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Source / Izvornik: **Buildings, 2022, 12**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.3390/buildings12081233 buildings

IMPACT FACTOR 3.8

CITESCORE 3.1

Article

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Topic
Advances in the Sustainability Assessment of Building and Infrastructure Projects

Edited by
Prof. Dr. Víctor Yepes, Dr. Ignacio J. Navarro Martínez and
Dr. Antonio J. Sánchez-Garrido

MDPI

https://doi.org/10.3390/buildings12081233 buildings

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Building Interventions in Mediterranean Towns—Developing a Framework for Selecting the Optimal Spatial Organization and Construction Technology from a Sustainable Development Perspective

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Abstract: Mediterranean towns and their surroundings show specific characteristics, such as urban structure, presence of complex stratification of heritage, and often seasonality, which makes the choice of spatial organization and construction technology for building construction of high importance in relation to sustainable development. For such purpose, the SOnCT model, based on multi-criteria decision analysis, has been developed which takes into account optimal building interventions in Mediterranean towns from a sustainable development perspective, highlighting their spatial-technical aspects. The presented research answers the questions of how sustainable development goals can be implemented in the case of construction interventions in Mediterranean areas, especially in smaller settlements that present very fragile status and specific characteristics not comparable to northern towns. This paper presents the construction and verification of the evaluation and prioritization model for selecting the optimal spatial organization and construction technology based on the criteria of sustainability, spatial characteristics, and the United Nations' Sustainable development goals.

Keywords: project management; building intervention; Mediterranean area; spatial intervention; evaluation model; prioritization; Historic Urban Landscape; UN sustainable development goals

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Citation: Marović, I.; Mrak, I.; Ambruš, D.; Krstičević, J. Building Interventions in Mediterranean Towns—Developing a Framework for Selecting the Optimal Spatial Organization and Construction Technology from a Sustainable Development Perspective. *Buildings* **2022**, *12*, 1233. https://doi.org/10.3390/buildings12081233

Academic Editors: Víctor Yepes, Ignacio J. Navarro Martínez and Antonio J. Sánchez-Garrido

Received: 2 August 2022
Accepted: 11 August 2022
Published: 13 August 2022

1. Introduction

Mediterranean towns and their surroundings present various characteristics specific to the area that regard spatial, social, and cultural characteristics. Often, the settlements present a very complex stratification of heritage and urban structure that makes it difficult to intervene without impacting physical characteristics, daily life, economic activities, or even surrounding territory and infrastructure. Frequently used designs, spatial, construction proposals, spatial organization, and construction technology can have a high impact on spatial functioning, blocking economic activities, physical communication, daily social and cultural activities, and access to public closed and open spaces as well as on the characteristics of built structures or green areas, even exacerbating the extreme character of the climate. The Mediterranean identity acquires ever more importance with the formation of supranational unions such as the European Union [1]. Mediterranean areas, besides having a very long and rich history, are also a major touristic area in the world [2] and a constant inspiration for culture and arts.

Therefore, the need arises to understand how to approach construction interventions in organizational—spatial and temporal terms, and choice of technology. These aspects are highly influenced by the characteristics of Mediterranean settlements and can be important for the achievement of the United Nation's Sustainable development goals (UN SDGs) that are a part of the United Nations' Agenda 2030 [3]; therefore, it would be highly useful to allow for evaluation of the UN SDGs fulfillment in construction processes, for example, in public procurement and choice of spatial organization and construction technology for proposed spatial intervention. Such an evaluation and prioritization model could aid in building work organization—in terms of spatial organization and choice of technology, which would respect the spatial, social, and cultural characteristics of Mediterranean settlements in the sustainable development perspective that is considered in the UN SDGs. This would provide not just the opportunity to establish broad sets of criteria based upon the UN SDGs for building intervention, but also similar sets of criteria that would be appropriate for assessments in other Mediterranean areas.

All the aforementioned implies the need for using a multi-criteria decision analysis (MCDA) approach or at least using one or several multi-criteria methods throughout the decision-making process. Various researchers [4–10] have proposed different MCDA approaches based on the number of criteria and their type (qualitative or quantitative), but the most used methods are AHP [4,6,11–13], PROMETHEE [14–17], and their operational synergies [18], as well as approaches that manage stakeholders at the same time such as multi-actor multi-criteria analysis methodology, i.e., MAMCA [8,19], or decision support concept, i.e., DSC [20–23].

Therefore, this research aimed to create a framework for selecting an optimal spatial organization and construction technology, based on an MCDA approach, from a sustainable development perspective considering the spatial characteristics and specificities of Mediterranean areas. Based on the above, the hypothesis is stated as follows: "It is possible to determine how to approach the realization of construction intervention in a small Mediterranean town, based on the UN SDGs, using an evaluation and prioritization model." For this, some research questions were asked:

What are the sustainable development goals for Mediterranean area settlements? What spatial characteristics and sustainable development goals of Mediterranean settlements can impact or be impacted by the choice of intervention technology and organization? How can we choose the optimal construction intervention technology and organization based on sustainable development and the UN SDGs for Mediterranean settlement?

The model was verified in a case study of a spatial intervention in the historic center of Kastav, Croatia, a small municipality that embeds many of the typical characteristics of Mediterranean settlements (further described in more detail).

2. Spatial Characteristics of Mediterranean Areas

2.1. Characteristics of Mediterranean Areas That Differ in Spatial Planning with Respect to Northern Urban Areas of the European Union and North America

Settlements in the Mediterranean area present some common characteristics—diversity of cultural heritage, stratification, and some challenges [24]. In particular, various authors indicate some common characteristics of the Mediterranean area that differ from northern and western areas [25,26]. In particular, these include spatial, social, and institutional characteristics, as well as characteristics of built and natural areas.

Some authors relate to the gaps in institutions [27]. Institutional characteristics relate to a different type of governance and weak planning. Social characteristics (related to institutional) are weaker social and demographic aspects, as well as instability. Spatial characteristics are particularly related to the presence of natural and cultural heritage, ecological fragility, as well as to processes of peri-urbanization [26] or "rurban" zones [28].

Today, the development of Mediterranean areas is seen as being different from those of northern and western areas (such as Northern Europe and the USA), where the development processes cannot be explained and analyzed with the same urban and regional development models as in northern countries [26,27,29,30].

The Mediterranean regions today are described as networks with a series of nodes, where the polycentric models are becoming more prevalent with the less defined areas of urban and peri-urban land, fringe areas, or territorial fractures [26,30–32]. Mediterranean cities often create a network of smaller cities within their peri-urban territory, which is economically more significant than the bigger city, resulting in the possibility of experiencing two typical effects due to the vicinity of bigger cities (aggregation effect and shadow effect) [27]. According to [33], modern planning often considers cities as "winners" and "losers" and this perspective is even reflected in some official documents on the development of the Mediterranean area that have strong northern-centric positions that view the Mediterranean as a periphery.

Although a positive trait of modern tradition is the protection of city centers, since the Athens Charter [34], the modern tradition of planning [35,36] introduces morphologies and functions different from Mediterranean traditions (with a rare exception of Plečnik's Ljubljana plan from 1912) [29,37,38]. The introduction of new forms creates a fracture with the traditional spatial organization in spatial and mental terms and introduces frequent demolitions of existing spaces and their reconstruction in modernist ideas [37].

In fact, ref. [1] considers the "space" as a physical and mental category typical of the postmodern category or interest, in contrast to modernism which avoids concepts of contextualization or regionalism, although some authors indicate the attempt to combine modernistic and postmodern approaches [39].

Although modernism was greatly inspired by the Mediterranean urban structure and expressed its importance by choosing Mediterranean cities as the site of CIAM (Athens, Marseilles, and Dubrovnik), praising its dense structure (with simple forms of single buildings [33]), it did not appropriate the human scale of the Mediterranean environments, where walking and slow movement are the bases of spatial experience, reflection, and communication [40]. In fact, the Mediterranean area presents complex spaces where the modernist simplistic zoning approach does not give very positive results [33]. It is probably due to the apparent simplicity of modernist planning that alternate planning systems or combinations [41] are generally not used. A generative planning process based on traditional and contemporary principles and legislation could be a better alternative for the planning of historic settlements [42], especially in Mediterranean urban areas that have a long tradition of adaptive spatial interventions [43].

It is important to notice that in the traditional approach to interventions in Mediterranean areas, the definition of roles and obligations, as well as control and management, was the basic and continuous part of the planning system [42]. The same goes for semi-dense continuous settlements [44] and the protection of natural environments.

The evolution of cities from a sustainable development perspective requires models, decision aid processes, and tools for investments [45], especially in the presence of high Cultural Built Heritage (CBH) [46–48] and its importance in the landscape [49]; however, this crisis, in particular, created pressures for investments [50] which can be seen in the fast adaptation of Mediterranean cities to a sharing economy [51]. In fact, since the 1970s, the understanding is that decision-makers and the economy produce "land as a commodity" [51], and understanding the role of various stakeholders in relation to different sustainability goals is important [47,52].

2.2. Environment Built in Mediterranean Areas

In Mediterranean areas, rural areas are often transformed into urban and peri-urban areas, with a subsequent diminishing in natural resources. Illegal construction and erection of buildings are also characteristic of Mediterranean areas. In fact, some Mediterranean countries have a characteristic process of "legalization" of illegal constructions [53,54]. The peri-urban areas and fringe areas develop with the creation of sprawl and fractures, related to the fall of planning, and illegal construction but also the introduction to foreign modern planning models and Americanization of lifestyle [29].

The industry is transferred outside of the city. Mediterranean cities are characterized by "urbanization without industrialization" [53] and also the fact that phases of urbanization and industrialization are not often connected [27]. As a result, the spatial development of smaller and bigger Mediterranean cities can be very different [55].

The bigger cities have a problem with the population leaving the cities and the sprawl generated from the cities. This creates a problem that sprawl from bigger urban areas creates pressure on the smaller historic cities in the vicinity, such as in the case study situation. Sprawl is determined by inefficient land, infrastructure, and energy use, as well as low productivity [53] of labor. Investments and competition for investments have a low and negative impact on land use and the overall economy, in opposition to northern urban zones and models. Peri-urban areas also experience development due to the transfer of activities from centers to peri-urban areas and migration [53].

Another characteristic is the scattered development seen in peri-urban zones. Scattered peri-urban areas host most production, generally of smaller scale, and touristic activities, occupying important touristic areas, often separated from historic centers. User-oriented services are located in the centers, while the biggest and wealthiest activities, such as the financial and IT sectors, search for more economic land and tend to occupy peripheric positions [32]; this is then followed by an increase in roads and a decrease in green areas [56].

Due to changes related to development, Mediterranean areas face demographic, structural, and environmental challenges [57]. Up to the 1990s, Mediterranean areas had seen a population increase, followed by population stability or decrease. At the same time, it is often socially characterized by economic, social, and sometimes religious instability [26,30]. Some areas also face big challenges such as policy, security, economic, social, and environmental questions, as well as cultural and human rights [58].

The informal economy, low work costs, and over-use of resources are some of the characteristics of Mediterranean areas which are problematic because they hinder the development of a strong middle class [26,27,33].

The scattered pattern of settlements creates less energy-efficient interventions than the compactness of traditional cities. Even the Urban Heating Island effect in historic centers has more positive effects than in scattered areas. In winter, it helps with the heating of buildings and is mitigated in summer by smaller sun exposure surfaces [54].

Mediterranean areas are zones of ecological crisis, especially in rural areas. Scattered urban and peri-urban development creates great pressures on rural and natural land [53] (and the seaside, as in the case of many Mediterranean cities). Mediterranean cities show a decrease in biocapacity and an increase in ecological footprint [59]. In fact, [60] the UN 2030 Agenda highlights the importance of activities for the achievement of climate change resilience, resource sustainability, pollution and waste reduction, protection of biodiversity, ecosystems, and collaboration of Mediterranean countries. An analysis of the management plans of UNESCO-protected heritage sites (Venice, Krf, and Dubrovnik) shows, that there are some main challenges in common to the Mediterranean areas—intensive tourism, transportation, and gentrification (museification) [24].

2.3. Historic Urban Landscape (HUL) and Resilience

A long history, often pluri-millennial, of Mediterranean areas and their urban and rural development is greatly based on stratification and adaptation to climate [41], and tends to produce similar historic centers characteristic for all of the Mediterranean area.

The CBH is seen as particularly important due to tourism and local identity. On the other hand, tourism uses cultural and natural heritage [61], often with little investment in them, which creates great pressures on heritage [57] both in terms of use and adaptation, over-using spatial resources, and creating gentrification with the increase in real estate prices [62,63]. There is also the danger of adjusting the heritage to a touristic narrative [64]. The contemporary vision of development and new technologies also create expectations that CBH can be adapted easily [50,61] or that it cannot be included in spatial development. This is a problem because CBH cannot be replicated (because it was created based on different life [65] and technological conditions) and is a common heritage [47,66] that greatly considers the future [67], and, therefore, its Complex Social Value [68] is important, as well as its value as a social, cultural and economic resource.

The preservation of CBH can help with the creation of new jobs rooted in the local community, and the characteristics of CBH with aspects of common or even public good, independent of the property rights, shifts the focus from the physical aspects of CBH to the social aspects [69,70].

The loss of heritage can be traumatic for the local and international population [71] and lead to a loss of spatial identity [56]. This is particularly important as the extant historic areas tend to be in poor physical condition and have lower urban functionality [72].

Sustainability and resilience are important for the continuation of the human environment and human society. As robustness and redundancy are among the characteristics that allow for resilience, small historic centers are especially vulnerable to various pressures. As the spheres of resilience (infrastructure, institutions, economy, and society [73]) are all very fragile in Mediterranean cities, they require great attention in every intervention. The Mediterranean built environment, which is greatly different from modern spatial organizations, cannot be easily repeated and requires care during planning and interventions. In spatial terms, the scattering development greatly hinders resilience [32].

The Historic Urban Landscape (HUL) [69] approach, which continues active heritage preservation with considered heritage elements in a wider spatial perspective [72], is helped by decision-aid tools based on sustainable development goals and can increase rationality and transparency, especially in a complex spatial context, in areas with a stratification of heritage presence [74]. This process can be aided by multicriteria evaluations that reflect the multiplicity of values and goals [47,75].

Punctual project definition without proper attention to the effects the intervention can have during and after the construction phase is still the most common approach to intervention organization and technology choice. In the HUL environment, it can have even more impact due to the characteristics of CBH and the still prevalent bounding approach [75]. It is not possible to make interventions in HUL without taking into consideration the multiplicity of aspects of heritage and the possible impact the interventions, their organization, and choice of technology can have on the HUL characteristics.

In particular, ref. [69] indicates the importance of new tools for the sustainability of heritage transformation, as well as management, assessment, and participation, and highlights the planning element in heritage management. Furthermore, ref. [76] stresses the inadequate management plans as one of the major challenges of HUL management, as well as the need to include the local level. In a similar vein, some authors indicate the importance of documenting and analyzing the city based on historical facts and cartographic documentation, also in relation to its regional specificities and roles [77].

Small Mediterranean settlements often have different HUL categories [69], from monumental buildings to open urban spaces and infrastructure, that can be threatened, among other factors, by climate change. Especially characteristic are public spaces which are related to public life and freedom [78]. It is, therefore, strange that sustainability is mostly researched in economic aspects and less in environmental and social aspects [79]. Different elements of public infrastructure can impact the possibility and ease of use for persons with disabilities and mobility issues [80] and hinder their benefits from HUL [81].

On the other hand, studies of the HUL approach in different countries show that the weak links are public participation and lack of definition of the responsibilities for urban heritage management (lack of specific administration roles), and still tends to be mostly implemented and studied in Europe and China [82].

2.4. Urban Structure in Historic Centers in Mediterranean Areas

The climate impacted the traditional urban structure of Mediterranean settlements in great measure. One research example [29] shows that out of the distinctive Mediterranean characteristics, “urban structure” was the most defining element of the Mediterranean towns, followed by cultural identity and landscape, while social behavior resulted in the least common element. It was also found that of all the characterizing factors, the most endangered was the urban structure, which is worrying as it is also the element that produces the complexity of activities and relationships characteristic of Mediterranean towns. Especially important were events and food, while the importance of architecture depended on its quality.

Among spaces relevant to social life, public open spaces have a particular role, both as main squares and smaller spaces, based on pedestrian movement, detail, and the permeation of public and private spaces relevant to creating local identity [40,83]. Interestingly, historic towns in the Adriatic area often had more than 25% of their area designated to open public spaces together with different religious buildings [65].

In fact, although the character of Mediterranean towns is considered to be spontaneously created during history, and therefore somehow taken for granted, it is actually a result of a complex process of emergence based on a long history of codes, some of which (at least in written form) date back to Byzantine codes that dictated not plans but rules of spatial organization and processes and extended in all Mediterranean areas, even up to northern France [43]. Some of the main aspects are attention to avoiding damage to the extant, the definition of responsibilities, and the transition between private and public spaces. The regulatory aspect is also noticeable in Adriatic towns.

There are some characteristics related to "urban structure", i.e., densely built condensed core (important for climate [84]), high buildings, narrow, usually labyrinth-like streets or a regular roman plan, with a small (but important) square and church (or other place of worship), with small but important green elements [29,40,85]. Some of the main characteristics of the urban structure are listed in Table 1.

Many Mediterranean towns experience great growth in population and tourism and sequent changes in social and spatial structure which makes it an important and difficult task to preserve the characteristics of these cities.

Table 1. Characteristics of urban structure in a Mediterranean area.

Spatial-Technical Aspect	Characteristic	Authors
	Compact	
Urban form	Narrow streets	[85]
	Galleries	
	Urban structure	
	Surrounding landscape	
	Public open spaces	
	Complexity due to stratification and adaptation to land	
	Adaptation to climate	
	Passages	[41]
	Lights and shadows	
	Dilatations and contractions	
	Urban rhythms	
	Forms of representation	[40]
	Stratification	
	Movement	
	Minimum damage	[43]
	Spaces of transition between private and public	
	Patio	
	Less surface	
	Screens	
	Vegetation	
Building form	Grids	[85]
	Small openings	
	Evaporative cooling	
	Water elements	
	Light color	
	Architecture	[29]
	Visuals	[43]
	Economic activities	
Intangible	Food	
	Events	
	Behavior	
	Informality	
	Communities	[40]
	Sensuous geography	

3. Materials and Methods

In order to address how the existing body of knowledge in civil engineering and urban planning has developed in the direction of building interventions, especially spatial organization and construction technology selection, a systematic analysis of the UN SDGs and systematic literature review were conducted in this study as well as direct correspondence and collaboration with experts. The conducted research (Figure 1) was performed in two essential stages, (i) the definition of criteria regarding the UN SDGs for the SOnCT model and (ii) the SOnCT model, closely followed by the discussion.

A systematic literature review was conducted for the purpose of defining the spatial and technological aspects of sustainable development goals with an emphasis on the analysis of sustainability spheres and the characteristics of Mediterranean areas and towns. The aforementioned resulted in the definition of very precise criteria for evaluation and prioritization of spatial organization and construction technology based on the UN SDGs that are defined in the hierarchical goal structure for the herein proposed SOnCT model (see Figure 2). The framework for selection of optimal spatial organization and construction technology from a sustainable development perspective (SOnCT model) consists of several steps, as shown in Figure 1, and follows 1, literature analysis, 2. analysis of the UN SDGs, 3. consultation with local experts in spatial planning and spatial management, 4. definition of criteria needed for an evaluation and prioritization model, 5. definition of organization and technology alternatives for the proposed spatial intervention, 6. creation of the evaluation and prioritization model, and 7. verification of the model compared to the proposed alternatives. The core of the proposed model is a multi-criteria decision analysis (MCDA) where different MCDA methods can be used to achieve the optimal solution to the problem.

Since the previously defined criteria can be both qualitative and/or quantitative, the SOnCT model uses the strengths of the PROMETHEE methods for steps six and seven. For this analysis, the VisualPROMETHEE software [86] was used which can give the results of the final ranking in both PROMETHEE II and PROMETHEE Diamond output. The major strength of PROMETHEE is that the method can cope with a large number of criteria, and their clusters, at the same time as well as clear insight into the final results by the decision-maker. On the other hand, the major weakness is the lack of the possibility to develop a hierarchical goal structure, and a need for an experienced decision analyst during phases one and two (Figure 2).

The literature analysis showed some major topics related to Mediterranean areas—from characteristics of historic urban structure to issues related to more recent development (such as scattering) to economic; especially touristic and social topics.

The analysis of the UN SDGs was done by filtering the goals that could be directly translated into criteria. Verifying the coverage of the issues related to the development of Mediterranean areas, it was seen as necessary to introduce an intermediate step—consultation with spatial planning experts that could define criteria related to the UN SDGs that reflected the Mediterranean area issues from the literature review and local conditions (Tables 2 and 3). This produced additional criteria that could easily be considered as a development of some of the UN SDG goals (mostly Goal 11 but not only).

The expert in spatial planning and sustainable development also defined the main sustainability spheres and criteria that were later used for the verification of the minimum sustainability of alternatives in Phase 1 of the SOnCT evaluation and prioritization model.

Three organizational and technological alternatives of spatial intervention were defined and values for each criterion were assigned by construction organization and technology experts in consultation with experts in construction management and spatial planning. Those three alternatives were then evaluated, according to defined criteria, in Phase 2 of the SOnCT evaluation and prioritization model.

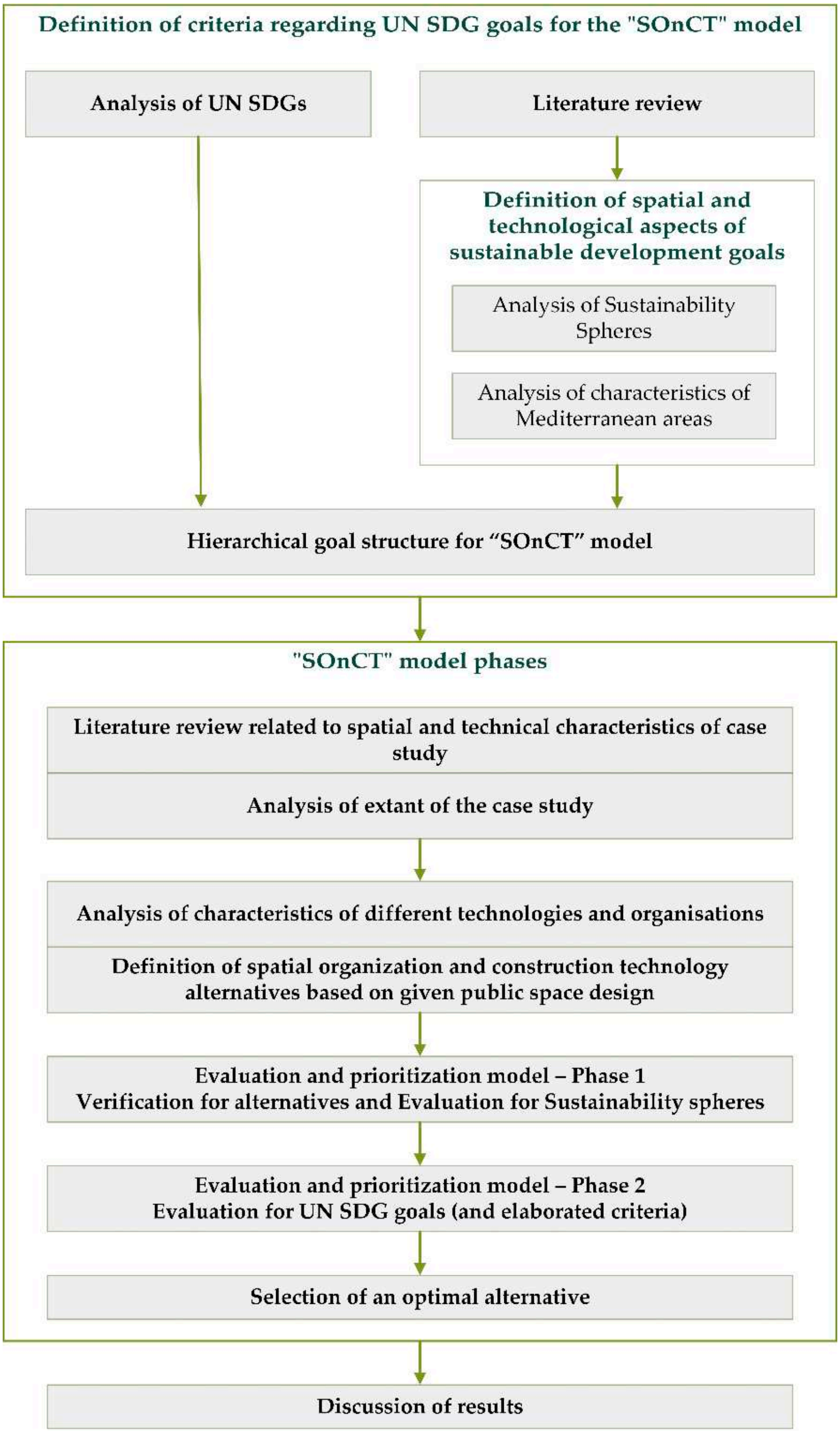

Figure 1. Research phases diagram.

Table 2. Main categories of impacts related to spheres of sustainability.

Sphere of Sustainability	No.	Spatial-Technological Criteria	Related SDG	Function Direction
Ecological	1	Technology that pollutes soil, water, and air (as gasses and articles or ionic and non-ionic radiation)	2, 3, 6, 11, 14	MIN
	2	Allows for recycling and purification	6, 11, 12	MAX
	3	Organization and technology that require additional spaces in natural areas (for example outside of built areas)	11, 12, 15	MIN
	4	Use of sustainable energy	7, 11	MAX
Economic	5	Problems with optimization of resource use	7, 11, 12, 14, 17	MIN
	6	Price/efficiency and efficacy	8, 11, 17	MAX
	7	Education during use	1, 4, 7	MAX
	8	Need for new infrastructure (such as roads and other infrastructure)	11, 15	MIN
Social	9	Activities and technologies that produce noise	3, 11	MIN
	10	Activities and technologies that disturb social space	3, 11	MIN
	11	Activities that disturb the communication of the local community	3, 11	MIN
	12	Interruption of the continuation of everyday life and social activities	3, 11	MIN
	13	Interruption of the continuation of economic activities	3, 8, 10, 11, 13	MIN
Cultural	14	Activities and technologies that impact material cultural heritage	11	MIN
	15	Activities and technologies that impact immaterial cultural heritage	11	MIN

Compiled by planning experts (based on four spheres of sustainable development) and used for the 1st phase of the evaluation and prioritization model.

Table 3. Analysis of possible impacts on the spatial organization and construction technology related to the characteristics of small Mediterranean towns.

Mediterranean Settlement Set of Characteristics	Spatial-Technological Criteria	Related SDG
Urban structure—narrow, chaotic	Possibility of use of small irregular streets and other public spaces, especially without stopping regular physical communication	11
	Activities that fit the best into a local seasonal pattern	11
	Activities that do not impact the height of ground floor passages or impact them minimally (with verification for safety)	3, 11
Concentrated dense structure	Traffic organization that allows covering all needs and safety	2, 9, 11
	Traffic organization that does not require additional areas outside built areas	2, 9, 11
	Activities that do not produce further peri-urbanization and scattering of urban areas	11, 15
	Activities that do not impact the existing material presence	11
Functional mix	Activities that do not disturb different functions—communication, pauses, discussion, access, and infrastructure function (water, sewage, other infrastructure), especially private	3, 6, 11
Small green areas	Activities that allow the maintenance and use of existing green	3, 11, 16
Relationship with sea	Activities that allow uninterrupted activities at the seaside and sea	1, 9, 11, 14
	Activities without pollution	1, 9, 11, 14
Traditional buildings	Activities that do not produce vibrations	11
	Activities that do not produce noise	11
	Activities that do not produce an impact on the construction of existing buildings	11
	Activities that do not produce dust and pollution	11
	Activities that do not impact characteristics of historic construction—small loadbearing capacity, vibration sensitivity, humidity	9, 11
Tourism	Allow for the continuation of activities	1, 11
Climate	Activities and technologies that do not cause higher temperatures and glow	11, 13
	Activities and technologies that do not cause stronger wind or that mitigate wind	11, 13
	Activities that mitigate climate, especially in traditional ways	11, 13

In the end, the research process and results are discussed and compared to similarly developed decision-aid tools that showed betterment in different urban areas and/or different management aspects in the same areas.

At the core of the proposed model is an opportunity to provide the decision-maker a tool to identify, evaluate, and analyze different alternatives before the decision and their implementation in real life. In our case, these alternatives are different construction technologies that need to be employed in order to support the construction process in Mediterranean areas and towns. Therefore, the main goal is defined as "selecting the optimal spatial organization and construction technology from a sustainable development perspective". Such a goal is defined by a group of experts, as previously mentioned, and results from a systematic literature review and their expert view. The created hierarchical goal structure (Figure 2) consists of the main goal and 17 objectives, i.e., sub-goals defined as the UN SDGs and the following criteria (also see Table 4).

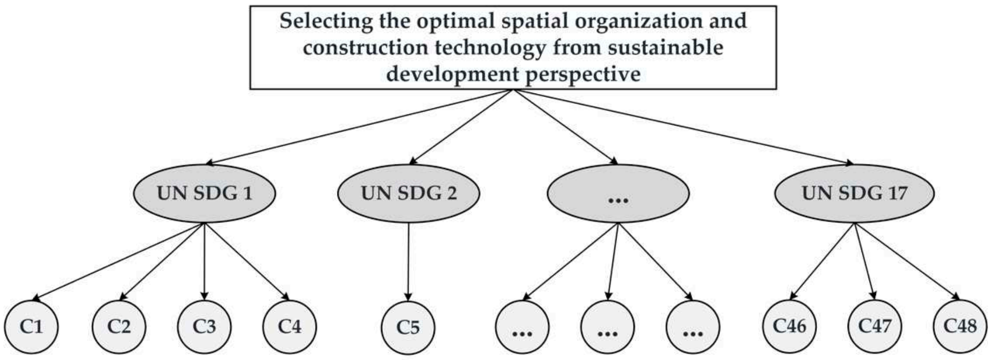

Figure 2. Hierarchical goal structure for the SOnCT model.

Table 4. Criteria for the evaluation and prioritization of different spatial organization and construction technology based on the UN SDGs and elaboration based on expert input.

SDG	Potential Criteria	Function Direction
Goal 1. End poverty in all its forms everywhere	C1—Choice of organization and technology that guarantees access to basic services	MAX
	C2—Organization/technology oriented to diminish the risk to persons, unities, health, heritage, socioeconomic assets, and ecosystems	MAX
	C3—Organization/technology takes measures that prevent and reduce hazard exposure and vulnerability to disaster, increasing preparedness for response and recovery	MAX
	C4—Opening of new jobs/labor intensity	MAX
Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	C5—Interventions/technologies that do not impact agricultural areas	MAX
Goal 3. Ensure healthy lives and promote well-being for all at all ages	C6—Technologies and organizations that do not create the risk of injury and death for persons working and/or passing nearby	MAX
	C7—Traffic organization that allows covering all needs and safety	MAX
	C8—Technologies that do not pollute the air (as gasses and articles or ionic and non-ionic radiation), water, or soil, or that improve their quality	MAX
	C9—Technologies that produce dust	MIN

Table 4. *Cont.*

SDG	Potential Criteria	Function Direction
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	C10—Opportunity for education and training using contemporary equipment, as well as historic construction and environmental protection-oriented techniques	MAX
	C11—Collaboration with educational institutions and specialized institutions with the goal of learning new skills	MAX
Goal 5. Achieve gender equality and empower all women and girls	C12—Use of technologies that allow for equal work for everyone	MAX
Goal 6. Ensure availability and sustainable management of water and sanitation for all	C13—Technologies that purify and recycle water	MAX
Goal 7. Ensure access to affordable, reliable, sustainable, and modern energy for all	C14—Use of energy-efficient technologies and organization	MAX
	C15—Technologies based on contemporary and advanced sustainable resources of energy	MAX
Goal 8. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all	C16—Innovative technologies that achieve higher productivity	MAX
	C17—Technologies that increase the quality of jobs	MAX
	C18—Technologies that increase work safety	MAX
	C19—Technologies that are accessible to micro, small, and medium enterprises	MAX
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation	C20—Technologies and materials with low CO2 emission per unit of value added	MAX
	C21—Technologies that result from domestic technology development, research, and innovation in developing countries	MAX
Goal 10. Reduce inequality within and among countries		
Goal 11. Make cities and human settlements inclusive, safe, resilient, and sustainable	C22—Organization and technologies that do not negatively impact transportation and accessibility (especially for vulnerable groups)	MAX
	C23—Implementation of procedures for inclusive and sustainable urbanization	MAX
	C24—Technologies that allow sustainable waste management	MAX
	C25—Technologies and organizations that do not negatively impact cultural and natural heritage	MAX
Activities and technologies without impact on material cultural heritage	C26—Possibility of use of small irregular streets and other public spaces, especially without stopping regular physical communication and use of infrastructure	MAX
	C27—Activities that allow the maintenance and use of existing green spaces	MAX
	C28—Activities that produce vibrations	MIN
	C29—Activities that produce noise	MIN
	C30—Activities that produce an impact on the construction of existing buildings	MIN
	C31—Activities that do not impact the existing material presence	MAX
	C32—Activities that mitigate climate, especially in traditional ways	MAX
	C33—Activities that produce further peri-urbanization and scattering of urban areas	MIN

Table 4. *Cont.*

SDG	Potential Criteria	Function Direction
Activities and technologies without an impact on immaterial cultural heritage	C34—Activities that do not disturb social space and communication for the local community, allowing for the continuation of everyday life and social activities	MAX
	C35—Activities that fit the best into a local seasonal pattern	MAX
Goal 12. Ensure sustainable consumption and production patterns	C36—Technologies that use resources sustainably, especially energy and materials	MAX
	C37—Technologies that produce the least waste, allow the recycling and reuse of materials or energy	MAX
	C38—Public procurement that promotes sustainable development as a goal	MAX
	C39—Organization and technologies that require additional areas outside built areas	
Goal 13. Take urgent action to combat climate change and its impacts	C40—Technologies that diminish or mitigate climate change effects (temperature, glow, rain, wind, etc.)	MAX
Goal 14. Conserve and sustainably use the oceans, seas, and marine resources for sustainable development	C41—Technologies that reduce marine pollution	
	C42—Activities that allow uninterrupted activities at the seaside and at sea	MAX
Goal 15. Protect, restore, and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation, halting biodiversity loss	C43—Technologies that do not cause desertification, halt and reverse land degradation and halt biodiversity loss	MAX
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels	C44—Transparent public procurement methods in all phases—before, during, and after construction works	MAX
	C45—Opportunity for public participation in the choice of technology	MAX
Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	C46—Multi-stakeholder organization with knowledge and skills exchange, especially towards developing and developed countries	MAX
	C47—Price/efficiency and efficacy	MAX
	C48—Multi-partner organization from various sectors (private enterprises, education, etc.)	MAX

Such a clear goal hierarchy allows the decision-maker and other involved stakeholders to express their attitudes towards each criterion during the weighting phase and to have clear insight into the criteria during the evaluation of alternatives. Often a hierarchical goal structure (HGS) is an iterative process that ends when all stakeholders agree [9,23,87], but in this case, our experts provide one final HGS with all criteria weighted equally. Therefore, the proposed SOnCT model seeks single-stakeholder and equal criteria weights rather than multi-stakeholder and different criteria weights. The reason lies in the stated research questions of this approach and seems to return valid answers, while the multi-stakeholder approach, which previously showed promising results [7,19–22,88–92], would be beneficial in the future research and maturity buildup of the proposed model.

Based on the author's own experience with similar methodological approaches [9,20,21,23,87], but also on the research of other authors [7,19,20,22,88–90] for solving such multi-criteria problems, we propose using PROMETHEE methods [14–17,92]. Here, the PROMETHEE II method [14–16] is used to obtain a complete range of alternatives. Such is done within two phases by producing a rank list via PROMETHEE II, and therefore, checking and verifying the results via the PROMETHEE Network and PROMETHEE Diamond. For both phases, the VisualPROMETHEE software [86] is used.

4. Results

4.1. Sustainability Criteria

Although the concept of sustainability was first related only to the natural sphere, today it is accepted that there are many aspects to it and it is generally interpreted as being economical, ecological, and social and cultural. When choosing the activities and technologies for intervention in HUL, there are some general aspects to consider related to the spheres of sustainability. Table 2 shows the elaboration of the sustainability spheres criteria.

The UN SDGs are a part of the Resolution Transforming our world: the 2030 Agenda for Sustainable Development, adopted by the General Assembly of the United Nations on 25 September 2015 [3]. There are 17 goals, with each elaborated in several sub-goals. Mostly, they are defined for national and international levels, so their implementation at the local level requires (typically) some elaboration/interpretation to distill the potential meaning or criteria that can be checked on this level. Table 3 shows the analysis of sustainable development criteria based on the analysis of characteristics of Mediterranean settlements (based on data from the literature review).

From the analysis of the elaboration of sustainable development goals—directly from the UN SDGs and by elaborating criteria from characteristics of Mediterranean areas in accordance with SDGs, some criteria turn out to be most important for the choice of spatial organization and construction technology. These 48 criteria are shown in Table 4.

4.2. Kastav

The city of Kastav, in Primorsko-Goranska County, Croatia, is a part of the Adriatic basin, one of six areas of the Mediterranean region, defined by EC Europe 2000+. It was chosen for verification of the evaluation and prioritization model because it presents many characteristics of a “typical” Mediterranean settlement as well as their vulnerabilities: ancient Greek and Mediterranean triple function (sacred, public, and private) [30], typical dense urban structure, elements of small private urban green and other elements (stairs, benches, etc.) occupying “fina”, steep Karstic terrain (typical for South European Mediterranean areas), stratification of cultural and natural elements, presence of water elements (in this case antique cistern), city walls, tall masonry traditional buildings, fragile constructions and infrastructure, touristic presence, scattered newer development in proximity, and others.

Kastav is a small Mediterranean municipality that extends over an area of 11 km^2, with 10,265 inhabitants and 3841 households [93]. The first known mention of it was in 1351 [94] (in the major medieval town formation period [95]). The municipality is mostly renowned for its historic heritage, especially its historic urban core, many different smaller rural historic zones, a forest, and also an industrial zone northeast of the historic old center. The area has also population and economic growth and subsequent typical sprawl and scattering development character. The historic center has characteristic city walls, dense urban structure, and hosts a big archeological area of Crekvina.

Kastav borders the City of Rijeka, capital of the county, a portal and ex-industrial city that suffered a deindustrialization process that resulted in the loss of jobs and depopulation, with the sequent transfer of economic activities in its vicinity (such as in the city of Kastav), as was already mentioned as a typical Mediterranean process. On the south and west, it borders the city of Opatija, a major touristic center with more than a century of touristic tradition. In the north, there are important natural and hunting areas, as well as a border with the Republic of Slovenia. Some bigger cities such as Trieste, Ljubljana, and Zagreb, are distant, 50 to 140 km.

Although deindustrialization often had a smaller effect in Mediterranean countries compared to that in Northern European countries, some cities (industrial centers) are the exception. Such is the case of Rijeka, in which the surrounding city of Kastav is located, which has experienced great problems with the loss of industrial jobs and subsequent suburbanization and emigration from the city center towards the peri-urban areas and smaller cities in its vicinity. Similarly, as in examples of some other Mediterranean areas, bigger cities felt more of the effect from the recent crisis, placing smaller cities under strain from uncontrolled development.

The historic center of Kastav (Figure 3) is situated at approximately 330 m above sea level. It has three distinctive zones: southern, traversed by the main road that divides the northern area into two distinctive zones—western and eastern. The main elements of the historic center are shown in Figure 3.

The northwestern zone is located at the highest level and is characterized by the presence of the main square, Lokvina (with antique water cistern), St. Jelena church, dense urban structure with partially amphitheatrical organization [94], terraced terrain, and the presence of a small urban green and larger green area in the northern part of the zone. This zone is considered to be the most ancient. The main square was probably developed on a Karstic geoformation "vrtača" (doline) and is encompassed by the gothic church and structures of the former castle [96]. The northeastern zone is also located on steep terrain and has irregular urban structure but is most recognizable by the important archeological site of Crekvina at the northern entrance to the city (historic center). This zone has also an important presence of green areas. The southern part is characterized by steep terrain and a road that arrives at the city terrace, city loggia, irregular urban texture, and the first square that leads through the southern city entrance—a narrow arched passage, to the northern part of the center. This zone started to develop in the 16th century [94]. It offers exceptional views of the sea and surrounding mountains.

There are important natural areas surrounding the historic center and especially important forest and recreation areas in the north. Heritage is also characterized by natural elements ("vrtače"), terraces, important rock formations, dry stonewalls, and prehistoric archeological sites.

In the proximity of the historic center, there are scattered smaller settlements and also the cemetery, industrial, and commercial zones. Traffic and parking are problematic in the whole historic area but walking and accessibility are also difficult due to the characteristics of the terrain.

The historic center is enclosed by a system of city walls with remains of fortifications (which is among the most important fortification systems in Croatia [96]), which also makes it an example of a fortified city, important as an authentic historic connection [77]. The wall system is characterized today by the stratification of natural elements that, together with built elements, create an important visual and constructive unit, making the intervention of city walls very challenging.

The importance of defense is also visible in its spatial organization (a broken "Y" organization). The urban organization follows a typical medieval urban structure with the main road connecting the two main town entrances [96], but orthogonal roads are somehow less recognizable due to the adaptation to steep terrain. Characteristic features of the historic central area are water cisterns, stone benches along the facades, a system of stairs, "sottoportico", and steep pedestrian paths. The area of the historic center is 27,000 m^2, 46% are built areas, 30% are open public areas, and 24% are gardens and other green areas. The urban structure and its most defining elements seem to have been mostly unchanged at least since 1819 [94] and it is typical of European Mediterranean medieval towns [97]. The area of open public spaces, presence of small urban green, and urban equipment along the facades, are typical of Mediterranean and Adriatic urban structures, such as in [43,65].

The historic center and its surrounding area (with rural, archaeological, and natural heritage) are recognized for protection by the national heritage registry [94,96] and planning documentation [98,99].

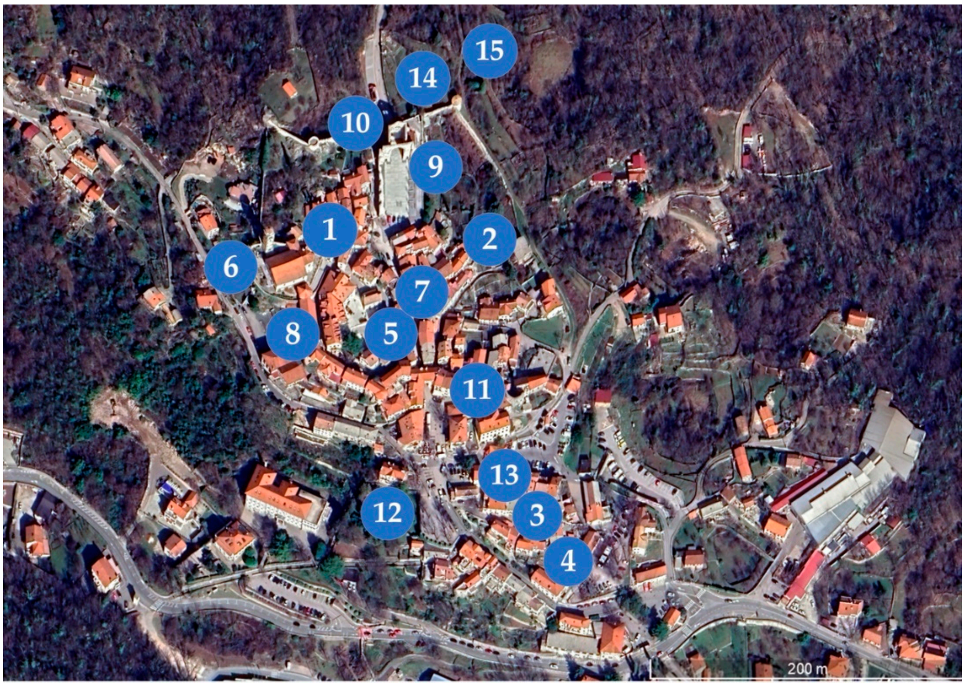

Figure 3. Kastav historic center: 1—Historic center northwestern zone, 2—Historic center northeastern zone, 3—Historic center southern zone, 4—main road, 5—Lokvina square with ancient water cistern, 6—St. Jelena Church, 7—St. Trinity Church, 8—Hotel, ex-castle, 9—archaeological site Crekvina, 10—Northern City entrance, 11—Southern City entrance with the arched passage, 12—City terrace, 13—City loggia, 14—City walls, and 15—a forest with recreational area and rural area (on Google Earth image).

The spatial intervention (main spatial elements are shown in Figure 4) considered the renewal of infrastructure and the main Lokvina square situated in the main part of the historic center. The square has the characteristic shape of a lunette defined by rows of buildings (city administration, hotel and restaurant, private residential buildings, and Church of St. Trinity) and a small green area. The buildings and the square have to be functional and accessible all year, and this is one of the important requirements for the choice of the spatial organization of construction works and construction technology. The arrival to the square is very difficult and includes the restricted passage through an arched passage of small dimensions. The terrain is steep and is higher towards the northwest. At the center of the terrain, there was a historical presence of the puddle (hence the name "Lokvina") that was later, in Ancient Roman times, transformed into a water cistern. This characteristic also posed challenges in terms of the organization and technology of construction works—mainly in terms of the weight and vibrations of construction works.

The proposed SOnCT model was tested in the case study of the Lokvina square reconstruction project. Taking into account all the aforementioned, to do any building interventions on the site one can approach either from the southern side (Figure 3 point 11) or the northern side (Figure 3 point 10). It is not possible to approach from any other way because of the height difference between fortified areas, inside city walls, and surrounding areas. Therefore, it is important to perform investigation activities on-site during the planning phases and create a precise spatial organization and technological plan for the reconstruction (Figure 5) before the start of the construction phase. The reconstruction works on Lokvina square required several different types of construction works, demolition, earthworks, concrete and formwork, and different installations.

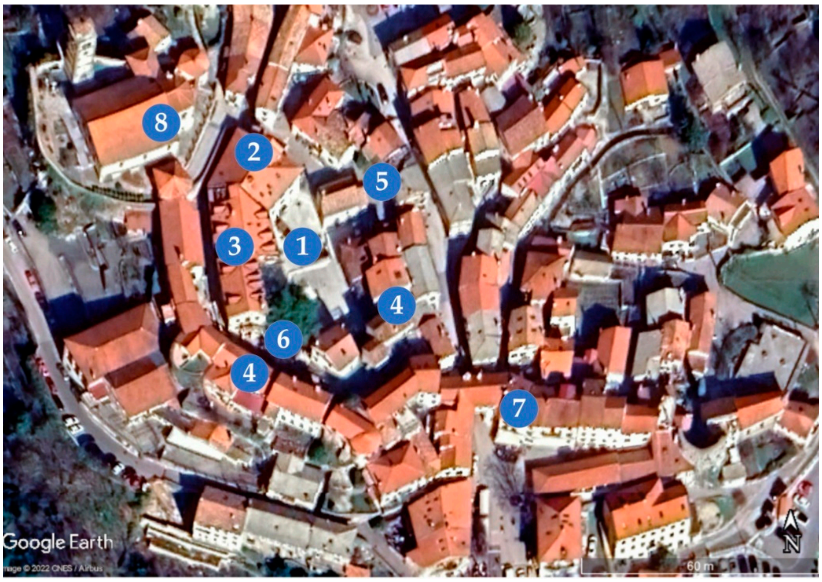

Figure 4. The central part of the intervention area: 1—Lokvina square with ancient water cistern, 2—City administration, 3—Hotel and restaurant, ex-castle, 4—private residential buildings, 5—St. Trinity Church, 6—green area, 7—Southern City entrance with the arched passage, and 8—St. Jelena church (on Google Earth image).

As there are only two possible points of entry into the historical center of the city of Kastav (Figure 5, marked with x) the initial plan was to compare four technologies in relation to the defined evaluation criteria that represent the different spatial organization and construction technology based on the UN SDGs. In relation to needed reconstruction works, analyzed technologies differ in the possibilities of only using manpower, using machine power, or using a combination. It is evident that, regardless of the entry location, the biggest difference between technologies is in the work activities related to transport to and from the construction site, namely, the surplus of materials from demolition works, excavated material and embankment material from earthworks, and concrete from concrete and formwork works. Therefore, these materials, i.e., their transport, can be organized in cycles (manpower and/or small vehicles) or continuously (belt conveyors and concrete pumps).

Therefore, the four analyzed spatial organization and construction technologies are set as follows: Technology_01 (south entrance, characterized by a large use of manpower in combination with small machines), Technology_02 (north entrance, characterized by the use of manpower in combination with small machines, belt conveyors, and concrete pumps), Technology_03 (north entrance, characterized by a large use of manpower in combination with small machines), and Technology_04 (south entrance, characterized by the use of manpower in combination with small machines, belt conveyors, and concrete pumps).

The yellow lines in Figure 5 represent transportation paths inside Kastav's historic center from both entrances. During the preliminary analysis of possible impacts of these technologies, according to Table 3, Technology_04 was dismissed due to the fact that it would occupy almost the whole square in front of the south city entrance that is packed with small business and commercial spaces. Additionally, it was concluded that the technologies from the north entrance seem to be much better, according to the Mediterranean settlement set of characteristics, than from the south, in spite of the fact that transportation to the disposal site is further away and transportation needs to proceed by a narrow macadam road through the forest. As the technologies 01 to 03 are shown in Figure 5, their detailed comparison according to defined criteria is shown in the following section.

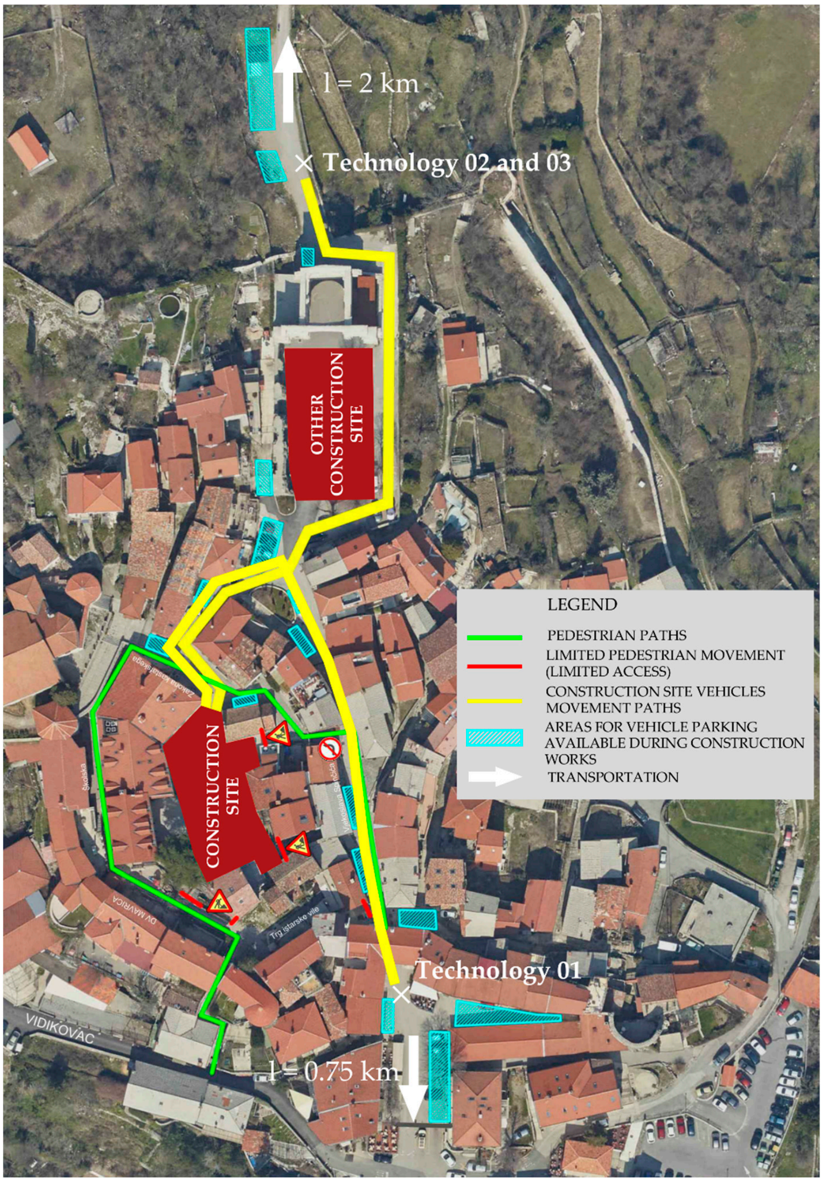

Figure 5. Organization scheme for building intervention in the historic center of the city of Kastav—topographic view of analyzed alternatives (modifications made based on [100]).

4.3. Results of the SOnCT Model Applied to the City of Kastav

A clear hierarchical goal structure and its weighting give the opportunity to proceed with the SOnCT model in order to evaluate and prioritize given alternatives. In this particular case, the decision-maker has a fixed HGS that gives them open hands in selecting experts that will help them to evaluate alternatives according to those sustainable criteria (Table 4). Of course, in cases of multi-stakeholder involvement, this step can also be based on their compromised point of view.

In the case of selecting the optimal spatial organization and construction technology from a sustainable development perspective on the building intervention in the city of Kastav, the same experts, as previously defined, were used to evaluate four potential alternatives. Their evaluation and preferences are visible in Appendix A (Figure A1) as the whole decision matrix is shown. It is important to highlight that for this HGS, the type of preference function applied to all criteria is the Usual one. This preference function is a very simple and appropriate one for criterion with a few very different evaluations. Such is often the case with qualitative criteria evaluated on a five-level qualitative scale. As criteria for the evaluation and prioritization of different spatial organization and construction technology based on the UN SDGs (Table 4) are defined by an expert as qualitative ones, this is the right preference function to use in the analysis.

Taking all of these into account, PROMETHEE II is used, and results in a complete ranking of all alternatives are presented in Figure 6a. The Phi net flow of each alternative is clearly visible, and it unambiguously shows which alternative is the optimal one. The strengths and weaknesses of each alternative, in relation to all defined criteria, are defined on a +1 (green) to −1 (red) scale. The alternative closest to +1 is perceived as the best one, while the option closest to −1 is perceived as the worst one. Knowing such, it is evident that the alternative "Technology_02" is the best one, i.e., optimal for this particular problem. The large span between the best and the worst alternative (+0.7609 and −0.5761) gives the data analyst insight and confidence that the criteria, in spite of their large number, are solid and correctly defined for this particular decision problem. In addition, the results from Figure 6a indicate that one of the analyzed technologies is a far better choice than the other.

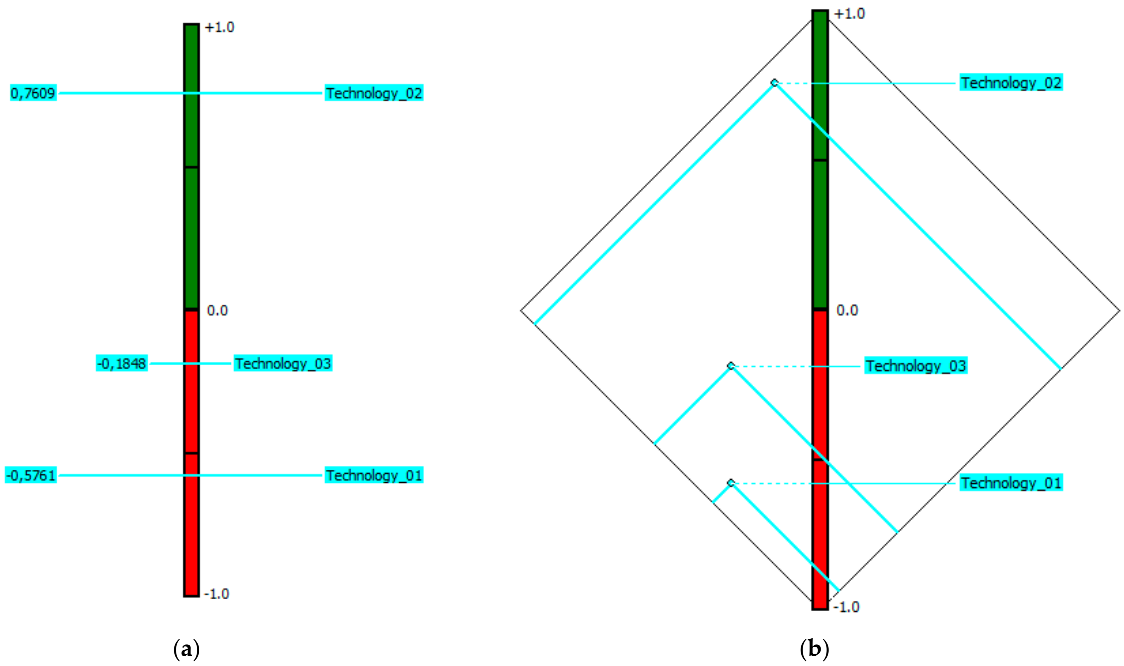

Figure 6. Results of multicriteria analysis from the SOnCT model by means of the VisualPROMETHEE software: (**a**) PROMETHEE II; (**b**) PROMETHEE Diamond.

To support such claims, it is also important to test and validate solutions from PROMETHEE II with other tools that VisualPROMETHEE offers. One such tool that can be used for validation is PROMETHEE Diamond and PROMETHEE Network. As each alternative in PROMETHEE Diamond is represented as a point in the Phi plane angled at 45° degrees in relation to the green-red Phi axis, it is evident that the Phi flow values correspond with the ones from PROMETHEE II (see Figure 6a,b). At the same time, the point of each alternative in the Phi plane is presented with Phi+ and Phi−, i.e., the results of the PROMETHEE Network and PROMETHEE I partial ranking. Therefore, the point of each alternative is a coordinate (Phi+, Phi−) that outlines a certain cone. Such is of utmost importance to data analysts and decision-makers as the alternative cones are overlapping or intersecting each other. If one alternative cone overlaps another, it means that the alternative is preferred over the other, while intersecting cones correspond to incomparable alternatives that seek further in detail analysis.

In the example of Figure 6b, it is evident that the cone of alternative "Technology_02" overlaps all the other alternatives and therefore it can be safe to conclude that this alternative is the optimal one.

5. Discussion

The research allows to answer the research questions and discuss the results.

The sustainable development goals for the Mediterranean area can be partially filtered directly from the UN SDGs (for example, those related to water pollution, which can be interpreted as organization or technology pollution water, etc.), but other of the UN SDGs do not allow for such direct translation into criteria. This is so because the UN SDGs are defined mostly regarding national and international policies and tend to lack local aspects and, even more importantly, spatial and technical aspects. Therefore, the UN SDGs had to be elaborated with spatial and technical aspects in mind, considering issues for Mediterranean area settlements. This aspect is an interesting gap in existing theory and practice and shows both the lack of spatial and technical aspects in policies and opens new perspectives for further research.

Although the acknowledgment of the importance of urban structure can be traced at least back to (Sitte [101], The Athens Charter Athens [34], UNESCO Convention [102], and some ICOMOS charters [83]) many sources dealing with the characteristics of Mediterranean urban and landscape environment, it strangely clashes with modern architectural theory [103], and even charters based on it (such as the Venice charter [104]) draw attention towards existing landscape and stratified heritage, a surprisingly contemporary issue.

The spatial characteristics and sustainable development goals of Mediterranean settlements that can impact or be impacted by the choice of intervention technology and spatial organization are different for bigger and smaller Mediterranean cities. Smaller Mediterranean city areas tend to have very different characteristics and models of development from northern cities and are very vulnerable to modification of the urban structure. The research on the Mediterranean spatial characteristics first regarded all Mediterranean areas, while more recently, it was found that South European areas had distinct development patterns due to lower population growth and other characteristics. It is not possible to separate the spatial characteristics of Mediterranean areas from their other characteristics such as economy, way of living, urban and economic dynamics, and so on, but there are still some characteristics that can be highlighted such as:

For historic centers: dense irregular urban structure, high traditional buildings, attention to privacy and views, presence of “fina” (even in areas where it does not have a particular name, such as in northern Adriatic), “sottoportico”, small green areas, stratification of cultural and natural heritage but also immaterial culture, way of living, socialization, urban and social dynamics, local economy, and activities related to tourism. For the rest of the territory, contemporary development is characterized by scattering and sprawl and the high use of natural resources. The development of smaller and bigger towns influences each other, creating pressure on smaller cities and the Mediterranean landscape with their already existing vulnerabilities to all types of spatial interventions, from spatial planning, building, and infrastructure design to construction works.

Therefore, the sustainable development goals for Mediterranean area settlements regard all sustainable development goals that can be directly traced from the UN SDGs without spatial and local components but have to take into consideration all the characteristics regarding local typical local characteristics—preservation of stratified heritage (urban, material, and immaterial) and the diminishing use of resources such as natural and rural terrain (for example because of scattering and sprawl) as well.

The optimal spatial organization and construction technology for needed construction works (based on the given design), can be done by creating and using an evaluation and prioritization model that takes into account the UN SDGs elaborated through sustainable development criteria based both directly on the elaboration of the UN SDGs and elaborating the UN SDGs through main sustainability spheres criteria and spatial and technological characteristics of Mediterranean areas.

The results for the SOnCT model showed that defined criteria in HGS (Figure 2 and Table 4) are correctly defined for a particular decision problem of a building intervention in the historic center of small Mediterranean towns. Such corresponds with prior multi-criteria research into Mediterranean towns, such as [21], but also gives more in detail insight into sustainability, spatial characteristics of Mediterranean towns, and the UN SDGs. The model shows that the best choice of technology is the one that offers not just the sustainable one in the long run [105] but also the sustainable one during the building intervention.

The theoretical part of the paper showed that there is a need to understand that the spatial and technical characteristics of small Mediterranean settlements are those aspects not already defined in the UN SDGs. To define a framework for selecting an optimal spatial organization and construction technology from a sustainable development perspective in this characteristic urban environment (present in a very wide territory), there is a necessity to take into consideration the spatial characteristics of small Mediterranean settlements (for example, dense urban structure, seasonality, social and cultural sustainability, etc.)

The model can be primarily used for small Mediterranean settlements, but also for every other town/or a part of the town, with similar urban characteristics which have to be verified by spatial planning experts. This aspect—a need for expert opinion, might also be considered as a limit of the framework, as well as dependency on the decision-maker to use such a model.

Additionally, the proposed model shows that it is appropriate to use the MCDA approach and adequate methods, especially the logic of the decision support concept, to select the optimal spatial organization and construction technology from a sustainable development perspective: One of the key aspects is a possibility of involving stakeholders into the creation of hierarchical goal study. This particular model gives fixed HGS based on Mediterranean area experts' points of view that is in relation to other approaches [8,19–23] but fails to include additional experts if needed; this is possible to add as the model is opened. In addition, it is important to note that, due to a large number of criteria, it is not possible to use AHP for alternatives comparison and selecting the optimal solution. Therefore, the PROMETHEE method is a much better method to use as it has no problems with comparing alternatives among a large number of criteria as long as they are hierarchically structured.

6. Conclusions

It is possible to determine how to approach the realization of construction intervention in a small Mediterranean town, based on the UN SDG, using the evaluation and prioritization model for the choice of good (Phase 1) and the best alternative (Phase 2) for the spatial organization and construction technology for a given design.

To do this, it is necessary to implement the spatial aspects characteristic of Mediterranean areas typical of small Mediterranean historic centers and their surrounding areas into the definition of the sustainable development criteria based on the UN SDGs as they do not consider spatial and technical characteristics. This is possible through the analysis of those characteristics, as well as characteristics of the development of those areas, and with consultations with local spatial planning and technology experts.

It is, therefore, possible to create an evaluation and prioritization model that allows for the optimal choice of spatial organization and construction technology in consideration of the goals of sustainable development as well as local spatial characteristics (that include physical configuration, but also built and natural heritage, immaterial heritage, way of living, economic activities, and their temporal fluctuation).

It was also found that even if today there is a growing awareness of the importance of the quality of spatial environment (such as in HUL), the general approach is still impacted by some of the international documents (such as the Venice charter) and modernist approach to cultural heritage that created a gap in our understanding of heritage, making it a distinctly post-modern contemporary topic.

As for the possibility to introduce models as here proposed in procedures of public procurements, it is also necessary to note that some countries introduced Green Public procurement, Public Procurement of Innovative solutions, or Pre-Commercial Procurement according to the EU Commission's suggestion [106,107], making the similar introduction of the UN SDGs also a potential possibility.

Author Contributions: Conceptualization, I.M. (Ivan Marović), I.M. (Iva Mrak), D.A. and J.K.; methodology, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; software, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; validation, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; formal analysis, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; investigation, I.M. (Ivan Marović), I.M. (Iva Mrak), D.A. and J.K.; resources, I.M. (Ivan Marović), I.M. (Iva Mrak), D.A. and J.K.; data curation, I.M. (Ivan Marović), I.M. (Iva Mrak), D.A. and J.K.; writing—original draft preparation, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; writing—review and editing, I.M. (Ivan Marović), I.M. (Iva Mrak), D.A. and J.K.; visualization, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; supervision, I.M. (Ivan Marović) and I.M. (Iva Mrak); project administration, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A.; funding acquisition, I.M. (Ivan Marović), I.M. (Iva Mrak) and D.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are available on request due to restrictions, e.g., privacy or ethics. The data presented in this study are available on request from the corresponding author. The data are not publicly available due to further research being published.

Acknowledgments: This research has been fully supported by the University of Rijeka under the project number uniri-pr-tehnic-19-18 (dsc4sum.gradri.uniri.hr).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Scenario1	criterion1	criterion2	criterion3	criterion4	criterion5	criterion6	criterion7	criterion8	criterion9	criterion10	criterion11	criterion12	criterion13	criterion14	criterion15	criterion16
Unit	5-point	impact	impact	y/n	impact	5-point	5-point	5-point	unit	5-point	unit	5-point	unit	5-point	5-point	5-point
Cluster/Group																
Preferences																
Min/Max	max	min	min	max	min	max	max	max	min	max	max	max	max	max	max	max
Weight	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics																
Minimum	3,00	1,00	2,00	1,00	1,00	2,00	3,00	3,00	0,00	3,00	1,00	2,00	0,00	2,00	2,00	1,00
Maximum	4,00	3,00	4,00	1,00	3,00	4,00	5,00	4,00	1,00	4,00	1,00	5,00	1,00	4,00	3,00	5,00
Average	3,33	2,00	3,00	1,00	2,00	2,67	4,00	3,33	0,67	3,67	1,00	3,67	0,33	3,00	2,33	3,00
Standard Dev.	0,47	0,82	0,82	0,00	0,82	0,94	0,82	0,47	0,47	0,47	0,00	1,25	0,47	0,82	0,47	1,63
Evaluations																
Technology_01	average	moderate	high	yes	very low	bad	average	average	yes	average	yes	bad	no	bad	bad	very bad
Technology_02	good	very low	low	yes	low	good	very good	good	no	good	yes	very good	yes	good	average	very good
Technology_03	average	low	moderate	yes	moderate	bad	good	average	yes	good	yes	good	no	average	bad	average

	criterion17	criterion18	criterion19	criterion20	criterion21	criterion22	criterion23	criterion24	criterion25	criterion26	criterion27	criterion28	criterion29	criterion30	criterion31	criterion32	criterion33	criterion34
Unit	5-point	5-point	5-point	5-point	unit	5-point	5-point	5-point	5-point	5-point	5-point	impact	impact	impact	5-point	5-point	5-point	5-point
Cluster/Group																		
Preferences																		
Min/Max	max	max	max	max	max	max	max	max	max	max	max	min	min	min	max	max	min	max
Weight	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics																		
Minimum	2,00	4,00	3,00	1,00	1,00	1,00	2,00	2,00	2,00	2,00	2,00	3,00	3,00	1,00	3,00	1,00	1,00	1,00
Maximum	4,00	5,00	5,00	4,00	1,00	4,00	4,00	5,00	4,00	3,00	4,00	5,00	5,00	3,00	5,00	5,00	5,00	4,00
Average	3,00	4,33	4,33	2,33	1,00	2,67	3,00	3,33	3,00	2,33	3,00	4,00	4,00	2,00	3,67	2,67	3,33	2,67
Standard Dev.	0,82	0,47	0,94	1,25	0,00	1,25	0,82	1,25	0,82	0,47	0,82	0,82	0,82	0,82	0,94	1,70	1,70	1,25
Evaluations																		
Technology_01	bad	good	very good	very bad	yes	very bad	bad	bad	bad	bad	bad	very high	very high	moderate	average	very bad	very bad	very bad
Technology_02	good	very good	average	good	yes	good	good	very good	good	average	good	moderate	moderate	very low	very good	very good	good	good
Technology_03	average	good	very good	bad	yes	average	average	average	average	bad	average	high	high	low	average	bad	very good	average

Figure A1. *Cont.*

☑	☑	☑	☑	☑	☑	☐	☐	☑	☑	☑	☑	☑	☑
criterion35	criterion36	criterion37	criterion38	criterion39	criterion40	criterion41	criterion42	criterion43	criterion44	criterion45	criterion46	criterion47	criterion48
5-point	5-point	unit	5-point	y/n	5-point	5-point	5-point	5-point	y/n	y/n	5-point	5-point	5-point
◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
max	max	max	max	min	max	max	max	max	max	max	max	max	max
1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2,00	1,00	0,00	1,00	1,00	2,00	n/a	n/a	2,00	1,00	0,00	3,00	1,00	2,00
4,00	4,00	1,00	2,00	1,00	3,00	n/a	n/a	3,00	1,00	0,00	5,00	5,00	4,00
3,00	2,67	0,33	1,33	1,00	2,33	n/a	n/a	2,67	1,00	0,00	3,67	3,00	3,00
0,82	1,25	0,47	0,47	0,00	0,47	n/a	n/a	0,47	0,00	0,00	0,94	1,63	0,82
bad	very bad	no	very bad	yes	bad	n/a	n/a	average	yes	no	average	very bad	bad
good	good	yes	bad	yes	average	n/a	n/a	average	yes	no	very good	very good	good
average	average	no	very bad	yes	bad	n/a	n/a	bad	yes	no	average	average	average

Figure A1. Decision matrix from VisualPROMETHEE.

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