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A Review of Sustainability Indicators for Small-Scale Construction Projects by Private Contractors

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ABSTRACT. *Implementation of sustainable construction has become a prerequisite of the global construction sector owing to its cost, time, and waste management. Environmental, social, and economical sustainability indicators are key parameters for attaining sustainability in construction projects. It was inferred from the literature that sustainability in construction projects cannot be achieved without developing these indicators. Prior researchers used numerous statistical and mathematical approaches, such as fuzzy decision-making procedures and structural equation modeling, to develop sustainability in construction projects. Before creating a framework, significant research was conducted to collect important sustainability indicators in construction projects. This literature review examines papers published by reputable publishers, covering the most recent and important investigations. As a result, the current study's objective is to compile the necessary sustainability indicators and create a framework that can be used for small-scale construction projects. The previously established sustainability indicators for construction projects are identified in this present study. However, these indicators were only developed and identified for mega-scale construction projects. This study offers researchers suggestions for framing research for private contractors to achieve sustainability in small-scale construction works by using an integrated strategy to identify the research needs in this field. Sustainability must be incorporated in small-scale construction projects from the beginning of planning and administration, which must be monitored throughout the project.*

Keywords: Sustainability indicators, Small-scale construction projects, Cost management, Waste generation. Planning, Framework

1. INTRODUCTION

Sustainability is now becoming highly significant in government and private sector construction including the building industry. Environmental, social, and economic sustainability have become increasingly crucial to construction project participants in both the private and government sectors [1]. The sector's adoption of a sustainable construction concept was delayed [2]. However, traditional tendering criteria were frequently employed as the routine commissioning method for small-scale construction projects (SSCPs), and sustainability elements were eliminated from the projects [3]. This is a challenge for improving project sustainability. The framework also has the potential to be adapted and applied [4]. Hence, it is necessary to identify a set of sustainability indicators that influence the construction process of SSCPs, which private contractors often drive. Private contractors must overcome significant challenges in order to improve the contractor sustainability performance for these SSCPs.

Waste management, sustainable buildings, and ecologically friendly materials are all essential developments. The industry's heterogeneous character of sustainability and the lack of defined guidelines and criteria for project sustainability integration are the key challenges [1]. Furthermore, in the construction sector, the fragmentation of the project process, in which project decisions and activities are poorly integrated, is difficult for meeting sustainability performance targets. Therefore, improving the project sustainability performance of SSCPs is a challenging issue. Comprehensive research has been conducted to collect significant sustainability indicators in construction projects. Furthermore, this literature review looks into papers published by reputable publishers, covering the most significant and recent findings. Appropriate indicators of sustainability can be crucial in enhancing sustainable building practices. Despite the considerable research on sustainability indicators, there is still a need to discover relevant sustainability metrics that may be utilized by private contractors in SSCPs.

Building trash production has traditionally increased quickly along with the pace of new construction projects [5]. In order to execute sustainable building on construction sites, waste reduction is a significant concern. Even though earlier studies had discovered several impediments, including a lack of environmental concerns and unresolved waste generation (WG), cost overrun (CO), and project delays (PD) difficulties for SSCPs, unsustainable construction could still be ascribed to these factors. This evaluation found that research on sustainability indicators in building projects is still spread over various subject areas and issues. Given study propose future research directions. This study aims to identify research gaps in the sustainability of small-scale building projects. This study involved a comprehensive analysis of the recently released journal publications as well as the existing literature. This was only available in the most prestigious sustainability periodicals. This literature review aims to point out potential future research directions for this topic and identify key study areas of sustainability in small-scale building projects.

Small-scale construction projects are as essential as large construction projects. These are also important and play role in the basis of any country's economy. Private contractors handle the largest portion of small-scale projects. Furthermore, many contractors are unfamiliar with sustainability indicators. The major problems in small-scale construction projects are waste generation and project delays. In Pakistan, Study for sustainability indicators for private contractors has not been undertaken. Therefore, the current study aims to collect the appropriate sustainability indicators and develop a framework that can implement in small-scale construction projects. Many researchers have studied sustainability indicators for resolving many problems of construction projects in developed countries. So, there is need to resolve certain major issues in small-scale construction projects by sustainability indicators. Before developing a framework, previous literature has been studied in depth to collect considerable sustainability indicators in construction projects. Moreover, this literature research reviews the paper published by high publishers, including the most recent and relevant studies. It covers enough material to show the development and limitations in this area of research.

2. PRIVATE CONTRACTORS

For private contractors to compete in a cutthroat economic climate, success in a building is a crucial problem. Despite its size and importance to the economy, the construction industry has witnessed the increase in the number of failed private contractors in recent years.

2.1. Problems Faced by Private Contractors in Developed Countries

Numerous studies have been done to identify and manage the issues that the industry faces in developed nations. The challenges faced by private contractors are those that affect SSCPs. This study was done by Morris and Jamieson [6]. They examined the data of more than 4000 building projects and found that small-scale projects frequently experienced delays and cost overruns worldwide. They also discovered that projects were rarely finished on time or within the allocated budget. Significant changes to the task scope necessitated a longer approval process, which raised the project cost [7]. This was particularly true in Europe developed nations, where construction investments account for roughly half of all assets, and delays in the 1970s and 1980s reached substantial proportions. Construction owners and a significant number of private contractors that carry out construction work for governmental agencies in industrialized nations have been questioned to identify and rank the causes for such delays in importance.

Construction waste has major social and environmental effects, which were examined in this study by Tafesse, Girma [8], in order to suggest management techniques. Utilizing descriptive statistics, data were examined. The findings indicated that roughly 95.71% of active building projects face difficulties related to construction waste. Additionally, 75.71% of private contractors were not specialist designated to tackle waste concerns [9]. Therefore, governments should prioritize making the entire business climate for all private contractors better [10]. Lack of experience was the primary cause of failure for private contractors (or simply private enterprises and builders) [11]. According to the research, the five most devastating effects of construction waste are, in terms of hierarchy: project cost overruns, environmental pollution, lower profit, a lack of sustainability practices on-site, and threats to public health and safety. Engaging a waste management officer, using prefabricated or off-site components, and applying strong sustainability indicators onshore, such as handling, reusing, and recycling goods left over on the sites, are all sustainable methods to reduce the consequences of construction waste.

2.2. Problems Faced by Private Contractors in Developing Countries

Many difficulties and challenges are faced by contractors in the building sector. In developing countries, however, these problems and obstacles occur with general socioeconomic stress. Performance measurement of private contractors in developing countries was done by [12]. According to the report, the five main effects of construction waste are, in order of importance: project cost overrun, environmental pollution, decreased profit, lack of sustainability procedures onsite, and dangers to public health and safety. Moreover, Confirmatory factor analysis (CFA) identified the underlying latent factors that substantially impact the contractor's profitability (CFA) [13].To lessen the effects of building waste, employing a waste management officer, using prefabricated or off-site components, and implementing strong sustainability indicators onsite such as managing, reusing, and recycling items left over on the sites, are all sustainable practices [9]. There are 11 practical solutions, which may be divided into four

categories: Teaching personnel about sustainable practices, controlling construction sites' procedures, stepping up cost control, and Enhancing equipment management.

The findings may help private contractors in other developing nations, measure the effectiveness of such methods, and strengthen their competitive advantages. Ineffective management in the first phases of a company's lifecycle is a primary factor in private contractors' failure to succeed. To lower operating expenses, clients frequently administer their companies independently. According to CIDB, DPW, and CETA [14], issues with small, developing contractors were present in South Africa's contractor development initiatives: It was challenging for selection criteria to collect those with lack of skills, passion, and ability to work as a contractors; Following the statistical analysis, the top five aspects to consider include delayed activity. Figure 1 depicts the implications of skill shortages in private contractor firms. It was shown that a lack of project managers had the greatest impact (43.9%) for sustainable construction [15].

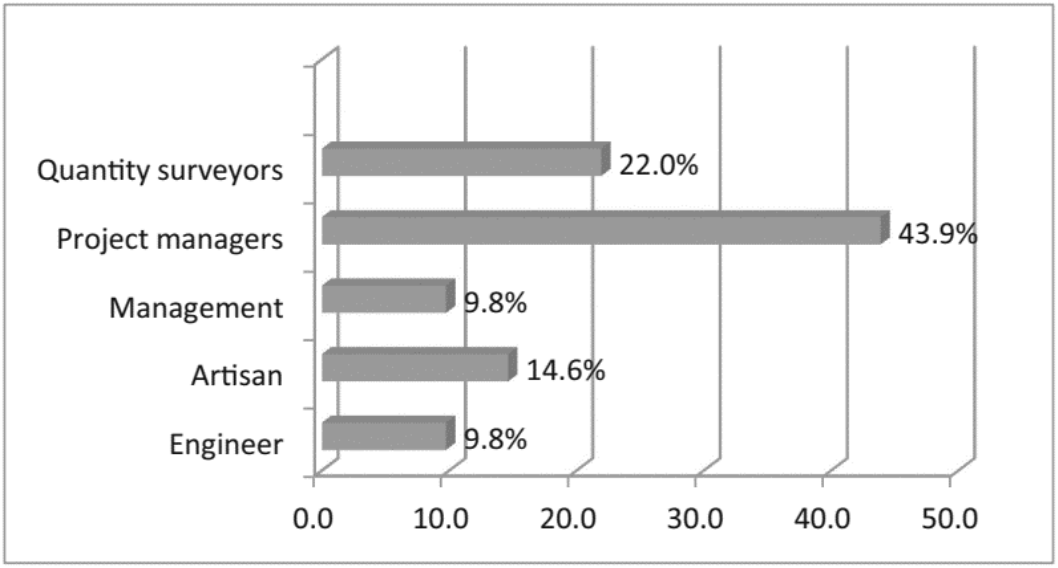

Fig-1: Professional skill shortages' consequences on sustainable construction [16].

Both storage and computing expenses should be affordable, particularly for small and medium-sized contractors that play an important role in the construction industry [17]. Rework wasted employee ingenuity, a lengthy approval procedure, and the requirement to wait because others are not doing work [18]. Two aspects that may lead to business success in the construction sector are sustainable building methods and cost management. However, private contractors need to improve their skills related to time management, scope, and affordable sustainability indicators etc.

3. SMALL-SCALE CONSTRUCTION PROJECTS

In engineering, construction projects are coordinated efforts to create a building or structure. Construction projects comprise a large number of modest initiatives. Mega-scale construction projects need collaborative efforts of humans; these projects are regularly managed and supervised by a project manager and a construction manager. As project size grows, so does its complexity, demanding a larger crew. But small-scale construction projects are not managed frequently.

3.1. Nature of Small-scale Construction Projects in Developed Countries

Construction methods and techniques are various in different scales of construction to complete the project. Construction projects in developed countries can also greatly influence its quality. It revealed that project size differentiators differed throughout the sector, but overall, a project's disclose that project of complexity Lekan, Chukwuemeka [19]. Best distinguishes SSCPs initiatives and large-scale construction projects the nine most often cited markers of project complexity (i.e., characteristics). This study led to the understanding of the consensus process in a SSCPs application instance by building contractors [17]. Sustainability indicators also contribute to additional site advantages such as reduced building times, excellent environmental monitoring, enhancing the quality and sustainability of SSCPs testing relevant and adequate indicators for small-scale building projects in developed nations. They contained indicators for both sustainability and framework. These issues were identified as a result of changes in our SSCPs in developed nations, and warnings were issued that ensuring sustainability would be difficult

[20]. Conventional on-site building methods have long been criticized in SSCPs for their durability, low productivity, less safety, and high waste.

Many construction firms in developed countries, like United Kingdom, do not report on sustainability issues, meaning that office-based and site-based staff take a basic approach to learning sustainability [21]. Moreover, Concept of project success was changed as shows in Figure 2, this approach is changing into "sustainable project success," with more integrated sustainability considerations [22]. Enshassi, Al-Najjar [23] was discovered that the top ten of 42 analysed factors in different developed countries having caused cost overruns in construction works was an increase in material costs caused by ongoing border shutdowns, delays in construction, the supply of construction materials and facilities by contractors, variances in the cost of building materials, construction materials documentary by some suppliers, resource management constraint [24], funds and as-built materials, and as-built materials.

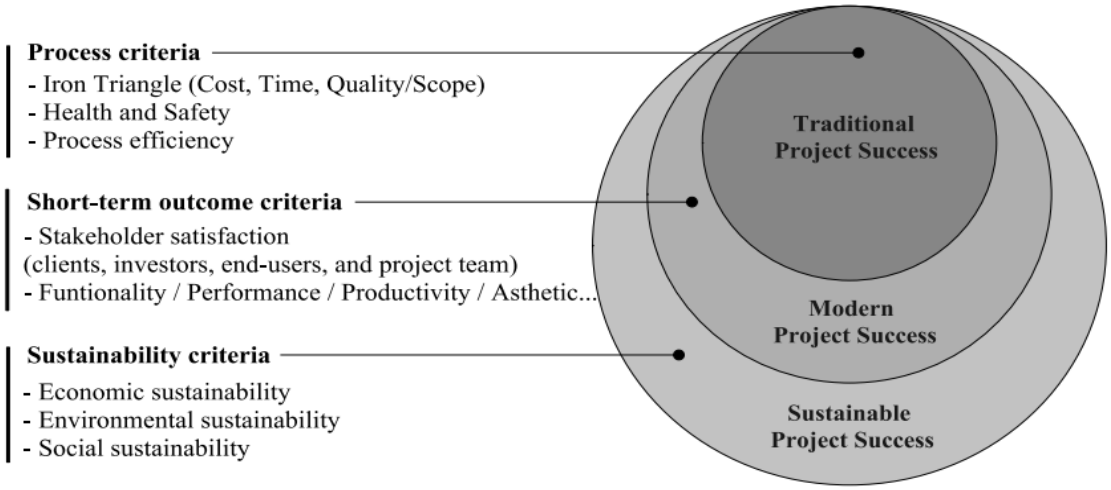

Fig-2: Multiple schools of thought about the definition of project success [22].

In developed nations, challenges to SSCPs a lack of awareness about sustainability, insufficient research on how to increase sustainability, technology shortcomings, and regionally less valued approaches.

3.2. Nature of Small-scale Construction Projects in Developing Countries

Construction researchers have a responsibility to help uplift billions of people out of poverty in poor nations. Most public works contracts in underdeveloped nations was for less than US $15 000 [25]. Effective planning is required for building projects to be completed at a reasonable cost. Because of the job's unavoidable environmental and financial consequences, all construction projects need rigorous planning [19]. Construction projects at scale introduce a range of challenges in managing many people and teams, often with high uncertainty. However, new methods can be adapted easily in SSCPs [26]. When no major cost is required, projects are frequently small. SSCPs are those where any project have contract sum of less than 5 Million Malaysian Ringgit [27]. Project values less than 10 million Sri Lankan rupees was considered as SSCPs the construction duration is restricted to 12 months; and the staff engaged are more generalists than specialists. Further, there is a general lack of sustainability knowledge. Despite the enormous need for construction research in developing nations, progress has slowed down significantly. Thus, many new concerns have arisen that demand the attention of construction engineers in some developing nations.

Many scholars are interested in the failure reasons of construction projects in developing countries. Most likely even though construction projects in poor nations confront more challenges than in wealthy countries. A comprehensive analysis of the aspects associated with residential construction in the province of Kuwait was carried out by Koushki, Al ‐ Rashid [28]. This research study was done to fill a knowledge gap. Poor expected cash, breach of contractual obligations by either the client or the contractor and private contractors, poor management of the construction workforce, poor or nonexistent project planning, and trying to ensure quality delivery within scope and costs were typical issues confronting SSCPs by Le-Hoai, Lee [29]. Inadequate site supervision and monitoring, poor project management support, the owner's financial issues, the contractor's money troubles, and design revisions were identified as the most severe and frequent reasons for cost overruns in the Vietnamese construction sector. Small initiatives in underdeveloped nations have several challenges, including resource restrictions, a lack of technical and administrative aptitude, and a lack of expertise.

4. CONSTRUCTION PROJECTS SUSTAINABILITY

Sustainability plays a fundamental role in construction. The researchers explored how sustainability might improve construction projects. One important study demonstrated how construction projects are conducted to produce better sustainability aspects [30]. Sustainable building construction frequently emphasized minimizing environmental harm and may include elements like waste minimization, recycling, and management, with a stronger focus on serving the community than on making a profit [19]. Sustainability is a process-driven journey with no single defined path that may be reached through many initiatives [27]. The triple bottom line idea proposed that sustainability in construction would be achieved by responding to social, environmental, and economic. Different categories of sustainability indicators were developed as shown in Table 1. Sustainable building addresses not just environmental or ecologic sustainability challenges, but also economic (e.g., competition, and construction time), cultural (e.g., safety and health,), and technological sustainability.

Economic sustainability can be defined as both direct and indirect savings, expenditure, and construction time [31]. Financial well-being is linked to financial profit from building projects that benefit the public, contractor, client, and government [31]. Financial or economic sustainability may therefore be defined as the specification of construction costs, running expenses, operation and rehabilitation costs, and market opportunity. Global concepts of social sustainability state that the demands of social groups participating in the building process, such as inhabitants, contractors, and so on, must be considered to increase overall satisfaction [32]. As a basis of this description, social evaluation indicators attempted to concentrate on all stakeholders as well as the building sector. Unfortunately, the social part of a well-known sustainability evaluation method only examined interior environmental quality when it came to residents' housing needs. However, according to the agreed-upon definition, social sustainability can encompass a wide range of approaches to managing from safety to other psychological and physiological demands of stakeholders [33]. As a result, social sustainability evaluation systems can be based on a variety of human requirements, including comfort and health, safety, culture and history, access and integrated approach, social contact, and so on.

The sharp increasing solid waste generation has raised environmental concerns worldwide, which have escalated to a worrying level. Environmental sustainability is defined as the long-term viability of a natural environment that leads to long-term development by using resources for delivery and emissions [34]. It has acknowledged the environmental side of sustainability as a devaluation of economic action, where a reduction in resources can reduce stress on natural processes and extend environmental benefits to the economy [35]. Energy consumption is recognized as a norm in terms of water usage, carbon emissions, the use of renewable sources, low health-hazardous equipment, renewable energy use, and sustainable environmental measures. Therefore, the concept of adopting environmental indicators and technologies for environmental sustainability has been increasingly recognized and included in recent years.

Table 1: Sustainability indicators in various type of construction projects.

Theme	Sustainability category	Indicators	Author (year)
A. Social Life Cycle Assessment			
Sustainability infrastructure rating system	Management, society, environment and economy	29	Diaz-Sarachaga, Jato-Espino [36]
Hydropower sustainability	Environmental, social, economic, and Technical,	28	Tahseen and Karney [37]
Environmental sustainability	Less use of land, sustainable use of nature, and non-renewable energy resources.	13	Baños-González, Martínez-Fernández [38]
B. Life Cycle Cost			
Renewable and sustainable Energy	eco-efficiency; socioeconomic, and socio-environment. Lifecycle; environmental indicators, economic indicators, and social indicators	44	Chong, Teo [39]
C. Life Cycle Assessment			
Life cycle sustainability assessment	Social, Environmental, Economical;	19	Steen and Palander [40]

Life Cycle Analysis (LCA), is a well-recognized decision-making support technique that is used only to evaluate the environmental burden. LCA seeks to assess the significant environmental implications of a product or procedure across its full life cycle. LCA studies for buildings, like LCC, may be concerned with the entire structure or its constituent pieces, such as materials or elements. The majority of LCA literature review fall under the latter type [41].

The identification and analysis of social factors in life cycle estimates is frequently claimed to be difficult due to their diversified character, the diversity of stakeholder groups impacted by them, and the potential for a higher change in time relative to environmental aspects [42]. As a result, few research has concentrated on a holistic evaluation of structures that includes social factors as well as environmental and economic facts [41]. However, this is a significant shortcoming in the building assessment sector, since the word "sustainable" is built on three pillars, and all components must be examined sequentially in making choices in order to get meaningful outcomes.

LCC intends to assess the cost efficiency of different design options by taking into account the probable startup and operating expenditures that will be spent over a specific time period. The use of LCC estimates in construction projects became increasingly common as people became more conscious of the importance of building operations and maintenance expenses, as well as the developing "value for money" trend. According to Flanagan and Jewell [43], the operating and maintenance expenditures of an office building will be three times the capital price after 25 years. Sustainability concerns, as well as the growth of the project finance model, have pushed LCC strategies to the forefront. However, there are also issues connected with a lack of consistent data on cost, performance, and uncertainty in predicting future expenses [44]. The consequences of inflation are also included. the estimate of building average lifespan is critical in LCC. Ashworth [45] contends that the uncertainty in building life expectancy are driven by obsolescence rather than deterioration. However, the new methodologies are still growing, so future research should focus on the challenges encountered in developing a uniform approach. One of the key challenges is the lack of regional data.

Fig-3: LCA, LCC, and SLCA relationship indicated the key to sustainability.

Life Cycle Sustainability Analysis (LCSA) = (LCC+LCA+SLCA). The LCSA calculations, as shown in the formula, incorporate the SLCA in addition to the LCC and LCA as shown in figure 3 that ensure sustainability. The social factor in the assessment of product or process sustainably refers to the effects on stakeholders [46]. Because SLCA studies are still in their early stages, a number of obstacles in methodology, such as the identification of social criteria to be employed and the requirement for region-specific data, have been identified [47]. Several scholars have sought to study if and how social elements may be included in LCA estimates for application areas. However, Zamagni [48] identifies problems, particularly with SLCA, and adds that further research is needed to improve computations. There is no doubt that the construction industry plays a vital role in the long-term growth of nations. To date, a range of life cycle-oriented methodologies with various aims for analyzing the various components of sustainability have been offered. However, there is still a need for a clear, systematic, and consistent technique for combining economic, environmental, and social impact evaluations.

4.1. Indicators Of Sustainability in Small-scale Construction Projects

Indicators are numbers or other metrics that provide information about a complicated event. Shortlisted sustainability indicators are shown below in Table 2 from literature based on three pillars of sustainability. A prioritization matrix can provide the importance and relevance of the sustainability indicators, as well as the amount of labor were necessary to implement them [49]. The above sustainability indicators are evaluated for small-scale construction projects like wastewater treatment plants, small developments, and small contractor firms as well.

As stated in the introduction, there is a high need for small-scale construction project indicators (buildings). More sustainability metrics were often implemented into their management system [50]. The category of economic sustainability indicators studied in the literature. Yadegaridehkordi, Hourmand [51]. A fuzzy multi-criteria decision-making technique was used to evaluate sustainability indicators for buildings. Building construction has had

significant environmental consequences despite its value in national economic progress. As a result, sustainability evaluation models were provided to account for indicators to quantify the examined reality.

Table-2: Shortlisted Sustainability Indicators from Literature

Sustainability indicators	**Indicative references**					
Economical Sustainability Indicators	[52]	[53]	[54]	[55]	[56]	[57]
Financial/Economic performance	✓	✓				✓
Economic and Political stability				✓		✓
Life cycle costs						
Innovation management/new product development	✓					✓
Resource planning	✓		✓	✓		✓
Cost management plan		✓	✓			✓
Environmental Sustainability Indicators						
Energy efficiency		✓	✓			✓
Control on air pollution						
Eco-efficiency		✓			✓	
Waste Management						
Water consumption		✓		✓	✓	
Social Sustainability Indicators						
Social responsibility	✓		✓			
Public conveniences in the project area			✓			✓
Corporate sustainability and organizational culture		✓				
Labor practices	✓	✓		✓		✓
Community relationships and involvement		✓		✓	✓	
Contractor - supplier relationship	✓	✓			✓	

The construction industry is defined as a group of firms and organizations that collaborate to create structures, buildings, and residential areas. Adverse environmental effects from using primary building resources in the construction industry [58]. Every project's ultimate objective is a success. A successful project will frequently achieve its initial goals or objectives [59]. This study created a detail set of sustainability indicators for small-scale wastewater treatment plants in Bolivia state, a lower-middle-income nation. The most important sustainability indicators, such as the utilization of renewable energy, water consumption, and water recycling. In contrast, the most significant variable in the socioeconomic category is building site safety. As a result, numerous evaluation criteria have been proposed in the literature. While broad evaluation criteria may apply to all construction projects, the following are the most typical causes: (1) financial issues on the owner's part, (2) change orders/variations, and (3) a lack of communication/poor relationship [60]. Cossio, Norrman [61]developed indicators for assessing the sustainability of small-scale wastewater treatment facilities in poor and lower-middle-income nations. Sustainability indicators can quickly achieve the requirements of sustainable construction. Thus, several studies propose sustainability metrics for analyzing planning and operation.

5. CONCLUSION

Sustainability is becoming popular during the construction phase of a project, but it has yet to become as widespread. Previous research work about barriers in adopting sustainability was analyzed and reviewed. This study aimed to evaluate the considerable sustainability indicators in construction projects. Selecting the appropriate sustainability indicators for three different pillars during the construction phase is essential to achieve Sustainability. The followings conclusions are drawn based on the research work:

- The major problems faced by private contractors are waste management, inadequate planning, and unawareness of suitable sustainability indicators. Moreover, SSCPs issues are poor site management, lack of sustainability in construction, and cost management issues.

- Sustainability indicators also contribute to additional site advantages such as reduced construction duration, good environmental monitoring, and enhancing the quality of construction.

- In construction projects, sustainability indicators and their framework are becoming more important. The study inferred that the SSCPs indicators are different from large-scale construction projects and need to be explored.

Moreover, different applications of sustainability indicators are particularly important for increasing SSCPs sustainability. The sustainability indicators must be limited and easy to use for private contractors in SSCPs. Additionally, future research must look at the effects and implications of sustainability indicators in medium and large building projects.

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