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An Index to Measure Sustainability of a Business Project in the Construction Industry: Lithuanian Case

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Abstract: The continuous growth of the world population, resource scarcity and the threat of climate change pose numerous environmental and social problems to the world. Therefore, much hope is put in the concept of sustainability. Companies are increasingly coming under strong global pressure to incorporate sustainability considerations into their project decision-making process. Business projects in the construction industry are among the most important, as this sector is one of the largest sectors and of major importance for the national economy and therefore has a huge impact on the environment and society. Thus, we have to explore ways to integrate sustainability into the management of those projects. This paper presents a composite sustainability index of a project (CSIP) which has been created following a review of existing literature and a pilot research study. A pilot research study was conducted in the Lithuanian construction industry between January 2015 and June 2015. Sustainability criteria were chosen and grouped on the basis of the analysis of the literature and different standards relating to sustainability applicable in the construction industry. A survey was used to select and rank the most important sustainability criteria. The index was constructed using multi-criteria decision-making methods. The results of the pilot study revealed that practitioners in the Lithuanian construction sector attach most importance to 15 sustainability criteria. A composite sustainability index of a project combining all these criteria may be useful in assessing the sustainability of a business project and making decisions regarding project portfolio selection and financial resource allocation. When addressing the issue of financial resource allocation in a project portfolio, the decision-maker could take into account not only the project's return and risk, but also its sustainability. The understanding of this study should enable companies to execute sustainable projects, which could make a contribution to the sustainable development of organizations and thereby increase their competitive advantage.

Keywords: project portfolio management; sustainability; composite sustainability index; construction industry; sustainable construction; resource allocation

1. Introduction

Sustainability is considered one of the most significant challenges facing society today. The concept of sustainability is widely applied by many companies through their mission statement and strategy. It is also one of the most popular research fields for scholars. More recently, the idea of sustainability has also been incorporated into project management [1,2]. At the 22nd World Congress of the International Project Management Association (IPMA) in 2008, IPMA President Mary McKinlay stated that "the further development of the project management profession requires project managers to take responsibility for sustainability" [3]. The consideration of sustainability is gaining a greater prominence in the field of project portfolio management. There is an increasing understanding of the need to develop methods, tools and techniques to integrate sustainability criteria into the management of projects, as well as a growing need of knowledge and concepts on how to adopt sustainability in project portfolio management [4–10]. Silvius and Tharp [11] concluded that "the relationship between sustainability and project management is [...] picking up momentum".

Although quite a few scholars understand that sustainability should be integrated into project portfolio management, the integration of sustainability as such and especially the assessment of the sustainability of a business project remain a complex and open issue [12]. Hence, there is a need to develop a tool that would allow quantifying the sustainability of a business project. Taking into account the fact that sustainability indicators and composite index are used to assess different aspects of sustainability [8,13–23], we decided to develop a composite sustainability index to assess the sustainability of a project (CSIP). The construction industry was chosen for research purposes. The importance of the construction industry for the three elements of sustainability (e.g., environmental, social, economic) cannot be disregarded, since construction is of great economic significance and has a strong environmental and social impact.

The aim of this article is to propose a tool to measure the sustainability of a business project in the construction industry.

The objectives of this article are as follows: (1) to analyze the scientific literature on the relationship between sustainability and project portfolio management; (2) to review the literature on sustainability in construction project portfolio management; (3) to present the Lithuanian construction sector; (4) to develop a composite sustainability index of a project; (5) to show the possibilities of integrating a composite sustainability index of a project into project portfolio management (more specifically, financial resource allocation in a project portfolio).

The research methods are: analysis of scientific literature and other information sources, survey and statistical analysis, and multi-criteria decision analysis (MCDA).

2. Sustainability in Project Portfolio Management

While there are plenty of sources on project management (project portfolio management) or sustainability itself, there are relatively few authors that have linked sustainability with project management [7,10]. This connection involves many concepts depending on the approach adopted by the research team [10].

Sustainability in project management has at its core the preservation of natural resources, positive impacts on the society and the strengthening of the global economy. The Project Management Institute states that sustainability in project management is a new global model of making business and managing a project to incorporate sustainability in every phase [24].

Tom Taylor, former chairman of the Association for Project Management, was one of the first to suggest that the project management community should encompass the issue of sustainability, and thereby contribute towards a more sustainable society [25]. In some of the first publications on sustainability and project management, Labuschagne and Brent [26] related sustainable development to project life cycle management in the manufacturing industry. They described three goals for sustainable development (*i.e.*, social equity, economic efficiency, and environmental performance) in various project life cycle management problems.

Project management approaches and instruments were put together in toolboxes and handbooks to manage sustainability projects. Moreover, project sustainability checks have been developed for specific project types such as facility and infrastructure projects [27]. In addition, studies of appraising sustainability in projects have been reported for construction projects [28]. Gareis *et al.* [1] developed a model to address relationships between sustainable development and project management. The model comprises sustainable development principles and project management objects. Further, a Maturity Model for integrating sustainability into project management was developed by Silvius and Schipper [29]. The model assesses the level (*i.e.*, business process, business model, and product and services delivered by the project) on which different aspects of sustainability are considered in the project.

A more academic approach to sustainability in projects was taken by Oehlmann [30]. She developed the "Sustainable Footprint Methodology" to analyze and determine the relevant social, environmental and economic impacts of a project. Furthermore, the problem of selecting the best portfolio with respect to the organizational strategy that includes sustainable goals was considered by Vandaele and Decouttere [31]. The authors developed a data envelopment analysis (DEA) model with the aim of supporting strategic Research and Development portfolio management. The authors then proposed to use development costs, investment costs, and technical risk as inputs for DEA, and performance indicators, such as market size, competition, sales potential, profitability or technical probability of success, as outputs for DEA. In addition, Sanchez [32] developed a framework to help ensure that organization is working on the right projects to implement its business strategy and satisfy stakeholders' demands. The author believes that this conceptual framework has a good potential for integrating sustainability and project management in operational terms. Khalili-Damghani and Tavana [33] proposed a comprehensive framework for sustainable strategic project selection problem.

Finally, PRiSM (Projects integrating Sustainable Methods) was developed by Global Precipitation Measurement GPM Global as a means of creating a methodology that took environmental and social factors into account. It is a sustainability-based project delivery method. PRiSM was developed for organizations to integrate project processes with sustainability initiatives. The principles of PRiSM adhere to the P5 Standard which integrates the products (technical aspect), processes (governance aspect), profit (financial aspect), planet (environmental aspect) and people (social aspect) matters into the project. "The GPM P5 Standard is a tool that supports the alignment of Portfolios, Programs and Projects with organisational strategy for Sustainability and focuses on the Impacts of Projects Processes and Deliverables on the Environment, Society, the corporate bottom line and the local economy" [34].

The literature analysis revealed that sustainability is becoming more and more important in the field of project portfolio management. The project management community realizes the necessity to develop methods, tools and techniques to integrate sustainability criteria into project portfolio management.

3. Sustainability in Construction Project Portfolio Management

In 1994, the concept of sustainable construction was born at a tactical level in the building sector and in civil engineering [8]. Kibert [35] defines sustainable construction as the responsible development and management of a healthily built environment based on the efficient use of resources and ecological principles.

Sustainability in construction covers not only environmental issues, technical efficiency and functional requirements, but also urban renewal and social aspects. Sustainable construction aims to design buildings that would allow saving energy and resources, protecting the health of residents and ensuring their well-being. As a result of the introduction of new European standards on sustainable construction products, processes and works, the application of strategies towards energy efficiency in buildings, compliance with building energy performance requirements, the application of energy performance certification with a view to achieving the Europe 2020 targets, the future development of the construction industry is related to building energy performance, resource efficiency, low carbon economy, energy efficiency, sustainable buildings, *etc.* [36].

Internationally recognized environmental assessment systems for buildings (e.g., BREEAM (Building Research Establishment Environmental Assessment Method, UK), LEED (Leadership in Energy and Environmental Design, USA), DGNB (German Sustainable Building Council, Germany) are oriented towards energy saving, efficient water use, reduced CO_2 emissions, improved quality of life, resource management and appropriate consumption.

Still, the need to focus on sustainability issues is neglected in almost all current literature relating to construction portfolio management [37]. For example, Tong *et al.* [38] recommended the use of generic algorithm optimization in the building and construction portfolio management. They argued that the proposed model can be used to forecast long-term asset management strategies and help minimize total maintenance and replacement costs. Hernandez *et al.* [39] introduced a metric known as the Project Value to Portfolio Value (PV2PV) to assess added value (from a financial perspective) of a new construction project to the value of the company's actual portfolio of construction projects. The PV2PV indicator allows establishing a modified ranking of the individual projects of the portfolio should a new incoming project be included in the firm's portfolio of standing projects. Guo and Yu [40] highlighted the current situation of the Chinese construction industry and argued for the adoption of project portfolio management.

However, only few authors have considered how sustainability could be measured in construction project portfolio management. Sanchez and Lopez [8] developed a methodology to identify sustainability indicators in construction project management. Al-Kilidar *et al.* [41] presented a maturity model for the implementation of sustainable project portfolio management in construction. The maturity model provides guidance on how project portfolio management can move beyond resource balancing to provide a higher level of portfolio oversight for the construction industry including the incorporation of sustainability considerations. Siew [37] proposed robust methods to account for sustainability across two critical stages: screening and optimal portfolio selection. During the screening stage, sustainability criteria are proposed followed by the use of second order moment to measure sustainability. The means and variances derived from the screening stage are then used to find the efficient portfolio frontier (the expected return is substituted by the expected sustainability score of projects, while the variance of return is substituted by dispersion of the sustainability score).

Thus, as mentioned in the introduction, there is a huge demand to develop a tool that would allow assessing the sustainability of a business project in the construction industry. To this end, we propose to use a composite sustainability index of a project (CSIP).

4. Overview of the Lithuanian Construction Sector

The construction sector is one of the most important sectors in the European Union. In the European Commission's Communication "Strategy for the sustainable competitiveness of the construction sector and its enterprises" adopted in 2012, the construction sector, which generates almost 10% of GDP and provides 20 million jobs in the EU, is identified as having a significant influence on the development of the EU economy.

The construction sector represents an important part of the Lithuanian economy. In 2007–2013, this sector generated from 6% to 10% GDP, employed from 7% to 12% of the country's labor force. Furthermore, one job in construction is related to another 3–4 jobs in other sectors. Construction production processes and operation of buildings consume about 50% of Lithuania's energy needs; buildings and engineering structures absorb around 50% of the country's total material investments.

However, the Lithuanian construction sector faces a number of major challenges, such as ageing social and engineering infrastructure, low labor productivity which is almost half the EU average (according to Eurostat data, one worker employed in the Lithuanian construction sector generated approximately EUR 24.5 thousand of value in 2014, whereas the EU average stood at EUR 47.5 thousand), low investment in scientific research and development (according to the Lithuanian Department of Statistics, expenditure on scientific research and experimental development in the construction sector amounted to only EUR 0.2 million in 2013) [42].

The development of the construction sector is inextricably linked with the initiatives to promote the development and growth of the EU economy as a whole and individual national economies, as well as related strategic documents. The Europe 2020 strategy put forward three mutually reinforcing priorities: smart growth (developing an economy based on knowledge and innovation); sustainable growth (promoting a more resource efficient, greener and more competitive economy); inclusive growth (fostering a high-employment economy delivering social and territorial cohesion). The headline targets under these priorities, which have a direct impact on the construction sector, are as follows: reduce greenhouse gas emissions by at least 20% compared to 1990 levels; increase the share of renewable energy in final energy consumption to 20%; and achieve a 20% increase in energy efficiency [42].

In the light of the growing demands of the Lithuanian economy and the current level of the construction sector, relatively low labor productivity, increasing expenditure on resources and a shortage of highly qualified human resources, and initiatives by other countries to enhance the competitiveness of the construction sector, the Lithuanian construction sector needs a new approach.

5. A Composite Sustainability Index of a Project

Various methodologies exist to construct composite indicators (CIs). Nardo *et al.* [43] described a framework for the construction of a composite indicator, which includes several steps, among which weighting and aggregation are the most significant. The other steps are as follows: selection of indicators and data, imputation of missing data, and normalization of the selected indicators. Furthermore, Hatefi and Torabi [44] proposed a common weight multi-criteria decision analysis (MCDA)-DEA approach for constructing CIs, whereas Zhou *et al.* [23] developed a multiplicative optimisation approach for constructing CIs, using the weighted product (WP) method.

On the basis of various methodologies used to construct composite indices [8,13,14,22,45,46], one of the methodologies for constructing a composite sustainability index is presented below (see Figure 1).

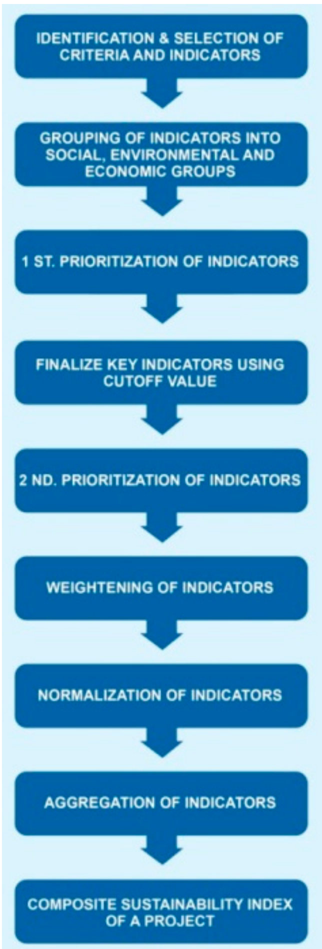

Figure 1. A methodology for constructing a composite sustainability index of a project.

The construction of a composite sustainability index of a project is divided into several steps. Identification and selection of criteria and indicators is a primary requirement for constructing a composite sustainability index. Based on the analysis of the literature [8,14,21,23,47–50] and different standards relating to sustainability applicable in the construction industry, ISO-21932-2013 standard (sustainability in buildings and civil engineering) [51] was selected as a criteria framework. A total of 56 criteria were chosen, which were then grouped into social (15 criteria), environmental (23 criteria) and economic (18 criteria) groups (see Table S1)

The survey was conducted in two stages. In the first stage, questionnaires were sent out to 226 professionals. In order to ensure a professional survey, experts were selected on the basis of the following criteria: their position, competence and work experience. After the questionnaire was sent out, including follow-up reminders, a total of 29 responses were received, of which 15 from CEO, six from engineers, and eight from project managers. Thus, 29 construction professionals took part in the first stage. According to Keeney *et al.* [52], "there are no universally agreed criteria for the selection of experts", thus it is up to researchers to decide on the number and qualifications of the experts used. In order to identify key issues, these experts were asked to rate, on a 5-point Likert scale, the level of importance of each item, with 1 meaning not important, and 5 meaning very important. The survey results were compiled, and the mean value of each criterion was determined. Sustainability issues were arranged in ascending order of their mean values. The critical value was considered as the basis for identifying key sustainability criteria. Thus, the cut-off value 3.00 was used, consequently, sustainability issues with the mean value greater than 3.00 were identified as important. According to Van Cauwenberg *et al.* [53], if too many indicators were considered the indicators would become difficult to understand. Therefore, we selected the most important sustainability criteria.

After the first stage, 15 criteria (four economic, six environmental and five social criteria) of construction sustainability were selected to be used in the second stage. The group of professionals in the second stage was made up of two groups of experts, namely 12 professionals from the first stage, and 10 additional new professionals representing the construction industry. Thus, this expert group was composed of 22 professionals in total (nine CEO, three engineers and 10 project managers). The professionals had to rank the importance of each criterion from 1 to 15, where the highest score was 15 points and the lowest 1 point. The obtained results are shown in Table 1 below.

Table 1. Criteria and indicators.

Dimension	Code	Criteria	Indicator	Points
ENVIRONMENTAL	I_1	Water consumption	m^3/Net income	141
ENVIRONMENTAL	I_2	GHG emission	CO_2 t/Net income	160
ENVIRONMENTAL	I_3	Use of durable materials	Costs for durable materials/Costs for al materials	108
ENVIRONMENTAL	I_4	Use of materials with low health risk	Costs for materials with low health risk/Costs for all materials	104
ENVIRONMENTAL	I_5	Use of renewable energy	Renewable energy/All energy	116
ENVIRONMENTAL	I_6	Energy consumption	Gigajoules (GJ)/Net income	202
SOCIAL	I_7	Project declared of general interest	Project costs/All costs	32
SOCIAL	I_8	Safety and health of workers	Number of injuries/Total number of employees	286
SOCIAL	I_9	Leadership/Knowledge management	Number of accredited professionals/Total number of employees	218
SOCIAL	I_{10}	Local workers during construction, operation and maintenance	Number of local workers/Total number of employees	95
SOCIAL	I_{11}	Training of workers	Yearly training hours/Total number of employee	117
ECONOMIC	I_{12}	Reduction of direct costs	Direct costs/All costs	299
ECONOMIC	I_{13}	Reduction of indirect costs	Indirect costs/All costs	262
ECONOMIC	I_{14}	Maintenance costs	Maintenance costs/All costs	199
ECONOMIC	I_{15}	Construction time	Number of months/Net income	301

Since experts very often hold different opinions and views about the problem at hand, it is necessary to assess the degree of agreement between their opinions. Agreement between two experts can be quantified by the correlation coefficient. Where the number of experts is greater than two, the level of agreement among the group experts is determined by the coefficient of concordance [54]. Therefore, the degree of agreement between the opinions of the experts was assessed by applying Kendall's coefficient of concordance W. Kendall's coefficient of concordance W is calculated in accordance with the following formula [55]:

$$W = \frac{12S}{m^2\left(n^3 - n\right)} \quad (1)$$

where:

- W is Kendall's coefficient of concordance;
- S is the sum of the deviation of ranks from the mean;
- n is the number of objects (criteria) ($i = 1, 2, \ldots, n$);
- m is the number of experts ($j = 1, 2, \ldots, m$).

where expert opinions are practically unanimous, the value of W is close to one; on the other hand, when assessments are conflicting, the value of W is close to zero. The calculated value of the coefficient of concordance ($W = 0.73$) indicated that the expert assessments are very similar.

The reliability of the expert opinions was also evaluated. M. Kendall demonstrated [40] that if the number of objects (criteria) is greater than seven ($n > 7$), the significance of the coefficient of concordance may be determined using Pearson criterion χ^2. Random value

$$\chi^2 = m\,(n-1)\,W = \frac{12S}{mn\,(n+1)} \quad (2)$$

is distributed by the χ^2 distribution with $\nu = n - 1$ degree of freedom. According to the selected level of significance α (in practice, the value of α is 0.05 or 0,01), the critical value χ^2_{kr} is obtained from the table of the χ^2 distribution with $\nu = n - 1$ degree of freedom. If the value of χ^2 calculated in accordance with Formula (2) is greater than χ^2_{kr}, expert assessments are in agreement. In our case, $\chi^2 > \chi^2_{kr}$ (224.74 > 23.68). Hence, the expert assessments are in agreement and may be used for further research.

Another important step is weighting of the indicators. Individual indicators characterizing the research object make a different impact on the objective under consideration. Therefore, in the case of quantitative multi-criteria assessments, it is essential to establish the significance of indicators, *i.e.*, their weights. The most common method is the so-called subjective assessment when the weights of indicators are determined by experts [56]. When the calculation of weights is based on expert assessments, the weights of indicators are determined by applying mathematical statistical methods. The values of weights and their accuracy depend on the selected assessment method. Irrespective of the method applied, the assessment logic is the same: the most important ith indicator will have the greatest weight ω_i. It is agreed that the sum of weights must be equal to one [56]:

$$\sum_{i=1}^{m} \omega_i = 1 \quad (3)$$

Table 2 below shows the significance of each criterion.

The analysis of the significance of criteria based on the expert assessment showed that construction time, reduction of direct costs, safety and health of workers are the most important criteria for construction companies, whereas such criteria as a project declared of general interest, local workers during construction, operation and maintenance are least important.

Table 2. Weighting factors of criteria and their groups.

Code	Criteria and Their Groups	Weighting Factors by Group	Total Weighting Factor
	ENVIRONMENTAL	0.315	
I_6	Energy consumption	0.243	0.077
I_2	GHG emission	0.193	0.061
I_1	Water consumption	0.170	0.053
I_5	Use of renewable energy	0.140	0.044
I_3	Use of durable materials	0.130	0.041
I_4	Use of materials with low health risk	0.125	0.039
	SOCIAL	0.283	
I_8	Safety and health of workers	0.382	0.108
I_9	Leadership/Knowledge management	0.291	0.083
I_{11}	Training of workers	0.156	0.044
I_{10}	Local workers during construction, operation and maintenance	0.127	0.036
I_7	Project declared of general interest	0.043	0.012
	ECONOMIC	0.402	
I_{15}	Construction time	0.284	0.114
I_{12}	Reduction of direct costs	0.282	0.113
I_{13}	Reduction of indirect costs	0.247	0.099
I_{14}	Maintenance costs	0.188	0.075

The next step is normalization, which is necessary as indicators are usually expressed in different units. Possible normalization methods are: minimum-maximum, distance to a reference, and the percentage of annual differences over consecutive years [23]. When applying a distance to a reference method, the normalized value is calculated as the ratio between the indicator and an external benchmark (or target value). The external benchmark can be defined by norms and standards for a specific production sector, local legal regulations or any other relevant documents [23].

It should be noted that we encounter a problem when assessing the sustainability of a new project that the project concerned does not have a tendency. Therefore, a baseline (the simplest reference point) or target value should be used [57]. In our case, we propose to use target values for each indicator. (Every company should set targets for each indicator, for instance, project costs for durable materials should account for at least 20% of all costs allocated to acquire materials. Consequently, I_{tar} = 20%. Assume the project's I_3 = 10%. The normalized value of I_3 would equal 0.5.).

Normalized indicators are described by Equations (4) and (5):

$$\bar{I}_i = \frac{I_i}{I_{itar}} \tag{4}$$

$$\bar{I}_i = \frac{I_{itar}}{I_i} \tag{5}$$

where:

I_i is the value of ith sustainability indicator;
I_{itar} is the target value of ith sustainability indicator;
$0 \leqslant \bar{I}_i \leqslant 1$.

In the light of their impact on sustainability, the indicators are divided into groups consisting of indicators whose increasing value has a positive impact on sustainability (Equation (4)), or alternatively those whose increasing values have a negative impact (Equation (5)). Normalization equation depends on which group the indicator belongs to (see Table 3).

Table 3. Type of indicators.

Code	Criteria	Indicator	Type
I_1	Water consumption	m^3/Net income	*min*
I_2	GHG emission	CO_2 t/Net income	*min*
I_3	Use of durable materials	Costs for durable materials/ Costs for al materials	*max*
I_4	Use of materials with low health risk	Costs for materials with low health risk/Costs for all materials	*max*
I_5	Use of renewable energy	Renewable energy/All energy	*max*
I_6	Energy consumption	GJ/Net income	*min*
I_7	Project declared of general interest	Project costs/All costs	*max*
I_8	Safety and health of workers	Number of injuries/Total number of employees	*min*
I_9	Leadership/Knowledge management	Number of accredited professionals/Total number of employees	*max*
I_{10}	Local workers during construction, operation and maintenance	Number of local workers/ Total number of employees	*max*
I_{11}	Training of workers	Yearly training hours/ Total number of employee	*max*
I_{12}	Reduction of direct costs	Direct costs/All costs	*min*
I_{13}	Reduction of indirect costs	Indirect costs/All costs	*min*
I_{14}	Maintenance costs	Maintenance costs/All costs	*min*
I_{15}	Construction time	Number of months/Net income	*min*

After normalization, the indicators do not have any dimension, and they range between 0 and 1, with 0 being worst and 1 being best.

The final step is aggregation. At this stage, an aggregate index, called a composite sustainability index of a project is developed. The most common form of aggregation is the summing-up of the weighted and normalized individual indicators. Simple Additive Weighting (SAW) is widely applied because it is transparent, simple to use and easy to understand. Considering this, a composite sustainability index of a project is calculated as:

$$CSIP = \sum_{i=1}^{m} \omega_i I_i \tag{6}$$

where:

$CSIP$ is a composite sustainability index of a project;
ω_i is the weight of sustainability indicator i;
I_i is the normalized value of sustainability indicator i;

$$0 \leqslant CSIP \leqslant 1$$

$$\begin{aligned} CSIP = {} & 0.053I_1 + 0.061I_2 + 0.041I_3 + 0.039I_4 + 0.044I_5 + 0.077I_6 + 0.012I_7 + 0.108I_8 \\ & + 0.083I_9 + 0.036I_{10} + 0.044I_{11} + 0.113I_{12} + 0.099I_{13} + 0.075I_{14} + 0.114I_{15} \end{aligned}$$

Sustainability indices of projects calculated by using Equation (6) would allow the decision-makers to compare projects and make rational decisions regarding resource allocation in a project portfolio.

6. Integrating a Composite Sustainability Index into Project Portfolio Management

Modern portfolio theory [58] is based on optimization of two criteria, such as return and risk. With the view of obtaining the best portfolio, the decision-maker needs to make some trade-offs among these two criteria, based on his choice. This model proposed by Markowitz [58] does not reflect the complexity and multi-dimensionality of the decision-making process in portfolio selection;

therefore, the issue of considering several criteria in the portfolio selection problem is not only a necessity but also a reality [59]. Steur *et al.* [60] proposed an important modification based on multi-criteria decision-making theory. Instead of relying on a risk and return-oriented decision, they pursue several investment objectives simultaneously. Multi-dimensional optimizations have been applied to various criteria (e.g., portfolio size, transaction costs or aspects of taxation) [61]. The integration of corporate sustainability was proposed by Peylo [62] with a three-dimensional optimization framework. The basic concept of this framework is to control two main financial criteria (portfolio return and risk) together with portfolio sustainability in an integrated approach. Based on this framework, we propose to integrate project sustainability analysis into project portfolio management. We suggest performing not only financial and risk analyses but also sustainability analysis in order to calculate a composite sustainability index of a project when selecting projects to a portfolio and deciding on financial resource allocation in a project portfolio (see Figure 2).

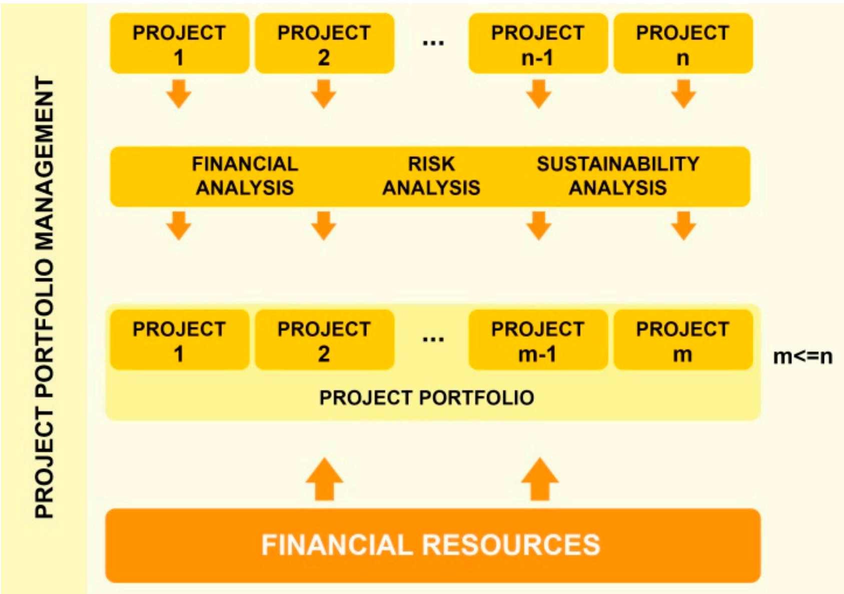

Figure 2. Sustainability-oriented financial resource allocation in a project portfolio.

There are several possible approaches to the integration of sustainability into portfolio theory [62]. One option would be to combine the concept of sustainability and portfolio theory by selecting a set of appropriate projects using sustainability criteria as the first step and applying a portfolio optimization to set up an efficient portfolio as the second step. As a second alternative, the portfolio optimization could be applied first and then a certain degree of sustainability could be added to the portfolio. A third alternative would be to integrate sustainability as an additional criterion into a new three-objective portfolio optimization.

The aim of integrating sustainability analysis into project portfolio management is to allocate financial resources, taking into account not only the project's return and risk but also its impact on the environment and society. Once, financial, risk and sustainability analyses are performed, it should be decided which criteria (financial or non-financial) are given priority by a decision-maker prior to any allocation of financial resources in a project portfolio. For instance, a simple weighting function (using a weight λ) could be applied that would express preference of a decision-maker [62]. For example, a project portfolio could be constructed taking into account only return and risk (financial portfolio, $\lambda = 1$). Furthermore, it could also be constructed taking into account project sustainability rather than just return and risk, by attaching equal weight to financial and sustainability criteria (balanced portfolio, $\lambda = 0.5$). Lastly, the best possible sustainable portfolio could also be constructed ($\lambda = 0$).

7. Conclusions

The literature analysis revealed that sustainability has only recently been linked to project management, and today there is an increasing understanding of the need to develop methods, tools and techniques to integrate sustainability criteria into project portfolio management.

The literature analysis also showed that, although quite a few scholars understand the necessity to integrate sustainability into project portfolio management and construction project portfolio management in particular, the integration of sustainability and, especially the assessment of project sustainability, remain a complex and open issue.

This pilot research study identified 15 sustainability criteria, comprising four economic, five social and six environmental criteria, which are important for practitioners in the construction industry. Furthermore, the analysis of the significance of criteria revealed that construction companies attach most importance to the economic criteria, followed by the environmental and then social criteria. In order to ensure the reliability of the list of criteria and their weighting factors, further research should be carried out. Sustainable development can be achieved when the overall level of the fulfilment of the needs and objectives of all stakeholders is the highest; therefore, further research will involve the society, sustainability experts and architects as these groups may hold different views because of having different professional experience or representing different interest groups.

This article makes an original contribution by proposing a way to measure the sustainability of a business project in the construction industry. The CSIP provides decision-makers with an easy to interpret instrument to assess the sustainability of a business project. Based on the review of existing literature, this has not been attempted. There are a number of different methods to assess the sustainability of buildings, but not that of a business project in the construction industry.

We have also shown the possibilities of integrating this indicator into project portfolio management. We proposed that not only financial and risk analyses but also sustainability analysis should be performed when selecting projects to a portfolio and deciding on financial resource allocation in a project portfolio. Finally, further research is required to verify how the proposed integration of sustainability into project portfolio management (more specifically, financial resource allocation in a project portfolio) could be implemented in practice.

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