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Towards a Unified Framework for Project Success Score Computation in Construction Projects

Athanasios Lamprou and Dimitra G. Vagiona *

Department of Spatial Planning and Development, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece
* Correspondence: dimvag@plandevel.auth.gr

Abstract: The discussion of project success has expanded beyond project management and success criteria. The main cause of the failure to evaluate project performance in construction projects is the absence of a shared definition and a common set of criteria for project success. The aim of this paper is to develop a framework which includes certain success criteria to assess construction projects and allows for the calculation of a Project Success Score (PSS). The Rapid Impact Assessment Matrix (RIAM) approach is adopted and modified appropriately, providing a framework that combines primary and secondary success criteria to compute a comprehensive Project Success Score (PSS). Seventeen (17) success criteria are included in the framework, and their corresponding thresholds are formulated to determine the limits of failure of a project. The final PSS consists of five distinct classes, which range from the level of absolute success (PSS in the range of 9361 to 13,500) to the level of absolute failure (13 to 384). Finally, a web application that simulates the PSS framework is developed. The web application was tested by an end-user, in order to assess its applicability and ease of use, and the facilitation of the whole computation process of PSS was ensured. This paper provides a rational framework through which construction projects can be rapidly assessed, with the aim of highlighting the potential unsuccessful criteria in each project and increasing the probability of more effective project outcomes.

Keywords: construction projects; project success; Project Success Score (PSS); success criteria

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1. Introduction

The nature and definition of project success have been debated extensively in academia and practice, yet no consensus has been achieved. The literature regularly uses terms such as on-time completion, within-budget completion, to-specification completion, the success of the product created, and success in reaching the project's business objectives to describe project success and how well a project is completed [1]. In addition, project success is strongly dependent on the expectations and perceptions of various stakeholders, as well as the time at which the assessment of success is performed [2]. However, significant research into project success has already been carried out in terms of defining the drivers of project success. The drivers for each project differ for different types of projects and, as noted by Muller and Turner [3], what is acceptable in one project without affecting the perceived success may be perceived as utter failure in another. In particular, in the construction industry, there is a great need to define a set of standard indicators that construction executives and project managers may use to measure construction performance at the project level [4]. A construction project, according to Chitkara [5], is a high-value, time-bound special construction mission that creates a construction facility or service with preset performance objectives in terms of quality specification, completion time, budgeted cost, and other stated limitations.

Amongst the primary drivers of project success are the Success Criteria (SC). Cost, scope, and time are three of the most common project success criteria used in all projects

(e.g., [6–8]). If a project is completed on time and on budget while meeting its stated objectives, then it is usually called a success. However, several new criteria for measuring project success have been proposed and adopted by researchers over the last few decades, depending on the distinct goals and objectives of the project under study. These include: technical specifications and requirements (e.g., [1,9,10]), client/user satisfaction (e.g., [8,11,12]), stakeholder satisfaction (e.g., [9,11,13]), project team/personnel satisfaction (e.g., [6,12,14]), contractor satisfaction (e.g., [10,11,13]), supplier satisfaction (e.g., [15,16]), use (e.g., [1,11,17]), functionality (e.g., [9,10,13]), effectiveness (e.g., [11,12,18]), health and safety (e.g., [8,11,12,19–21]), business and commercial performance (e.g., [6,7,12]), future perspective (e.g., [11–13]), strategic goals/objectives and competitiveness (e.g., [6,8,11]) and environmental impact (e.g., [8,10,12]).

In this paper, we aim to define an overall Project Success Score (PSS) for the construction industry, using multiple success criteria in the calculations. The ultimate purpose of the proposed model is the rational and integrated interpretation and assessment of overall project success, both after the completion and during the operation of the project. The basic parameters used for the assessment of project success are the most important success criteria found in the international literature [22].

In order to calculate the overall Project Success Score (PSS), the basic philosophy of Rapid Impact Assessment Matrix (RIAM) is adopted, with respect to the identification and separation of the most important success criteria, as well as the calculation of the overall success degree for each project. The Rapid Impact Assessment Matrix (RIAM) approach is an analytical tool, used in environmental science to evaluate the total environmental impact of projects, programs, plans, strategies, and policies.

The paper offers three main contributions. First, we identify all of the potential success criteria that may contribute to the success of a project. Second, we combine the potential success criteria into an assessment framework and construct a mathematical model that has practical utility for determining the project success score. Third, the proposed assessment framework overcomes the challenges of defining project success, through aligning project success criteria to a common reference framework.

The remainder of this paper is organized as follows: Section 2 describes the RIAM approach and its applications in the environmental impact assessment of projects. Section 3 presents the methodological framework followed for the overall PSS, providing both the interpretation and assessment classes of the criteria, as well as the classes of the overall PSS. In Section 4, a short description of the developed web application is presented. Finally, in Section 5, the main conclusions of this study are provided.

2. Rapid Impact Assessment Matrix and Its Applications

The Rapid Impact Assessment Matrix (RIAM) method is an analytical tool used to assess the overall environmental impact of projects, programs, plans, strategies, and policies through an Environmental Impact Assessment (EIA) score. This method was developed by Pastakia [23] and Pastakia and Jensen [24] and can be used to record and evaluate impacts in a transparent, continuous, and accurate manner. It has a simple and fully structured character, involving the analysis of various select components of a project under a set of pre-defined evaluation and judgment rules.

The important assessment criteria can be divided into two categories: (a) criteria that are important to the condition and can affect the EIA score (i.e., group A—importance of condition, A1; and magnitude of change/effect, A2); and (b) criteria that are important to the situation, but should not affect the EIA score (i.e., group B—permanence, B1; reversibility, B2; and cumulative, B3). The assessment of each component is carried out using specific criteria and scales. The scoring system necessitates simple multiplication of the points assigned to each of the group's criteria (A). The value criteria group (B) scores are summed together to obtain a single total. The condition's final assessment score is calculated by multiplying the sum of group A scores with the result of the group B scores. Physical/Chemical (PC), Biological/Ecological (BE), Sociological/Cultural (SC), and Eco-

nomic/Operational (EO) environmental components are considered. The environmental score includes 11 range bands and ranges from −108 to 108. The individual classes of the method describe the magnitude of the change and effect of each condition, from their positive to negative aspect.

To date, the RIAM method has been applied in many cases, mainly related to environmental and other modern issues.

El-Naqa [25] has performed an Environmental Impact Assessment of three alternatives proposed to rehabilitate the solid waste landfill in the Russeifa area, northeast Jordan, using the RIAM method. According to the RIAM analysis, the most important negative implications were groundwater contamination, air pollution, and public health, and the least negative impacts would be caused by relocating the landfill to a better-managed sanitary landfill.

Kuitunen et al. [26] have investigated whether the RIAM method could be used to analyze, interpret, and evaluate 142 different projects, plans, and programs in Central Finland, as well as whether the method could be used to communicate the conclusions of environmental impact statements. Their findings revealed that the RIAM method can be used to compare environmental and social impacts, even when the projects are highly varied and are not limited to the alternatives of a single project.

In their study, Ijäs et al. [27] have amended the RIAM scoring system by adding one additional criterion (susceptibility of the target environment) to the framework, as well as extending the ordinal scales used by Pastakia and Jansen [24]. They considered 37 cases in total, ranging from minor construction and restoration projects to more comprehensive education provision plans. Their findings revealed that the scoring structure employed in RIAM may be tweaked to fit the problem at hand, thus increasing its applicability. However, modifications to B group criteria had no significant impact on the method's final scores, indicating that criteria A1 (importance) and A2 (magnitude) are critical to the overall results.

Mondal and Dasgupta et al. [28] have applied the RIAM method to five distinct municipal solid waste disposal options in Varanasi, northern India, and showed that the sanitary landfill was the best option, given the current circumstances.

The modified RIAM technique has been proposed by Gilbuena et al. [29] as a means for systematically and quantitatively evaluating the socio-economic and environmental implications of projected structural flood mitigation measures in Metro Manila in the Philippines. The findings of the RIAM analysis offered a clear view of the consequences of the implementation of such projects.

Li et al. [30] have developed two main enhancements to make the RIAM technique more suitable in the strategic environmental assessment (SEA) context: weighting assessment indicators and developing an integrated environmental assessment score (IES). An SEA of the development plan for the Nansha District in Guangzhou, a capital city of China, was conducted using the upgraded RIAM process. Five development options in Wanqingsha (WQS), a Nansha sub-unit with considerable biological resources and where industrial development could have an influence on air quality in the Hong Kong Special Administrative Region, were evaluated.

Taheri et al. [31] have conducted EIA using the RIAM regarding several municipal solid waste disposal alternatives in the Tabriz landfill and concluded that composting with the sanitary landfill was the most recommended option, given the current circumstances.

Valizadeh and Hakimian [32] have used the RIAM method and a modified (Iranian) Leopold matrix to estimate the environmental impacts of four (open dumping, sanitary landfill, composting, and recycling) different waste management options in Birjand, Iran. The results revealed that the composting option was established as the top priority, being the most reasonable technique for municipal solid waste management in the study area.

Using the environmental quick impact assessment matrix technique, Shayesteh et al. [33] have assessed four scenarios for industrial waste disposal (recycling, sanitary landfill, pyrolysis, and incineration) in the Brujen industrial park, western Iran. According to the

results, pyrolysis and recycling had the most detrimental and beneficial environmental impacts, respectively.

3. Methodological Framework of the Project Success Score

In order to calculate a Project Success Score, a methodological process consisting of four successive stages is proposed. In the first stage, we identify the primary and secondary project success criteria that contribute to project success. In the second stage, the definitions of the selected criteria, along with their assessment classes, are provided. In the third stage, the PSS calculations are presented. Finally, the fourth stage provides the range bands of the PSS.

3.1. Identification of the Basic Principles of the Proposed Model of Project Success

The seventeen (17) most important and frequently cited project success criteria in the international literature [20], which have been distinguished and evaluated in terms of their relative importance by Lamprou and Vagiona [22], were separated into the following two categories based on their importance degree (weight):

(1) Primary Success Criteria (PSC). Criteria with primary significance and roles, which can individually affect and change the overall project success score, including
   - Cost/budget (SC1) (e.g., [6–8]);
   - Time/schedule (SC2) (e.g., [6–8]);
   - Client/user/end-user satisfaction (SC3) (e.g., [8,11,12]);
   - Quality/technical performance (SC4) (e.g., [6–8]);

(2) Secondary Success Criteria (SSC): Criteria with secondary significance and role that should not individually be capable of changing the overall project success score
   - Effectiveness (SC5) (e.g., [11,12,18]);
   - Technical specifications and requirements (SC6) (e.g., [1,9,10]);
   - Functionality (SC7) (e.g., [9,10,13]);
   - Health and safety (SC8) (e.g., [8,11,12,19–21]);
   - Future perspective (SC9) (e.g., [11–13]);
   - Business and commercial performance (SC10) (e.g., [6,7,12]);
   - Use/utilization (SC11) (e.g., [1,11,17]);
   - Environmental impact (SC12) (e.g., [8,10,12]);
   - Other stakeholders' satisfaction (SC13) (e.g., [9,11,13]);
   - Strategic goals/objectives and competitiveness (SC14) (e.g., [6,8,11]);
   - Contractor's satisfaction (SC15) (e.g., [10,11,13]);
   - Project team/personnel satisfaction (SC16) (e.g., [6,12,14]);
   - Supplier satisfaction (SC17) (e.g., [15,16]).

3.2. Project Success Criteria and Assessment Classes

The project success criteria used in the proposed project success model and their detailed interpretations/definitions are provided below. Their assessment classes, accompanied by appropriate numerical values contributing to the calculation of the overall PSS, were developed by the authors based on their experience in project management and are presented in Table 1.

Table 1. Project Success Criteria and Scales.

Criteria	Scale	Description
SC1	3	On the estimated budget/cost (on budget)
	3	Deviation under the estimated budget/cost (under budget)
	2	Deviation $\leq$ 15% over the estimated budget/cost (over budget)
	1	Deviation > 15% over the estimated budget/cost (over budget)

Table 1. *Cont.*

Criteria	Scale	Description
SC2	3	On the estimated schedule/time (on schedule)
	3	Deviation $\leq$ 5% under the estimated schedule/time (under schedule)
	3	Deviation > 5% under the estimated schedule/time (under schedule)
	2	Deviation $\leq$ 30% over the estimated schedule/time (over schedule)
	1	Deviation > 30% over the estimated schedule/time (over schedule)
SC3	5	Complete satisfaction of the client/user/end-user (client/user/end-user satisfaction percentage $\geq$ 80%)
	4	Significant satisfaction of the client/user/end-user (client/user/end-user satisfaction percentage 60–80%)
	3	Partial satisfaction of the client/user/end-user (client/user/end-user satisfaction percentage 40–60%)
	2	Minimum satisfaction of the client/user/end-user (client/user/end-user satisfaction percentage 20–40%)
	1	Non-satisfaction of the client/user/end-user (client/user/end-user satisfaction percentage $\leq$ 20%)
SC4	5	Very high quality/technical performance
	4	High quality/technical performance
	3	Moderate quality/technical performance
	2	Low quality/technical performance
	1	Very low quality/technical performance
SC5	5	Very high effectiveness (achievement $\geq$ 80% of goals/objectives + production $\geq$ 80% of expected results)
	4	High effectiveness (achievement 60–80% of goals/objectives + production 60–80% of expected results)
	3	Moderate effectiveness (achievement 40–60% of goals/objectives + production 40–60% of expected results)
	2	Low effectiveness (achievement 20–40% of goals/objectives + production 20–40% of expected results)
	1	Very low effectiveness (achievement $\leq$ 20% of goals/objectives + production $\leq$ 20% of expected results)
SC6	3	Complete satisfaction of the technical specifications and requirements
	2	Partial satisfaction of the technical specifications and requirements
	1	Non-satisfaction of the technical specifications and requirements
SC7	5	Very high functionality
	4	High functionality
	3	Moderate functionality
	2	Low functionality
	1	Very low functionality
SC8	4	Maximum health and safety level (full compliance with health and safety measures/rules + zero accidents/injuries)
	3	High health and safety level (significant compliance with health and safety measures/rules + minimum accidents/injuries)
	2	Moderate health and safety (level partial compliance with health and safety measures/rules + few accidents/injuries)
	1	Low health and safety level (incomplete compliance with health and safety measures/rules + several accidents/injuries)
SC9	4	Sufficient sustainability/durability + creation of new capabilities/opportunities + development of new technologies and innovations + activation of the development of future projects/works
	3	Sufficient sustainability/durability + creation of new capabilities/opportunities + activation of the development of future projects/works
	2	Sufficient sustainability/durability + creation of new capabilities/opportunities
	2	Sufficient sustainability/durability + development of new technologies and innovations
	2	Sufficient sustainability/durability + activation of the development of future projects/works
	1	Lack of future perspective

Table 1. *Cont.*

Criteria	Scale	Description
SC10	6	High business performance + high commercial performance
	5	High business performance + moderate commercial performance
	5	Moderate business performance + high commercial performance
	4	High business performance + low commercial performance
	4	Low business performance + high commercial performance
	3	Moderate business performance + moderate commercial performance
	2	Moderate business performance + low commercial performance
	2	Low business performance + moderate commercial performance
	1	Low business performance + low commercial performance
SC11	5	Easiness of acceptance and use/utilization + direct project impact
	4	Easiness of acceptance and use/utilization + indirect project impact
	3	Difficulty of acceptance and use/utilization + direct project impact
	2	Difficulty of acceptance and use/utilization + indirect project impact
	1	Non acceptance and use/utilization + No project impact
SC12	4	Disturbing/non-disturbing activities + full compliance with Environmental Assessment Approval
	3	Non-disturbing activities + partial compliance with Environmental Assessment Approval
	3	Disturbing activities + partial compliance with Environmental Assessment Approval
	2	Non-disturbing activities + low compliance with Environmental Assessment Approval
	2	Disturbing activities + low compliance with Environmental Assessment Approval
	1	Non-disturbing activities + non-compliance with Environmental Assessment Approval
	1	Disturbing activities + non-compliance with Environmental Assessment Approval
SC13	5	Complete satisfaction of other stakeholders (other stakeholder satisfaction percentage $\geq$ 80%)
	4	Significant satisfaction of other stakeholders (other stakeholder satisfaction percentage 60–80%)
	3	Partial satisfaction of other stakeholders (other stakeholder satisfaction percentage 40–60%)
	2	Minimum satisfaction of other stakeholders (other stakeholder satisfaction percentage 20–40%)
	1	Non-satisfaction of other stakeholders (other stakeholder satisfaction percentage $\leq$ 20%)
SC14	4	Complete achievement of strategic goals/objectives + high competitiveness
	3	Complete achievement of strategic goals/objectives + moderate competitiveness
	3	Partial achievement of strategic goals/objectives + high competitiveness
	2	Complete achievement of strategic goals/objectives + low competitiveness
	2	Partial achievement of strategic goals/objectives + moderate competitiveness
	2	Non achievement of strategic goals/objectives + high competitiveness
	1	Partial achievement of strategic goals/objectives + low competitiveness
	1	Non achievement of strategic goals/objectives + moderate competitiveness
	1	Non achievement of strategic goals/objectives + low competitiveness
SC15	5	Complete contractor satisfaction (satisfaction percentage $\geq$ 80%)
	4	Significant contractor satisfaction (satisfaction percentage 60–80%)
	3	Partial contractor satisfaction (satisfaction percentage 40–60%)
	2	Minimum contractor satisfaction (satisfaction percentage 20–40%)
	1	Nonsatisfaction of the contractor (satisfaction percentage $\leq$ 20%)
SC16	5	Complete project team/personnel satisfaction (satisfaction percentage of project team members/personnel $\geq$ 80%)
	4	Significant project team/personnel satisfaction (satisfaction percentage of project team members/personnel 60–80%)
	3	Partial project team/personnel satisfaction (satisfaction percentage of project team members/personnel 40–60%)

Table 1. *Cont.*

Criteria	Scale	Description
SC17	2	Minimum project team/personnel satisfaction (satisfaction percentage of project team members/personnel 20–40%)
	1	Non project team/personnel satisfaction (satisfaction percentage of project team members/personnel $\leq$ 20%)
	5	Complete supplier satisfaction (supplier satisfaction percentage $\geq$ 80%)
	4	Significant supplier satisfaction (supplier satisfaction percentage 60–80%)
	3	Partial supplier satisfaction (supplier satisfaction percentage 40–60%)
	2	Minimum supplier satisfaction (supplier satisfaction percentage 20–40%)
	1	Nonsatisfaction of the suppliers (supplier satisfaction percentage $\leq$ 20%)

Cost/Budget (SC1)

SC1 defines the degree to which the examined project is executed and completed within the initially estimated budget/cost. The total project budget/cost encompasses all the costs from the beginning to the completion and delivery of a project, including any added costs that emerge during the execution stage. The variations in the final budget/cost of a project at completion, compared to the initially estimated budget/cost, are considered particularly significant and can affect the overall level of success.

Time/Schedule (SC2)

SC2 refers to the total duration from the beginning to the completion of a project. This criterion examines the degree to which the examined project is executed and completed within the initially estimated schedule/time (time scheduling). The deviations in the overall completion time of a project, compared to the initially estimated schedule/time, may affect the overall level of success.

Client/user/end-user satisfaction (SC3)

SC3 describes the level of satisfaction of the client/user/end-user/recipient with respect to the implemented/completed project (and its products or services), based on their initial needs, requirements, and expectations. This criterion clearly marks the success of a project, ensuring the satisfaction of the client/user/end-user/recipient in the long-term. This specific parameter is taken into account and can be evaluated during the period of the project's operation/function (i.e., a short time after the project delivery).

Quality/technical performance (SC4)

SC4 includes the set of quality and/or technical characteristics and elements that a project should have (its products and services) in order to meet the pre-determined requirements of the stakeholders. Quality consists of the guarantee of a project, aiming to attract clients/users to use or acquire it. The evaluation/control of project quality is considered subjective, according to the needs and expectations of individual stakeholders.

Effectiveness (SC5)

SC5 denotes the degree to which a project achieves its goals and objectives and delivers the intended or expected results. The criterion examines whether the project delivers the results produced (products/deliverables), as identified by the main stakeholders of the project during the early stages of project development. It should be noted that the appropriate results of a project should be fully aligned with the objectives of the project organization, as well as with the needs, requirements, and expectation of its clients/users/recipients.

Technical specifications and requirements (SC6)

SC6 includes the set of rules, principles, instructions, and technical practices and requirements that should be adopted and used during the execution of the project. The technical specifications and requirements of a project are determined by the main project stakeholders during the early stages of its development. The assessment of this criterion refers to the degree to which the defined technical specifications and requirements can be achieved or applied in a project.

Functionality (SC7)

SC7 refers to the degree to which a project fulfills its intended/expected function. This specific criterion is related to the needs and expectations of the main project stakeholders and can be evaluated/assessed based on the degree of compliance/fulfillment/achievement of all performance or function specifications. The concept of functionality can be translated as the achievement of the "fit for purpose" for a project. In addition, the evaluation of the criterion can be carried out a reasonable period of time after the delivery and initial operation of a project (e.g., a time period of 6 months).

Health and Safety (SC8)

SC8 expresses the set of health and safety conditions and measures that are adopted during the execution and/or operation of a project. This criterion expresses the degree to which the general conditions prevailing in a project promote/ensure its execution and/or operate in high health and safety conditions without a significant number of accidents and injuries.

Future Perspective (SC9)

SC9 examines the degree to which an implemented/completed project has sufficient sustainability/durability, creates new capabilities/opportunities, develops new technologies and innovations, and activates the development of future projects or works. This specific criterion has a mainly mid- and/or long-term character and can be evaluated a significant period of time after the delivery and initial operation of a project (e.g., time period 1–3 years).

Business and commercial performance (SC10)

SC10 reveals the degree of business benefit and profitability that emerges from the implementation of a project for its main stakeholders. Many projects aim to generate value and profit, while others focus mainly on the social benefit. This specific criterion is particularly important and appears after the completion and delivery of a project, where the concepts of business and commercial performance can be clearly distinguished.

Use/Utilization (SC11)

SC11 describes the degree of the use or utilization of a project and its products by the clients/users/recipients for whom it is initially intended (target group). This criterion also examines the easiness of acceptance and use/utilization of the project by the targeted clients/users/recipients, as well as the direct impact of the project on them. An important parameter for the effective and continuous use/utilization of a project is the guaranteed minimization of possible technical or operational problems over time.

Environmental impact (SC12)

SC12 refers to the environmental management and environmental friendliness/sensitivity of a project during its execution and/or operation. The evaluation of a project's environmental impact includes the adoption/implementation of frameworks, guidelines, and standards that reflect the level of the environmental performance at all stages of its lifecycle.

Other stakeholder satisfaction (SC13)

SC13 examines the level of satisfaction of other stakeholders with the implemented/completed project based on their initial needs, requirements, and expectations. This is an important success criterion with only relatively recent reference in the literature, as the other stakeholders may be directly or indirectly affected by the project.

Strategic goals/objectives and competitiveness (SC14)

SC14 expresses the degree of achievement of the defined strategic goals and objectives of a project, as well as its level of competitiveness. The strategic goals and objectives of a project are precisely defined among the main stakeholders during the early stages of project development. Additionally, the concept of competitiveness refers mainly to the distinct advantage that the project organization acquires through the implementation and operation of the project.

Contractor satisfaction (SC15)

SC15 considers the level of satisfaction of the contractors with the implemented/completed project based on their initial needs, requirements, and expectations. The project contractor (e.g., a person or company/business) is considered one of the most important

project stakeholders, as they formally undertake and are responsible for the complete and smooth execution/implementation of the project.

Project team/personnel satisfaction (SC16)

SC16 discloses the level of satisfaction of the project team/personnel with the implemented/completed project, based on their initial needs, requirements, and expectations. Project team/personnel satisfaction is particularly important, as the project team/personnel are essentially the main stakeholders involved in its execution/implementation.

Supplier satisfaction (SC17)

SC17 expresses the level of satisfaction of suppliers during the project execution, based on their needs, requirements, and expectations. It should be noted that there may be only one or several suppliers according to the needs and requirements of the project execution/implementation. The maintenance of good relationships and perfect cooperation with the project supplier(s) is regarded as an ultimate goal for project organization.

The assessment of each individual SC was performed based on the nature of each criterion, and the corresponding scales are proposed by the authors, as detailed in Table 1.

3.3. Calculation of the Project Success Score (PSS)

Each success criterion consists of distinct evaluation classes, to which the appropriate numerical values are attributed and contribute to the calculation of the overall PSS. In case of the PSCs, multiplication of the performances of each criterion is used (Equation (1)), while for the SSCs, a sum of the performances of each criterion is used according to the defined classes (Equation (2)). The overall PSS is obtained through multiplication of the individual scores (individual sets) of the success criteria of the two categories (Equation (3)). The scoring approach calls for straightforward multiplication of the scores assigned to each PSC criterion. The use of multiplication of the PSCs is crucial, as it guarantees that the weight of each score is appropriately reflected. Meanwhile, the SSC scores are combined into a single sum, which ensures that the score of an individual value does not strongly affect the aggregate score, such that the importance of each SSC value is properly considered as a whole.

$$\text{PSC} = (\text{SC1}) \times (\text{SC2}) \times (\text{SC3}) \times (\text{SC4}), \quad (1)$$

$$\text{SSC} = (\text{SC5}) + (\text{SC6}) + (\text{SC7}) + (\text{SC8}) + (\text{SC9}) + (\text{SC10}) + (\text{SC11}) + (\text{SC12}) + (\text{SC13}) + (\text{SC14}) + (\text{SC15}) + (\text{SC16}) + (\text{SC17}), \quad (2)$$

$$\text{PSS} = (\text{PSC}) \times (\text{SSC}). \quad (3)$$

3.4. Conversion of PSS to Range Bands

The application of the proposed project success model leads to the extraction of an overall PSS, as mentioned above, based on the individual performances of various success criteria (i.e., primary and secondary criteria). The selected (primary and secondary) success criteria have maximum (max) and minimum (min) performance values, and corresponding thresholds were formulated as the limits of failure of a project (Table 2). The thresholds of project failure express the distinct point at which a project is considered to have an unsuccessful outcome for each of the examined success criteria, based on our expertise and judgments. Values over the thresholds of failure refer to projects that are considered partially or fully successful, whilst values equal to or under the thresholds refer to unsuccessful projects.

Individual project success scores are grouped together into ranges, through which they can be compared to create a more certain system of assessment. Conditions that act as markers for the change in bands establish ranges (Table 3). Particularly, the success or failure of the final project consists of five distinct classes (based on final success score), ranging from the level of absolute success to the level of absolute failure. For example, the "absolute success" of a project is determined by setting the maximum performance values for all of the success criteria (i.e., SC1 = 3, SC2 = 3, SC3 = 5, SC4 = 5, SC5 = 5, SC6 = 3, SC7 = 5, SC8 = 4, SC9 = 4, SC10 = 6, SC11 = 5, SC12 = 4, SC13 = 5, SC14 = 4, SC15 = 5,

SC16 = 5, SC17 = 5; PSS = (3 × 3 × 5 × 5) × (5 + 3 + 5 + 4 + 4 + 6 + 5 + 4 + 5 + 4 + 5 + 5 + 5) = 13,500), while the "absolute failure" of a project is determined by setting the minimum performance values for all of the success criteria (SC1 = 1, SC2 = 1, SC3 = 1, SC4 = 1, SC5 = 1, SC6 = 1, SC7 = 1, SC8 = 1, SC9 = 1, SC10 = 1, SC11 = 1, SC12 = 1, SC13 = 1, SC14 = 1, SC15 = 1, SC16 = 1, SC17 = 1; PSS = (1 × 1 × 1 × 1) × (1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1) = 13). Alternatively, a project is regarded as completely successful when the individual success criteria are rated with their maximum performance, and completely unsuccessful when the individual success criteria are rated with their minimum performance. The exact intermediate class of success between the two ultimate classes (i.e., absolute success and absolute failure) reflects the "partial success" of a project (PSS in the range of 1188–2925). The upper limit of the "partial success" of a project occurs when the primary success criteria (SC1–SC4) receive their maximum values, whilst the secondary success criteria (SC5–SC17) receive their minimum values, respectively. Additionally, the lower limit of the "partial success" of a project is formulated by setting to all success criteria values as equal to or slightly higher than the pre-determined thresholds of project failure. The class that is placed between "partial success" and "absolute success" is defined as "project success" (PSS ranging from 2925 to 9360). The upper limit of "project success" is extracted when the primary success criteria receive their maximum values, whilst most secondary success criteria receive values slightly lower than their maximum performance values. The lower limit of "project success" is estimated by setting the maximum values for the primary success criteria and the minimum values for the secondary success criteria. Finally, the class placed between "partial success" and "absolute failure" is defined as "project failure" (PSS ranging from 384 to 1188). The upper limit of "project failure" results from the values of the success criteria that are equal or slightly higher than the thresholds of project failure, whilst the lower limit of "project failure" is obtained when the performances of the individual success criteria coincide with the thresholds of project failure.

Table 2. Min, max, and threshold performance values of SC and PSS.

Success Criteria (SC)	Min	Max	Threshold	Project Success Score (PSS)					
				12	**384**	**1188**	**2925**	**9360**	**13,500**
SC1	1	3	≤2	1	2	2	3	3	3
SC2	1	3	≤2	1	2	2	3	3	3
SC3	1	5	≤2	1	2	3	5	4	5
SC4	1	5	≤2	1	2	3	5	5	5
SC5	1	5	≤2	1	2	3	1	5	5
SC6	1	3	≤1	1	1	2	1	3	3
SC7	1	5	≤2	1	2	3	1	5	5
SC8	1	4	≤1	1	1	2	1	4	4
SC9	1	4	≤1	1	1	1	1	2	4
SC10	1	6	≤2	1	2	2	1	4	6
SC11	1	5	≤2	1	2	3	1	5	5
SC12	1	4	≤3	1	3	3	1	4	4
SC13	1	5	≤2	1	2	3	1	4	5
SC14	1	4	≤2	1	2	2	1	4	4
SC15	1	5	≤2	1	2	3	1	4	5
SC16	1	5	≤2	1	2	3	1	4	5
SC17	1	5	≤2	1	2	3	1	4	5

Table 3. Conversion of PSS to Range Bands.

PSS	Description of Success Range
13–384	Absolute Project Failure
385–1188	Project Failure
1189–2925	Partial Project Success
2926–9360	Project Success
9361–13,500	Absolute Project Success

4. Project Success Score Web Application

Next, we developed a web application that simulates the PSS framework with the aim of facilitating the whole PSS calculation process.

The link to the project success evaluation web application is "https://www.projectsuccess.gr (accessed on 20 May 2022)", and its use is simple and user-friendly. By entering this link in a web browser, a brief description of the web application, as well as the login point for any user, are displayed. It should be noted that the web application is designed in the Greek language. The web application was tested for its applicability by a practitioner (engineer), and the end-user noted that the web application is user-friendly, easy to use, and simple.

A necessary pre-condition to be able to log in to the web application is registration of the user in the system with an e-mail address and a password of their choice. The system supports two ways to log in: as a simple user, for the subsequent evaluation of project success, or as an administrator, for the general management of the evaluated projects by all users of the application.

After successfully logging into the system, the user can create one or more projects under evaluation, accompanied by an appropriate title and a brief description (Figure 1).

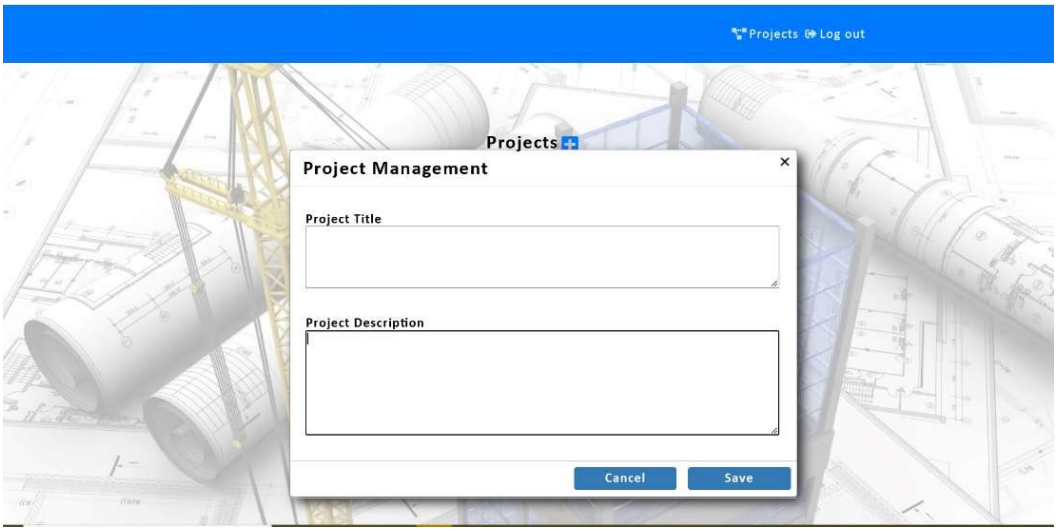

Figure 1. Creation of the examined projects (project title and description).

The main part of the web application formats the evaluation in the form of questions regarding performance in the 17 project success criteria; namely, cost/budget (SC1), time/schedule (SC2), client/user/end-user satisfaction (SC3), quality/technical performance (SC4), effectiveness (SC5), technical specifications and requirements (SC6), functionality (SC7), health and safety (SC8), future perspective (SC9), business and commercial performance (SC10), use/utilization (SC11), environmental impact (SC12), other stakeholder satisfaction (SC13), strategic goals/objectives and competitiveness (SC14), contractor satisfaction (SC15), project team/personnel satisfaction (SC16), and supplier satisfaction (SC17). An example is presented in Figure 2.

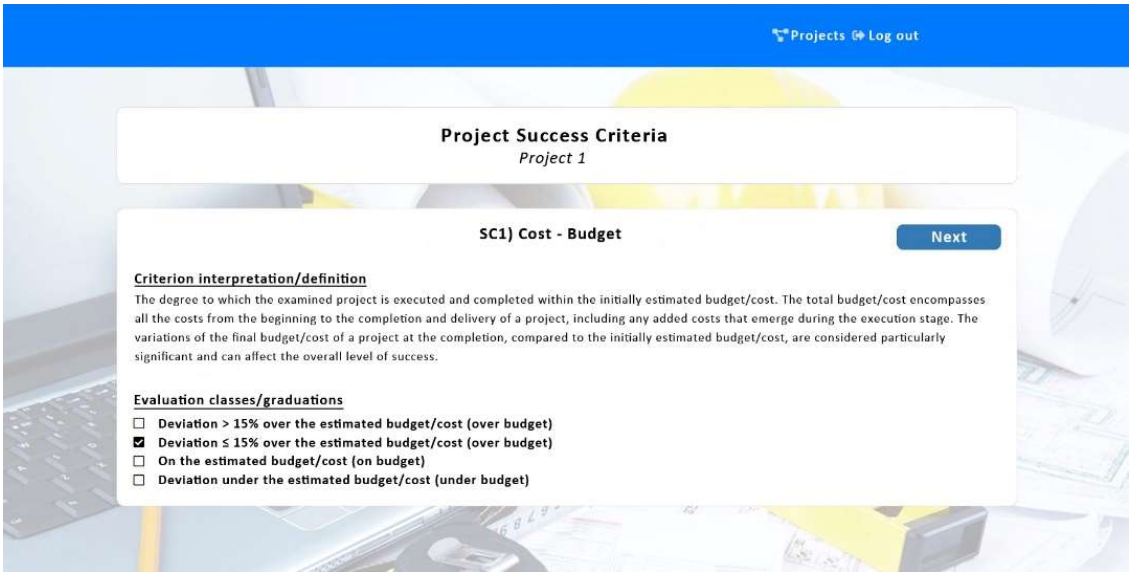

Figure 2. Evaluation of performance for the Cost/Budget success criterion.

The function of the web application is completed after the input of responses to all the inquiries regarding the performance of the 17 project success criteria, which is followed by the calculation of the overall success score for each project. Subsequently, the extracted project success score is ranked into one of the five distinct classes of project success (absolute project success, project success, partial project success, project failure, or absolute project failure), and a special report is provided in cases where the success criteria are under the thresholds of project failure (Figure 3).

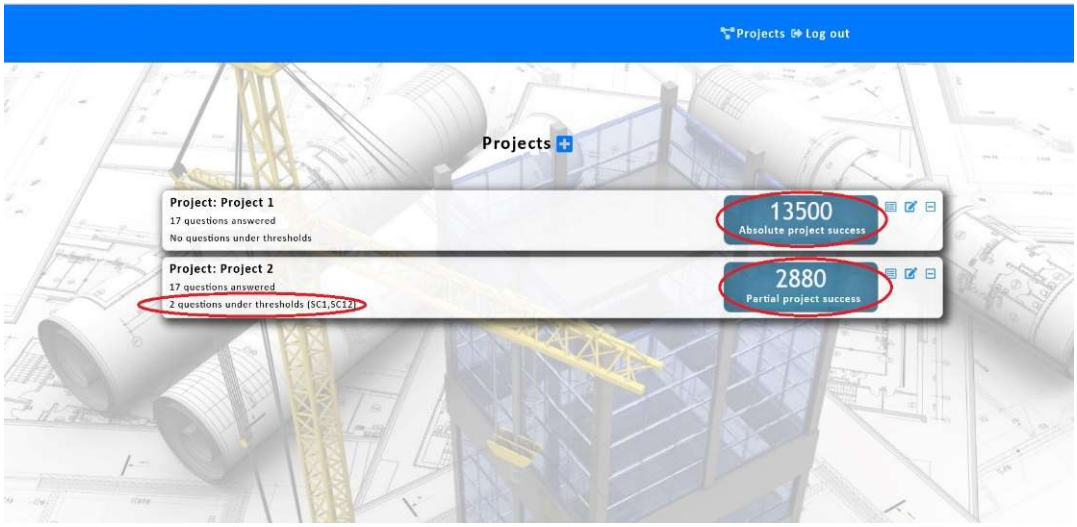

Figure 3. The Project Success Score and the potential success criteria under thresholds.

Finally, the administrator of the web application is enabled to extract the results of the project success evaluations for all users, referring to the responses of the 17 inquiries (success criteria), as well as the exported project success scores (Figure 4), in an Excel file format.

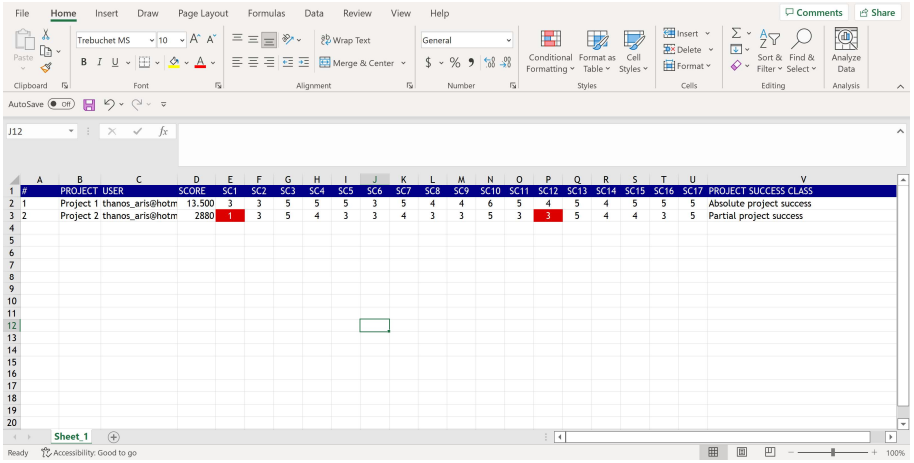

Figure 4. The extracted excel file including the project success evaluation results.

5. Conclusions

Project success is one of the most widely discussed issues within the scientific field of Project Management. Success criteria (SC) are fundamental components of project success, used for the primary evaluation/assessment of project success. The present paper aimed to facilitate the deployment of an innovative framework for project success assessment considering a set of success criteria (SC). The proposed project success framework adopts the basic philosophy of the Rapid Impact Assessment Matrix (RIAM) and incorporates various SC for the computation of a Project Success Score (PSS). Seventeen (17) important SC identified from the literature were separated into two categories—primary and secondary success criteria—considering their significance and contribution to project success. For each SC, a comprehensive interpretation was provided, together with pre-defined assessment scales. The project success assessment scales express the different performances of the examined success criteria, to which appropriate numerical values are attributed for the computation of a PSS. Additionally, the maximum and minimum values, as well as the thresholds of project failure, for the 17 examined SC were determined in detail, allowing for the establishment of distinct success range bands. The finally extracted PSS will fall into one of the five different and appropriately ranked range bands of project success. The proposed framework may serve as a basis for the interpretation and assessment of project success, both after the completion of the execution phase and during the early stages of the operation stage.

Originality

It should be highlighted that the present research developed, for the first time, distinct assessment scales based on the most important and discussed success criteria in the field of Project Management. An extensive literature review revealed some conspicuous deficiencies and gaps in terms of project success assessment.

Contributions of the paper

This paper contributes to the academic field of project management by providing an integrated framework for assessing project success through the PSS. The proposed methodology structures a comprehensive list of success criteria into an assessment framework and approach that has practical utility for construction enterprises and companies, in order to determine the success of their projects. This paradigm can be used by policymakers, construction professionals, and other stakeholders to interpret the success of their projects more accurately. In addition, engineers, professionals, and project managers will be able to measure the success of their construction projects, considering both objective and subjective measures of project success. Project success is of significant importance for the reputation of companies and organizations. Therefore, empirical testing of the proposed framework on a project-by-project basis within a construction company is expected to contribute to identifying the SC that constantly fall outside the bounds of success and enhance the related

processes. The main contribution of the current research is that we attempted to incorporate all conceivable success criteria into an assessment framework and a mathematical model that can determine the project success score. As such, the PSS considers the project success based on several success criteria and is expected to have a high accuracy assessment.

Limitations

One limitation of the study is that the corresponding scales of each success criterion were proposed by the authors, based on their expertise and personal judgement. Therefore, they may be subject to some bias.

Future research

Validation of the proposed framework is suggested for future research. Project managers and project team members should evaluate their projects using the proposed framework, the results of which are expected to provide useful conclusions regarding the reliability of the model. In addition, the inclusion of critical success factors into the assessment framework of project success is another direction for future research.

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