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RESEARCH PAPER

Integrating Sustainability into Construction Engineering Projects: Perspective of Sustainable Project Planning

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ABSTRACT

This study examines how sustainability may be included in construction engineering project management practices utilizing project planning approaches. To aid construction engineers and managers in better understanding and implementing sustainable practices, the essential tool of sustainable project management, sustainable project planning, has been developed and validated. Sustainable construction approaches can greatly reduce the environmental and social effect of construction projects. Investigations have mostly ignored the significance of HOPSCA. Researchers used a case study approach to assess a well-known HOPSCA project in China that involved several SCPs. Utilizing both qualitative and quantitative techniques, such as exploratory and confirmatory factor analyses of statistical data and content analysis of interviews with construction engineering project managers, sustainable project planning was defined and assessed. Which integrates sustainability principles and should have three components: managerial control, risk response, and work consensus, can be used to predict the performance of sustainable buildings and projects.

KEYWORDS Construction Engineering Project, Construction Practice, Critical Factors, HOPSCA Projects, Project Management, Sustainability, Sustainable Project Planning

Introduction

Sustainability has become a more important consideration in project development as a result of the growing number of stakeholders and the requirement to establish a balance between environmental, economic, and social goals. Recently, it has been suggested that project techniques include sustainability, which has three components: economic, environmental, and social, in an effort to address environmental and social issues in the same way as economic ones. (Gareis, 2013)Project deliverables and the project delivery method, in particular the project's goal and management strategy, will be put to the test by the demand for sustainability (Gareis, et al., 2013; SaraMarcelino-Sádaba, et al., 2015). This is particularly true for large-scale engineering construction projects that must simultaneously manage schedules, optimize resources, and accomplish sustainability goals. To improve stakeholder cooperation, achieve a number of deliverable objectives, and ensure a high level of sustainability, long-term, complex, and uncertain construction engineering projects involving numerous stakeholders (Van Marrewijk, et al., 2008;(Larson & Chang, 2016) Chang, et al., 2016).(e.g., governments, suppliers, designers, owners, contractors, and end-users) are gradually necessary(Alfons Van Marrewijk, Stewart R Clegg, Tyrone S Pitsis, & Marcel Veenswijk, 2008). As a result, it has been difficult to include environmental issues in building engineering projects.

A possible method for putting sustainability into practice is sustainable project management, which is the process of monitoring projects to ensure that their sustainability objectives are met(A Van Marrewijk, S.R. Clegg, T.S. Pitsis, & M Veenswijk, 2008). According to research, in order to handle sustainability-related issues relating to the principles of life-cycle management for a project's resources, processes, deliverables, and impacts, project support activities must be planned, monitored, and regulated. Both an internal and external perspective are necessary for a sustainable project management. The former emphasises the project delivery process throughout the project life cycle, whereas the later emphasises the long-term generation of project deliverables(Carvalho & Rabechini, 2017). This paper explores how to integrate sustainability into engineering projects from the standpoint of project management. Planning was regarded as a system-thinking activity and an essential component of the project life cycle in terms of project management. The needs of stakeholders are met as a result of internal and external (local, regional, and legal) considerations (at different levels of the project structure). Sustainability must be taken into account throughout project planning in order to ensure that construction engineering projects are implemented responsibly. This is because sustainability objectives, such as cost, resources, schedule, and stakeholder satisfaction, directly affect construction engineering project outcomes(Aarseth, Ahola, Aaltonen, Økland, & Andersen, 2017). Although managers and specialists in construction engineering recognize the value of project planning, it is still unclear how much effort will be needed to achieve a high degree of sustainability. Sustainable project planning, as defined and scientifically assessed, is essential to achieving sustainability-related objectives in construction engineering projects. Project planning has already been investigated from a number of angles. The actual planning processes have been the focus of the majority of studies. Currently, there aren't adequate structure analyses and assessment criteria for construction engineering projects that expressly state how sustainability can be achieved through effective design.

The economic growth of developing countries like China is facilitated by an increasing number of development projects (Peng, et al., 2016; Yan, et al., 2017). In 2016, China contributed $19,356.7 billion to world building. It contributed more than 51.85% of the nation's total exports and over 26.01 percent of the GDP of the nation. Thousands of different career alternatives(""China Statistical Yearbook," 2017). Having said that, the industry has also come under fire for using resources excessively. Whenever anything is consumed, contaminants are released. Recent studies have found a clear conflict between China's economic development and environmental protection. Politicians and building industry workers have an amazing task ahead of them. industry. Sustainable building (SC) has received recent attention as a possible solution to this issue. The majority of people believe that sustainable construction practices (SCP) should be used to create new paradigms of development and lessen the environmental harm caused by building projects. Empirical evaluations of successful cases are frequently used in the construction industry to establish industry best practices.

Study on HOPSCA programs is scarce compared to the significant research on SCP. Hotels, offices, parking lots, shopping malls, and convention centers are examples of multifunctional buildings that can effectively provide a range of high-quality services to nearby communities with the seamless integration of HOPSCA. Zhang argues that one fundamental effect of China's growing urbanization may be HOPSCA (2014). Due to the potential to increase economic growth and land-use efficiency, HOPSCA projects are crucial to China's urban development. East Asia(Jing, 2013). SCP use in HOPSCA projects can therefore aid in the sustainable growth of Chinese cities. When compared to other types of construction projects, HOPSCA projects last longer, cost more money, and have a bigger impact on the neighbourhood(Cheng, XU, SHI, & GU, 2010). A HOPSCA includes a range of applications, architectural designs, and building standards. SCP is therefore thought to be more difficult to execute than other project categories in HOPSCA.

This study's goal is to use project planning to evaluate sustainable project management techniques in building engineering projects. By introducing and examining the idea of sustainable project planning to take sustainability into consideration in construction project management, this research intends to fill a vacuum in the literature. This study asks two crucial issues about sustainability in construction engineering project design. How can the planning of sustainable projects be assessed? To help with these research issues, the section that follows summarises earlier research on project planning's definition, assessment, and long-term needs. Engineers working in the construction sector will be better equipped to understand and assess sustainable project design thanks to this research.

It's possible that HOPSCA programs won't be able to apply the findings of earlier studies. As a result, research on model HOPSCA situations is necessary to discover new information. In this paper, the main focus is on "how to do SCP appropriately in HOPSCA projects." The critical factors for implementing SCP in HOPSCA were identified and assessed using a case study in China. Analyses and models of the relationships between various components were also created. According to (Oyebanji, Liyanage, & Akintoye, 2017), important aspects are those few fundamental components that are essential to achieving a specific goal. Practitioners can identify the best methods for implementing SCP in their projects by looking at these variables. The study's author hoped that it would offer suggestions for improving the SCP in genuine HOPSCA initiatives. The suggestions presented in this study for SCP improvement can help HOPSCA activities. This study expands on existing SCP research to include HOPSCA activities, which advances our understanding of the theoretical implications of SCP.

Literature Review

Project planning is a crucial component for the successful execution of projects, according to researchers (DovDvir & ThomasLechler, 2004; Boz & El-adaway, 2013). There are several definitions of project planning, including those of its elements, methods, and steps, as well as its obligations and liabilities. Project planning is the process of giving the project team specific instructions regarding what needs to be done, when it needs to be done, and how much money and other resources need to be allocated in order to successfully complete the project's deliverables(M. Zeynalian & Trigunarsyah, 2013). Project planning can also be thought of as a decision-making process that entails systematic clarification of project objectives, identification of activities, establishment of precedence relationships, planning of timelines, definition of project completion dates, ongoing comparison of project schedule objectives, and provision of resources to meet project requirements in order to realize the goals and courses of action of various stakeholder groups (PMI, 2013; OferZwikael & ArikSadeh, 2007). To implement sustainable project management, it is essential to define the roles of project planning in terms of the many planning activities that can be used, especially for engineering building projects. The activities of project planning should be connected to the idea of sustainability as part of the concept of sustainable project planning in order to secure the social, ecological, and financial success of the project execution.

Defining Sustainable Project Planning.

According to the research that is currently available on the subject, the primary goal of project planning is to remove ambiguity(A Laufer, Kusek, & Cohenca-Zall, 1997). Planning effort has even been proposed as a risk management strategy in high-risk environments. More importantly, though, effective planning provides the necessary abilities to clarify and guide a project's behaviour in order to increase its efficiency(GérardBachy & Ari-PekkaHameri, 1997). This project can be successfully finished on schedule while also reaching its extra goals of social good, environmental stewardship, and economic sustainability, according to a long-term comparison of actual progress and projected details(Stockstrom & Herstatt, 2008). Project planning is one of many techniques used to manage projects. Another benefit of effective project planning is that it allows for the dissemination of clear project objectives to the entire team. (A. Laufer & Tucker, 2006)According to, the four distinct elements of effective engineering planning are execution, coordination, control, and forecasting. Worries regarding the project are what are driving its execution. Coordination in the context of a project means speaking with many parties. Control includes keeping track of how the project is progressing, making adjustments when deviations from the original plan occur, and anticipating any hazards that might materialise during execution. Sustainable project planning requires a revaluation of the concept's roles, key qualities, and methodologies in order to attain sustainability-related goals. As a result, more study is needed to understand the meaning and components of sustainable project planning for engineering building projects.

The evaluation of sustainable project planning must be based on the measurement of project planning since it places a lot of emphasis on project planning practises. Researchers have examined project planning using a variety of metrics with different angles, names, and parts. By looking at the project's scope, budget, and timeline from this perspective, the planning's actual content may be assessed(DovDvir & ThomasLechler, 2004). Similar to this, variances in cost, schedule, quality, and man-hours are taken into account when evaluating the success of engineering project planning(Faniran, Oluwoye, & Lenard, 1998).The three categories of project planning approaches used by ERP are scope planning, baseline planning, and risk planning (Tasevska, et al., 2013; Salomo, et al., 2007). The planning level is calculated using a number of additional indicators, despite the fact that their validity is unknown. However, experts favour a process-based approach to studying project planning. Despite not being viewed as a necessary component, planning process assessments are included in maturity models that concentrate on the capabilities of organisational processes.

When it comes to the most widely used maturity model, the Software Capability Maturity Model (SW-CMM), just one planning process is included in 18 core process areas. However, PMBOK's identification of 47 project processes, encompassing 24 (51 percent) elements, is extremely important to the planning processes. (Zwikael & Globerson, 2004)It has proposed that the remaining 17 procedures on organisational support and the 16 procedures on project manager knowledge from the PMBOK be combined to create the Project Management Planning Quality (PMPQ), one of the most complete evaluations of planning quality currently available. Even while the tools could track development during every stage of the planning process, their capacity for adaptation would be constrained.

(Grover & Goslar, 1993)Explain to managers the significance of goal-setting and communication in the planning process using the five questions from the IS planning maturity framework. The engineering design process was organised using value engineering and constructability(Puddicombe, 2006). You need a formal structure, which includes written procedures and papers, as well as a sizable number of stakeholders and committed resources, in order to create a plan(Papke-shields & Boyer-wright, 2017). The empirical evaluation of sustainable project planning in construction engineering projects must also be built on the project's sustainability-related functions. These scales are therefore inadequate for specifying and analysing sustainable project planning in the field of construction engineering. In other words, it is necessary to develop a scale for evaluating the sustainability of project planning services and practices. The goal will be to standardize and promote sustainable project planning in building engineering projects from the perspective of sustainable project management.

La Defense in Paris first suggested HOPSCA in 1986 as a hotel, office building complex, park, shopping centre, convention centre, and apartment building(Zhang, 2014). Modern cities can benefit from the HOPSCA concept of integrated business development. The urgent need for HOPSCA is due to the generally accepted goals of urban planning, which include low density, compact development, and an unplanned mix of uses(Hu, Fan, & Zhao, 2011). By using scrap materials and creating spaces with multiple uses, these kinds of development initiatives can enhance the quality of life of nearby people while conserving land resources (Yu and Ju, 2013; Ning, 2016). These traits are present in all HOPSCA projects: Larger geographic coverage, integration of a collection of structures with a variety of uses and architectural styles, enhanced resource utilisation efficiency, and major impacts on the local economy, environment, and society are just a few of the benefits (Zhang, 2014; Ning, 2016; Sinkko, 2014; Yu-jie, 2015).

HOPSCA is currently viewed as a novel strategy for the growth of luxury real estate in China as well as a potential remedy for urban issues like traffic jams, population density, and a shortage of available land(Zhang, 2014). HOPSCA efforts have multiplied throughout China, especially in populous areas like Shanghai, Beijing, and Hangzhou. Through the accomplishment of several tasks in a small space, HOPSCAs can assist local inhabitants in saving time and money on their everyday visits. This will help to alleviate some of the problems brought on by insufficient public transportation in major Chinese cities (e.g. Hong Kong). HOPSCAs also help to improve the efficiency of land usage and disperse urban inhabitants. Urban development in China is increasingly dependent on HOPSCA programmes(Cao, 2015). It is possible to support sustainable urban development in China through enhancing the sustainability of HOPSCA programmes(Zhang, 2014). It's time to look into how SCP might fit into HOPSCA projects.

Previous Measurement of Project Planning.

Building on the idea of sustainable development, construction-oriented sustainable development (SC)(Bourdeau, 1999). Charles Kibert defines sustainable construction as "the design and management of a healthy built environment based on resource efficiency and ecological principles"(Kibert, 2022). As a result, environmental and social concerns, including things like resident health, are essential SC principles that must be taken into account throughout a project's lifecycle. According to the Agenda 21 for Sustainable Construction in Developing Countries Report, SC is a comprehensive process that aims to restore and sustain harmony between natural and manmade environments in order to build settlements that respect human dignity and advance economic fairness.(Plessis, 2002). Through its "harmony" ideology, SC seeks to achieve a balance between the economy, society, and the environment rather than concentrating solely on the financial benefits of a project. The idea of the triple bottom line, which includes the environmental, social, and economic bottom lines, now embraces these components of SC.

For different architectural characteristics and objectives, several SC technologies and management techniques are required. For example, LEED-HOMES sustainability criteria differ from LEED-BD+C sustainability standards for retail buildings (US Green Building Council, 2014a; 2014b). Additional project-based investigations were carried out in compliance with this justification in order to incorporate project-specific information with the SCP approach. For instance, (Ozcan-Deniz & Zhu, 2017)considered building roads. To balance projects' competing sustainability objectives, such as cost, time, and greenhouse gas emissions, a multi-objective optimization model was created. The research conducted by Zuo et al. specifically focused on commercial structures (2012). The researchers thoroughly examined Australian enterprises that were carbon-neutral. The investigation by (Ravindu, 2015) focused on a factory.

According to research on industrial structures in underdeveloped countries, "climate-responsive, regionally suitable design is vital for green buildings." Researchers found through project-based studies that for SCP plans to be successful, they must be tailored to the particular requirements of each project. Effective methods for implementing SCP have been investigated in a number of construction projects. However, research on HOPSCA is lacking. The potential social, environmental, and economic implications of HOPSCA projects in China are discussed in Section 2.2. As a result, the long-term growth of Chinese cities may be hampered as well as the sustainability of HOPSCA programmes. Therefore, this study looked into key SCP implementation elements in HOPSCA programmes in an effort to fill this gap. As a result, it added to our understanding of SCP, particularly in the area of HOPSCA project-based studies.

Material and Methods

Secondary data refers to information that has already been collected from primary sources and made available to researchers. In other words, this is already-known knowledge from the past. The information may have been gathered by one researcher for a specific study and then made available to another researcher. Similar to the national census, the data may have been collected for broad use without a clearly defined study goal. Data that is seen as secondary in one study may, in certain situations, be seen as primary in another. When data is used again, it serves as both primary and secondary data for the initial study. Public records, websites, books, journals, and newspapers are just a few of the many sources of secondary data(formplus, 2021).

The use of previously acquired data to respond to fresh research questions that were not addressed in the initial study is known as secondary qualitative data analysis(Hinds et, 1997). It is easier to train new researchers if primary datasets are made available for secondary analysis on their own. The methodical search and organisation of interview transcripts, observation notes, and other non-textual resources gathered by the researcher are referred to as data analysis in qualitative research.

Framework

Recommendations for doing a comprehensive literature review are being followed by us. Using search phrases, journals and papers from various sources are combed in the first step to find pertinent data for this study. (Kitchenham, 2004) Additionally, materials from various periodicals, articles, and books are included in this collection. We followed the stages recommended by(A & Churchill, 1979), with procedural adjustment as suggested by(Flynn & Pearcy, 2001), with the aim of developing a valid and reliable scale of SPP in construction engineering projects(Stratman & Roth, 2002). Sustainable project planning (SPP) was defined and evaluated using both qualitative and quantitative methods, such as exploratory and confirmatory factor analyses of statistical data and content analysis of interviews with construction engineering project managers (SPP). The adopted steps are as following;

- Assessment of the Articles
- Reading the articles and getting information
- Articles are grouped according to their type
- The research studies that served as the foundation for this judgement.
- Quality evaluation
- Analysis of the data
- Draw of conclusion

Results and Discussion

Although sustainable project management offers guidance, it is not immediately clear what actions should be taken or what the key components of sustainable project planning are. To learn more about long-term project planning, 25 project managers from the fields of civil engineering, construction, energy, and chemical engineering completed a survey. The interview wasn't scheduled until the concept of sustainable project planning in building engineering projects had reached its theoretical apex. The participants were chosen using Creswell's stratified convenience sampling method [45]. Nearly half of the participants have been in their current jobs for at least ten years, and all have at least five years of project management experience in the field of construction engineering. More than

96 percent of respondents identified project guarantee as the most important criteria for successful project implementation and long-term viability. 22 out of 25 respondents (88%) emphasized the importance of risk reduction, which shows that sustainable project planning should reduce the risk and uncertainty of delay, waste, and cost that might occur throughout the life cycle of construction engineering projects. More respondents valued the team perception component (76%) than the external orientation dimension (52%); this finding suggests that sustainable project planning will give project stakeholders' social identities and sentiments more consideration.

Using project planning principles to ensure the project's success in terms of both financial viability and social and ecological sustainability, sustainable project planning was defined based on a review of the literature and in-depth interviews. The project's social, environmental, and economic goals will then be accomplished over its entire life cycle thanks to sustainable project planning [13]. "The sustainable project planning refers to the extent to which a project can guide the execution process of the project sustainably, which will affect the project success directly," says Interviewee A. Project Manager B highlights that "the sustainable project planning expresses the capability and the effectiveness that a project team uses project plan to perform project tasks and achieves project goal sustainably in a project life cycle," as stated by the project.

The purpose of this statistical assessment component is to investigate, examine, and develop a method for measuring SPP in engineering-type construction projects. To gather statistical information, researchers performed an online survey of project managers across several industries (civil engineering, energy, and petrochemical). The choice of project managers as a sample is suitable because the survey focuses on factors connected to projects. Project managers are often the only sources of data in organisational study [1,33].The study also found that managers' perspectives on the same phenomenon were more sensitive than those of people in other professions. Project managers are likely to be more informed of the present situation than their superior and other members of the project team with regard to the planning and execution phases of a construction engineering project. The research team's built database of project managers served as the target population. There were 315 responses, which means that 68% of those contacted responded. Due to inconsistent and lacking responses, more than 20% of the cases were eliminated, leaving 303 cases that could be examined further. In order to ensure the quality of the response in a project planning scenario where 40% of respondents had more than 10 years of professional experience, wave analysis was employed to assess the likelihood of non-response bias [49]. Non-response bias was not a problem in this experiment, as shown by the lack of significant variations in means between the first and second halves of replies on any scale at $p = 0.05$.

Exploratory Factor Analysis

In order to comprehend the multiple facets of SPP, we performed exploratory factor analysis (EFA) to hunt for components with a lot of variance. According to Guadagnoli and Velicer [49], when conducting exploratory and confirmatory factor analysis simultaneously, there is no theoretical or empirical rationale for a required sample size. As a result, we divided all cases into two data sets: an exploratory data set (153 instances) and a confirmatory data set (150 instances)[50]. An exploratory data set was first associated with a total of 25 SPP elements. 11 elements were dropped from the inquiry due to the low inter-correlation, leaving 14 for the next step. The bivariate correlations of all items were then assessed to verify that none were greater than 0.9, as suggested by Field [51]. Principal Axis Factor Analysis with Oblique Rotation was used to evaluate 14 items. Using Bartlett's Test of Sphericity, it was concluded that the Kaiser-Meyer-Olkin index of 0.851 was statistically significant (894.93, df = 91, p0.000) [52]. We expected the SPP scale factors to represent sub dimensions of a similar construct, so exploratory component analysis with oblique

(Promax) rotation allowed factors to share variance, which was found appropriate in our scenario.

According to exploratory factor analysis, there are three variables that make up sustainable project planning, and each of these aspects is evaluated using a total of seven items. The first SPP dimension accounts for 41.40 percent of the variation in the model, whereas the second and third dimensions each contribute 10.38 and 8.02 percent.

Factor 1- Managerial Control (MR)

There were five components used to load the first factor. A sustainable project planning process and its results can successfully lead, oversee, and manage projects, as shown by a number of challenges. These items show how managerial control measures were implemented during the project planning phase and how they were used sustainably for the duration of the construction engineering project lifecycle. This element is referred to as managerial control.

Factor 2- Risk Response (RR)

Five more factors are connected to the second factor. It is important to focus on sustainable risk management and preventative measures in construction engineering projects in order to decrease resource waste, cost overruns and social tensions. As a result, we call this factor Risk Reaction.

Factor 3- Work Consensus (WC)

A team member's long-term view on project planning and results is the main topic of the third element's four sections. The identities of team members as stakeholders must also be taken into account during the duration of a construction engineering project. These identities are transmitted through collaboration, communication, negotiation, and acknowledgment.

Confirmatory Factor Analysis

The hypothesised structure of the SPP scale was validated using numerous exploratory component analysis data sets in order to meet the requirements for evaluating scale reliability and validity. A corroboration factor analysis (CFA). Koufteros and colleagues claim that LISREL version 8.7 can be used to fit a hierarchical sequence of confirmatory factor analysis and validate the SPP factor structure [54]. SPP, a single 14-element factor used in Model 1, is used. A set of goodness-of-fit metrics are compiled for each alternative model in order to compare them. Correlations between first-order elements appear to be further constrained by structure in Model 4, which appears to be an extreme variant of Model 3. The ability of Sustainable Project Planning (SPP) to distinguish between diverse project types is demonstrated by its second-order factor structure (D=178.09, df=4, P=0.000) [55]. Construct reliability (CR), Cronbach's Alpha (CA), and the average extracted variance for each SPP item are all included in the standardised regression weights and reliability measures for each SPP item. The acceptable CR and AVE levels are 0.7 [56] and 0.45, respectively. For each construct, there were AVEs that were bigger than the squared correlation between two sets of components that supported discriminant validity [58].

Construct Validity

The SPP scale's ability to forecast project outcomes was assessed during the finalisation phase. The effectiveness of a theory is assessed by contrasting it with other recently accepted ideas in the literature and by examining the particular causes and effects of the theory [59]. Structural Equation Modelling (SEM) was used to evaluate one outcome—Project Success—identified in previous research as an indicator of construct validity [14].

17 major factors impacting the adoption of SCP in this HOPSCA project were found once the coding activities were finished. The associations between these important factors were examined using the Nominal Group Technique (NGT) (Gallagher et al., 1993). Two imaginary groups were created during this process to talk about the connections between the key elements. There were two researchers and eight individuals who were very important in each group. The supplemental materials also contain the interview questions. The speech was recorded using a self-intersection matrix (SSIM2), and the results were examined to find discrepancies between the perspectives of the hypothetical groups. Any discrepancies between the two groups were collated and presented to each separately. The groups finally came to an agreement a fourth time.

There were several factors found. For these important components, it is imperative to create an ISM-based structural model. The following sections provide an overview of ISM procedures (Shi et al., 2015; Singh and Kant, 2008; Shi et al., 2016). The supplemental resources contain the mathematical computations for MACMIC and ISM.

An initial reachability matrix is created using the SSIM, and this matrix is then used to verify transitivity. The final reachability matrix has been created as a result. The matrix of ultimate reachability is divided into several tiers. A directed graph is built based on the connections shown in the final reachability matrix. As a result, all transitive connections have been broken. In the past, ISM has frequently been used in investigations pertaining to sustainability (Shi et al., 2015; Shi et al., 2016; Shen et al., 2016). Numerous pieces of related literature have detailed explanations of how ISM is computed.

Based on the strength of their interaction and the strength of their driving power, the main components were categorised using MICMAC analysis. The process's input data are displayed. Strongly motivating ISM variables frequently have a major impact on other ISM components. During this period, additional influences may significantly affect variables with a high power of dependence. Malone asserts that a power is considered strong if it is more than the average level of all of these factors, and vice versa (1975). 17 key components in all are categorised into independent, dependent, linked, and autonomous groups (Malone, 1975)

Despite being a widely accepted theoretical concept, project planning is rarely understood in terms of how much time should be spent on it for sustainable project management and how construction engineering projects should evaluate their sustainable project planning. This article defined sustainable projects and provided evidence to back up this assertion. It created a scale to assess how well sustainability is incorporated into project design and to gauge the accomplishment of construction engineering projects throughout the course of their lifespans (the SPP). To create a long-term project strategy, we conducted interviews and a poll. Studies show that construction engineering projects that have enough sustainable project planning outperform those that don't. It is essential to ensure that sustainable project management is implemented throughout the whole lifecycle of a construction engineering project in order to achieve project sustainability. Silvius and Schipper's [12] claim that project managers have a skill gap in sustainability is almost congruent with the three components of SPP, namely systems thinking competencies, anticipatory competencies, and interpersonal abilities. Construction engineering projects, in accordance with current research, require sustainable project planning to accomplish self-sustaining and self-remaining in the project life cycle [60].

Conclusion

Engineering construction projects may benefit greatly from the monitoring tool created for sustainable project planning in this work. Due to the significant of sustainable project planning from a sustainable management perspective, we have a better understanding of project planning and sustainability. To correctly organise and manage construction engineering projects, managers must be aware of the core goal of sustainable project planning and the time commitment necessary for sustainable project planning activities. In order to raise the project's quality, engineering for sustainable building emphasises the significance of sustainability in project planning, monitoring, assessment, and decision-making [69]. The sustainability objectives of construction engineering can be directly impacted by project planning because it bridges the planning and implementation phases. It's crucial to find solutions to the following problems: What should be the main focus of sustainable project planning activities, and how much effort should be put into those efforts? There aren't many studies that look at project planning or sustainable function-based evaluation across a project's life cycle. An examination of sustainable project planning in construction engineering projects is necessary given the present focus on sustainability. By creating a new measurement scale, our research evaluated sustainable project planning in the context of building engineering projects.

SCP has been thoroughly investigated in numerous construction projects. In contrast, the literature has mostly ignored SCP in HOPSCA programmes. Initiatives from HOPSCA may have a big impact on China's biggest cities. As a result, research is necessary to decide how to incorporate SCP in HOPSCA. This study looked at an excellent HOPSCA in China to determine and assess the necessary elements for SCP adoption. Additionally, the interactions between these parameters were examined and predicted. The difficulty of generalising results is one of the case study method's inherent drawbacks. However, it is well known that one advantage of the case study approach is the presentation of crucial lessons acquired from comparable enterprises or circumstances (Mitropoulos and Nichita, 2009; Yin, 2013). This study reveals 17 critical factors that can affect SCP acceptance in HOPSCA programmes. As part of HOPSCA programmes, these elements can be used as a checklist to help practitioners improve their SCP. A framework for analysing the vast array of factors was created in response. The connections between various parameters were shown. This structural model can be used to evaluate the potency of various SC strategies. As high-level components frequently have a significant influence on other aspects, SC techniques can be somewhat effective if they can affect factors at the higher levels of the structural model. In the end, a classification using MICMAC analysis was carried out. ISM analysis was used in this study to examine how various components relate to one another.

Recommendations

The study's shortcomings should be considered in subsequent research. An initial case study from China served as the basis for this investigation. As a result, the context of the research significantly influenced the conclusions. Despite the fact that this research has been carefully examined and approved by important project participants, historical concerns must be taken into account before it can be applied to future HOPSCA programmes. Additionally, the structural model created in this work might be tested using a larger sample size.

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