatory Factor Analysis (CFA)

Index	Recommended Value	Adopted Sources
CMIN/DF	0 < CMIN/DF < 3 (Good Fit) 3 < CMIN/DF < 5 (Poor Fit)	Hooper, Coughlan and Mullen (2008)
CFI	0 < CFI < 1	Bentler (1988)
RMSEA	RMSEA ≤ .06 (Good Fit) RMSEA > .10 (Poor Fit)	Hu and Bentler (1999) Browne and Cudeck (1993)

According to the first-level CFA model, there were loading factors of less than 0.5 and the data was regarded and calculated once again. Several trials were performed to ensure that all scales met the recommended levels.

Table 9: Indexes References Value for CFA analysis.

Index References	Original Model	Modified Model
CMIN/DF	2.950	2.653
CFI	.828	.904
RMSEA	.098	.090

The modified result was presented in Table 9. It can be concluded that CMIN/DF value of 2.653 was considered an acceptable model fit. A CFI of 0.904 and RMSEA of 0.09 showed an acceptable fit in this research.

4.1.5 Structural Equation Modelling

Structural Equation Modelling (SEM) is multivariate analysis method that is employed to classify how different variables interact and influence one another (Crockett, 2012). In the first stage, the researcher identified the direct relationship between the independent and dependent variable. Given that the results in Table 10, project management practices have significant positive impact on the sustainable construction practices at a high level ($p < 0.001$).

Table 10: Relationship between Independent and Dependent Variable

	Estimate	S.E.	C.R.	P
SPF <--- PMPF	.814	.063	12.944	***

Figure 4 illustrates the direct relationship between project management practices and sustainable construction practices.

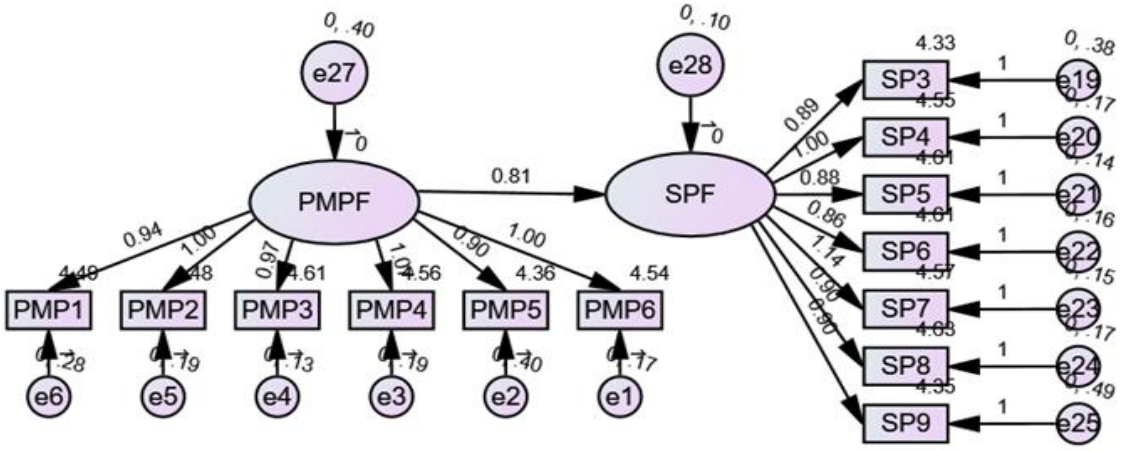

Figure 0: SEM Model Describing Relationship between PMP and SP

In the second analysis, the researcher figured out indirect effect from project management practices to sustainable construction, mediating by green technology. The findings show that green technology and project management practices both have substantial impacts on sustainable construction, and that project management practices also have an indirect impact on sustainable building through green technology.

Table 11: Relationship between Independent, Mediating and Dependent Variable

			Estimate	S.E.	C.R.	P
GTF	<---	PMPF	.879	.066	13.325	***
SPF	<---	GTF	.742	.061	12.251	***

From Table 11, project management practices are indirectly related to sustainable construction practices (mediated by green technology) as p- value is significant at 0.001. Thus, it can be concluded that a better project management approach leads to enhanced sustainable construction practices, which is accentuated when green technology is used.

It can be seen in Figure 5 that the impact of project management practices on the sustainable projects by the integration of green technology.

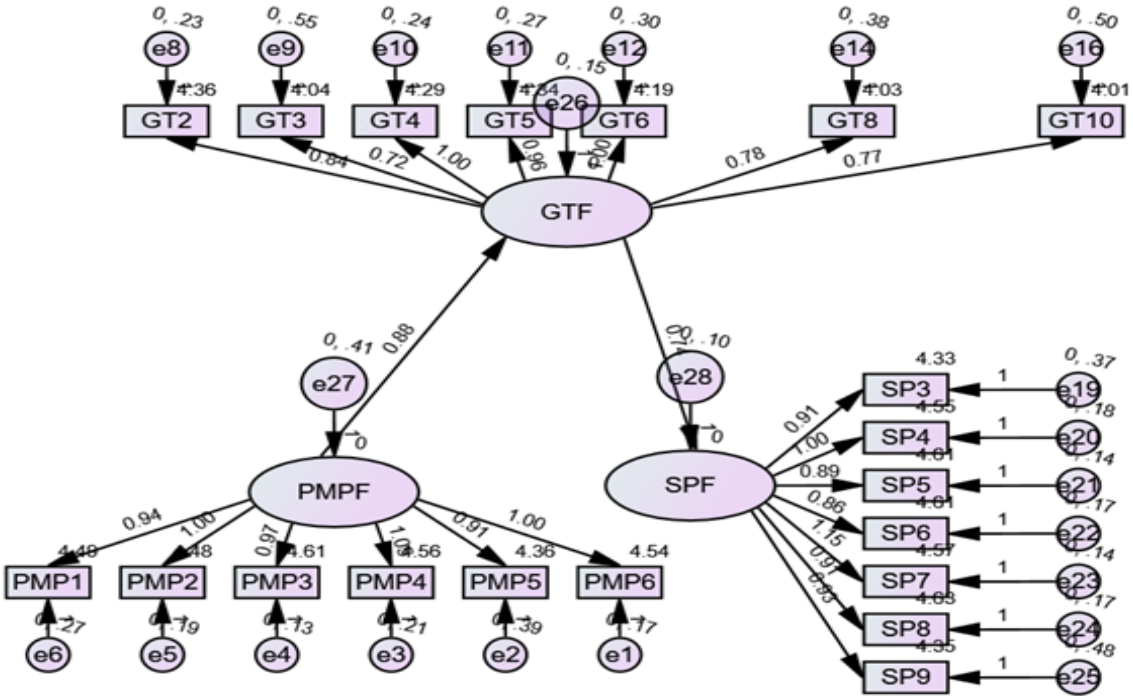

Figure 5: SEM Model Describing Relationship between PMP, GT and SP

5 Discussion

The present research intended to investigate the impact of project management practices towards sustainable building projects. Also, the effect of green technology on the adoption of sustainable practices was explored. This section discusses and evaluates the main findings of the research and, provides any limitations or implications of the research following the data analysis in previous section.

5.1 Project Management Practices and Sustainable Construction

As provided by theoretical framework in literature review section, project management is essential to the success of every construction project, but it has an even more important role to play in sustainable construction. The effective management of construction projects can contribute help to achieve more sustainable building project. The study's findings indicate that project management practices have a strong correlation with sustainable construction, with a value of 0.749, which is consistent with previous research performed by Tabassi et al. (2006). From Table 11, it can be observed that project management practices are still positively associated with sustainable approaches following the introduction of the mediating factors. It is recommended that project management techniques need to be considered in making decisions on sustainable practises since they are a significant determinant of sustainable building projects. Specifically, enhanced project management practices can bring the success of sustainable construction projects in UK.

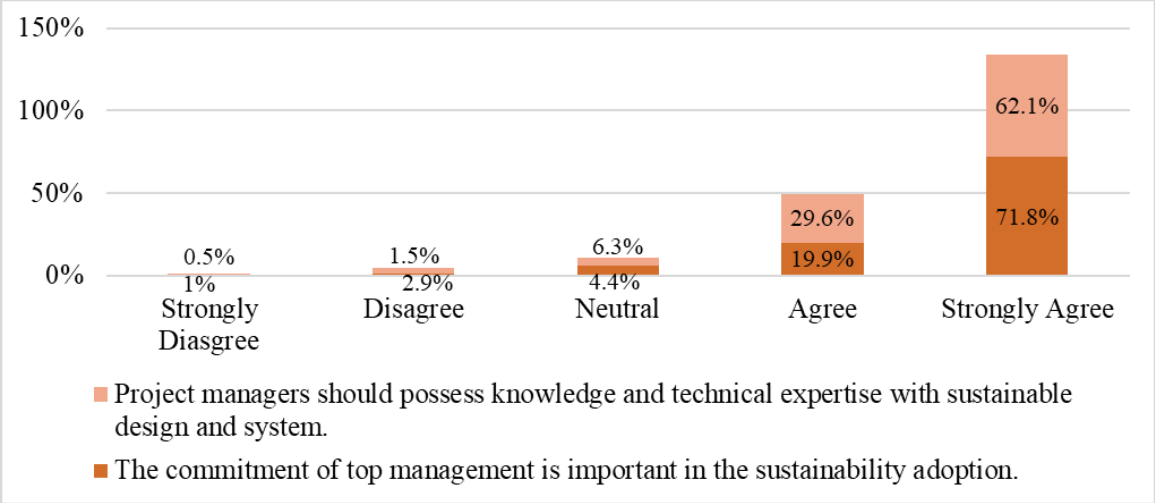

Figure 6: Responses from Survey

In relation with the results from Figure 6, 71.8% of respondents believed that the commitment of top management is important in sustainability adoption while 62.1% considered that project managers should possess knowledge and technical expertise with sustainable design and design. The article suggests that project managers should play an integral role in implementing the latest project management practices including agile project management. The observations are consistent with Hwang and Ng's (2013) statement that a project manager must have fundamental knowledge and abilities in order to successfully carry out a sustainable building project. It is essential to take into account not only the procedures for handling projects but also additional components like stakeholder

management, resource management, or quality management to address every aspect of sustainability in order to pursue sustainable building practises in UK.

5.2 Role of Green Technology in Adoption of Sustainable Construction Practices

As discussed by SEM analysis in the previous section, adoption of sustainable approaches in the construction industry will be more effective if managing building projects with the aid of digital technology. Based on Table 7, the result suggests that there is a significant correlation between green technology and sustainable construction practices (r = 0.692, p <0.001), confirming that these two variables are strongly related to each other. This finding aligns with the previous research done by Li *et al.* (2022). Using data analysis provided in Table 11, the application of green technology enhances the interaction between project management practises and sustainable construction projects. Advanced technologies may encourage successful management practises by providing innovative as well as sustainable techniques for project planning, material and application of resources, and waste management. Furthermore, it appears that most of the UK professionals who responded agree that integrating digital technology into projects increases the sustainability of the building sector. With the introduction of green technology, it is noted that reduce the final cost and delays will be avoided which have an impact on economical sustainability.

Innovative technology will improve the sustainable construction sector in UK since adoption of green technologies can increase transparency and visibility which results in better interorganizational collaboration. Moreover, project managers can lower the environmental effect of building projects and guarantee that sustainability goals are met by incorporating green technology into project management procedures. Sustainability practices in association with BIM and Lean need to be improved constantly as they act as driving force for evolution in UK construction industry. Sustainability is a process involving continuous improvement (Ehrenfeld, 2008), technological progress must also be continually improved which include staff training, promoting the concept and encouraging more people to become familiar with and apply green technologies. The research investigation additionally highlights out that the process of proposing questions on green technology helped to increase the respondents' overall awareness.

5.3 Limitations of the research

There are some limitations to the present research that should be considered. Firstly, the research was carried out in the context of sustainable construction in UK. As a consequence,

the relevance of the results to other organizations or projects in different countries may be restricted. This limitation could be overcome in the future research that focuses into the manner in which sustainable practices are implemented in various perspectives. Secondly, the data gathered for this study was mostly reliant on the subjective opinions of the experts who answered the questionnaires. There is a chance of bias and inconsistencies between objective information and respondents' judgements with multi-item scales in the survey. Further study might solve this particular issue by including objective measures and performing case studies to supplement the survey data. Thirdly, the research's sample size was limited which might have affected the statistical validity of the analysis. In the future studies, a bigger sample size and additional data collection techniques such as interviews and focus groups should be employed.

6 Conclusion

The purpose of this research is to explore the effect of project management approaches on sustainable construction as well as to identify the impact of mediating factors in the industry. The participants were recruited through snowball sampling from UK construction organizations. The reliability, validity, correlation, CFA, and SEM were employed to test the relations and affirm the findings. The responses collected from the survey were tested reliable and valid. Consistent with the theoretical framework, this research provides that the implementation of sustainability in building projects requires effective project management practices. The professionals in the UK construction industry believe that project management practices have direct impact on the adoption of sustainable construction practices. In the perspective of project management practices, the findings suggest that the integration of digital technology also known as green technology can bring a better establishment of construction sector in UK.

The following recommendations are also made to promote sustainable construction in United Kingdom. It is advised that construction corporations in the UK to give attention to incorporating green technology into their projects based on this research's outcomes. Additionally, future academics are advised to investigate other aspects of project management, such as the responsibilities and competency of project managers, stakeholder management, and change management. Case studies might be carried out to investigate the positive and negative aspects of incorporating sustainability into construction projects. It would be beneficial to conduct further research on sustainable practices in the construction

industry in other countries as to provide greater generalizability of the study findings. This will aid in determining if the findings of this study have particular relevance to the UK background or if they are applicable to other countries as well.

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