Asian Journal of Civil Engineering (2023) 24:245–266
https://doi.org/10.1007/s42107-022-00500-5

ORIGINAL PAPER

Developing sustainability assessment indicators for measuring contractor's performance during the construction phase of construction projects in Jordan

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Received: 11 March 2022 / Accepted: 24 August 2022 / Published online: 17 September 2022

Abstract

The development of sustainability assessment indicators has become a hot topic globally, while sustainability practices are uncontrollably growing in the construction industry. However, the construction industry itself has negative impacts on the environment, society, and the economy. Therefore, during the construction phase, the contractors who are responsible for delivering construction projects should have a suitably adaptable sustainability solution. Qualified and experienced contractors are, of course, vital for the success of construction projects, and measuring their performance with respect to sustainability during the construction phase is crucial. However, there is currently very little evidence of a comprehensive and integrated assessment approach. This research aims to properly devise a smoother development process and improve potential deliverables for the construction industry in Jordan. A list of sustainability assessment indicators was developed for use during the construction phase, to assess the performance of the contractors, using a review of the literature, surveys, and by drawing upon expert opinion. As a result, 78 indicators have been formulated, across the five major dimensions of environmental, social, economic, lean manufacturing, and cultural, all of which influence contractor performance regarding sustainability practices.

Keywords Sustainability assessment · Sustainability indicators · Construction industry · Contractor's performance · Jordan

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Introduction

According to Du Plessis (2007), "Construction is the broad process/mechanism for the realization of human settlements and the creation of infrastructure that supports development. This includes the extraction and beneficiation of raw materials, the manufacturing of construction materials and components, the construction project cycle from feasibility to deconstruction, and the management and operation of the built environment". Therefore, the construction industry is highly motivated to ensure the adoption of sustainability practices during the construction phase of a project (Srivastava et al., 2021). The construction industry contributes significantly to meeting the needs of society, improving the quality of life of the people, and strengthening the economic growth of a country (Albtoush et al., 2022; Khanzadi et al., 2020; Sedayu et al., 2020; Sharifi & Sharbatdar, 2021). It contributes effectively to encouraging internal and external investment (CBJ, 2018), which has become the backbone of the Jordanian economy (Albtoush et al., 2022). The general political climate and the safe investment environment are just two of the many factors that have influenced the growth of this industry in recent years (Albtoush et al., 2022; Anisurrahman & Alshuwaikhat, 2019). The gross domestic product (GDP) ascribed to construction in Jordan increased by approximately 21% during 2021 (Anisurrahman & Alshuwaikhat, 2019; Trade Economics, 2020), reaching JOD 249 million in the third quarter of 2021 compared to JOD 206 million in the second quarter of the same year (Trade Economics, 2020). The construction sector represents more than 60% of the investment projects in the region, or around 33% of GDP, and offers job opportunities for around 30% of the labor force (Jordan Times, 2019). Due to the geopolitical conditions in the region in recent years, the percentage of immigration has increased dramatically particularly for safety issues (DoS, 2016; GAN, 2020), which has led to an increased demand for public construction (MPWH, 2016). However, while Jordan has developed a successful and thriving construction sector, it has been strongly criticized for being a major contributor to carbon emissions, global warming, and environmental degradation (Alam et al., 2017). Globally, construction is responsible for 30–40% of total energy consumption (Lafargeholcim, 2015) and between 40 and 50% of greenhouse gas (GHG) emissions (MPIC, 2017). While construction creates facilities for human activities and social development, its impacts on the environment, society and economy, both negative and positive, are very profound (Alam et al., 2017; Durgam et al., 2022). In terms of environmental concerns, different types of negative impacts that the construction industry can create, related to social and economic issues, are considered serious problems, which have significant impacts on the country (Sharifi & Sharbatdar, 2021) and on our lives (Sedayu et al., 2020). For instance, the construction industry contributes to the increasing demands for natural resources, which is a particular problem for countries with inadequate resources (OGC, 2007).

Every day, sustainability as terminology is getting more widely spread. Sustainability, a term that is increasingly used as "A thought for long-term goals", because it is a dynamic balance of three mutually interrelated elements: natural ecosystems, resource conservation and enhancement; economic production; and the provision of social infrastructure such as jobs, housing, education, medical care, and cultural opportunities (Bell & Morse, 2008; Sharifi & Sharbatdar, 2021). While Zakrzewska et al. (2022) define sustainability as a dynamic process that combines economic, social, institutional, and environmental dimensions, the concept of sustainability performance is more difficult to define due to its broad and subjective characteristics, especially with regard to its environmental dimension and the way in which this interacts with other economic and social dimensions. Thus, it is necessary to propose a common framework for measuring sustainability performance and sustainable practices that have positive impacts upon the industry (St Flour & Bokhoree, 2021). Jordan demonstrated its commitment to sustainable development when the Jordanian government signed the UN Agenda 2030 in 2015 (CSIS, 2018). However, there remains a lack of laws and regulations regarding sustainable construction, and an absence of penalties for those who build using unsustainable methods.

The construction industry has three main phases: design, construction, and operation. Sustainable construction is carried out throughout these three phases. Addressing sustainability into the design phase refers to the design process that integrates an environmentally friendly approach to reduce negative impacts on the environment and considers nature resources as part of the design, thereby improving building performance (Elmansy, 2014; U.S. GSA, 2021). It is about optimizing site projects, minimizing-renewable energy, using friendly materials and products, conserving water uses, and optimizing occupational practices (U.S. GSA, 2021). In contrast, sustainability in construction is the practice of creating a healthy built environment using recyclable materials in building and minimizing energy consumption and waste production during the construction of a project where possible and protecting the natural environment around the site (BigRentz, 2020; Jackson, 2021). Finally, sustainability in operation is about promoting sustainability practices during the occupation aiming to the achievements of the facility itself. It will encourage end-users to play their part in the evaluation to identify how satisfied people are with the building and to examine how the facility is meeting its environmental objectives throughout its operational life (OGC, 2007). The current study considers sustainability assessment only during the construction phase.

In fact, there is a lack of awareness of sustainable practices in the construction industry, and there continues to be a widespread use of traditional materials in construction, even those that are harmful to the environment, with little evident appetite for more environmentally friendly materials (CSIS, 2018). In addition, there is insufficient expertise among Jordanian contractors to implement sustainable projects. The authorities in Jordan have responded to the need for establishing environmental regulations that help reduce the negative impacts of the construction industry, partly to identify problems related to the environmental, social, and economic impacts of the industry, and to identify the most important measures to implement (CSIS, 2018; Raynsford, 2000). Thus, there is an urgent need to have authenticated construction firms to help develop the Jordanian economy while avoiding any obstacles that might impair the development of the construction industry.

Among the green management practices that are missing during the construction phase include reducing the waste of construction materials, minimizing energy and water use, and reducing pollution (Raynsford, 2000). As a result, highly competitive and profound changes in the construction industry are forcing contractors to continuously improve their performance. Construction contractors, who typically manage any interaction between construction activities and sustainability, play an important role in environmental protection (Fei et al., 2021; Kim & Huynh, 2008). Performance measurement is the heart of ceaseless improvement. Generally, improving contractors' efficiency and effectiveness is the main objective of this research, to assist managers and members of an organization to improve the outcomes from delivering construction projects and for the purposes of identifying the strengths and weaknesses in their performance during construction (Khanzadi et al., 2020). Contractors do not recognize the importance of sustainability or how to apply sustainable practices during the construction phase. It is worth mentioning that some projects are specifically designed to be sustainable, but these efforts become nullified during the construction phase, because the practices of contractors are far from sustainable, which ultimately results in an unsustainable project (Sedayu et al., 2020).

In 2021, Jordan lacks qualified contractors with sufficient experience in implementing sustainable projects, a situation worsened by the lack of detailed studies on construction projects before construction begins, the lack of experience within the industry in dealing with complications that occur during construction. This is due to the relative ease with which a construction company can be established in Jordan, thereby allowing unqualified members to enter the contracting world, which can lead to serious problems during the construction of a project (Sedayu et al., 2020). It also means that it is common for the profit motive to take priority over quality, and no environmental, social, and economic impact studies are done before a project is initiated.

Supporting the construction sector to become more sustainable ensures the development of effective solutions to these problems over the long term, so that that the positive impacts might be noticed in the short term. Although many studies have covered several dimensions of sustainability, there is still a lack of experience in applying the principles of this science on the ground, which limits the impact of any theoretical benefits. Therefore, this research aims to develop a system for evaluating and qualifying contractors to enter the field of sustainable construction. This involves outlining the most important problems arising from the traditional methods of construction, clarifying the impact of the application of sustainability practices on this sector, and the issues that prevent its implementation, and explaining the need to move away from traditional methods of construction toward new strategies based on a more sustainable methodology. The current research study remains open to the possibility that rating systems developed elsewhere, may provide important information for the development of a rating system in Jordan (Sharifi & Sharbatdar, 2021). Ultimately, the current research study proposes an assessment of sustainability performance for the Jordanian construction industry, that is linked to rewards, the like of which has never before existed in the country.

The paper is structured as follows:

- Section 2 provides a literature review on the topic;
- Section 3 provides the methods of the current study;
- Section 4 provides the techniques used in determining sustainability assessment indicators;
- Section 5 presents the results, and the discussion of the results, including a comparison with the existing rating systems worldwide;
- Section 6 present the conclusions.

Literature review

By reviewing previous literature related to the importance of sustainability and its dimensions, some researchers have touched on the importance of implementing sustainability in the construction phase as it is considered an important part of the project life cycle. Myers (2005) presents the initiatives that encourage sustainable construction in Britain and reviews the responsibility of large companies toward society and their attitudes toward sustainability, which were mostly negative. The study argues that the construction industry is overly complex already and it does not need the extra complication necessary to transform it into a sustainable industry. As a result, only a few companies changed their construction methods to fall in line with the concepts of sustainability. Sarkis et al. (2012) look at the Analytic Hierarchy Process (AHP), a model to help decision-makers in selecting sub-contractors, clarifying the benefits of this model on the sustainability of the built environment and discussing the economic, social, and environmental impacts when it is applied to projects. Vazquez et al. (2013) focus more on the importance of the project construction phase in shaping the relationship between humans and the environment, emphasizing the importance of meeting sustainability principles at the execution phase of hospital projects in Brazil.

It is estimated that 60% of the solid waste in urban centers is construction waste and reducing this and other environmental harms starts at the design phase of a project, using sustainability principles from the outset and continuing to applying them during the construction phase of the building. Controlling all aspects of a project requires a bird's eye view over its entire life cycle (Khanzadi et al., 2020). This study concludes that the sustainability of a project cannot be limited to its operational phase only but must also be sustainable during the construction phase. Jiang et al. (2019) presented a comparison between the sustainable performance of prefabricated and traditional buildings. Their study focuses on studying the construction phase only. They generated 16 indicators from a literature review, questionnaire survey, and specialist interviews to conduct a sustainability evaluation of the buildings' performance. Finally, Sedayu et al. (2020) conducted a study to propose measures required to improve construction project management performance using the green buildings concept in Indonesia. The study applies importance-performance analysis to measure user satisfaction and the performance of contractors. The results indicate that the technical factors affecting construction projects are dominant in measuring the constructor's performance, so the use of the green buildings concept is important for construction projects in Indonesia.

There are relatively few studies discussing the importance of sustainable construction; most focus on the design phase, and none of them offer a clear and precise system or set of practices that could be applied by contractors during the construction phase to evaluate their sustainability performance, or even to determine the extent of their experience in implementing sustainable projects. However, the current situation in Jordan is that contractors are delivering either sustainable or traditional construction projects with no performance evaluation in place.

This research aims to develop a practical tool that includes sustainability assessment indicators that have been set and analyzed in scientific ways to assess the performance of contractors during the construction phase of projects in Jordan. This will ensure reducing the destructive effects of construction by delivering future construction projects in a more efficient and sustainable manner.

Research methodology

Worldwide, different methods are available for developing sustainability assessment indicators (Sharifi & Sharbatdar, 2021). However, the overall methods for how to develop a list of indicators to assess contractor performance are still lacking, and as shown in the literature review in the previous section, studies which are related to the current research are limited. Therefore, the current research aims to develop a list of indicators that measure the sustainability performance of construction contractors. This was developed through four phases, as shown in Fig. 1.

Phase I carries out a thorough review of the relevant literature for the study area. The importance of this phase is first to identify the research problem and formulate the research objective by reviewing and carefully studying the literature to identify the best sustainability practices worldwide. A gap was identified in the knowledge and references regarding the performance assessment of contractors when delivering construction projects. Consequently, the research problem is the absence of a precise assessment of the sustainability performance of contractors in Jordan, to enable them to be evaluated and classified, which currently impedes sustainability practices in Jordanian construction projects.

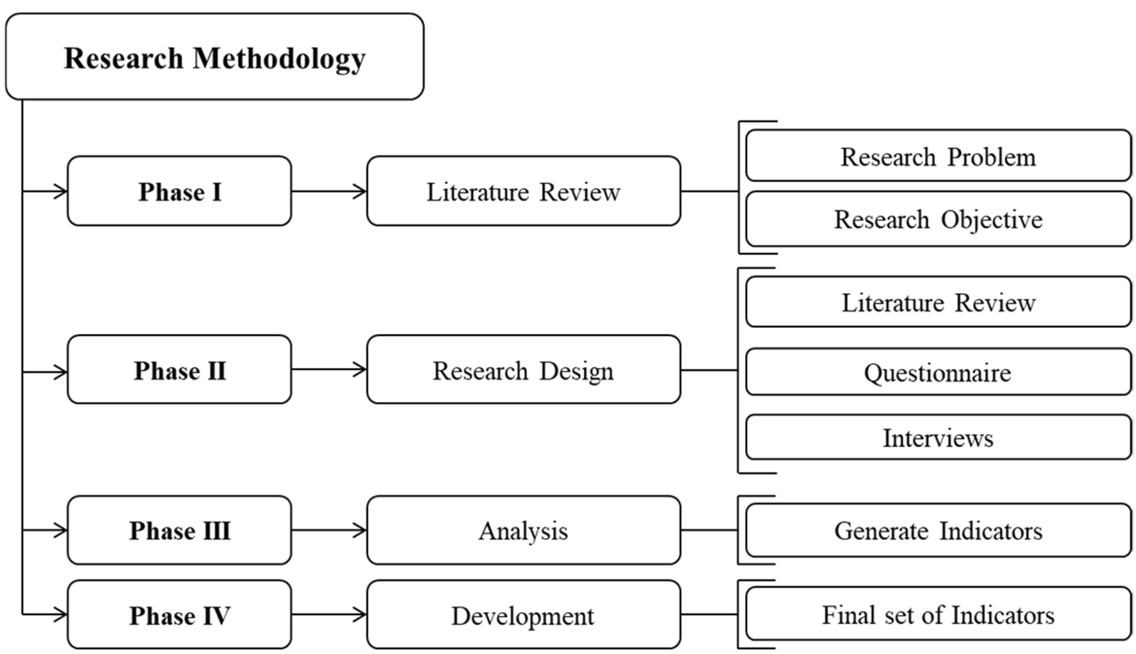

Fig. 1 Research methodology summary (adapted by the authors)

In Phase II, a list of indicators is identified by reviewing the literature as a technique for collecting data, conducting a questionnaire survey, and commencing interviews. The questionnaire was designed following a review of the relevant literature. Thus, a survey instrument that includes 42 indicators was conducted and distributed to 300 engineers and experts. Only 106 of them answered questionnaires in full, giving is a 35% response rate. The small sample size is indicative of the limited number of people in the industry who are nominated experts in the field of sustainability. This is followed by suggesting a type of creation method that uses the experts' opinions to develop a set of sustainability assessment indicators. The reason is that a specific and rigorous data set is required, as well as a favorable environment for citizens to participate in the decision-making process, both of which are lacking in Jordan. Thus, a panel of experts is formed here to present their opinions on the proposed set of indicators. The panel included academics and experts who are currently working in the public and private sectors and are familiar with sustainability practices. By the end of this phase, 78 indicators were generated.

In Phase III, an analysis was conducted on the collected data using statistical techniques to determine the weight and importance of each indicator.

In Phase IV, the generated list of indicators was developed, along with their weightings, and the scoring system to be used when certifying contractors' performance during the construction phase. Two additional categories were added to the list to make five main categories and 78 indicators.

Determining Sustainability Assessment Indicators

Researchers argue that many tools have been developed for the purposes of sustainability assessment that fail to consider all sustainability dimensions in a comprehensive way and, in most cases, these tools focus on only one of the three main sustainability dimensions, namely environmental, social, or economic (St Flour & Bokhoree, 2021). These methodologies often fail to address country-specific contexts and issues; since these can alter drastically between nations in terms of history, physical formation, economy, local customs, the significance of religion, political and institutional systems, and so on, such methodologies are often not generalizable to other parts of the world. As a result, the main objective of most existing assessment models is to discover the specific condition of the country through the chosen indicators. In many cases, the indicators do not provide the answer as to why the level of sustainability achievements differs from one place to another.

In the proposed model for the development of sustainability assessment indicators for measuring contractors' performance, the limitations of the existing models are sought to be highlighted and overcome in the best possible way, with comprehensive coverage of the key issues that improve contractor performance and enhance the deliverables for construction projects in Jordan. Three major dimensions were identified following the review of a wide range of literature, namely the environmental, social, and economic dimensions, and then 14 sub-categories were identified within these. On this basis, this study then attempts to present a comprehensive and integrated model of sustainability assessment indicators that incorporates the link between existing theories and practices by overcoming the afore-mentioned limitations from previous studies in the best possible way.

Literature Review

A literature review is an approach used to review the existing knowledge from existing studies on the specific topic of the research to gain a full understanding of the current status. It can also reveal which areas require further investigation to enhance the work already done (Hart, 2018). Based on previous literature and through understanding the problems and limitations facing the application of sustainability practices in the construction sector, especially in Jordan, 42 indicators have been reached and data collected on the three dimensions of sustainability. These practices were allocated to either environmental, social, or economic, where the environmental dimension includes 21 indicators, and the economic and social dimensions include 11 and 10 indicators, respectively, as shown in Table 1.

Questionnaire preparation and conducting the survey

The sustainability concept varies from one region to another, and indicators should be precisely formulated based on location, the country under study, institutional and regulatory frameworks, available resources, and the national policies, programs, and plans that need to be followed (Yigitcanlar & Teriman, 2015). Consequently, to formulate specific indicators within the Jordanian context, a questionnaire survey was designed, using a 5-Point Likert Scale [strongly agree (5), agree, neutral, disagree to strongly disagree (1)] that covered the three dimensions of environmental, social, and economic. Multiple-choice questions were closed to make the questionnaire easy to answer. Respondents were asked to give each indicator related to each aspect of sustainability a score based on its importance. The questionnaire survey was sent via Google forms and a time limit was set of 2 weeks; any forms returned after this period were discarded. All those that were returned were used to rank the indicators and each one was given a weight of importance. The completed

Table 1 Sustainable assessment indicators during the construction phase

Main category	Sub-category	Indicators	References
Environmental dimension	Safety	Surround the site with a fence that is made from re-used materials (old iron sheets—Zenko)	EcoConsult (2017) and SS (2016)
		Smoking is forbidden in materials storage areas	JGBG (2013)
		Periodically cleanliness inspections of the site must be implemented, around the hangers and streets to remove screws, steel pieces, and everything that would harm residents or vehicles in the surrounding areas or compromise the general view	ISI (2018) and SS (2016)
	Leadership	The contractor should hire an inspector to monitor general safety, waste management, and environmental practices	EcoConsult (2017)
		An environmental practices section should be added to the monthly report	EcoConsult (2017; USGBC (2019)
	Energy	Use LED lights inside the building when working at night during the project	USGBC (2019) and JGBG (2013)
		For night shifts, artificial lights should be placed in positions that reduce light pollution as much as possible	USGBC (2019) and JGBG (2013)
	Quality Control	Materials shall be supplied on time according to the work schedule; this practice will protect materials—such as steel—from being on the site for too long before being used	USGBC (2019) and MPWH (2013)
		Store materials in specifically demarcated spaces and storage areas	USGBC (2019)
	Waste management	The contractor should clarify the policy that is used to remove obstacles from the site, such as curbstones, pipes, and wires, and the possibility of reusing them later	MPWH (2013)
		Never dispose of material waste on any private properties next to the site	SS (2016) and JGBG (2013)
		Correctly dispose of the backfills without throwing it onto private property	SS (2016) and JGBG (2013)
		Establish a policy for waste management according to the sustainability criteria • Hazardous waste should be separated and go through appropriate pathways to their ultimate disposal under a specialist's supervision	EcoConsult (2017)
		• Non-hazardous waste to be disposed of in co-ordination with the appropriate authorities	EcoConsult (2017)
		• Recyclable waste should be recycled in co-ordination with the appropriate parties	EcoConsult (2017)
		Cut materials precisely to decrease waste as much as possible	EcoConsult (2017) and JGBG (2013)
		Avoid burning paper and plastic waste inside the site	EcoConsult (2017) and JGBG (2013)
	Wellbeing	Apply a water spraying system daily, to reduce the dust resulting from the construction process and to reduce the harm from dust to the surrounding community	USGBC (2019)
		Operational procedures, policies and training must be in place with respect to the transport, handling and disposal of materials that give off exceptional amounts of dust	USGBC (2019)
	Water	In the case of finding any water resources on the project site, such as groundwater, the contractor should protect it and inform the authorities	EcoConsult (2017) and MPWH (2013)
		Use water that is fit for human consumption in construction	EcoConsult (2017) and MPWH (2013)

Table 1 (continued)

Main category	Sub-category	Indicators	References
Economic dimension	Community	Supply the necessary building materials from nearby stores instead of transporting them from other governorates	ISI (2018)
		Provide training opportunities for the local community	MPWH (2013)
	Water	Ensure there are no leaks in the water pipes to reduce water waste during construction	ISI (2018)
	Materials	Use steel molds or bricks instead of wooden frameworks wherever possible	USGBC (2019)
		Supply materials from factories or firms that are certified for fabricating products via eco-friendly manufacturing processes to support the sustainable production sector	USGBC (2019)
	Planning	Choose locations for materials storage to be as far as possible from water erosion paths to reduce the chances of water damage, especially in the winter	MPWH (2013)
		Establish shoring or shot Crete systems for the excavated area to avoid landslides or any similar disasters, especially in winter	SS (2016)
		Periodic maintenance of all machinery must be carried out to reduce harmful gas emissions	SS (2016)
		Check quantities before supplying materials to reduce waste and surplus as much as possible	ISI (2018)
Social dimension	Insurance	Issuance of an insurance policy for all laborers	SS (2016)
		Issuing work permits for laborers	SS (2016)
	Community	Commitment to occupational health and safety regulations by laborers	ISI (2018)
		Create job opportunities for locals in porting and guarding activities	MPWH (2013)
		Contract with local artisanal workers, if they have the required competence, in preference to contracting with artisanal from other governorates	MPWH (2013)
		Labor's commitment to ethical regulations, such as respecting neighbor's properties	MPWH (2013)
		Provide environmental training opportunities for laborers and locals to contribute to spreading environmental awareness	MPWH (2013)
	Safety	Provide first aid kits	JGBG (2013)
		Register all accidents and injuries that happen during the project with social security and count them at the end of the project	SS (2016)
		Provide the staff with uniforms that meet all safety requirements (vests, safety shoes, and helmets)	EcoConsult (2017) and SS (2016)
	Leadership	Develop a crisis management plan for emergencies that might occur, such as fires	ISI (2018) and SS (2016)
		Strengthen the communication skills between the staff members	EcoConsult (2017)

questionnaires that were returned and answered in full were considered valid to be analyzed using SPSS. The questionnaires were distributed to 300 participants in the field of sustainable construction, as shown in Table 2.

The response rate from the returned and valid questionnaires was 33%. For each item, a mean score of 3.5 or higher was used as a cutoff point, which produced a final set of 42 indicators, with rankings, as shown in Table 3.

Table 2 The characteristics of the respondents to the questionnaires

Respondents' characteristics	Number	Percent (%)
Level of education		
PhD	13	4.3
MSc	76	25.3
BSc	211	70.4
Experience level (years)		
5–10	70	23.3
11–20	200	66.7
21–30	25	8.3
> 30	5	1.7
Job responsibilities		
Director	17	5.7
Engineer	232	77.3
Project manger	27	9
Consultant	24	8

Interviews

Following the questionnaire survey, a series of interviews was carried out to gain greater insights into the development of a list of indicators to assess contractor performance. The interviews were commenced with specialists from the Ministry of Public Works and Housing MPWH, university professors, as well as specialists in the field of sustainability from the Jordanian Engineers Association and the Jordanian Green Building Council. A total of eight respondents were contacted from the questionnaire survey for the purposes of conducting an interview. The interviewees were chosen based on their expertise and specialisms in the field of sustainable construction. The interviews were semi-structured, based on a list of questions related to developed categories, and covered the following aspects:

1. The development of such indicators related to the given categories.
2. Ranking the developed indicators and the need to extend the list.
3. Rate the developed indicators based on their importance.
4. Develop a scale of achievements for measuring contractor performance.

In line with the current COVID-19 restrictions in Jordan, three of the interviews were conducted over the telephone, and the remaining five over Skype. Their profiles are given in Table 4.

The interviews were all transcribed and analyzed using a qualitative analysis approach. The results from the analysis were applied to the list of indicators and grouped into new categories within the three dimensions of environmental, social, and economic. The interview questions enabled the interviewees to share their knowledge and experiences regarding developing a list of indicators for the purposes of sustainability assessment, and they offered their opinions and attitudes openly and broadly. The analysis, as mentioned earlier, used a thematic approach, coding similar data with an appropriate theme. The coded data were then used to developed and feed the developed list of sustainability assessment indicators more precisely and more broadly.

Results and discussion

Based on the literature review, an initial assessment was conducted which resulted in 42 indicators across the 3 main dimensions. The questionnaire was distributed to over 300 engineers and specialists. There were 106 fully completed questionnaires that were received back and statistically analyzed. It should be noted that, at the first phase of developing the list of sustainability assessment indicators, the literature review produced five main categories embedded into the three sustainability dimensions. Then, the initial list was tested by conducting the questionnaire survey. The completed questionnaires indicated the importance of each indicator. The indicators were then rated and given a weight to be used in measuring the performance of the contractors during the construction phase. In the final phase of developing the list, semi-structured interviews were conducted. As a result of these interviews, more indicators were added which were then grouped into new categories. This led to creating the final model that contains 78 indicators divided into five categories (environmental, social, economic, lean manufacturing, and cultural). The two new categories (lean manufacturing and cultural) were added, because they influenced the application of sustainability indicators during construction and led to the upgrading of the sustainable assessment guide. Specifically, lean manufacturing was defined by one interviewee P5 as a manufacturing approach that focuses on avoiding waste while concurrently optimizing productivity to save time and operating costs, while also increasing the level of quality and improving time management (Diann, 2020). The cultural category was added, because, in some research cases, it can be considered as the fourth dimension of sustainability. According to Hawkes (2001), the environmental, economic, and social issues in one country cannot be solved separately from the culture of the society in which these issues arise. Consequently, this category was added to the model with two sub-categories, namely heritage and human rights. Heritage was included as one of the sub-categories in this new dimension, because Jordan has

Table 3 Main findings from conducting questionnaire survey

Main category	Sub-category	Code	Indicators	Mean	Standard Deviation	Rank
Environmental dimension	Safety	E1	Surround the site with a fence that is made from re-used materials (old iron sheets—Zenko)	4.08	1.22829	1
		E2	Smoking is forbidden in materials storage areas	3.86	0.92135	9.5
		E3	Periodically cleanliness inspections of the site must be implemented, around the hangers and streets to remove screws, steel pieces, and everything that would harm residents or vehicles in the surrounding areas or compromise the general view	3.99	1.05883	6
	Leadership	E4	The contractor should hire an inspector to monitor the general safety, waste management, and environmental practices	3.8	1.17207	15.5
		E5	An environmental practices section should be added to the monthly report	3.86	0.92135	9.5
	Energy	E6	Use LED lights inside the building when working at night during the project	4.02	1.0539	4
		E7	For night shifts, artificial lights should be placed in positions that reduce light pollution as much as possible	3.79	1.12182	17
	Quality control	E8	Materials shall be supplied on time according to the work schedule; this practice will protect materials—such as steel—from being on the site for too long before being used	3.85	0.96792	11
		E9	Store materials in specifically demarcated spaces and storage areas	3.82	1.14926	13
	Waste management	E10	The contractor should clarify the policy that is used to remove obstacles from the site, such as curbstones, pipes, and wires, and the possibility of reusing them later	3.63	1.11604	20
		E11	Never dispose of material waste on any private properties next to the site	3.89	1.17116	7.5
		E12	Correctly dispose of the backfills without throwing it onto private property	4.06	0.98288	2
		E13	Establish a policy for waste management according to the sustainability criteria Hazardous waste should be separated and go through appropriate pathways to their ultimate disposal under a specialist's supervision	4	1.13707	5
		E14	Non-hazardous waste to be disposed of in co-ordination with the appropriate authorities	3.81	1.10732	14
		E15	Recyclable waste should be recycled in co-ordination with the appropriate parties	3.8	1.23091	15.5
		E16	Cut materials precisely to decrease waste as much as possible	3.83	0.9434	12
		E17	Avoid burning paper and plastic waste inside the site	3.76	1.11119	18
	Wellbeing	E18	Apply a water spraying system daily, to reduce the dust resulting from the construction process and to reduce the harm from dust to the surrounding community	3.51	1.12362	21
		E19	Operational procedures, policies and training must be in place with respect to the transport, handling and disposal of materials that give off exceptional amounts of dust	3.73	1.01359	19
	Water	E20	In the case of finding any water resources on the project site, such as groundwater, the contractor should protect it and inform the authorities	4.04	1.00423	3

Table 3 (continued)

Main category	Sub-category	Code	Indicators	Mean	Standard Deviation	Rank
		E21	Use water that is fit for human consumption in construction	3.89	0.95235	7.5
Economic dimension	Community	EC1	Supply the necessary building materials from nearby stores instead of transporting them from other governorates	3.89	0.89775	5
		EC2	Provide training opportunities for the local community	3.82	0.94687	6
	Water	EC3	Ensure there are no leaks in the water pipes to reduce water waste during construction	3.92	0.86082	3
	Materials	EC4	Use steel molds or bricks instead of wooden frameworks wherever possible	3.47	1.2509	11
		EC5	Supply materials from factories or firms that are certified for fabricating products via eco-friendly manufacturing processes to support the sustainable production sector	3.52	1.12349	10
	Planning	EC6	Choose locations for materials storage to be as far as possible from water erosion paths to reduce the chances of water damage, especially in the winter	4	0.9101	1
		EC7	Establish shoring or shot Crete systems for the excavated area to avoid landslides or any similar disasters, especially in winter	3.75	0.98857	9
		EC8	Periodic maintenance of all machinery must be carried out to reduce harmful gas emissions	3.8	1.10096	7.5
		EC9	Check quantities before supplying materials to reduce waste and surplus as much as possible	3.91	0.91115	4
	Insurance	EC10	Issuance of an insurance policy for all laborers	3.8	1.08246	7.5
		EC11	Issuing work permits for laborers	3.97	1.12326	2
Social dimension	Community	S1	Commitment to occupational health and safety regulations by laborers	4.08	0.86217	1
		S2	Create job opportunities for locals in porting and guarding activities	3.84	0.7461	7
		S3	Contract with local artisanal workers, if they have the required competence, in preference to contracting with artisanal from other governorates	3.88	0.92736	4.5
		S4	Labor’s commitment to ethical regulations such as respecting neighbor’s properties	3.96	0.73485	2.5
		S5	Provide environmental training opportunities for laborers and locals to contribute to spreading environmental awareness	3.8	0.8165	9
	Safety	S6	Provide first aid kits	3.84	0.89815	7
		S7	Register all accidents and injuries that happen during the project with social security and count them at the end of the project	3.96	0.78951	2.5
		S8	Provide the staff with uniforms that meet all safety requirements (vests, safety shoes, and helmets)	3.88	0.97125	4.5
	Leadership	S9	Develop a crisis management plan for emergencies that might occur, such as fires	3.84	0.89815	7
		S10	Strengthen the communication skills between the staff members	3.72	1.02144	10

a long history, and its cultural legacy deserves more attention. There are many archaeological sites in Jordan that are not listed by the Department of Antiquities (DOA); indeed, studies have shown that there are 870 archaeological sites in Jordan that have been destroyed, 390 were looted, and there

Table 4 The characteristics of the respondents to the interviews

Expert code	Level of education	Job title	Experience	Interview duration (min)	Via
P1	PhD	Director	13	65	Telephone
P2	BSc	Engineer	15	40	Telephone
P3	BSc	Director	17	50	Skype
P4	MSc	Director	20	60	Skype
P5	BSc	Director	22	55	Skype
P6	PhD	Engineer	17	45	Skype
P7	MSc	Engineer	18	30	Telephone
P8	BSc	Director	19	35	Skype

are thought to be thousands of sites that remain undiscovered and/or undeclared (DOA, 2022). The second sub-category is human rights. Unfortunately, there are many violations of human rights in projects in all regions of the world, so we have added indicators that preserve the rights and dignity of the labor force and to eliminate all kinds of racism. The initial list of indicators is given in Fig. 2 refer to Table 1 and the final list of indicators is given in Fig. 3 refer to Table 5.

There are nine indicators that were added to the environmental dimension, six indicators to the economic dimension, and seven to the social dimension. The main five categories were chosen by taking the most frequently mentioned categories from the literature, the questionnaire survey, and the

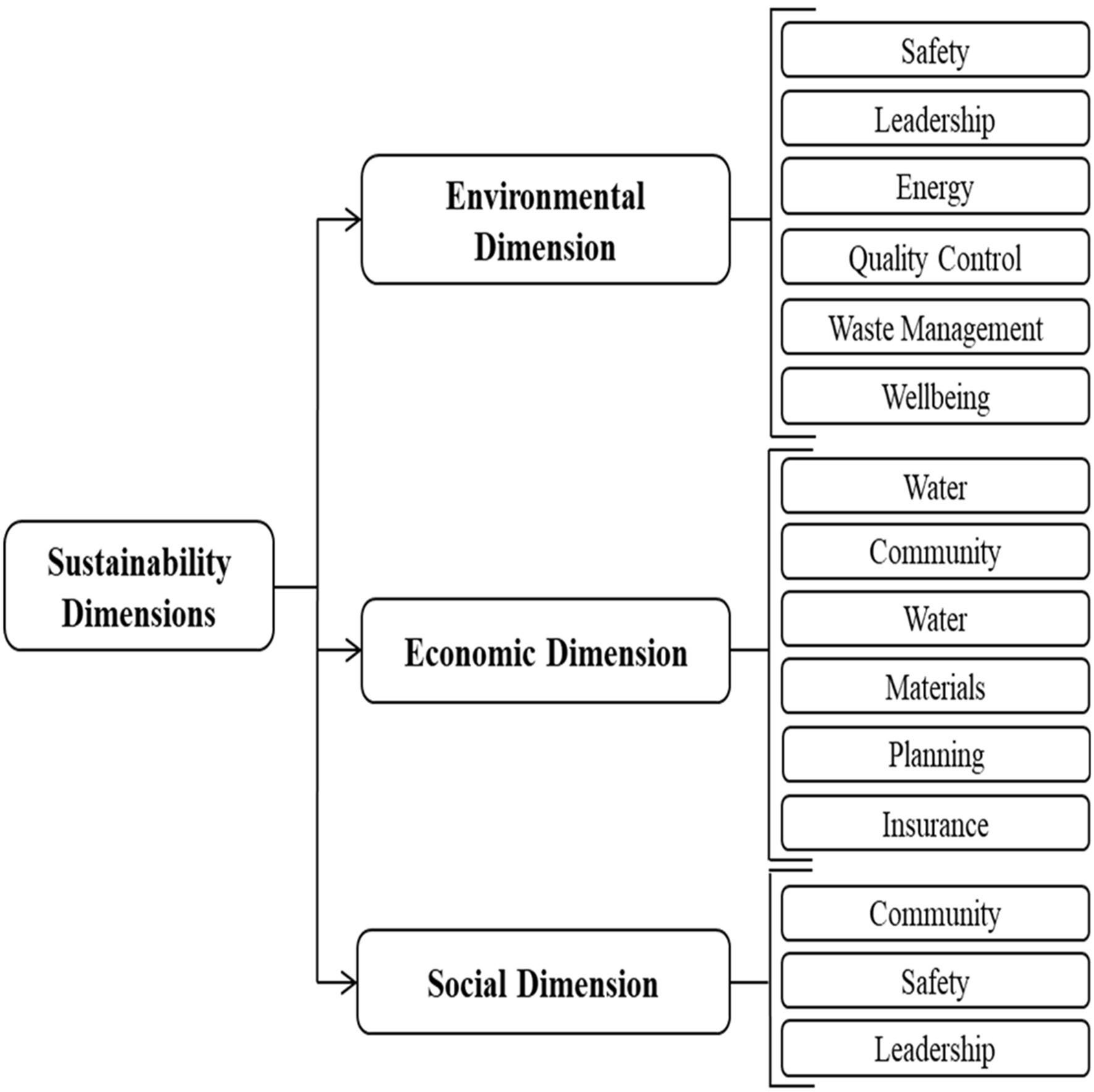

Fig. 2 Categories and sub-categories before the interviews

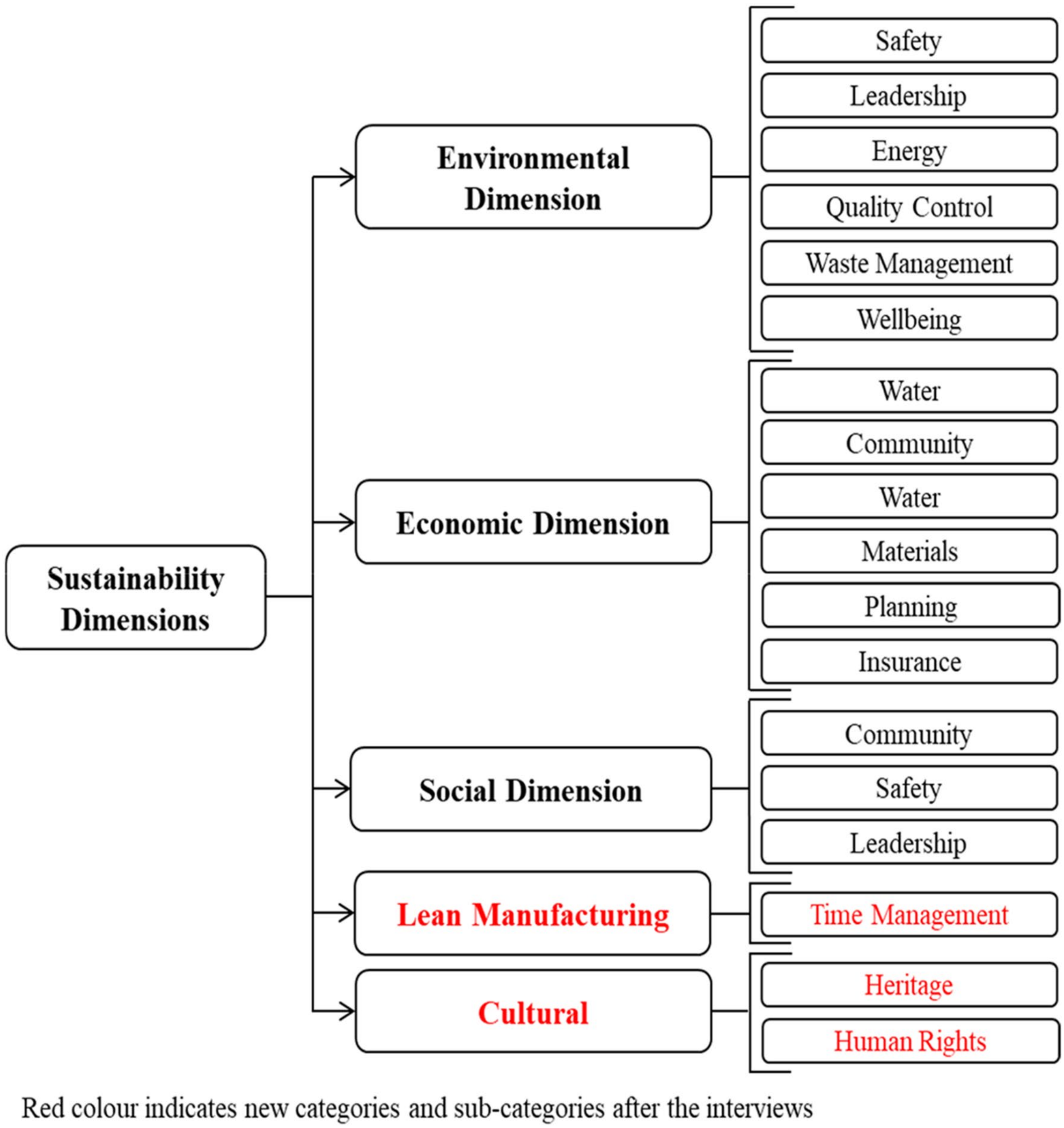

Fig. 3 Categories and sub-categories after the interviews

interviews, each of which was given a rating score. The rating output for the main categories was determined using SPSS software. The mean, standard deviation, rank, weight*100%, and rating (score) for each category are shown in Table 5. This assessment tool is a multi-dimensional method that covers different environmental, social, and economical issues. Therefore, the process of creating the weighting system for the categories and the indicators, within the context of the local community, is calculated by dividing the mean of each category, for example, on the summation of means for all categories and so on for indicators as shown in Eq. 1

$$\text{weight} = \frac{\overline{X}}{\sum \overline{X}}, \quad (1)$$

where x is the mean for (category/indicator).

Each indicator in each category has been given an award based on its weight and mean using Eq. 1.

Calculating the weighting score for each (category/indicator), the system can define the importance of each indicator according to the local context within which the tool is developed. The final score is 332 and contractors should be graded according to these awards. The list of developed categories, and the indicators, are given in Table 5.

Table 5 Final list of main/sub-categories and indicators for sustainability assessment

Main category	Sub-category	Code	Indicators	Mean	Weight *100%	Rating score
Environmental dimension	Safety	E1	Smoking is forbidden in material storage areas	4.4	3.41	4
		E2	Periodically clean the site, around the hangers and streets, to remove screws, steel pieces, and everything that would harm residents or vehicles in the surrounding areas or compromise the general view	4.6	3.57	5
		E3	Surround the site with a fence that is made from re-used materials (old iron sheets—Zenko)	4.6	3.57	5
	Leadership	E4	An environmental practices section should be added to the monthly report	4.2	3.26	4
		E5	The contractor should hire an inspector to monitor the general safety, waste management, and environmental practices	4	3.10	4
		E6	Protect wild animals during construction	4.4	3.42	4
		E7	A report must be prepared detailing gas emissions resulting from any burning operation	3.6	2.79	4
		E8	The contractor must provide alternative solutions to execute the works that have less impact on the environment	4	3.10	4
		E9	The contractor must source alternative materials that have less impact on environment than those mentioned in the tender	3	2.33	3
	Energy	E10	Use LED lights inside the building when working at night during the project	4.6	3.57	5
		E11	For night shifts, artificial lights should be placed in positions that reduce light pollution as much as possible	4.4	3.45	4
		E12	Electric excavators and compactors for excavation works must be used where appropriate	3.4	2.64	3
	Quality control	E13	Materials shall be supplied on time according to the work schedule; this practice will protect materials—such as steel—from being on the site for too long before being used	4.2	3.26	4
		E14	Store materials in specifically demarcated spaces and storage areas	4.4	3.42	4
		E15	Efforts must be made to use as little paper as possible for internal correspondence	4.6	3.57	5
		E16	Construct portable toilets for laborers inside the project site	4.4	3.42	4
		E17	The contractor should clarify the policy that is used to remove obstacles from the site, such as curbstones, pipes, and wires, and the possibility of reusing them later	4.2	3.26	4

Table 5 (continued)

Main category	Sub-category	Code	Indicators	Mean	Weight *100%	Rating score
		E18	Never dispose of material waste on any private properties next to the site	4.8	3.73	5
		E19	Correctly dispose of the backfills without throwing it onto private property	4.8	3.73	5
	Waste management	E20	Establish a policy for waste management according to the sustainability criteria • Hazardous waste should be separated and go through appropriate pathways to their ultimate disposal under a specialist's supervision • Non-hazardous waste to be disposed of in co-ordination with the appropriate authorities • Recyclable waste should be recycled in co-ordination with the appropriate parties	5	3.88	5
		E21	Cut materials precisely to decrease waste as much as possible	4.4	3.42	4
		E22	Avoid burning paper and plastic waste inside the site	4.6	3.57	5
		E23	Avoid storing wastes on sites as temporary piles for long time	4.4	3.42	4
		E24	Replanting the trees that were removed from the site for absolutely necessary matters	4.8	3.73	5
		E25	Apply a water spraying system daily, to reduce the dust resulting from the construction process and to reduce the harm from dust to the surrounding community	4.6	3.57	5
	Wellbeing	E26	Operational procedures, policies and training must be in place with respect to the transport, handling and disposal of materials that give off exceptional amounts of dust • Such materials should be transferred to the site in bags or closed containers • The height of any fall should be reduced as much as possible	3.6	2.79	4
	Water	E27	Care must be taken not to harm any natural or artificial water resources in the surrounding areas of the project during the construction phase	4	3.11	4
		E28	In the case of finding any water resources on the project site, such as groundwater, the contractor should protect it and inform the authorities	3.6	2.79	4
		E29	Use water that is fit for human consumption in construction	4.6	3.57	5
		E30	Plant native flora on the project site to avoid high care and irrigation needed for other strange plants	4.6	3.57	5
Total rating score				**130***		

Table 5 (continued)

Main category	Sub-category	Code	Indicators	Mean	Weight *100%	Rating score
Economic dimension	Community	EC1	Supply the necessary building materials from nearby stores instead of transporting them from other governorates	4	6.56	4
		EC2	Provide training opportunities for the local community	3.4	5.57	3
		EC3	Propose a model for rainwater harvesting to use for construction purposes	4.2	6.89	4
	Water	EC4	Ensure there are no leaks in the water pipes to reduce water waste during construction	4.8	6.87	5
		EC5	The waste resulting from cutting tiles must be sent for recycling into Arabic tiles	3	4.90	3
		EC6	The tiles' waste resulting from cutting tiles processes could be re-used in artistic forms and placed on the landscape	4.4	6.21	4
	Materials	EC7	Use steel molds or bricks instead of wooden frameworks wherever possible	4.4	3.03	4
		EC8	Supply materials from factories or firms that are certified for fabricating products via eco-friendly manufacturing processes to support the sustainable production sector	2.8	4.59	3
	Planning	EC9	Choose locations for materials storage to be as far as possible from water erosion paths to reduce the chances of water damage, especially in the winter	3	4.92	3
		EC10	Establish shoring or shot Crete systems for the excavated area to avoid landslides or any similar disasters, especially in winter	3.8	6.20	4
		EC11	Periodic maintenance of all machinery must be carried out to reduce harmful gas emissions	3.6	5.90	4
		E12	Ensure that all shipments are documented	4.8	6.87	5
		E13	Check quantities before supplying materials to reduce waste and surplus as much as possible	4.4	7.21	4
		E14	All drivers should have a validated license suitable for the vehicles for which they are insured to drive	3.2	5.25	3
	Insurance	E15	Issuance of an insurance policy for all laborers	4.2	6.89	4
		E16	Issuing work permits for laborers	3.2	5.25	3
		E17	Issuing health insurance for all laborers	4.2	6.89	4
Total rating score				**64***		
Social dimension	Community	S1	Install a fence around the site with warning signage designed to prevent the locals from entering the site	4.6	6.44	5
		S2	Commitment to occupational health and safety regulations by laborers	3.8	5.32	4

Table 5 (continued)

Main category	Sub-category	Code	Indicators	Mean	Weight *100%	Rating score
		S3	Create job opportunities for locals in porting and guarding activities	4.6	6.44	5
		S4	Contract with local artisanal workers, if they have the required competence, in preference to contracting with artisanal from other governorates	4.8	5.72	5
		S5	Labor's commitment to ethical regulations such as respecting neighbor's properties	4.6	5.40	5
		S6	Only quiet tasks must be executed outside of normal working hours	4.4	3.04	4
		S7	Traffic flows must not be interrupted during ready-mix concrete casting	4.4	6.16	4
		S8	Provide environmental training opportunities for laborers and locals to contribute to spreading environmental awareness	4.6	5.44	5
	Safety	S9	Providing first aid kits	4.6	6.44	5
		S10	Register all accidents and injuries that happen during the project with social security and count them at the end of the project	4.2	5.88	4
		S11	Provide the staff with uniforms that meet all safety requirements (vests, safety shoes, and helmets)	4.8	6.72	5
		S12	Using a modular system to create appropriate housing for laborers	4.2	5.88	4
	Leadership	S13	Develop a crisis management plan for emergencies that might occur, such as fires	4.6	6.44	5
		S14	Hold periodic, high-priority meetings to discuss environmental practices	3.6	5.04	4
		S15	Strengthen the communication skills between the staff members	4.6	6.44	5
	Transportation	S16	Speed limits for vehicles should not exceed 40 km/hour in streets surrounding the site in order not to damage the street or disturb the neighbors	4.6	6.44	5
		S17	Providing collective transportation for laborers to minimize the use of private cars	4.8	6.72	5
Total rating score				**79***		
Lean manufacturing	Time management	L1	Involve sub-contractors in the preparation of the time plan for the project	4.6	27.38	5
		L2	Receive materials in a timely manner to avoid accumulation and damage before installation, such as with reinforcing steel	3.8	22.62	4
		L3	Ensure the correct data cards are attached to materials and equipment to enable proper use	4.2	25	4
		L4	Commit to the time schedule for supplying materials	4.2	25	4
Total rating score				**17***		

Table 5 (continued)

Main category	Sub-category	Code	Indicators	Mean	Weight *100%	Rating score
Cultural	Heritage	C1	The contractor should contact the DOA before starting work to provide a list of possible existing antiquities or ruins at the project site or surrounding areas	4.2	9.72	4
		C2	The contractor should contact the DOA upon finding any monuments, historical sites or any small pieces of possible archeological interest	4.4	10.19	4
		C3	The contractor should clarify a plan to protect any ruins that are uncovered during excavation	4.4	10.19	4
		C4	The contractor must get written approval from the DOA before removing any buildings, foundations, structures, walls or any other obstruction	3.6	8.33	4
		C5	Antiquities must be moved carefully, without causing damage, and under DOA supervision	4.4	10.19	4
		C6	Any antiquities that are uncovered must be treated with the highest level of respect	4.2	9.72	4
	Human rights	C7	Pluralism and respect for human rights must be enhanced and maintained between management and laborers, regardless of gender, race, or religion	4.6	10.65	5
		C8	Opportunities and processes must be made available to staff members to express an opinion, lodge a complaint and propose solutions	4.4	10.19	4
		C9	Gender inequality and gendered racism must be reduced at every opportunity	4.4	10.19	4
		C10	No staff member should work more than 10 h per day	4.6	10.65	5
Total rating score				**42***		
Total rating score for all dimensions				**332****		

*Bold values indicate the total rating score for each category

**Bold value indicates the total rating score for all dimensions

The final list of indicators is shown in Table 5. The weight for each category and indicator were adjusted due to the additional sub-categories and indicators that were added. A new statistical analysis was prepared for the updated model; hence, the highest and lowest scores were changed as shown. To develop these sub-categories and indicators into a comprehensive model that can be adopted by the specialized authorities to evaluate contractor performance during the construction phase of a project, these were all discussed with specialists and experts in the field of sustainable construction. Their opinions and experiences helped to establish the final model, in which indicators among the three main dimensions were added. In the environmental dimension, the total number of indicators grew from 21 to 30, while six indicators were added to the economic dimension to become 17, and the total number of indicators within the social dimension is also 17. Moreover, two further sub-categories were added to the model, namely cultural and lean manufacturing, with combined indicators of 14. Therefore, the developed model contains a total of 78 indicators distributed across five categories. Figure 4 shows the weight of each category.

As shown in Fig. 4, the environmental dimension has the highest weight at 39% and incorporates a total of 30 indicators across the 7 sub-categories which are safety, leadership, energy, quality control, waste management, well-being, and

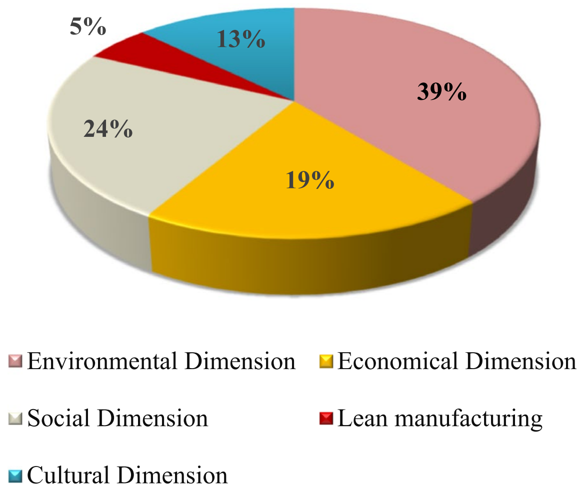

Fig. 4 Weights of the categories

Table 6 Distribution of marks

Dimension	Total marks
Environmental dimension (EnD)	130
Economical dimension (EcD)	64
Social dimension (SD)	79
Cultural dimension (CD)	42
Lean manufacturing (LM)	17
Total	332

water. Following our studies, analysis, and discussions with the experts, this category became the one with the highest number of indicators to emphasize the importance of focusing on improving contractor behavior toward the environment during the construction phase. According to the experts, taking responsibility for their actions should be one of the top priorities and this is shown in the awards of the indicators. The maximum score which can be obtained to measure a contractor's performance during the construction phase is given in Table 6, where the maximum score which can be obtained 332 is distributed, as shown in Table 6.

Performance indicators: environmental dimension (EnD)

The environmental dimension is about the ability to use natural resources without undermining the equilibrium and integrity of ecosystems, and reduce the burden on the environment (Bell & Morse, 2008; Sami & Farid, 2021; Sharifi & Sharbatdar, 2021; St Flour & Bokhoree, 2021; Zakrzewska et al., 2022). The environmental dimension was ranked first in importance, with a weight of 39% across the five categories. Subsequently, 7 sub-categories and 30 indicators were generated from this research, between which were assigned a total of 130 marks. The highest ranked indicator is E20, with a weight of 3.88, while the lowest ranked is E9, with a weight of 2.33.

Performance indicators: social dimension (SD)

The social dimension is about ensuring equality of opportunities for people, involving welfare, quality of life, and sustainable human development. It should liberate individual capacities and fulfill human needs, thus ending poverty and improving individual quality of life, offering security with full rights and liberties in the long term, and engendering social cohesion (Bell & Morse, 2008; Sami & Farid, 2021; Sharifi & Sharbatdar, 2021; St Flour & Bokhoree, 2021; Zakrzewska et al., 2022). The social dimension was ranked second in importance with a weight 24% across five categories. Subsequently, 4 sub-categories and 17 indicators were generated from doing this research, between which were assigned a total of 79 marks. Indicators S11 and S17 are the highest ranking, both with a weight of 6.72, while the lowest ranked indicator is S6, with a weight of 3.04.

Performance indicators: economical dimension (EcD)

The economic dimension is about the efficiency of economic and technological activities, fostering investment and productivity, economic growth, and economic output potential (Bell & Morse, 2008; Sami & Farid, 2021; Sharifi & Sharbatdar, 2021; St Flour & Bokhoree, 2021; Zakrzewska et al., 2022). The economic dimension was ranked third in importance with a weight of 19% across five categories. In total, 5 sub-categories and 17 indicators were generated from doing this research, between which were assigned a total of 64 marks. The EC13 indicator is ranked highest, with a weight of 7.21, while the lowest is EC7, with a weight of 3.03.

Performance indicators: cultural dimension (CD)

The cultural dimension is about creativity, heritage, knowledge, and diversity. These principles are essentially connected to human development and make up the cultural dimension of sustainable development (Wiktor-Mach, 2020). The cultural dimension was ranked fourth in terms of importance with a weight of 13% across five categories. Two subcategories and 10 indicators were generated throughout this research, and the maximum rating assigned to this category is 42 marks. Indicators C7 and C10 are the highest ranking, both with a weight of 10.65, while C4 is ranked the lowest with a weight of 8.33.

Table 7 Award system for sustainability assessment (JGBG, 2013)

Description	Award
If the contractor scores 80% or above of the total potential points	Certified (Class A)
If the contractor scores between 70 and 79% of the total potential points	Certified (Class B)
If the contractor scores between 60 and 69% of the total potential points	Certified (Class C)
If the contractor scores between 50 and 59% of the total potential points	Certified (Class D)
If the contractor scores less than 50% of the total potential points	Not certified

Performance indicators: lean manufacturing

Lean manufacturing is a production philosophy that concentrates on customer value and targets to serve the customer as efficiently as possible by eliminating all unnecessary waste from the operation (Järvenpää & Lanz, 2020). Waste means all the actions that do not add value to the customer, and value is something that the customer is willing to pay for. It is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability (Resta et al., 2016). Lean emphasizes the efficient flow of products over the maximum utilization of resources (Järvenpää & Lanz, 2020). It is a multi-dimensional approach that encompasses a wide variety of management practices that work synergistically and are mutually reinforcing (Resta et al., 2016). The importance of lean production in this context is in satisfying the expectations of the end-users throughout the entire operational life of the building, from the start of the construction phase, during the years of building use, all the way through to demolition. This dimension ranked fifth in importance with a weight of 5% across the five categories. Only one sub-category was produced with four indicators and the maximum rating assigned to this category is 17 marks. L1 is the indicator ranked first with a weight of 27.38, while the lowest ranked is L2 with a weight of 22.62.

Certification criteria

The certification criteria are based on the summation of scores which were assigned to indicators on the assessment list. The score for each sub-category comes from the summation of all scores which are given to each indicator. Then, the total score for each category comes from the summation of the score for each sub-category. The formulas for these workings are given in Eqs. 2–5

$$\text{Indicator's result} = \text{Indicators result's score} * \text{weight of the indicator,} \tag{2}$$

$$\text{Sub-Category's result} = \sum \text{Indicators result's score} * \text{weight of the Sub-Category,} \tag{3}$$

$$\text{Category result} = \sum \text{Sub-Category result's score} * \text{weight of the Category,} \tag{4}$$

$$\text{Total assessment level} = \sum \text{Category results.} \tag{5}$$

The score results multiply by the specific weight for each category, sub-category, and indicator. The total sum of each parameter will appear on the indicator, and finally, the sum of indicator levels will be shown on the category level with their relative weights. The result of this awarding system can be driven by applying Eq. 4 that derives the contribution of each category and Eq. 5 that derives the summation of all weights to classify contractor performance. Five levels are considered to classify contractor performance including Class A, Class B, Class C, Class D, and finally not certified. The classification criteria of the contractor performance of the awarding system for sustainability assessment are shown in Table 7 which are based on proposed classes in the Jordan Green Building Guide (JGBG, 2013).

It is clear from the previous discussion that each category, sub-category, and indicator have a weight and a score. The summation of all results obtained from each one is inputted to the given equations to arrive at the final awarding scheme. For example, if a certain practice has achieved a mean equal to 4.6, it would be awarded a 5. Therefore, it could be recognized that the rating of many indicators is 5. In fact, 12 indicators have been rated to 5 and only 2 indicators are rated to 3. Moreover, the slight differences in the standard deviations and the weights between the indicators made it possible to rank them. Thus, PE 20 states "Establish a policy for waste management according to the sustainability criteria" and is ranked first, with a mean of 5, S.D 0, weight 3.88%, and it was rated according to its mean of 5. This rating is only achievable if the contractor establishes a sustainable system to manage both hazardous and non-hazardous waste during the construction phase, as well as recycling and reusing materials as much as possible; unsustainable methods of waste management will be awarded zero. It should be noticed that the zero deviation of this practice clarifies its importance. Subsequently, the practice that ranked last was (PE9) states, “A report must be prepared detailing gas emissions resulting from any burning operation” with a mean of 3, S.D 1.87083, weight 2.33, and a rating of 3. The total reward for this category is 130/332 with a percentage of 39%.

The findings from the study suggest that all the indicators were important in assessing contractor performance during the construction phase with respect to sustainability across the entire execution stage. These results indicate that environmental protection plays a crucial role in defining sustainability; the social category comes second in importance, while lean manufacturing is at the bottom of the list with a weight of 5%.

Implications of the assessment indicators in practice

The discussions with the experts proved that the list of indicators is comprehensive and are applicable to construction projects in Jordan. However, real differences will only be made when systemic changes are made at multiple levels. For example, with regard to national legislation, some governmental systems should be adjusted, and new instructions must be enacted. Serious steps should be considered in the education sector and in raising awareness, too, because the community needs to be more conscious and aware of their rights and duties toward the planet. Some specialists suggested that the Ministry of Public Works and Housing could collaborate with the Green Building Society to agree on this model. Then, the agreed list of actions could be added to all tender documents produced for each project, and all contractors must then commit to it as a condition of their involvement in the project. It is important for the assessment process to be objective and free from bias, so it should ideally be carried out by a third-party committee, assigned by the MPWH, and acting independently, during the construction phase.

Conclusions and future pathways

Sustainability as an approach to development is becoming an urgent requirement globally, and construction is no exception; in reality, it might be the most important industry with which to start, especially in Jordan. The literature to date lacks clear systems and codes for contractors to follow during the construction phase to execute a sustainable project; this was the motivation for this scientific paper.

The system of Sustainability Assessment Indicators for measuring contractor performance during the construction phase, developed herein, provides a blend of comprehensive and functional guidelines, based on sound sustainability research in Jordan. It also offers a set of achievable goals for local authorities and national policymakers who wish to deliver a project in a sustainable manner. The system contains five main categories, namely, environmental, social, economic, cultural, and lean manufacturing with 19 subcategories and 78 indicators. The findings indicated that the most important category is the environmental one, though they all play a role. The experts who were interviewed all agreed that the proposed system is a unique strategy, providing a set of indicators that the contractor can follow during the construction phase, in cooperation with all involved parties. The proposed system has great potential to accelerate the understanding and implementation of sustainable construction.

The possible limitations of this proposed system are the willingness of the contractors to participate on a voluntary basis, and the ability of professional training organizations to raise the awareness of sustainability within the construction industry. We recognize the challenges of implementing this system in Jordan due to limited funding, technology, and infrastructure, and the lack of a comprehensive national plan to drive sustainability deeper into the construction industry. The country needs a higher level of awareness, appropriate planning, and a consideration of the proposed system as forming part of the tender documentation, so that contractors see the economic benefits of sustainability, in addition to protecting the environment and raising social awareness about sustainable construction and infrastructure development.

The findings from this study may help decision-makers and other stakeholders analyze the issues with the current strategy, especially in the construction phase, and implement the most realistic actions to encourage sustainable development in Jordan. Using a structured framework that provides logical steps, based on a problem-solving approach, will increase the potential of sustainable projects to be successful. This model is only a first step on the path toward sustainable construction; further studies and annual revisions will be necessary to continue moving forward.

Finally, this model creates a comprehensive and integrated sustainability assessment method, which may require further development, to measure the performance of contractors who are delivering both public and private projects in Jordan. In the end, this rating system, or a derivation of it, will require concerted effort from all involved authorities to ensure that it is properly applied and developed.

Funding The authors have not disclosed any funding.

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. On behalf of all authors, the corresponding author states that there is no conflict of interest.

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