

# Improvement of Contractor's Competitiveness through Sustainable Construction Practices in UAE

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**Abstract**—Sustainability of construction projects is an important issue to be addressed since the sector will continue to be developed in the coming years, especially in developing countries. Thus, it is significant to discover approaches and solutions for improving sustainability. Currently, the construction industry is the largest consumer of natural resources. This is the same in other countries in the Gulf region, and the United Arab Emirates (UAE) has limited natural resources such as water, electricity, etc. Recently, the UAE has taken several actions in order to implement sustainable initiatives within its construction industry. Within the industry, the contractors' role is significant in promoting sustainable development by taking the responsibility to minimize their negative impacts on the environment and society, and maximize their economic distribution. In this research, sustainability will be studied as an important key to bring competitive advantages to contracting organizations. The contractors should understand the need to improve their sustainable performance in order to expand their business competitiveness. Competitiveness at the construction project level refers to a contractor's ability to compete for a project. There is less focus on how to improve contractors' competitiveness by implementing sustainable construction practices. Based on an inclusive literature review on the relationship between sustainability performance and business competitiveness, this research will conduct a study of sustainable practice in the construction industry and the relationship between sustainability performance and business competitiveness in order to develop a framework for evaluating how contractors can improve their competitiveness in terms of more efficient processes, enhancements in productivity, and lower costs of compliance in order to reduce the initial project cost and obtain market opportunities in the UAE. The research findings will provide a framework that can be a useful guideline for contractors to develop their sustainability policy, strategy and practice for meeting the increased requirements for sustainable development in construction.

**Keywords**—Sustainable construction practice, sustainability, competitiveness, construction industry, contractors.

## I. INTRODUCTION

THE construction industry is considered part of any country's national economy and industrial development. It is often known as a key for economic growth especially in developing countries. The constructed environment comprises one of the main pillars of economic growth, but from another perspective, its construction has important influences on resources, such as land, materials, energy, water, and on the living and working environment. The construction industry is often known as an industry that degrades the natural environment [1]. Several researchers have raised concerns

about the continued negative effects of the construction industry on the environment [2], [3]. The idea of sustainable construction has been introduced and emphasized mostly in developed countries while there is less attention toward the sustainability concept in developing countries. The UAE is no exception.

The most widely accepted definition of sustainable development is meeting "the needs of the present without compromising future generations' needs", according to the definition suggested by the World Commission and Environment and Development [4]. Bourdeau [5] states that, according to this definition, it is obvious that the numerous activities of the construction sector have to be analyzed when considering sustainable development. Rackwitz et al. [6] state that the immediate implications for the planning, design and operation of construction projects are clear: save energy, save non-renewable resources, consider the re-cycling of construction materials, do not pollute the air, water or oil with toxic substances, save arable land, and do not interfere with the water supply, etc.

From another perspective, the recent economic recession affected the construction industry's business environment, increased competition and changed the nature of some businesses. The increased competition forced organizations to submit lower bids for contracts, and companies had to implement organizational restructuring so they could respond to changes more quickly. In the UAE, this competition has been increased further by the appearance of international contractors looking for new opportunities. The construction contractors have been forced into using several strategies, plans and ideas in bidding in order to win contracts in a progressively competitive atmosphere [7], [8].

There is a lack of effective studies and research which focus on improving the suitability of construction practices in the UAE. There are few studies concentrating on the contribution of the sustainable construction industry and the relationship between sustainability performance and business competitiveness in the UAE. Thus, it is essential to improve sustainability practices as a source of competitive advantage leading to more efficient processes, enhancements in productivity, and lower costs of compliance in order to reduce the initial project costs and obtain further market opportunities [9], [10].

## II. LITERATURE REVIEW

### A. Sustainable Technology in the Construction Industry

The concept of sustainability in construction development refers to the integration of environmental, social and economic

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considerations into construction business strategies and practices [11]. The principle of sustainable development is the application, including the comprehensive construction cycle from the extraction of raw materials, through the planning, design and construction of buildings and infrastructure, until final deconstruction and management of the subsequent waste [12]. Sustainability in construction is an approach to building which encourages the achievement of goals related with the triple bottom line of economic sustainability to promote economic growth, environmental sustainability to minimize environmental impacts, and social sustainability to maintain social inclusion with economic growth [13]. The triple bottom line concept of sustainability with its interface on society, environment and the economy is illustrated in Fig. 1.



Fig. 1 Triple bottom concept of sustainability [13]

In [14], the sustainable construction concept focuses on creating a sustainable built environment under six principles: 1) minimize resource consumption, 2) maximize resource reuse, 3) use renewable or recyclable resources, 4) protect the natural environment, 5) create a healthy, non-toxic environment, and 6) pursue quality in creating the built environment. Much has been considered regarding efforts for reducing waste generation and improving methods in minimization of the negative impacts of construction activities on the environment [11]. Many research efforts have been made on environmental issues in the construction industry, including impacts of rapid infrastructure growth on the environment; investigation on the waste flows and control on construction sites; techniques for feasibility assessment of construction projects in contributing to the achievement of sustainable development; and evaluation of sustainable performance of construction projects and contractor activities [15]-[18].

#### B. Sustainability Development Needs in UAE

In developing countries, construction development's share of total energy consumption is much higher than in developed countries due to fast economic development and quick urbanization, which increases energy use. In addition, population growth in developing countries leads to greater problems concerning pollution and waste generation, which results in greater CO<sub>2</sub> emissions in the atmosphere. Many

researchers discuss that transportation infrastructure in coastal areas, for example, is exposed to rising sea levels as a result of climate change [19]-[21].

According to the White House Initiative on Global Climate Change [22], CO<sub>2</sub> production levels have been reducing in developed countries since 1995, while levels have been increasing in developing countries since 1995. This proves a clear warning that developing countries are in a critical situation and necessary actions have to be taken in order to reduce CO<sub>2</sub> emission levels.

The UAE is considered a developing country. Since the discovery of oil and its resultant export in recent decades, economic development and population have been growing very fast [21]. Consequently, the demand for energy and resultant CO<sub>2</sub> emissions is increasing, which are considered two important concerns in the UAE. The statistics of the UAE show the increase in greenhouse gas (GHG) production in the range of 33% to 35% between 1997 and 2006 [22].

Recently, in the Dubai Global Energy Forum, the Dubai Electricity and Water Authority (DEWA) announced that over the last 11 years, the increase in electricity and water usage has reached 203% and 144%, respectively. The use of electricity and water in Dubai is anticipated to increase by 93% and 59%, respectively, by 2021 [20]-[22]. Therefore, sustainable construction practices have to be concentrated more in developing countries as construction is still under development and growing very fast. Additionally, any move towards sustainability in the construction industry is very important as it may shift the economic development towards sustainability to enhance the welfare of society.

The effective use of proper plant and equipment, the minimizing of waste, economical designs and improved quality in construction will lead to the awarding of more projects which will result in increased market share and profitability. Many researchers have raised their belief that sustainability and cost efficiency are the key foundations for the long-time survival of any organization. Therefore, it is extremely important to construction companies to implement sustainable construction practices in order to increase their market share and ensure their long-term survival. Accordingly, a study about the relationship between sustainability and contractors' competitiveness has been conducted in order to investigate a framework.

#### C. Measuring Business Competitiveness

Competitiveness is considered as a management or economics perspective that is superior to the traditional economic indicators such as profitability, productivity or market share, which are not counting deficiently continuous improvements of performance [23]. Competitiveness can provide management a direction on how to improve its operations in terms of long-term and sustainable performance [23].

Competitiveness research at the construction industry level has seen a difficult argument between productivity and competitiveness. Some research considers [16]-[23] competitiveness as a modern term and uses productivity for

competitiveness without identifying the difference between the two concepts. Some studies dispute that productivity is the right basis for competitive advantage, describing competitiveness by using productivity [23]. Researchers considered various productivity measurements, i.e. labor productivity, capital productivity or total factor productivity, as a shift from looking just at productivity to the wider concept of competitiveness [23].

Calculating contractors' competitiveness is a pragmatic study which has enhanced the inequity. The research is suggesting a 'standard' procedure: (1) identifying

competitiveness indicators; (2) collecting data for the indicators; and (3) calculating a competitiveness index. Research implements such a methodology but does not reevaluate whether the measured index has reflected the sustained performance of firms, as was pointed out by the definitions of competitiveness [23].

Lu et al. [24] studied the success factors of competitiveness factors for competitiveness of contractors in China. They found that there are 35 major factors that enhance a contractor's competitiveness in the Chinese construction market, as illustrated in Table I.

TABLE I  
SELECTED SUCCESS FACTORS FOR CONTRACTOR COMPETITIVENESS CONSIDERED IN THE PRESENT STUDY [24]

Code	Factors	Code	Factors
F1	Strategic awareness and perspective	F25	Relationship with subcontractors/suppliers
F2	An explicit competitive strategy	F26	Relationship with government departments
F3	Matching strategy to a company's situation	F27	Relationship with public
F4	Strategy implementation	F28	Market research and planning
F5	Suitability of organization structure	F29	Capability of gathering and processing information of new projects/contracts
F6	Clearly defined and allocated functions for different departments	F30	Availability of product and price information of labor, materials, plants, and other resources
F7	Communication and coordination among functional departments	F31	Logistic and Supply chain management
F8	Motivation and job satisfaction	F32	Bidding strategy
F9	Interaction between management and general staff	F33	Experiences in bidding
F10	Firm's history	F34	Bidding resources
F11	Firm's size	F35	Proper decision on whether to purchase or to hire plant
F12	Organization culture	F36	Plant management
F13	Business coverage	F37	Quality management
F14	Leader's personality and capability	F38	Time management
F15	Current capacity of human resources	F39	Cost management
F16	Sustainable development of human resources	F40	Health and safety management
F17	Financial resources	F41	Environment management
F18	Financing ability	F42	Contract management
F19	Financial stability	F43	Risk management
F20	Technological innovation ability	F44	Project insurance
F21	Sustainable development of technology and R&D	F45	Claim skills
F22	IT application	F46	Dispute resolving skills
F23	Relationship with clients/owners	F47	Knowledge and expertise on law
F24	Relationship with designers/consultants	F48	Site management

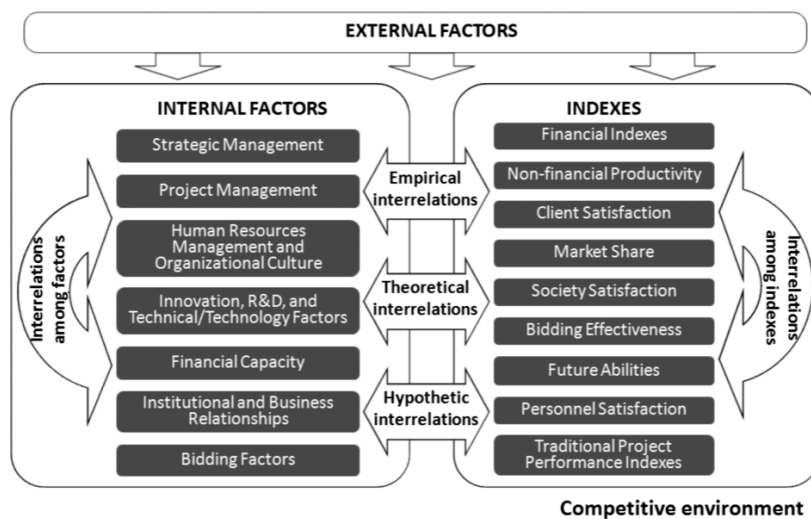


Fig. 2 Conceptual interrelationship model for competitiveness [25]

The above-mentioned factors are obtained through survey data and then through two statistical analyses: ranking analysis and factor analysis are ranked. Those most important factors for a successful bidding approach are “having an explicit competitive strategy” and “developing a good relationship with the government”.

A complete list of factors and indexes has been deduced from the relevant literature. It has been discovered that there is a final set of 58 internal factors (grouped in seven categories), 11 external factors, and 29 indexes (grouped in nine categories). The theoretical model (refer to Fig. 2) displays these groups of factors and indexes associated with competitiveness and the interrelationships that would control competitiveness in a construction industry.

Orozco et al. [25] is proposing modeling competitiveness factors and indexes for construction companies. They propose an interrelationship model to describe how these above variables are interrelated based on well-known business models. The proposed model was assessed using the partial least squares path modeling method. The results show that leadership has, in general, the strongest impact on the competitiveness indexes, which means that whatever the objective is set by the construction company, close attention should be paid to leadership.

#### *D. Relation between Sustainability and Competitiveness*

The construction industry has a major influence on the environment, so the improvements in environmental performance in the construction business have to be identified as major contributors to maintain contractor competitiveness [15].

Achieving competitive benefits in the construction industry is a foundation for any company desiring to continue to compete in any market. This requires that companies search for new approaches, methods and processes to keep them competitive. Due to the negative impact of the construction industry on the environment, it is important that companies working in the construction field attempt to implement sustainable practices through protecting the environment, enhancing society and growing the economy [11]. These goals will motivate competition between construction specialists and will be accomplished by using innovation and sustainability as a strategy for accomplishing competitiveness in construction. The relationship between innovation, sustainability and competitive advantage is cyclic, as shown in Fig. 3.

In terms of construction, innovation is the employment of a new or improved production or execution method. This includes important changes in methods, equipment and software. Process innovations can be planned to minimize production costs, accelerate service delivery and increase quality [11]. Additionally, Lopez and Brandes [26] discuss that innovation and technology are considered as two of the most significant aspects for competitiveness, as they enable and confirm sustained productivity improvements and economic growth.



Fig. 3 The relationship between sustainability, innovation and competitive advantage [11]

Porter and van der Linde [27] believe that there is a relationship between sustainability and competitiveness: “Proper designed environmental standards can trigger innovations that lower the total cost of a product or improve its value. Such innovations allow companies to use a range of inputs more productively from raw materials to energy to labor thus offsetting the costs of improving environmental impact and ending the stalemate. Eventually, this increases resource productivity, and it makes companies more competitive”.

Robinson et al. [28] discuss that implementing sustainable construction practices can have viable advantages such as cost saving from waste reduction strategies, improved human development and better labor practices by minimizing the risks relating to dangerous construction sites, having a good reputation, loyalty, increased market access and an improvement in repeat business. According to a survey conducted in the UK construction industry, Adetunji et al. [29] found that the sustainability approach and effective reporting to stakeholders can help improve contractors' reputation and business competitiveness. Sustainable construction is therefore considered highly important for the long-term capability of contractors. Fergusson and Langford [30] also explored the relationships between environmental strategic development, competitive benefit and business performance improvement. Improved environmental competencies lead to an increase in the opportunities for companies to gain competitive advantages that lead to improved business performance. Tan et al. [11] reviewed sustainable development in construction to propose a framework which helps contractors to improve their competitiveness by implementing sustainable construction practices based on an empirical study.

The relationship between economic and environmental performance and social responsibility committed by firms has been studied by many researchers [31]. Lee and Ball [32] discuss that top managers' commitment toward environmental aspects will impact the decision of different types of business approach and financial performance. Wagner and Schaltegger [31] studied the relationship between sustainability performance, business competitiveness and economic success, and suggest a framework for evaluating the relationship between sustainability performance and business

competitiveness, as shown in Fig. 4. Furthermore, Wagner and Schaltegger [31] also propose a phenomenological link between sustainability performance and economic success, according to the model shown in Fig. 5. The decreasing curve in Fig. 5 specifies the traditional view of environmental economics. They argue that environmental protection activities would reduce economic success and the reason for environmental regulation is to correct the negative behavior which would accordingly lead to additional costs for companies. Alternatively, the 'revisionist' view argues that the implementation of sustainable practices by a company has a beneficial impact on its economic success. The reason is that improved sustainable performance is a source of competitive advantage leading to more efficient processes, improvements in productivity, a reduction of the costs of compliance, and in finding new market opportunities. However, these benefits will be decreasing after the peak point due to the increasing investment on sustainable activities.

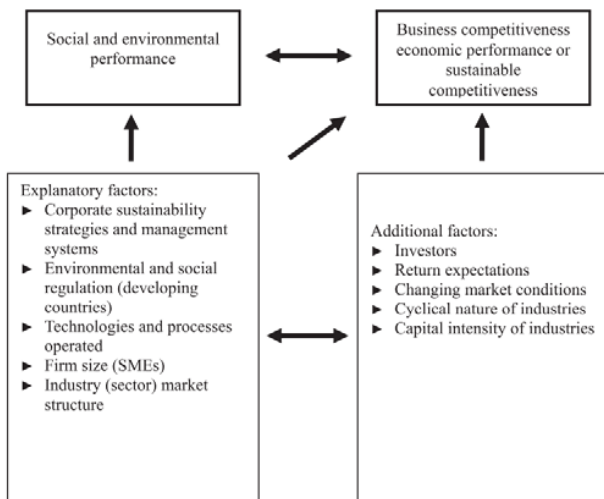


Fig. 4 Framework for the interaction of explanatory factors with sustainability performance and competitiveness [28]

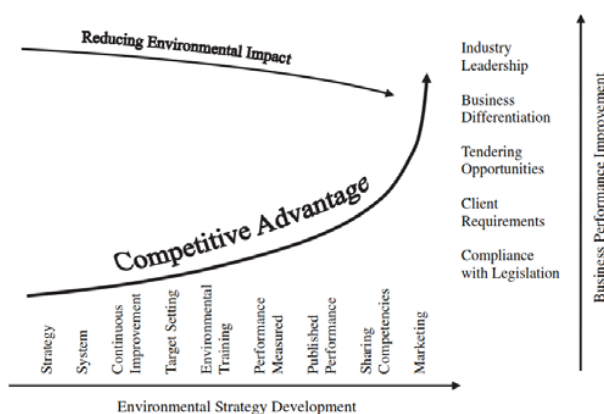


Fig. 5 Relationship between environmental strategy development, performance improvement and competitive advantage [31]

Trufil and Hunter [33] develop a sustainability framework

for small- and medium-sized enterprises to help improve business competitiveness and encourage their creativity. This framework provides a benchmark method for construction businesses to measure, analyze and improve their sustainable performance. It is believed that the improvement of environmental performance in a construction industry provides the chance for increasing its competitive advantage [30]. They also introduce a framework for explaining the relationship between strategy development, performance improvement and competitive advantage. The implementation of environmental approaches will improve contractors' capabilities in environmental management, and subsequently lead to improvements in business performance.

Tan et al. [11], propose a framework for improving a contractor's competitiveness through implementing sustainable construction practices, as demonstrated in Fig. 6.

In the view of the above, proposing a framework can help contractors to improve their competitiveness by implementing sustainable construction practices. Implementation of sustainable construction practices in an effective way leads to an increase in sustainability performance, and consequently will lead to an increase in business competitiveness by considering long-run profitability.

#### E. Research Questions/Hypothesis

A review of the literature has indicated the need to answer the following question:

1. Can construction contractors be more economically competitive using sustainable practices?

Accordingly, to answer the above research question, there is need to answer the following hypotheses:

1. Will saving on material wastage lead to improvements in business competitiveness?
2. Will strategic procurement lead to improvements in business competitiveness?
3. Will On-Time Delivery lead to improvements in business competitiveness?
4. Will reductions on inventory costs lead to improvements in business competitiveness?

### III. RESEARCH DATA ANALYSIS AND DISCUSSION

#### A. Research Strategy

The literature review provided theoretical information about sustainable practices in construction in the UAE. The literature review presented in-depth information about sustainability, its importance in the built environment, and its relation to improving contractors' competitiveness. This section focuses on the research methods, data collection and analysis methods adopted to achieve these research objectives.

Any research in sustainability concepts needs to consider the three pillars of sustainability which are economic, social, and environmental. Thus, in pursuing research for proving a hypothesis is true or false, this research focuses on the economic pillar which has a direct impact on the main factor of contractors' competitiveness in terms of reduction in initial project costs. The sustainable practices considered in this

research paper which affect the project's initial cost are:

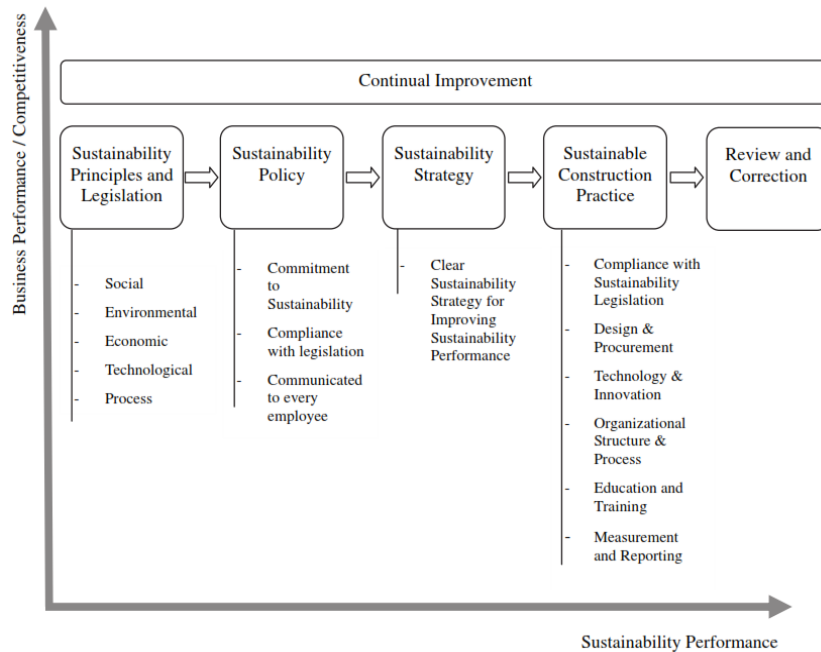


Fig. 6 A framework to improve contractor's competitiveness by implementing sustainable construction practices [11]

- Sustainable Materials Management (SMM): This is a systemic approach to using and reusing materials more productively over their entire lifecycle. It represents a change in how our society thinks about the use of natural resources and environmental protection. More productive and less impactful use of materials helps our society remain economically competitive, contributes to our prosperity and protects the environment in a resource-constrained future.
- Sustainable Procurement (Strategic Procurement): This is a process whereby organizations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organization, but also to society and the economy, whilst minimizing damage to the environment. Sustainable procurement is utilized to improve the project's whole life value through the promotion of best practice construction procurement throughout the supply chain.
- On-Time, Smart and Sustainable shipment and delivery: Sustainable shipping is a holistic management concept for sustainable development applied to the shipping sector and incorporating environmental and social responsibility. There are a number of factors to consider when choosing the appropriate transport solution for your goods. Your needs and demands, as well as the requirements of your goods are of course essential to the decision. Still, it is often possible to make a choice that also minimizes the environmental impact. Today, there is a wide range of smart and sustainable solutions in the market that challenges traditional ones. Short sea shipping, eco-

friendly container train solutions, Less Than Container Load (LCL) shipping and a combination of different transport modes in intermodal freight transports are a few of the available greener alternatives.

- Sustainable Inventory Management: Sustainable inventory management seeks to reduce the environmental and social impacts of an industry without affecting its profitability. Warehouse emission depends on the total inventory and the warehouse energy consumption per unit item. Managing inventories, and thereby material flows, is of key importance for achieving efficient and sustainable supply chains. Green inventory management is characterized by complementing the traditional economic (cost) focus with environmental (emissions) considerations.

Fig. 7 illustrates the research principal regarding the relationship between sustainable practices and business competitiveness. Business competitiveness here considers the factors which affect the reduction in initial project costs using sustainable practices by more efficient processes, enhancements in productivity, and lower costs of compliance. The greater the use of sustainable practices, the better and more sustainable contractors' business competitiveness is, and the higher the chances of obtaining market opportunities.

#### B. Data Collection

Quantitative methods are used in this research in order to allow for more analysis. On this basis, to perform the research study on "Contractors' competitiveness through sustainable practices in the UAE", quantitative research methods were adopted in this study. Fig. 8 illustrates the research methods



used in this research.

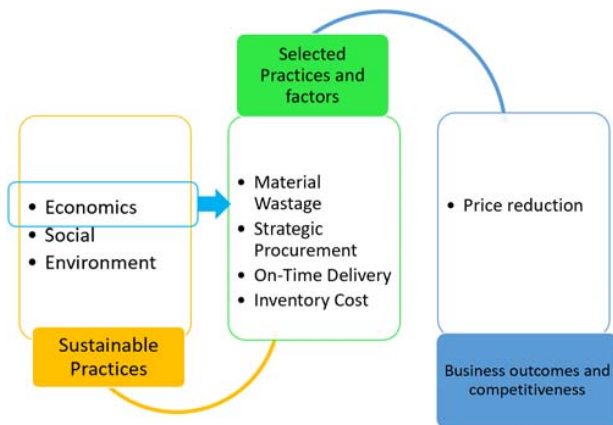


Fig. 7 Research principle of impact of sustainability on contractors' competitiveness from the economic perspective

An opinion survey was conducted by forwarding the

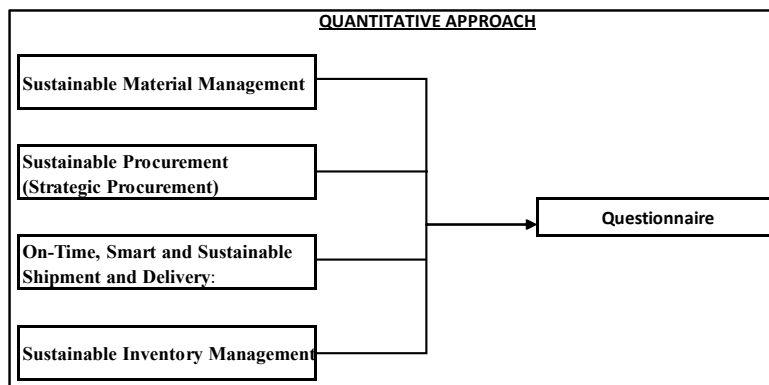


Fig. 8 Research method

Overall, data collection is an important stage in the research as it decides the overall objectives of the research study. This phase provides in-depth information about views and opinions, thus fulfilling the validity of the objectives.

### C. Measures

Five-item scales were designed for this study to measure business competitiveness based on reduction in a project's initial costs that is driven from four different factors: material wastage, strategic procurement, on-time delivery of material and inventory cost. All the variables were measured by their effectiveness level on reduction in initial project costs based on a five-point Likert-type scale ranging from "Scale-Five" to "Scale-One".

A descriptive statistics method was used for the data measurement on the basis that the descriptive analysis method is the simplest method of analysis which provides the general overview of the results. Under the descriptive statistics method of analysis, measurement of dispersion based on the mean and standard deviation are also carried out and the numerical data

questionnaire to individual professionals working in different construction fields in the UAE. A total of 110 responses were collected. The majority of participants were from managerial and senior levels. Their views and responses were obtained in regard to the different aspects of sustainable development practices on the economic pillar, which are: importance of contractors' competitiveness in terms of more efficient processes, enhancements in productivity, and lower costs of compliance in order to reduce the initial project costs and obtain market opportunities. The questionnaire was divided into five sections in accordance with the research objectives and using the five-points Likert scale (scaled from 5 as highest to 1 as the lowest) which indicates degrees of opinion on each factor. The questionnaire included with both closed-type questions in order to get straightforward analysis with quick answers by selecting the appropriate scale and open-type questions to encourage the respondents to provide free responses.

analysis provided in the form of tabulation. The standard deviation method of analysis provides a useful basis for interpreting the data in terms of probability. This method of analysis assigns the numerical value to any given variable based on their empirical properties. The probability figure that is calculated using the statistical tests gives the highest level of significance to prove the research hypothesis. The regression model is then obtained using the collected data.

### D. Data Analysis

To test the association between variables, the SAS program was used to conduct a descriptive statistics method. The data were analyzed in order to figure out the impacts of four sustainable practices from the economic perspective toward business competitiveness. In this study, price reduction was considered as a valuable output of business competitiveness which could have a regression relationship with multiple sustainable practices. Accordingly, the effectiveness of each variable on price reduction measured statistically based on collected data through the survey. Moreover, based on

measured statistical data on variables, the regression model obtained drew the relationship between output of business competitiveness in terms of price reduction and four measured variables of sustainable practices: material wastage, strategic procurement, on-time delivery of material and inventory cost.

#### IV. FINDINGS AND DISCUSSION

##### A. General Information of the Respondents

The questionnaires were sent to 134 individuals working in construction companies in order to obtain their personal views and opinions regarding the research subject. In all, 110 responses were received, and this enabled quite satisfactory result to conduct this analysis. Results indicate that respondents' opinions about sustainable practice advantages on material wastage are with mean of 3.87 and standard deviation of 0.39 which is measured based on three different questions with following means and standard deviations: question 1 with Mean of 4.22 and Standard deviation of 0.73, question 2 with Mean of 3.37 and standard deviation of 0.70, and question 3 with Mean of 4.01 and standard deviation of 0.66. This indicates a valuable impact of saving on material wastage as an advantage of sustainable practices.

The second proposed sustainable practice is strategic procurement which assists on higher quality of material in terms of sustainability and cost saving from an economical point of view. This practice scored a mean of 4.08 with a standard deviation of 0.34 which is analyzed based on three related questions: question 1 with mean of 4.35 and standard deviation of 0.66, question 2 with mean of 4.29 and standard deviation of 0.61, and question 3 with mean of 3.59 and standard deviation of 0.73.

The third sustainable practice describes on-time material delivery using some logistics techniques to maximize the availability of material for the execution team to avoid the extra costs of idle machinery and manpower. This factor has a mean value of 3.63 with standard deviation of 0.45 which is followed by its contributed questions as follows: question 1 with mean of 4.11 and standard deviation of 0.78, question 2 with mean of 3.46 and standard deviation of 0.71, and question 3 with mean of 3.48 and standard deviation of 0.84.

The forth sustainable practice is related to inventory cost which indicates a major improvement on inventory and warehousing costs due to shorter inventory time frame and proper logistics systems which has a mean value of 3.68 with standard deviation of 0.44, with its contributed question, question 1 with mean of 4.11 and standard deviation of 0.78, question 2 with mean of 3.46 and standard deviation of 0.71, and question 3 with mean of 3.48 and standard deviation of 0.84.

The last factor which is the self-assessed improvement variables on price reduction indicate the overall improvement with mean value of 3.98 and standard deviation of 0.43 based on proposed factors: question 1 with mean of 4.35 and standard deviation of 0.72, question 2 with mean of 3.61 and standard deviation of 0.71, and question 3 with mean of 3.96 and standard deviation of 0.80. Table II is summarizing the

mean and standard deviation for each variable. In addition, Fig. 9 illustrates the standard deviation of each of the 110 respondents which is showing that the fluctuation of results is usually between 3.0 and 4.5. The results are verifying the improvement of contractors' business competitiveness through sustainable practices.

TABLE II  
SUMMARY OF STATISTICAL RESULT FOR EACH VARIABLE

Variable	Mean	Standard Deviation
Reduction in Material Wastage	3.87	0.39
Strategic Procurement	4.08	0.34
On time Delivery of material	3.63	0.45
Reduction in Inventory Cost	3.68	0.44
Overall Business Competitiveness by Sustainable Practices	3.98	0.43

##### B. Linear Regression

The linear regression model between price reduction (Y-output) and four independent variables, which are the economic perspective of sustainable practices, obtained by selecting an appropriate model are described in Table III. The collected data have been analyzed using the SAS program to create a regression model and equation.

TABLE III  
VARIABLES IN LINEAR REGRESSION

Predictor Variables	Response Variable
<i>Variables</i>	<i>Predicted _Value</i>
Material Wastage (X1)	Price Reduction
Strategic Procurement (X2)	
OT Delivery (X3)	
Inventory Cost (X4)	

The linear regression model includes all selected variables in the model to analyze their significant level and influence. The results of linear regression model are represented in Table IV.

Accordingly, the impact of price reduction of this model can be predicted through the linear regression model below (please note the regression model is driven from collected data):

$$\text{Impact of Project Initial Cost (Y)} = 1.46073 + 0.08295X1 + 0.23723X2 + 0.08361X3 + 0.24757X4$$

This prediction can help contractors to predict the required and effective variables for any new development prior to the construction phase.

##### C. Hypothesis Testing

Four hypotheses were tested in this research to examine the viability of using this research to assess the relationship between sustainability and contractors' business competitiveness. These hypotheses include: (1) saving on material wastage due to sustainable practices affects the project's initial cost estimate which leads to the improvement of contractors' business competitiveness; (2) strategic procurement due to sustainable practices affects the project's



initial cost estimate which leads to the improvement of contractors' competitiveness; (3) on-time delivery due to sustainable practices affects the project's initial cost estimate which leads to the improvement of contractors'

competitiveness; and (4) reduction on inventory cost due to sustainable practices affects the project's initial cost estimate which leads to the improvement of contractors' competitiveness.

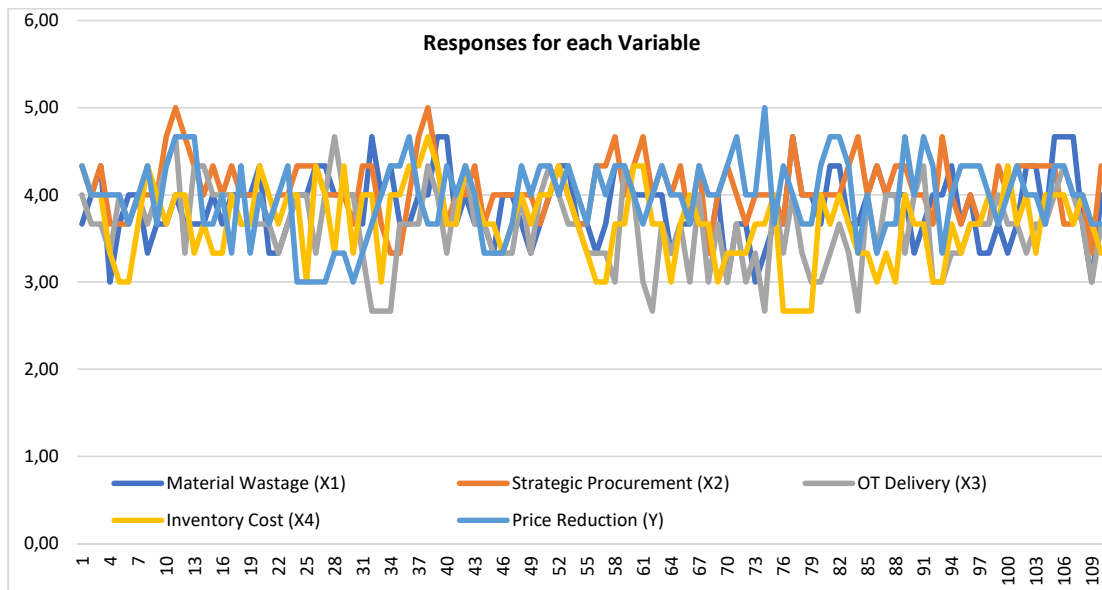


Fig. 9 Results of respondents' opinion for each variable

TABLE IV  
RESULTS OF LINEAR REGRESSION MODEL

Parameter Estimate						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	Intercept	1	1.46073	0.43287	3.37	0.0010
Material_Wastage_X1_	Material Wastage (X1)	1	0.08295	0.11584	0.72	0.4755
Strategic_Procurement_X2_	Strategic Procurement (X2)	1	0.23723	0.12713	1.87	0.0648
OT_Delivery_X3_	OT Delivery (X3)	1	0.08361	0.10382	0.81	0.4224
Inventory_Cost_X4_	Inventory Cost (X4)	1	0.24757	0.10341	2.39	0.0184

Statistical analysis can reflect the movement in relationships between dependent and independent variables. Practical indices and quantified relationships help demonstrate facts much faster than any written explanation, especially in the engineering and science fields. Accordingly, following the responses to the questionnaire to understand whether the implementation of sustainable practices will lead to the reduction of initial project costs which increases contractors' competitiveness in the UAE construction industries, the majority of replies proved the validity of these hypotheses according to the probability results below:

- H1: The first hypothesis has been validated since the calculated mean for saving on material wastage shows a 77.4% improvement on business competitiveness.
- H2: The second hypothesis has been validated since the calculated mean for strategic procurement shows an 81.6% improvement on business competitiveness.
- H3: The third hypothesis has also been validated since the calculated mean for On-Time Delivery shows a 72.6% improvement on business competitiveness.
- H4: Finally, the fourth hypothesis has been validated

since the calculated mean for reduction on inventory cost shows a 73.6% improvement on business competitiveness.

#### D. Proposed Application for Contractors

As a result of this research study, a practical framework was introduced based on a questionnaire analysis which takes into consideration the current procedures and policies of any construction company in order to evaluate and set some recommendations for the decision makers on how they can improve the business competitiveness through sustainable practices related to the proposed factors in this research: saving on material wastage, strategic procurement, on-time delivery, and reduction on inventory costs. This application provides contractors with an ability to analyze and evaluate their current process and procedures in terms of sustainable practices and encourages them towards sustainability to improve their competitiveness in the market.

The overall rating for each variable is measured in percentages which are categorized into three groups as follow: (1) above 70%, (2) between 50% and 70%, and (3) below

50%. The average rating above 70% will be highlighted in green where the required action is to monitor and control the running process. The rating scale between 50% and 70% will be highlighted in yellow, where the required action is to increase effectiveness of sustainable practices. Finally, if the rating scale is measured below 50%, it will be highlighted in red which indicates the need for full restructuring and implementation of new sustainable practices in order to achieve a higher degree of efficiency on that particular variable. The application questionnaire is required Excel software for running.

## V. CONCLUSION

The implementation of sustainable construction practices can contribute to the improvement of contractors' business competitiveness. There are only a few studies examining their contribution to business competitiveness, so this paper conducts a comprehensive study of sustainable practice in the construction industry and the relationship between sustainability performance and business competitiveness in order to develop a framework for evaluating how contractors can improve their competitiveness in terms of more efficient processes, enhancements in productivity, and lower costs of compliance in order to reduce the initial project costs and obtain market opportunities through implementing sustainable construction practices in the UAE. Therefore, a framework for evaluating sustainable construction practices is developed. The application of the framework can improve contractors' sustainability performance and also business competitiveness. The framework is a useful guideline for contractors to develop their sustainability policy, strategy and practice for meeting the increasing requirement for sustainable development in construction.

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