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Contractor Selection for Sgraffito Decoration of Cultural Heritage Buildings Using the WASPAS-SVNS Method

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Abstract: Sgraffito is an ancient decorative technique applied in walls, produced by using layers of cement plaster tinted in contrasting colours to a moistened surface. This decoration originated in Italy and has been expanded in different European cities or villages. Nowadays, this decoration technique has almost disappeared because of decomposition, inexperience, or lack of knowledge. The preservation and restoration of the sgraffito technique is the most challenging and vital task of cultural heritage buildings' preservation. Consequently, the conservation of sgraffito depends not only on the historical and architectural knowledge, studies, and conservation projects of the cultural heritage buildings, but also demands the experience, proper qualification, and knowledge of the contractor. This paper presents six principal criteria. Three possible variants for contractor selection for sgraffito decoration of cultural heritage buildings are proposed, and six principal criteria for their evaluation are suggested. The research employs the Analytic Hierarchy Process (AHP), SWARA (Step-Wise Weights Assessment Ratio Analysis), and WASPAS-SVNS (Weight Aggregated Sum Product Assessment-Single- Valued Neutrosophic Set) methods.

Keywords: cultural heritage; sgraffito decoration; contractor selection; multi-criteria decision-making; AHP; SWARA; WASPAS–SVNS

1. Introduction

A large number of researchers have presented many studies on contractor selection in the construction industry. However, contractor selection related to the cultural heritage field has been much less studied. Heritage projects differ from construction because of their complexity, originality, artistic expression, and historical, aesthetic, ethnic, and religious value. One of the commonly visible techniques in cultural heritage buildings is sgraffito decoration. This technique is an ancient decorative technique applied in walls, produced by using layers of cement plaster tinted in contrasting colours to a moistened surface. This decoration originated in Italy and has been expanded in different European cities or villages. However, nowadays, the sgraffito technique has almost disappeared because of decomposition, inexperience, or lack of knowledge. The conservation and restoration of the sgraffito technique is the most sophisticated task of cultural heritage buildings' preservation. Consequently, sgraffito techniques' conservation and restoration depends not only on the historical and architectural knowledge, studies, or conservation projects of the cultural heritage buildings, but also requires additional liability, ability, attention to technology for decoration and materials used, and qualified and experienced employees. Cultural heritage projects are more complex. Because of that, the contractors have to know the legislation of the construction and, most importantly, the legislation of heritage fields. Thus, the choice of a suitable contractor for heritage preservation and restoration performance is a very complex task for clients in construction management.

Contractor selection in construction management mainly focuses on the project on schedule, within budget, and with the demanded quality [1]. However, these main factors could not ensure a suitable contractor for construction performance. Improper contractor selection could create disagreements, delays, claims, disputes, and increased costs for project performance, organization, and management.

Nowadays, the essential criterion for tendering is the price [2]. However, the lowest price might not be the best solution to select a contractor. Accepting the lowest price tendering might be an essential cause of the project failure because, very often, the lowest price means misunderstanding, reactive contractor behaviour, diminishing quality, delays, claims, litigation, bankruptcy, cost overruns, and contractor's capabilities. Regarding the cost overruns, the most important reasons for them are technical, economic, contractual, psychological, and political [3].

Different criteria selection permits to determine and evaluate the advantages of contractors. However, a specific criterion cannot give a complete definition of aims suggested by clients. The criteria selection is a complicated assignment which permits to evaluate contractors, taking into account economic, social, and technological aspects, quality requirements and organizational management, relationships with clients and stakeholders.

This paper presents six principal criteria. Three possible variants for contractor selection for the sgraffito technique of cultural heritage buildings are proposed, and six principal criteria for their evaluation are suggested. The research employs the Analytic Hierarchy Process (AHA), SWARA, and WASPAS-SVNS methods.

2. Literature Review

2.1. Contractor Selection Approaches

The client for contractor selection applies the diversified type of pre-selection and selection procedures, like a prequalification, selective/restricted tendering, open tendering, negotiation [4], the lowest bid, economically advantageous offer, competitive dialogue, or e-procurement (auctions). Nevertheless, nowadays, the low bid is one of the most used methods for contractors' selection. Therefore, Hassim et al. [5] suggested the conceptual model for the construction tender price estimation. This model is based on local dominant aspects, which influence the tender and final price variety, integrated with the application of a fuzzy neural network. El-Sayegh and Rabie [6] developed the bi-parameter bidding model based on a modified price plus time. Moreover, Keung and Yiu [7] proposed the maintenance contractors bidding model, identifying the crucial objectives of bidding. Yan [8] analyzed the price-based awarding system and inefficient market performance for the construction of sustainable development projects. Although the price-based market competition could induce effectiveness and innovations by contractors, assure the public agencies from corruption and wastefulness, according to contractors, green innovations become unimportant, and contractors are less encouraged to provide the development for sustainability. Hartmann and Caerteling [9] examined the subcontractor selection, taking into account the price and trust. This selection was based on the conjoint analysis–choice experiments. Nguyen [10] presented a construction supplier selection based on the critical criteria determination. The author applied qualitative data analysis using word tags. Mamavi et al. [11], according to the public markets, evaluated the history performance impact to the supplier selection process. Mokhlesian [12] analyzed the supplier selection differences in construction and greener construction projects. Gosling et al. [13] presented a supplier selection, taking into account the flexibility of the supply chain.

Some researchers applied multiple attributes decision-making (MADM) or multi-criteria decision-making (MCDM) for a miscellaneous contractor, subcontractor and supplier selection.

Gao [14] developed multi-attribute reverse auctions (MARAs) for sustainable contractor selection for individual project corporation. Green contractor selection was presented by Zhang et al. [15], developing interval-valued dual unsure fuzzy doubtful unbalanced lingual set model, which is based on DEMATEL (Decision-Making Trial and Evaluation Laboratory) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) approaches. Trinkūnienė et al. [16] for contractor contracts presented MADM approaches: SAW, TOPSIS, COPRAS and EDAS. The authors also used the FAHP technique evaluating the weight of criteria. Moreover, the determination of the data structure was applied by CILOS (Method of indicators impact loss) and IDOCRIW (Integrated Determination of Objective Criteria Weights) methods. Kog and Yaman [17] developed a multi-agent system for contractor prequalification. Yang et al. [18] proposed the Data Envelopment Analysis (DEA), applying the Best Value (BV) method for the contractor/supplier selection. Palha et al. [19] presented the subcontractors selection by ROR-UTADIS approach. This method involves new forms of supplying priority information. Liu et al. [20] suggested a Group Decision-Making aggregation approach based on Two-Stage Partial Least Squares (PLS) Path Modeling. Attar et al. [21] presented the contractor prequalification model by Support Vector Machines approach. Rajaprasad [2] developed an Integrated Model for contractors' selection for a Housing Development Project. The presented model created using a combination of Analytic Hierarchy Process and Zero one integer linear programming. Aboelmagd [22] selected the best contractor by AHP method integrated with Value Engineering (VE) technique. This method permits to select a contractor achieving the best profit and value corresponding to the lower price. Assaf et al. [23] employed the AHP model for architects and engineering selection in construction projects. Sarkis et al. [24] applied AHP and ANP (Analytic Network Process) methods for subcontractor selection in the built environment based on sustainability principles. Hasnain et al. [25] developed an ANP-based decision support model for the Best Value road contractor selection. The contractor selection, focused on contractor organizational skills, has been proposed by Rashvand et al. [26], applying the ANP method. Nyongesa et al. [27], using Fuzzy AHP, suggested the partner selection for a construction-related virtual enterprise. Polat [28] presented an integrated decision method for subcontractor selection. The integrated decision technique includes AHP and PROMETHEE (Preference Ranking Organization method for Enrichment of Evaluations)methods. Later, Polat et al. [29] selected supplier contractor by fuzzy AHP and fuzzy TOPSIS approaches. Plebankiewicz [3] evaluated contractor prequalification based on Fuzzy Sets approaches. Later, Plebankiewicz and Kubek [30] proposed multi-criteria selection for the building material supplier. The multi-criteria selection is based on AHP and Fuzzy AHP techniques. The contractor prequalification has been used by Nasab and Ghamsarian [31], developing the Fuzzy MCDM model. This model is based on Fuzzy AHP and Fuzzy TOPSIS approaches. Turnaround maintenance contractor selection applying the AHP method was presented by Hadidi and Khater [32]. Alhumaidi [33] selected construction contractors by the quantitative Fuzzy Set method. This technique helps to rank various contractors based on different alternatives. Nassar and Hosny [34] evaluated contractor performance using the Fuzzy-C method. The researchers presented quantitative and qualitative measures, where the quantitative measure was submitted and determined in the database, and a qualitative measure was calculated using AHP. Subcontractor evaluation was presented by Keshavarz Ghorabaee et al. [35], developing a Fuzzy dynamic approach based on the EDAS technique. Hashemi et al. [36] proposed a group decision model based on Grey-Intuitionistic Fuzzy-ELECTRE and VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) approaches to handle the contractor evaluation problem. Afshar et al. [37] proposed a type-2 Fuzzy set for contractor prequalification. Ulubeyli and Kazaz [38] developed a subcontractor selection model (CoSMo) based on Fuzzy set theory. The WASPAS—G (The Weight Aggregated Sum Product Assessment with grey values) method was applied by Zavadskas et al. [39] for construction contractor selection. Abbasianjahromi et al. [40] presented the subcontractor selection model of construction projects. This model is based on Fuzzy Preference Selection Index. Niento-Morote and Ruz-Vila [4] used the Fuzzy Set Theory for the contractor prequalification process. Further, TOPSIS and VIKOR techniques were used for contractor selection for the road-building project [41]. Juan [42] presented contractor selection by a hybrid approach. This method was based on data envelopment studies and case–based argument. Zavadskas and Vilutienė [43] suggested the multi-criteria model for maintenance contractor selection. Brauers et al. [44] presented maintenance contractor selection, employing the MOORA (Multiobjective Optimization by ratio Analysis) method. Later, Zavadskas et al. [45] selected maintenance contractors by applying the COPRAS technique. Kaklauskas et al. [46] applied the COPRAS method for a retrofit contractor selection.

2.2. Criteria Considered

The sophisticated performance of contractors in lowest-price tendering type has been distinguished from many researchers in many studies. According to Loosemore and Richard [47], for many clients, the price is still a more important criterion for contractor selection. This trend shows the current business environment, where public procurement and competition are demanding a lot of efforts for the low tenders. Moreover, the clients need that low price corresponding to good value. The public agencies, selecting the contractor, specifically, take into account the investment value, total project duration time, and construction stage duration [48].

Nowadays, more researchers practice the “multi-criteria selection” method for the contractor selection procedure. Numerous researchers, focused on the client’s expectations, have proposed the contractor selection criteria. Financial soundness, technical and management ability, health and safety, and reputation were suggested by Hatush and Skitmore [49] for contractor prequalification. El-Sawalhi et al. [50] proposed the essential criteria, namely, financial stability, technical and management ability, contractor‘s experience and performance, reserves, quality control, health, and safety. Table 1 shows the most commonly cited criteria dealing with “Contractor selection criteria” or “Contractor pre-qualification criteria”.

Table 1. The most commonly cited contractor selection criteria.

Contractor Selection Criteria	Author
Bid Price/Price	Egemen and Mohamed [1], Plebankiewicz [3], Hartmann and Caerteling [9], Nguyen [10], Palha et al. [19], Liu et al. [20], Hasnain et al. [25], Polat [28], Nassar and Hosny [34], Ulubeyli and Kazaz [38], Zavadskas et al. [39], Abbasianjahromi et al. [40], Alptekin and Alptekin [51]
Financial Ability	Egemen and Mohamed [1], Rajaprasad [2], Plebankiewicz [3], Niento-Morote and Ruz-Vila [4], Keung and Yiu [7], Gao [14], Zhang et al. [15], Kog and Yaman [17], Liu et al. [20], Attar et al. [21], Aboelmagd [22], Assaf et al. [23], Polat [28], Nasab and Ghamsarian [31], Afshar et al. [37], Ulubeyli and Kazaz [38], Alptekin and Alptekin [51],
Technical Capacity	Egemen and Mohamed [1], Plebankiewicz [3], Niento-Morote and Ruz-Vila [4], Hartmann and Caerteling [9], Zhang et al. [15], Kog and Yaman [17], Liu et al. [20], Attar et al. [21], Assaf et al. [23], Nasab and Ghamsarian [31], Afshar et al. [37], Ulubeyli and Kazaz [38], Zavadskas et al. [39],
Management Ability	Egemen and Mohamed [1], Plebankiewicz [3], Niento-Morote and Ruz-Vila [4], Zhang et al. [15], Kog and Yaman [17], Yang et al. [18], Attar et al. [21], Assaf et al. [23], Hadidi and Khater [32], Afshar et al. [37], Zavadskas et al. [39]
Past Performance	Niento-Morote and Ruz-Vila [4], Keung and Yiu [7], Yang et al. [18], Liu et al. [20], Attar et al. [21], Hasnain et al. [25], Nasab and Ghamsarian [31], Hadidi and Khater [32], Afshar et al. [37], Ulubeyli and Kazaz [38], Zavadskas et al. [39]
Personnel	Egemen and Mohamed [1], Gosling et al. [13], Polat [28], Hadidi and Khater [32], Nassar and Hosny [34], Afshar et al. [37], Alptekin and Alptekin [51]

Table 1. *Cont.*

Contractor Selection Criteria	Author
Quality	Plebankiewicz [3], Hartmann and Caerteling [9], Nguyen [10], Attar et al. [21], Aboelmagd [22], Assaf et al. [23], Hasnain et al. [25], Polat [28], Nasab and Ghamsarian [31], Nassar and Hosny [34], Afshar et al. [37], Abbasianjahromi et al. [40]
Experience	Egemen and Mohamed [1], Rajaprasad [2], Niento-Morote and Ruz-Vila [4], Keung and Yiu [7], Gao [14], Yang et al. [18], Attar *et al.* [21], Aboelmagd [22], Assaf *et al.* [23], Nasab and Ghamsarian [31], Ulubeyli and Kazaz [38], Zavadskas et al. [39], Alptekin and Alptekin [51]
Health and Safety	Egemen and Mohamed [1], Niento-Morote and Ruz-Vila [4], Gao [14], Kog and Yaman [17], Liu et al. [20], Attar et al. [21], Hasnain et al. [25], Nasab and Ghamsarian [31], Hadidi and Khater [32], Afshar et al. [37], Zavadskas et al. [39]
Reputation	Niento-Morote and Ruz-Vila [4], Keung and Yiu [7], Kog and Yaman [17], Assaf et al. [23], Ulubeyli and Kazaz [38]
Relationship	Niento-Morote and Ruz-Vila [4], Gosling et al. [13], Ulubeyli and Kazaz [38]
Time	Plebankiewicz [3], Palha et al. [19], Abbasianjahromi et al. [40]

Furthermore, the researchers suggested other criteria, such as risk [19], environment [20,34], equipment resources and current workload [19,21,22,37,38], company characteristics [2] and business ethics [10], legal capacity [7,10,15], warranty [1,10], design [15,18], and firm background innovative capabilities [23].

Hassim et al. [5] presented criteria for construction tender price estimation. These criteria include intricacy of project and construction, acceptable construction schedule, market requirement, clients' financial situation. Keshavarz Ghorabaee et al. [35] proposed reliability, schedule-control and management ability, and labour quality criteria. Polat et al. [29] determined supplier selection criteria, followed by the quality of the product, delivery performance, lead time, total outlay of production, payment requirement, etc. Nyongesa et al. [27] suggested the criteria for partner selection, namely business, technical, and management. According to Mamavi et al. [11], the criteria, used in the most economically advantageous offer, are price, quality, technical value, aesthetic and functional aspects, global usage cost, profitability, innovativeness, technical assistance, performance in environmental protection. Juan [42] evaluated housing refurbishment contractors, using schedule and budget change, quality defect, experience, conflicts and complaints, and tangibles, empathy, reliability, responsiveness, assurance satisfaction criteria. Sarkis et al. [24] submitted the subcontractor selections' factors and subfactors, which are based on sustainability principles. The following factors are used: economic and business, environmental and social. Zavadskas and Vilutienė [43], Brauers et al. [44], and Zavadskas et al. [45] evaluated maintenance contractor by criteria description such as outlay of building, joint property administration, total service, number of maintained buildings, income from general property maintenance per employee. However, Zavadskas and Vilutienė [43], Zavadskas et al. [45] have also used qualitative criteria for maintenance contractor selection. These criteria consist of a length of time, market share, number of projects, management cost, work organization, etc.

Adebisi et al. [52] submitted the five factors to the breakdown of construction projects. The main obtained factors were, namely: human ability, preparation and structural quality, contractor selection and variety, disagreement and inflation, force majeure, and political risk. Nevertheless, the contractor selection and variety factor consists of lack of efficient procurement process, lack of qualified employees with technological, professional, and management experience essential for the project, variation of the project and inflationary increases in material cost. Aladag and Isik [53] presented Sustainable Key Performance Indicators (KPIs) for urban regeneration projects.

Sustainable Key Performance Indicators include "Economic KPIs", "Social KPIs", "Environmental KPIs", and "Innovation and Research and Development KPIs". Rashvand et al. [26], selecting contractors concerning management skills, have determined criteria, such as supervising and managing, problem-solving, organization improvement skills, resource management, and management knowledge. Nevertheless, Ustinovicius et al. [54] proposed proper contractor selection, taking into account the contract terms and conditions. Authors' determined criteria are qualifications, cost requirements of payments, timetable, performance guaranty, warranty, responsibility, and security.

The most common factors for the contractor selection are price, capacity, quality, responsibility, flexibility, and experience. However, these factors are generic criteria for contractor selection, which do not include the particular criteria relating to heritage projects. Selecting contractors for sgraffito decoration of cultural heritage buildings employs the heritage and construction regulations. Therefore, this study proposes six principal criteria groups, which are integrated with construction and the cultural heritage field and have been taken account into the authors' accomplished criteria to analyze.

3. Determining the Evaluation Criteria and Subcriteria of the Contractor Selection for Sgraffito Decoration Cultural Heritage Buildings

The standard process of contractors' selection does not ensure the selection of a suitable contractor. Selection of the perfect contractor is a vital procedure in construction [2] and, particularly, heritage projects.

Studies have shown that, for the best economic results and good quality, the lowest price tendering is not considered sufficient to ensure the desired results. Within the focus of the outcome of any construction and cultural heritage, activity is the realization of minimal cost, timely delivery, and quality-oriented structure. In this case, cultural heritage buildings' conservation and restoration, mainly, focus on sgraffito decoration, is more complicated. The contractors must have experience in the heritage field, knowledge of the legislation of construction and heritage activity, awareness of the sgraffito technique, and qualified employees. Therefore, the selection of a suitable contractor for the heritage project is a very complex task for clients in the construction industry. The contractor plays an essential part in project success, and consequently, contractor selection is a responsible and crucial decision-making process.

The present study determines subcriteria, which are grouped into six principal criteria (Figure 1), such as financial strength (x_1), contractors' value (x_2), subcontractors (x_3), management capability (x_4), risk (x_5), and reputation (x_6).

The financial strength criterion is considered, taking into account the subcriteria, such as income (x_{11}), days' sales (x_{12}) and payable (x_{13}) outstanding, current ratio (x_{14}) and profit before taxes (x_{15}). The contracts' value criterion consists of total contracts' value (x_{21}), performed heritage work's value (x_{22}) (not less than 100 thousand euro), the executed heritage buildings' contract value (x_{23}) (not less than 220 thousand euro) and the number of total contracts (x_{24}). The subcontractors' criterion describes the amount of total contracts (x_{31}). Management capability is presented by subcriteria, namely, activity duration (x_{41}), certification for special building material (x_{42}), ISO certification (x_{43}), total number of employee (x_{44}), qualified specialist for stone and bricks masonry work (x_{45}), for decorative plaster and coating works (x_{46}), and for polychrome and wall painting research (x_{47}). Risk criterion shows the company's dependence on various risk groups (from high-risk to the low-risk group) (x_{51}). The reputation criterion presents the reviews and complains (x_{61}) of clients and stakeholders.

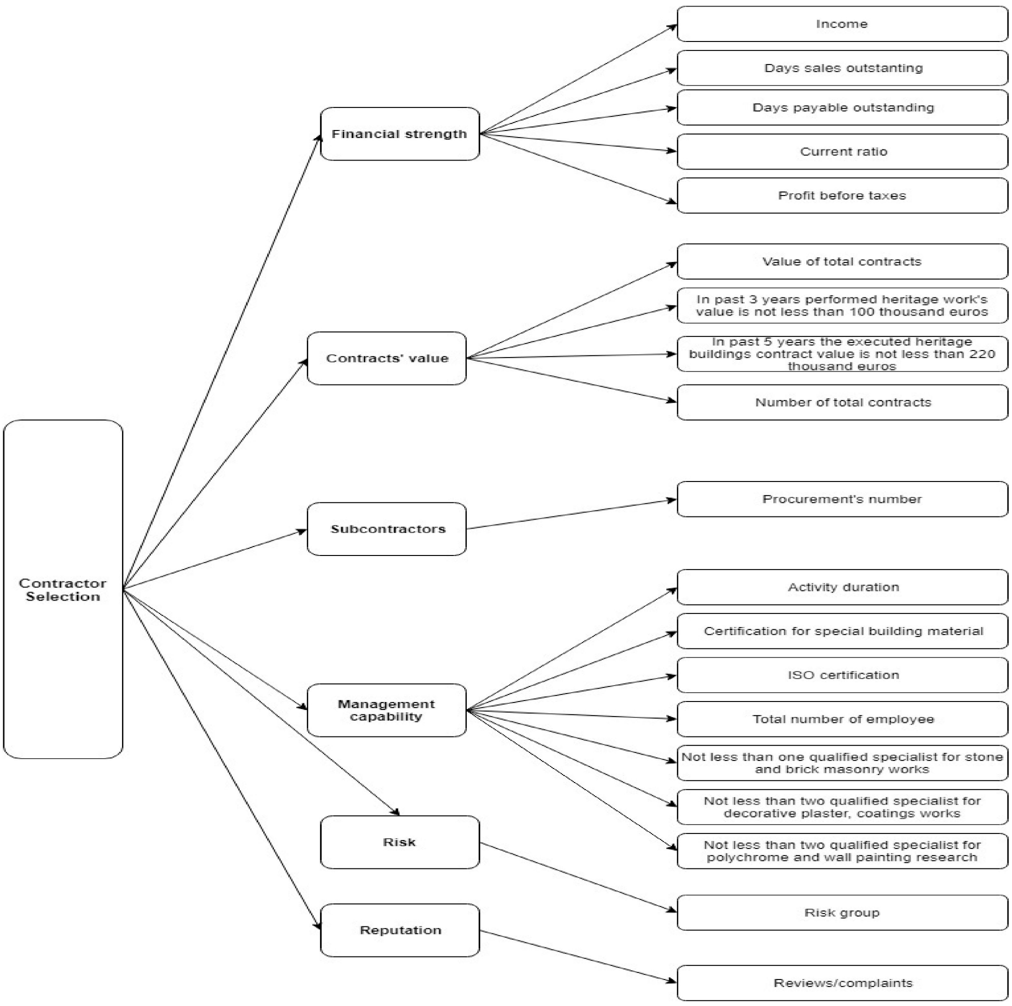

Figure 1. Criteria and subcriteria used in describing contractor selection for sgraffito decoration of cultural heritage buildings.

4. Case Study

4.1. St. Stephen Church

St. Stephen Church (Figure 2) was built in the late Renaissance style in the 17th century by Jesuit priest—Simonas Visockis. The church was refurbished in Classicism style in the 18th century. The church was damaged by the uprising in 1794, in 1812, and in 1863. Furthermore, the church was rebuilt by monks in 1715, in 1801–1806, in 1885–1888, and in 1893–1894. During the reconstruction works, the plan and structure of the church, the position of the main entrance and windows were changed.

St. Stephen Church was closed in 1944. Later, it was adaptively reused for a tile factory, where materials were stored.

Nowadays, St. Stephen Church is a single-nave in Latin cross plan with a barrel vaults church. The sacristy of the Church has three floors. Moreover, the interior church walls contain frescoes and decorated pilasters. The sgraffito technique, pilasters, and cornices decorate the exterior church walls. The main façade is symmetrical. It has the tower with the main entrance, which is surrounded by two staircase towers.

In 1992, St. Stephen Church was included in the Register of Cultural Heritage Building. The nature of the church's valuable properties is archaeological, architectural, artistic, historical, memorial, and sacral.

The St. Stephen Church restoration and conservation project preserves the nature of valuable properties.

Figure 2. The St. Stephen Church, Vilnius, Lithuania.

4.2. *Sgraffito Technique*

Sgraffito originated in Italy in the XVI century and has been expanded in Europe and, actually, has been used in African art. Sgraffito is an ancient decorative technique applied in walls, produced by applying layers of cement plaster tinted in contrasting colours to a moistened surface (Figure 3). Furthermore, for the base layer, it used carbon pigment mixed with slaked lime and sand, seeking to colour the sgraffito plaster a silvery black. The last layer was contrasted with the black, a white pulverized travertine was mixed with sand. The decorative design was engraved by cutting away this last layer, while still mild, to disclose the darker layer beneath [55]. The decoration was in two colours: black, where the surface was engraved, and white, where it was left. The sgraffito technique has been combined with fresco or mosaics.

Figure 3. Sgraffito technique, Palazzo della Carovana, Pisa, Italy.

St. Stephen Church is the only Renaissance church in Vilnius. The frieze, which is visible on the interior walls, is decorated by the sgraffito technique in the XVII century (Figure 4).

Figure 4. St. Stephen Church's exterior wall, Vilnius, Lithuania.

4.3. Preservation and Restoration of Sgraffito Decoration

The preservation and restoration of sgraffito decoration must be responsible and very careful, without unnecessary loss of historical, architectural, artistic value and damage of the heritage buildings. In seeking to preserve the decorative design and real heritage, the conservation and restoration performance has to be based upon professional judgment, quality, and experience.

In case of necessity to preserve and restore the cultural heritage buildings decorated with sgraffito technique, firstly, conservators and contractors should analyze the historical characteristics and development of heritage buildings. Secondly, the project should be prepared for conservation and restoration of the sgraffito technique. Moreover, damaged patterns and lost elements have to be replaced or restored, according to performed researches and restoration project.

4.4. Solving the Decision-Making Problem

The researchers decided to evaluate and determine the sgraffito decorations' contractor of heritage buildings selection problem, selecting diverse companies. The companies specialize in conservation, restoration of heritage buildings, frescoes, and mosaics. The sgraffito decorations' contractor selection problem is evaluated and determined using multi-criteria decision-making approaches.

Three enterprises have been discussed for sgraffito decorations' contractor selection. The full names of these companies are not provided for the sake of confidentiality.

The group of experts was developed, seeking to resolve the problem of sgraffito decorations' contractor selection. In this study, the qualified consultants have to set a group of criteria, determine criteria value and weights. The authors collaborated with ten experts from the local government, academics and professionals or experts in sgraffito technique and heritage buildings.

The dominant requirements for experts were capacity and knowledge in the sgraffito technique and cultural heritage field. Furthermore, the persons had to have more than ten years of experience in the sgraffito technique cultural heritage field.

5. Contractor Selection for Sgraffito Decoration of Cultural Heritage Buildings Using Multi-Criteria Decision-Making Approaches

5.1. Data Arrangement

The construction and heritage contractor is considered successful if they successfully had finished the projects within the time, within the budget, and within stakeholders' needs. The principal success factors of construction contractor are knowledge and accomplishment, project aspect, management capacity, supply chain and management skill, the opportunity of resources and information flows, effective outlay control measures, favourable market and marketing team, and opportunity of qualified and experienced employees [56]. Moreover, the contractor should be qualified in applying planned tasks into a physical process, including efficient communication with its employees, clients, suppliers, etc. The contractor should be able to capably manage interferences among work, employees and resources schedules, and the materials' delivery schedules, so as not to permit for any detractions from the original plans [2].

In this case, three companies have been considered for contractor selection for sgraffito decoration of cultural heritage buildings. The principal aim of selecting companies was leadership, experience and performance in the sgraffito decoration and cultural heritage field, qualified specialist for stone and brick masonry, decorative plaster, and polychrome works, management competence in the cultural heritage projects, and reputation. According to Khalfan et al. [57], the organization's reputation indicator is essential for trusting on a project and inter-organizational and intra-organizational relationships.

Table 2 shows the cultural heritage contractor selection alternative (A_1–A_3) with the represented set of criteria (x_1–x_6), subcriteria, and the evaluated values. These data were obtained from diverse enterprise's archives and papers.

The data demonstrated in Table 2 shows the enterprise's ability, knowledge and qualification, risk, and reputation. The company's characteristic was valued by a set of criteria, namely financial strength, contracts' value, subcontracts, management capability, risk, and reputation. The determination of the data of criteria presents the equivalence of given alternatives, i.e. all alternatives are less or more similar, respecting the represented criteria.

Table 2. The sgraffito decorations' contractor selection alternatives, criteria, and subcriteria.

Criteria		The Assessment of Criteria, Min/Max	Alternatives		
			A_1	**A_2**	**A_3**
Contracts' value	x_1	max			
Value of total contracts (million Eur)	x_{11}	max	31.3	17.2	9.5
In the past 3 years, performed heritage work's value is not less than 100 thousand euros (million Eur)	x_{12}	max	10.4	8.4	3.5
In the past 5 years, the executed heritage buildings contract value is not less than 220 thousand euros (million Eur)	x_{13}	max	4.85	3	0.34
Number of total contracts (number)	x_{14}	min	27	19	5
Financial strength	x_2	max			
Income (million Eur)	x_{21}	max	47.8	32.4	12
Days sales outstanding (days)	x_{22}	max	19.4	105.2	76.23
Days payable outstanding (days)	x_{23}	max	12.67	70.67	88.19
Current ratio	x_{24}	max	4.85	1.87	3.22
Profit before tax (%)	x_{25}	max	5.67	0.9	2.06
Subcontractors Procurement's number (number)	x_3	min	30	9	0
Management capability	x_4	max			
The duration of activity (years)	x_{41}	min	10	20	60
Certification for special building material (%)	x_{42}	max	1	1	1
Certification ISO (scores by the number of ISO)	x_{43}	max	3	3	3
Total number of employees (number)	x_{44}	min	162	207	244
Not less than one qualified specialist for stone and brock masonry works (%)	x_{45}	max	2.47%	1.90%	2.40%
Not less than two qualified specialists for decorative plaster, coatings works (%)	x_{46}	max	1.85%	1.45%	1.64%
Not less than two qualified specialists for polychrome and wall painting research (%)	x_{47}	max	1.23%	0.97%	1.22%
Risk Risk group (scores)	x_5	min	4	3	5
Reputation Reviews/complaints (scores)	x_6	min	2	3	1

5.2. Significance of Represented Criteria

The evaluation of the criteria significance is an important aspect, taking into account all the MCDM problems. The researchers have submitted diverse approaches, seeking to combine the different criteria, which allow for describing the considered object into a single generalising criterion. Moreover, quite substantially diverse multi-criteria decision-making approaches have been determined [58]. MCDM methods are applicable to different kinds of sophisticated economic [59], construction, management, mathematics, and information systems problems [60]. Evaluating buildings reconstruction projects is facing a lot of problems, which are estimating by qualitative criteria. The weights of these criteria may estimate, applying only subjective evaluation methods. Currently, these subjective methods are known, such as Delphi [61], expert judgment [62], AHP [63], SWARA [64], FARE (factor relationship) [65], KEMIRA (KEmeny Median Indicator Rank Accordance) [66], etc.

This paper presents the AHP, SWARA, and WASPAS-SVNS methods for the contractor selection process for sgraffito decoration of cultural heritage buildings (Figure 5). The AHP and SWARA approaches submit criteria weights determination. The weights of the criteria show the intensity of the importance of the specific criterion to the final ranking of the presented alternatives. Meanwhile, the WASPAS-SVNS approach is proposed for heritage contractors' comparison.

Seeking to use the WASPAS-SVNS method, firstly, the criteria weights must be determined. The weights of the criteria were established by the AHP and SWARA methods.

The Analytic Hierarchy Process (AHP) is an established method for resolving MCDM problems and using for the determination of criteria weights [63]. Currently, 20,281 articles and 23 reviews of the database Clarivate Analytics have mentioned this method. The AHP had been successfully used to solve the problems of civil engineering, construction technology and management [67–70], reconstruction [71,72], and renovation [73] field. Moreover, the published review articles presented the efficient AHP applying in these fields.

However, the AHP method applying in the cultural heritage buildings field is not so productive. This method has been applied to solve problems of the attractiveness of cultural heritage sites [74], sustainable historic waterfront revitalization decision support [75], renovation projects of cultural heritage buildings [76], contractor selection of cultural heritage buildings [77], optimized fire protection of cultural heritage structures [78], etc. The application of the AHP method in the cultural heritage field was presented by Morkūnaitė et al. [79].

The AHP method establishes the weights of hierarchically nonstructured or specific hierarchical level criteria in respect of those belonging to a higher level [58].

The Analytic Hierarchy Process (AHP) method is a stepwise procedure:

Step 1. When the experts finished comparing all the evaluation criteria, the results are presented in the pairwise comparison matrix (Table 3):

$$A = \left[c_{ij}\right] = \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{matrix} \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix}. \quad (1)$$

Step 2. The pairwise comparison matrix is normalised, as follows:

$$\overline{A} = \left[\bar{c}_{ij}\right] = \begin{bmatrix} c_{11}/\sum_{i=1}^{n} c_{i1} & c_{12}/\sum_{i=1}^{n} c_{i2} & \cdots & c_{1n}/\sum_{i=1}^{n} c_{in} \\ c_{21}/\sum_{i=1}^{n} c_{i1} & c_{22}/\sum_{i=1}^{n} c_{i2} & \cdots & c_{2n}/\sum_{i=1}^{n} c_{in} \\ \vdots & \vdots & \ddots & \vdots \\ c_{n1}/\sum_{i=1}^{n} c_{i1} & c_{n2}/\sum_{i=1}^{n} c_{i2} & \cdots & c_{nn}/\sum_{i=1}^{n} c_{in} \end{bmatrix} \quad (2)$$

Step 3. Estimate the criteria weights:

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = \begin{bmatrix} w_1 = \left(\prod_{j=1}^{n} \bar{c}_{1j}\right)^{1/n} / \sum_{i=1}^{n}\left(\prod_{j=1}^{n} \bar{c}_{ij}\right)^{1/n} \\ w_2 = \left(\prod_{j=1}^{n} \bar{c}_{1j}\right)^{1/n} / \sum_{i=1}^{n}\left(\prod_{j=1}^{n} \bar{c}_{ij}\right)^{1/n} \\ \vdots \\ w_n = \left(\prod_{j=1}^{n} \bar{c}_{1j}\right)^{1/n} / \sum_{i=1}^{n}\left(\prod_{j=1}^{n} \bar{c}_{ij}\right)^{1/n} \end{bmatrix} \quad (3)$$

Step 4. Define the largest eigenvalue:

$$\lambda_{max} = \sum_{j=1}^{n} c_{ij} w_{ij} \quad (4)$$

Step 5. Define the Consistency Index (CI):

$$CI = \frac{\lambda_{max} - 1}{n - 1} \quad (5)$$

n—number of compared criteria.
Step 6. Define the Consistency Ratio (CR):

$$CR = \frac{CI}{RI}, \quad (6)$$

RI—average consistency index. When $C.R.$ is smaller than or equal to 0.1, the importance of concordance ratio $C.R.$ is acceptable.

In this study, the largest eigenvalue $\lambda_{max} = 6.52$, $C.I.$ = 0.104, and $C.R.$ = 0.084 < 0.1; therefore, the evaluation of experts is arranged.

Table 3. Criteria pairwise comparison matrix.

Criteria	Financial Strength	Contracts' Value	Subcontractors	Management Capability	Risk	Reputation
Financial strength	1.00	0.50	7.00	6.00	4.00	3.00
Contracts' value	2.00	1.00	9.00	7.00	5.00	4.00
Subcontractors	0.14	0.11	1.00	0.33	0.25	0.17
Management capability	0.17	0.14	3.00	1.00	0.33	0.20
Risk	0.25	0.20	4.00	3.00	1.00	0.33
Reputation	0.33	0.25	6.00	5.00	3.00	1.00

The weights of criteria are shown in Table 4.

Table 4. The evaluation of expert.

ω_1	ω_2	ω_3	ω_4	ω_5	ω_6
0.401	0.271	0.029	0.050	0.089	0.160

The weights of partial criteria are presented in Tables 5–7. These weights were calculated in the same manner as the weights of criteria.

Table 5. Contract's value's partial criteria weights.

ω_{11}	ω_{12}	ω_{13}	ω_{14}
0.224	0.106	0.049	0.023

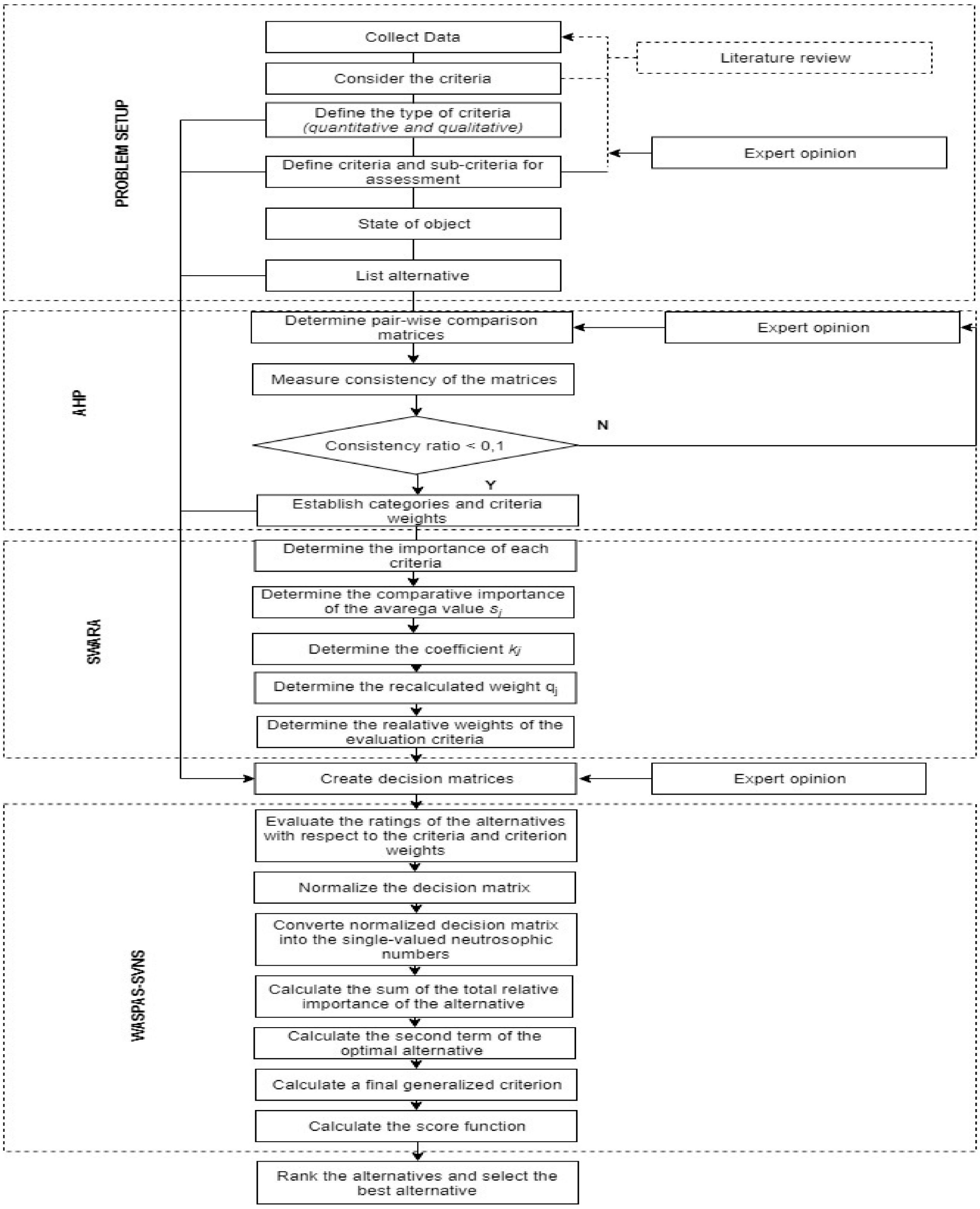

Figure 5. Proposed model for the contractor selection process for sgraffito decoration of cultural heritage buildings.

Table 6. Financial strengths' partial criteria weights.

ω_{21}	ω_{22}	ω_{23}	ω_{24}	ω_{25}
0.153	0.057	0.011	0.029	0.022

Table 7. Management capability's partial criteria weights.

ω_{41}	ω_{42}	ω_{43}	ω_{44}	ω_{45}	ω_{46}	ω_{47}
0.001	0.020	0.013	0.001	0.003	0.006	0.006

Criteria and subcriteria, follows as: Subcontractors' (x_3), Risk groups (x_5), Reputation's (x_6), was determined as weight 1: $\omega_3 = \omega_5 = \omega_6 = 1$.

The SWARA method is applied to determine the weights of the criteria [64]. This process is performed by a consistent and gradual pairwise comparison of criteria. This comparison is carried out by the experts' evaluation.

The steps by the SWARA technique are as follows:

Step 1. Determine the set of criteria.

Step 2. Accomplish the criteria ranking by expert evaluation, where the most important weight is situated in the first place.

Step 3. Define the average value of comparative importance S_j.

Step 4. Calculate the benefits of comparative importance:

$$k_j = s_j + 1 \tag{7}$$

Step 5. Recalculate the transitional weights as follows:

$$q_j = \frac{q_{j-1}}{k_j} \tag{8}$$

Step 6. Normalise the final weights:

$$w_j = \frac{w_j}{\sum\limits_{j=1}^{n} w_j} \tag{9}$$

n—a number of criteria.

Table 8 presents the SWARA approach results.

Table 8. The Weights of Criteria By SWARA method.

Indicator	Average Values of Comparative Importance Indicators, $s_{j\leftrightarrow j+1}$	Coefficients of Comparative Importance Indicators, k_j	Recalculated (Intermediate) Indicators Weights, q_j	Final Indicators Weights, w_j
bx_1	–	1.000	1.000	0.2507
x_2	–	1.130	0.885	0.2218
x_3	0.130	1.280	0.691	0.1732
x_4	0.280	1.221	0.566	0.1419
x_5	0.221	1.240	0.457	0.1145
x_6	0.240	1.170	0.390	0.0978
	0.170		3.989	

5.3. Contractor Selection for Sgraffito Decoration of Cultural Heritage Buildings by the WASPAS-SVNS Method

The considered MCDM method–WASPAS method was successfully applied to solve the different real-life problems: management [80,81], robust design selection [82], garage location choice [83], intelligent systems for construction industry [84,85], and autonomous robot navigation [86]. Moreover, Mardani et al. [87] presented a review of the SWARA and WASPAS methods. Seeking to find out the solution of the formulated MCDM issue, the authors applied the expansion of the WASPAS method, namely, WASPAS-SVNS. Initially, this approach was proposed for the site selection problem of the incineration plant [88]. The WASPAS-SVNS approach is based on the single-valued neutrosophic set. The discussed approach to the solution of the contractor selection for the sgraffito technique problem is outlined, using the stepwise procedure:

Step 1. The primary information includes the evaluations concerning the ratings of the alternatives with respect to the criteria and the criterion weights.

It is presented by the following data $x_{ij}, i = 1, 2, \ldots, m; j = 1, 2, \ldots, n$, which is an aggregated expert assessment of the i^{th} alternative by the j^{th} criterion. The results are presented in the decision matrix:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{10}$$

Step 2. Normalize the decision matrix X by vector normalization technique.

$$\widetilde{x}_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} (x_{ij})^2}} \tag{11}$$

Step 3. The obtained normalized decision matrix $\widetilde{X}$ in the crisp form converts into the single-valued neutrosophic numbers. Calculate the neutrosophic decision matrix $\widetilde{X}^n$ and apply the relationships between normalized values of the criteria of the alternatives and single-valued neutrosophic numbers. The neutrosophication step is performed, applying the same rules as in [69].

Step 4. Calculate the initial decision element. This presented element is related to the sum of the total relative significance of the alternative i.

$$\widetilde{Q}_i^{(1)} = \sum_{j=1}^{L_{\max}} \widetilde{x}^n_{+ij} \cdot w^n_{+j} + \left(\sum_{j=1}^{L_{\min}} \widetilde{x}^n_{-ij} \cdot w^n_{-j} \right)^c \tag{12}$$

$\widetilde{x}^n_{+ij}, w^n_{+j}$—associated with the criteria to be maximized;
$\widetilde{x}^n_{-ij}, w^n_{-j}$—associated with the criteria to be minimized.

Step 5. Calculate the multiplication of the neutrosophic variable and real crisp weight.

$$\lambda \widetilde{N}_1 = \left(1 - (1 - t_1)^\lambda, i_1^\lambda, f_1^\lambda\right), \lambda > 0 \tag{13}$$

Step 6. The single-valued neutrosophic number can be expressed by $\widetilde{N}_1 = (t_1, i_1, f_1)$; t corresponds to membership degree, i – to indeterminacy degree and t – to a nonmembership degree. The summation of two single-valued neutrosophic numbers is presented as follows:

$$\widetilde{N}_1 \oplus \widetilde{N}_2 = (t_1 + t_2 - t_1 t_2, i_1 i_2, f_1 f_2) \tag{14}$$

Step 7. The next requirement of the summation amount to the completing neutrosophic numbers is:

$$\widetilde{N}_1{}^c = (f_1, 1 - i_1, t_1) \tag{15}$$

Step 8. Determine the following condition of the optimal alternative in the WASPAS-SVNS methodology, applying the formulation of the product total relative importance of the alternative i:

$$\widetilde{Q}_i^{(2)} = \prod_{j=1}^{L_{\max}} \left(\widetilde{x}^n_{+ij}\right)^{w^n_{+j}} \cdot \left(\prod_{j=1}^{L_{\min}} \left(\widetilde{x}^n_{-ij}\right)^{w^n_{-j}} \right)^c \tag{16}$$

Step 9. Govern the multiplication of the neutrosophic numbers.

$$\widetilde{N}_1 \otimes \widetilde{N}_2 = (t_1 t_2, i_1 + i_2 - i_1 i_2, f_1 + f_2 - f_1 f_2) \tag{17}$$

Step 10. Calculate a definitive generalized criterion, allowing to rank the alternatives:

$$\widetilde{Q}_i = 0.5\widetilde{Q}_i^{(1)} + 0.5\widetilde{Q}_i^{(2)} \tag{18}$$

Step 11. Calculate the score function $S(\widetilde{Q}_i)$ for all ranking alternatives *i=1, 2, . . . m.*

$$S(\widetilde{N}_A) = \frac{3 + t_A - 2i_A - f_A}{4} \quad (19)$$

Step 12. Perform the final rankings of the alternatives by applying the descending order of the $S(\widetilde{Q}_i)$, i=1, 2, . . . , m.

Applying the second and third steps of the WASPAS-SVNS method, the obtained neutrosophic decision matrix is presented in Table 9.

Table 9. The decision matrix $\widetilde{X}^n$ after the neutrosophication step.

Criteria	I	II	III
c_{11}max	(0.8469, 0.1265, 0.1531)	(0.4654, 0.5519, 0.5346)	(0.2571, 0.7929, 0.7429)
c_{12}max	(0.7526, 0.1974, 0.2474)	(0.6079, 0.3421, 0.3921)	(0.2533, 0.7967, 0.7467)
c_{13}max	(0.8489, 0.1255, 0.1511)	(0.5251, 0.4623, 0.4749)	(0.0595, 0.9405, 0.9405)
c_{14}min	(0.8086, 0.1457, 0.1914)	(0.5690, 0.3965, 0.4310)	(0.1497, 0.8751, 0.8503)
c_{21}max	(0.8104, 0.1448, 0.1896)	(0.5493, 0.4260, 0.4507)	(0.2035, 0.8465, 0.7965)
c_{22}max	(0.1477, 0.8762, 0.8523)	(0.8009, 0.1496, 0.1991)	(0.5803, 0.3795, 0.4197)
c_{23}max	(0.1114, 0.8943, 0.8886)	(0.6214, 0.3286, 0.3786)	(0.7755, 0.1745, 0.2245)
c_{24}max	(0.7932, 0.1568, 0.2068)	(0.3058, 0.7442, 0.6942)	(0.5266, 0.4601, 0.4734)
c_{25}max	(0.9296, 0.0704, 0.0704)	(0.1476, 0.8762, 0.8524)	(0.3377, 0.7123, 0.6623)
c_{31}min	(0.9578, 0.0422, 0.0422)	(0.2873, 0.7627, 0.7127)	(0.0000, 1.0000, 1.0000)
c_{41}min	(0.1562, 0.8719, 0.8438)	(0.3123, 0.7377, 0.6877)	(0.9370, 0.0630, 0.0630)
c_{42}max	(0.5774, 0.3840, 0.4226)	(0.5774, 0.3840, 0.4226)	(0.5774, 0.3840, 0.4226)
c_{43}max	(0.5774, 0.3840, 0.4226)	(0.5774, 0.3840, 0.4226)	(0.5774, 0.3840, 0.4226)
c_{44}min	(0.4517, 0.5725, 0.5483)	(0.5772, 0.3843, 0.4228)	(0.6803, 0.2697, 0.3197)
c_{45}max	(0.6280, 0.3220, 0.3720)	(0.4831, 0.5254, 0.5169)	(0.6102, 0.3398, 0.3898)
c_{46}max	(0.6455, 0.3045, 0.3545)	(0.5059, 0.4911, 0.4941)	(0.5722, 0.3917, 0.4278)
c_{47}max	(0.6195, 0.3305, 0.3805)	(0.4885, 0.5172, 0.5115)	(0.6145, 0.3355, 0.3855)
c_{51}min	(0.5657, 0.4015, 0.4343)	(0.4243, 0.6136, 0.5757)	(0.7071, 0.2429, 0.2929)
c_{61}min	(0.5345, 0.4482, 0.4655)	(0.8018, 0.1491, 0.1982)	(0.2673, 0.7827, 0.7327)

The results of the WASPAS-SVNS approach, demonstrating the usage of steps 4–7, are shown in Tables 10 and 11.

Table 10. Numerical results of AHP and WASPAS-SVNS.

Generalized Function	Alternatives		
	I	II	III
$\widetilde{Q}^{(1)}$	(0.9313, 0.0612, 0.0687)	(0.8497, 0.1600, 0.1503)	(0.8885, 0.1182, 0.1115)
$\widetilde{Q}^{(2)}$	(0.2144, 0.7739, 0.7856)	(0.1472, 0.8512, 0.8528)	(0.0857, 0.9237, 0.9143)
$\widetilde{Q}$	(0.7677, 0.2176, 0.2323)	(0.6419, 0.3691, 0.3581)	(0.6808, 0.3304, 0.3192)
$S(\widetilde{Q})$	0.7751	0.6364	0.6752
Rank	*1*	*3*	*2*

In both cases, the priority was given to the A_1 heritages' contractor and the last priority was given to the A_2 heritages' contractor.

The sensitivity analysis of contractor selection for sgraffito decoration of cultural heritage buildings was studied applying the additional data of seven potential possibilities for the contractor. According to this information, we have formed the matrix for seven other management capability criteria, which is presented in Table 12. The authors selected the management capability for a sensitivity analysis because this criterion describes the quality of the sgraffito technique. Moreover, the quality is crucial for preservation and restoration for this type of technology.

Table 11. Numerical results of SWARA and WASPAS-SVNS.

Generalized Function	Alternatives		
	I	II	III
$\widetilde{Q}^{(1)}$	(0.8474, 0.1387, 0.1526)	(0.7998, 0.2083, 0.2002)	(0.8402, 0.1705, 0.1598)
$\widetilde{Q}^{(2)}$	(0.2102, 0.7802, 0.7898)	(0.1636, 0.8345, 0.8364)	(0.1143, 0.8941, 0.8857)
$\widetilde{Q}$	(0.6529, 0.3290, 0.3471)	(0.5908, 0.4170, 0.4092)	(0.6238, 0.3904, 0.3762)
$s(\widetilde{Q})$	0.6619	0.5869	0.6167
Rank	*1*	*3*	*2*

The sensitive analysis confirms the stability of the ranking order. According to the presented results of the sensitive study, the authors suggested analysing the contractor's characteristics, which could influence the awarding of procurement of sgraffito techniques performance.

Contractor A_3 for sgraffito technique of cultural heritage buildings has been selected. Although this contractor has considerable experience in the cultural heritage field and a large number of employees, a small number of qualified employees in sgraffito technique performance do not always allow for awarding the procurement for this performance. However, in all the possibilities, contractor A_3 demonstrates the second preferences. Seeking to award contractor A_3 was suggested to analyse the similar characteristics of diverse contractors. The data was obtained from various archives, documents, and statistics of different cultural heritage enterprises.

After the calculation of sensitive analysis was performed and the stability of ranking order was confirmed, the authors noticed that there was little difference between contractor A_3 and contractor A_1 in "Test 6". According to it, the authors agreed to analyse the possibilities of awarding contractor A_3 and proposed to modify the management capability criteria for "Tests 1–5" and "Test 7", and reconsider the presented criteria and their set for "Test 6", which is presented in Table 13.

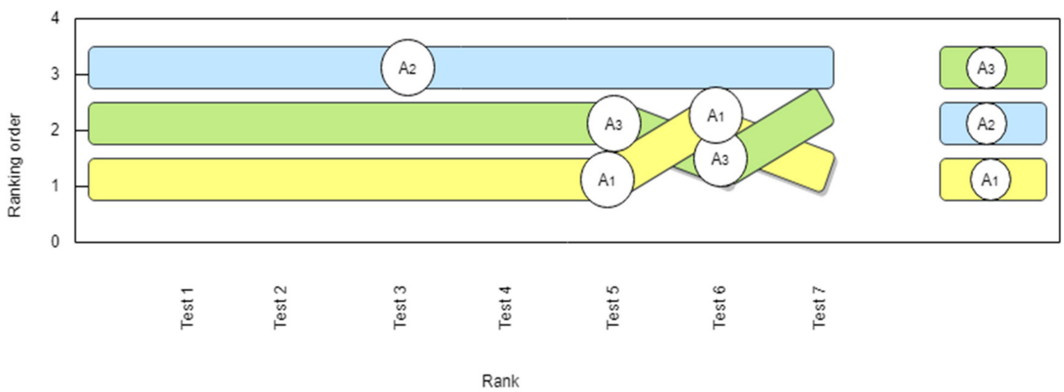

Figure 6. Sensitive analysis.

Table 13 and Figure 6 show the awarding of contractor A_3. This awarding depends not only on management capability criterion but also on the modification of criteria, such as the value of total contracts, performed heritage work's importance in the past three years, income, risk, and reputation.

Table 12. Tests for management capability criteria.

Test	Management Capability (x_4)						
	The Duration of Activity (Years)	**Certification for Special Building Material (%)**	**Certification ISO (Scores by the Number of ISO)**	**Total Number of Employees (Number)**	**Not Less Than One Qualified Specialist for Stone and Brock Masonry Works (%)**	**Not Less Than Two Qualified Specialists for Decorative Plaster, Coatings Works (%)**	**Not Less Than Two Qualified Specialists for Polychrome and Wall Painting Research (%)**
X	x_{41}	x_{42}	x_{43}	x_{44}	x_{45}	x_{46}	x_{47}
Test 1	3	1	3	25	4	8	8
Test 2	8	1	3	50	16	20	20
Test 3	10	1	3	150	13.33	18.67	18.67
Test 4	12	1	3	35	5.7	5.71	8.57
Test 5	15	1	3	86	4.65	3.49	4.65
Test 6	25	1	3	120	10	5	3.33
Test 7	30	1	3	90	3.33	4.44	2.22

Table 13. Test 6's replaced matrix.

Test 6					
Criteria		**The Assessment of Criteria, Min/Max**	**Alternatives**		
			A_1	**A_2**	**A_3**
Contracts' value	x_1	max			
Value of total contracts (million Eur)	x_{11}	max	25.3	15.2	15.5
In the past 3 years performed heritage work's value is not less than 100 thousand euros (million Eur)	x_{12}	max	10.4	8.4	4.5
In the past 5 years the executed heritage buildings contract value is not less than 220 thousand euros (million Eur)	x_{13}	max	4.85	3	0.34
Number of total contracts (number)	x_{14}	min	27	19	5
Financial strength	x_2	max			
Income (million Eur)	x_{21}	max	35.8	28.4	22
Days sales outstanding (days)	x_{22}	max	19.4	105.2	76.23
Days payable outstanding (days)	x_{23}	max	12.67	70.67	88.19
Current ratio	x_{24}	max	4.85	1.87	3.22
Profit before tax (%)	x_{25}	max	5.67	0.9	2.06
Subcontractors Procurement's number (number)	x_3	min	30	9	0
Management capability	x_4	max			
The duration of activity (years)	x_{41}	min	10	20	25
Certification for special building material (%)	x_{42}	max	1	1	1
Certification ISO (scores by the number of ISO)	x_{43}	max	3	3	3
Total number of employees (number)	x_{44}	min	162	207	120
Not less than one qualified specialist for stone and brock masonry works (%)	x_{45}	max	2.47%	1.90%	10.00%
Not less than two qualified specialists for decorative plaster, coatings works (%)	x_{46}	max	1.85%	1.45%	5.00%
Not less than two qualified specialists for polychrome and wall painting research (%)	x_{47}	max	1.23%	0.97%	3.33%
Risk Risk group (scores)	x_5	min	4	3	4
Reputation Reviews/ complaints (scores)	x_6	min	1	3	2

Modified adjustment of the "Test 6" establishes the award of contractor A_3 (Figure 6).

6. Discussion

The authors distinguished all processes in two parts: weights of criteria determination and the final ranking of alternatives. The authors performed the comparison of two weights calculation methods, such as the AHP and SWARA methods. These methods are subjective ones. For ranking of the alternatives, we applied the neutrosophic WASPAS method. This method is an objective method. The authors applied the AHP method to obtain the comparison results for the SWARA method. The SWARA method is quite new compared to the old AHP method. So, it was interesting to compare the result of two these methods.

The authors proposed a new problem formulation concerning contractor selection for sgraffito technique of cultural heritage buildings. The proposed set of criteria covers all aspects of this problem with respect to point of view of sustainable society.

7. Conclusions

Sgraffito decoration of cultural heritage buildings requires specific skills in the sgraffito decoration performance, accountability, ability and responsibility, knowledge, thoroughness, and experienced employee. Therefore, selecting a suitable contractor for sgraffito decoration of cultural heritage buildings is a difficult task. Due to this fact, the improper contractor could create delays, demands, increased outlays for project accomplishment, organization and supervision. In this study, the authors proposed a set of criteria, which permits to evaluate a heritages' contractor for sgraffito decoration. The presented criteria consist of financial strength, contracts' value, subcontractor, management capability, risk, and reputation.

The comparison of the AHP and SWARA methods shows that these approaches provide very close results, but the SWARA method requires a lot less computational resources. The WASPAS-SVNS method shows good performance in the process of alternative ranking. The preference was demonstrated to the A_1 heritages' contractor for sgraffito decoration. The A_1 heritages' contractor for sgraffito decoration lacks qualified employees, and this contractor was awarded procurement together with a subcontractor. However, the A_1 heritages' contractor for sgraffito decoration has the highest value of total contracts and performed heritage works, which leads in the top financial strengths. The last preference was demonstrated to the A_2 heritages' contractor for sgraffito decoration. Although A_2 heritages' contractor for sgraffito decoration has quite a large number of employees, it also has a lack of qualified employees for cultural heritage buildings' performance and cannot be awarded the procurement for this performance.

Observing the results of the sensitivity of the management capability criterion, the stability of ranking order was noticed. Seeking to award contractor A_3, the authors proposed to analyse the criteria, which could influence the awarding of procurement of preservation of restoration performance. The results show that awarding depends not only on management capability criterion, but also on criteria such as the value of total contracts, performed heritage work's value in the past three years, income, risk, and reputation.

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