

Developing Urban Resilience Criteria Using Multi-Criteria Analysis

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ABSTRACT Resilience can be defined as the capacity of a system to adapt and re-organize itself to mitigate expected and unexpected disturbance while retaining its essential attributes. The multifaceted dynamics of urban spaces with constant social, institutional and economic changes, and the impact of climate change on space and resources, underscore the need for an examination of this topic through the lens of resilience. This paper presents the application of multi-criteria analysis (MCA), a method suitable for problems with complex goals and many uncertainties, where the nature of the problem changes even during the problem-solving process, to the complex problem of spatial resilience. The AHP (Analytic Hierarchy Process) method was selected among numerous existing MCA methods.

Based on the understanding of theoretical fundamentals of multi-criteria analysis, within the framework of a methodological workshop, the students of Urban Studies at the University of Rijeka developed and applied spatial resilience criteria to the space and features present/existing in the area of the Campus or planned in different alternatives – in the Detailed Urban Plan (Alternative 1) and in newly developed plans presented by the students in the previously completed methodological workshop on the topic of Error Harvest (Alternative 2). The con-

clusions of the workshop confirmed that the selected scientific and artistic method combination is suitable for developing spatial resilience criteria and that it contributed to the goals of Urban Studies – the development of a well-founded, comprehensive and innovative planning and design approach to the future of urban space.

Key words: resilience, toughness, spatial planning, urban space, multi-criteria analysis, AHP.

1. Introduction

Identification of similarities between the development of urban systems and ecosystems, introduced as a theory in the early 1960s, marks the beginning of reflection on urban space from the resilience standpoint. The multifaceted dynamics of urban systems with constant social, institutional and economic changes, and the impact of climate change on physical space, underscored the need to examine space through the lens of resilience, defined, according to Holling (Holling and Walters, 1976), as “the ability of an ecosystem to absorb and use or even turn disturbances into a benefit”.

Existing planning and design tools and methods view space as a system of fixed-purpose zones and facilities, with planning not being adapted to changes and disturbances over time. A resilient space requires new methods and tools for spatial interventions, as well as a new “thesaurus of criteria” and a new dynamic of their interconnections.

The aim of this paper is to present the application of the multi-criteria analysis method to the development and implementation of criteria for evaluating an approach to design and planning that promotes urban resilience in the framework of a methodological workshop that allows an examination of the method itself, its advantages and disadvantages, as well as potential applications. Multi-criteria analysis, or MCA, is suitable for solving problems with highly complex goals, often vaguely formulated and characterized by numerous uncertainties, where the nature of the problem gradually changes during the process of solving it (Đorđević, 1990). This method is employed in various fields of science and human activities at different decision-making and planning levels.

This paper presents the results of the workshop conducted within the framework of the interdisciplinary university specialist study program Urban Studies at the University of Rijeka, where students and their professors developed potential criteria taking into consideration the need to ensure urban spatial resilience, and applied them to the case study – the Campus of the University of Rijeka. Among numerous MCA methods based on mathematics, the AHP (Analytic Hierarchy Process) was chosen for this experiment because of its advantages, as explained further in the paper.

2. Term and Concept of Resilience

According to Fiksel (Fiksel, 2006), socio-ecologic resilience is the capacity of a system to adapt and re-organize itself in order to mitigate disturbances while retaining its essential attributes. According to the resilience approach, there are three possible perspectives, focusing on: (1) equilibrium, (2) multiple equilibrium state, and (3) adaptive change.

The English term resilience, translated into Croatian as *otpornost*, is derived from the Latin verb *resilire*, used figuratively to describe a variety of retrograde motions, like *returning*, *rebounding* or *jumping back*. Although first used in late medieval France around 1430, as a legal term denoting a return to a prior legal status, it has converged with many disciplines, like physics, mechanics, materials science, physiology, psychology, biology and ecology, throughout history. In this space of transition across disciplines, a multi-disciplinary concept of resilience emerged, which cannot be unambiguously defined or strictly structured. Starting from the second half of the 20th century, due to its wide applicability across disciplines, from natural and technical sciences to the sciences dedicated to living systems, it has gained popularity in both scientific circles and the general public, up to the point of being raised on a pedestal as the “unifying concept in both ecological and social systems” (Gunderson and Pritchard, 2002). The determination to turn resilience into a new paradigm inseparable from “the social constructs that are subject to historical change” (Gößling-Reisemann, Hellige and Thier, 2018) can be examined in the context of the present time, characterized by the global aspiration to achieve the self-imposed dogma of sustainability, primarily understood in terms of ecosystems.

The systems theory framework of resilience that dominates today’s discourse and that we use here was established by the biologist and ecosystem researcher C.S. Holling (Holling and Walters, 1976). While working with a group of researchers at the *International Institute for Applied Systems Analysis – IIASA*, Holling expanded the notion of resilience over time as he acquired new insights through a transdisciplinary transfer of knowledge. The notion of *resilience* is viewed as analogous to engineering resilience, which focuses on stability, while *toughness* is viewed as analogous to ecological resilience, which is based on instability (Holling and Walters, 1976). Engineering resilience thus refers to a system’s capacity to absorb a disturbance, expressed as the time required for the system to return to equilibrium, whereas, according to Holling’s definition, ecological resilience is “the ability of an ecosystem to absorb and use or even turn disturbances into a benefit”.

In Urban Studies, we opted for the meaning of ecological resilience. The term *žilav* (tough) in the Croatian version of the name of the thematic framework of Urban Studies (*Žilavi kampus*) is a free translation and literary interpretation that reflects the desire for critical distancing from expected results and methods implied by the

buzzword *otpornost* – in English, resilience (Figure 1). *Žilavost*, or toughness, partly conveys the context that is the focus of research and imagining of Urban Studies, as well as the context from which the study program arose. This context is characterized by discontinuities, delays, various limitations, and exposure to frequent disturbances.

The planning and design approach that builds urban spatial resilience, arising from the desire to act without disregarding climate change, has clear objectives: to ensure that cities are prepared for disturbances, to facilitate the renewal of resources and to conserve ecosystems (Kallipoliti, 2024).

Figure 1. Diagram showing the definition and interpretation of resilience and toughness in Urban Studies



3. Literature Review

Making decisions in the process of selecting strategies and plans for the development of urban areas aimed at ensuring spatial resilience requires a more detailed definition of various aspects, i.e. criteria, that allow a comprehensive view of resilience.

On that basis, research on the term *resilience urban planning criteria* was conducted by performing a search in the Web of Science Core Collection (WoSCC) database using these keywords. Figure 2 provides a visual representation of the search results in VOSviewer. It presents the density visualization of the occurrence of the keywords searched and the related terms based on an automated analysis of a total of 400 sci-

According to the authors, this set of capacities was identified by integrating various approaches and movements promoting urban resilience.

A review paper by Masnavi, Gharai and Hajibandeh (2019) provides an extensive review of definitions of and studies on urban resilience, as well as the results of research analyzing the spatial resilience of Glasgow, Scotland. In this paper, the analysis of urban resilience in Glasgow involves various identified indices – diversity, redundancy, coherence, efficiency and modularity index. The authors conclude that, even though resilience has been studied extensively for many years, we still don't have a comprehensive and universal understanding of this term, especially when it comes to defining urban resilience.

4. Fundamental Theoretical Principle of Multi-Criteria Analysis and AHP

The multi-attribute decision-making or multi-criteria analysis (MCA) method is suitable for “ill-structured” problems (Nikolić and Borović, 1996; Farahani, SteadieSeifi and Asgari, 2010). They involve a very complex goal structure, often vaguely formulated and subject to uncertainties and changes during problem-solving (Đorđević, 1990), making it impossible to obtain a single solution. This lack of structuration entails multi-dimensional criteria for evaluating solutions (using different quantitative and qualitative measuring units) and variable limitations. The analysis, evaluation and final selection of the alternative urban planning solutions in the planning process involve these characteristics.

The MCA method requires a finite number of alternative solutions to be known in the beginning of the process, while the problem is resolved by finding the best alternative or a set of good alternatives with respect to defined attributes or criteria and their weights (Nikolić and Borović, 1996; Farahani et al., 2010).

Many MCA methods have been developed: dominant, maxmin, minmax, conjunctive and disjunctive method, lexicographic method, simple additive weighting (SAW), hierarchical additive weighting, multi attribute utility/value theory (MAUT/MAVT), ELECTRE (ELimination and (Et) Choice Translating REALity), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), hierarchical trade-offs, LINMAP (Linear Programming Techniques for Multidimensional Analysis of Preference), PROMETHEE (Preference Ranking Organization METHod for Enrichment Evaluations), AHP (Analytic Hierarchy Process), multi-criteria compromise ranking or VIKOR, and other (Deluka-Tibljaš, Karleuša and Dragičević, 2013).

Multi-criteria analysis can be defined as a decision-making method that involves a set of solutions (alternatives to be ranked or ordered by the decision-maker), a set of criteria (quantitative and qualitative, using different measures) and a set of values

(scores) assigned to each alternative under each criterion (Hajkowicz and Collins, 2007). Based on the above, a matrix X consisting of n - alternatives and m - criteria can be formed. The value of alternative i with respect to criterion j can be denoted by x_{ij} . At least two alternatives (solutions) and two criteria ($n \geq 2$ and $m \geq 2$) are required. Criteria weights are given in the form of the weight vector W , which contains m -weights, and the weight assigned to criterium j is denoted by w_j . The values in matrix X and vector W can be quantitative and qualitative. Most MCA methods rank or assign scores to alternatives; therefore, the following will be defined:

$$r_i = f^1(X, W) \text{ and } u_i = f_2(X, W)$$

where r_i denotes the ranking of the alternative, and u_i the total value of the alternative.

The criteria (groups of criteria) can be further broken down into lower-level criteria (sub-criteria). The importance (weight) of groups of criteria, individual criteria and sub-criteria can vary.

MCA is performed by applying the following algorithm (adapted from Hajkowicz Collins, 2007):

1. Choose solution options / alternatives
2. Define the criteria (groups of criteria, criteria, sub-criteria...)
3. Evaluate the alternatives against all criteria
4. Weight the criteria
5. Rank or score the alternatives
6. Perform sensitivity analysis
7. Make the final decision

Among the many previously mentioned MCA methods, the AHP (Analytic Hierarchy Process) method (Deluka-Tibljaš et al., 2013) is frequently used in decision-making in the field of spatial planning of urban areas and urban infrastructure as complex systems, as evident from the bibliometric analysis presented in Figures 2 and 3 (b).

The AHP method is designed for problems which can be presented in a hierarchical structure (Saaty, 1994; Saaty, 1996). The goal is on the highest hierarchical level, the criteria (groups of criteria) are on lower levels, while the alternatives (Figure 4) are on the lowest level. The AHP can be used to analyze problems that involve more than 4 hierarchical levels.

The AHP method involves calculating the weights, that is, priority or importance of criteria/sub-criteria and alternatives. Matrices of comparisons are used to determine preferences through pairwise comparisons of elements on the same hierarchical level with respect to the higher level (e.g. comparing the importance of each pair of criteria

with respect to the goal, comparing pairs of alternatives against each criterion and similar) using the values listed in Table 1.

Figure 4.
Hierarchical problem structuring (goal – criteria – sub-criteria – alternatives)

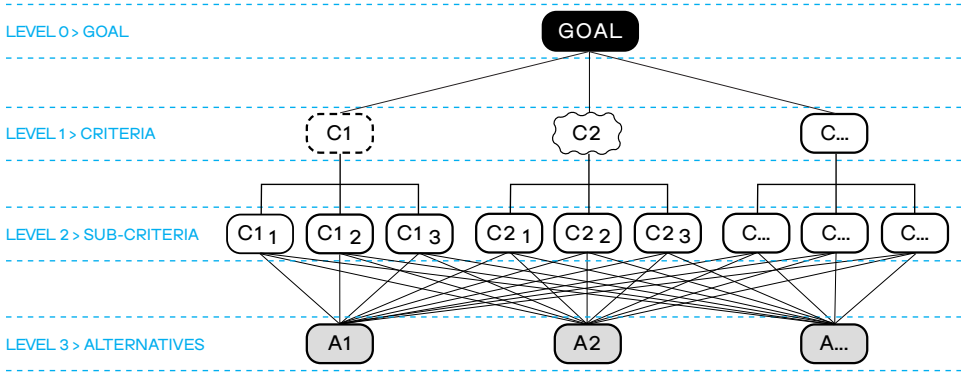


Table 1.
Pairwise evaluation of criteria/alternatives according to the AHP method (Saaty, 1994)

Numerical values	Definition of importance (preference)
1	Equal importance (no preference)
3	Moderate importance (moderate preference)
5	Strong importance (strong preference)
7	Very strong importance (very strong preference)
9	Extreme importance (extreme preference)
2, 4, 6, 8	Intermediate values used when compromise is required
Reciprocal values	Indicate the inverse relation between criteria or alternatives

The final result obtained by the application of the AHP method (as described in detail in Saaty, 1994; Saaty, 1996) is a priority vector that ranks all alternatives with respect to the goal in a ranking list. The advantage of this method lies in the fact that it can be used even when only the pairwise comparison of alternatives under individual (sub-) criteria and the relative importance of criteria with respect to the goal are known (including the pairwise comparison between the sub-criteria and the superordinate criterion, if defined), as well as when precise values of alternatives under each (sub-)criterion and the weights of all (sub-)criteria are known. The two approaches can be combined.

All of the above underscores the suitability of the AHP method for performing a multi-criteria analysis within the planned workshop in Urban Studies.

5. Multi-Criteria Analysis as a Method in Urban Studies

The multi-criteria analysis has been implemented in Urban Studies through a methodological workshop that combines Architecture and Infrastructure 2 as the dominant and Project Studio 2 as the associated course unit. In this way, the professors from the two combined course units had the opportunity to jointly develop tasks in the scientific and artistic field by combining scientific and artistic research methods, which is the priority objective of the Urban Studies program.

The first aim of the workshop was to introduce the students to the possibilities, advantages, and limitations of multi-criteria analysis as the method used to resolve urban planning problems with goals that are complex, like the goal of achieving urban resilience as defined in Resilient Campus, the thematic framework, and case study for the first generation of students. The second aim was to understand the connection between the multi-criteria analysis and planning solutions – the existing one and the new planning solutions developed by the students in the previously completed methodological workshop, with the aim to achieve spatial resilience of the University Campus. In the given case study, the identified problem – the urban plan for the University Campus that has not been implemented, opening up the possibility of rethinking the space – is precisely the type of problem that justifies the choice of the MCA and the AHP methods described in the previous section.

The students were provided with selected preparatory reading materials ahead of the workshop (Tsolaki-Fiaka, Bathrellos and Skilodimou, 2018; Rosasco and Sdino, 2023; García et al., 2020); before the practical part – the experiment, the students were also introduced to the theoretical basis of the multi-criteria analysis method (Karleuša and Ožanić, 2011) and the AHP method, and presented with several examples of the development of evaluation criteria for spatial planning in the area of water management and transport infrastructure (Karleuša, Ožanić and Deluka-Tibljaš, 2014; Deluka-Tibljaš, Karleuša and Benac, 2011; Ištoka Otković et al., 2021.).

The workshop was regularly guided and moderated by professors. Students had 3 main tasks:

- To develop spatial resilience criteria for the given case study – alternatives for the development of the University Campus – and analyze their importance;
- To transform jointly adopted spatial resilience criteria for the previously developed ideas into spatial images using AI text-to-image generator – Midjourney v5.1;
- To experimentally apply the AHP multi-criteria analysis method in selecting the optimal solution/alternative for the Campus (by evaluating criteria importance/weight and the presented alternatives) – using the AHP-OS tool available online.

The main steps of the MCA method – developing criteria, evaluating criteria weight/importance and comparing alternatives – require at least two criteria and two alter-

natives. In this case, the planned alternative, i.e. full development in line with the current Detailed Urban Plan of the University Campus and the University Hospital Center in Trsat (Sl.N. PGŽ 29/05) (hereinafter referred to as Alternative 1), was selected as one of the alternatives for the criteria development process.

The spatial development options for the University Campus developed by the students in the previously completed methodological workshop – Error Harvest (also described in the present issue of the journal) within the study program were also included in the process as alternatives. In short, Error Harvest is a design-led method based on using spatial and social deficiencies (*flaws*) or crises and processes (tools) of a given context for productive purposes (*goal*). In this case, the students were tasked with achieving spatial resilience in the spatial context of the University Campus using pre-defined or identified flaws, such as unused empty spaces, strong wind gusts (*bora*), wild boar incursions, oversized and non-functional pedestrian walkways.

In the Error Harvest methodological workshop, the students were divided into groups (three groups, each consisting of three students), and this structure was also used in the multi-criteria analysis methodological workshop. The results of the Error Harvest workshop were elaborated as speculative solutions in the following three alternatives:

Heterogeneity Potential of Empty Space (hereinafter referred to as Alternative A2a, Team A): a solution that leaves the unmaintained empty space resulting from not building on the Campus to human and more-than-human users in line with the principle of self-organized occupation by heterogeneous crowds. This alternative's resilience characteristics involve the creation of redundant parallel systems; random scenario generation; establishment of new forms of interdependence and communication among individual systems, and alignment with the actual needs of the wider context.

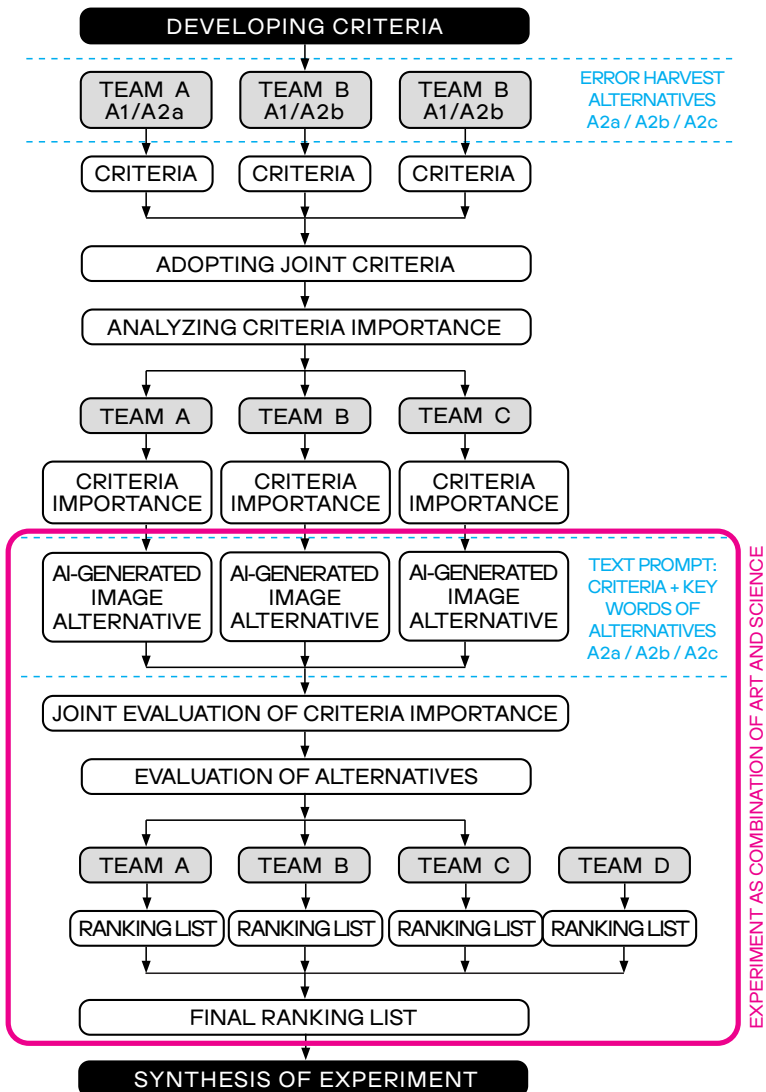
Year of the Pig (hereinafter referred to as Alternative A2b, Team B): this alternative views the problem of increase in the number of wild boars in the rural areas of the County as a source of raw material for meat production in the empty urban space at the Campus exposed to strong gusts of *bora*, an ideal environment for dry curing meat, especially the production of dry-cured ham or *pršut*. It also promotes institutional resilience by presenting options for strengthening institutional interconnections among the constituent units of the University, seen as a joint research and development project.

Win Your Own Campus (hereinafter referred to as Alternative A2c, Team C): the "backbone" of the solution is the developed central *cul-de-sac* promenade, to be divided into plots allocated to the students from all University constituent units for a 5-year management period. Students are granted autonomy in decision-making and in creating facilities and services according to their own wishes, with the responsibility of acting as good stewards. Spatial resilience is presented as inseparable from social resilience, which is based on the values of civic responsibility and care.

The professors concluded that the elaboration of solutions at this level of detail could provide a suitable basis for applying the selected multi-criteria analysis method – the AHP method.

Students completed the tasks by working collaboratively in teams consisting of three students; the teams were interdisciplinary due to the different academic backgrounds of the students, who had completed different study programs (architecture, civil engineering, landscape architecture, law) before enrolling in Urban Studies. The steps involved in conducting the workshop and the experiment are presented in Figure 5.

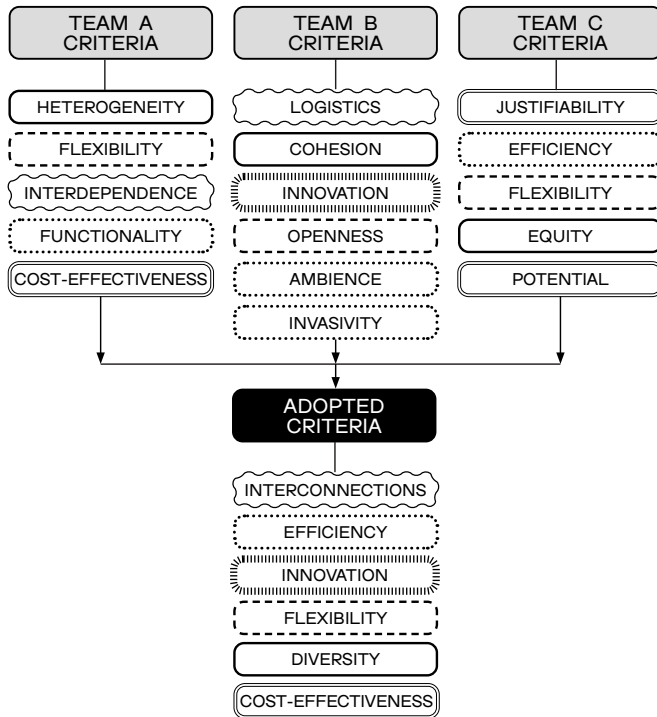
Figure 5.
Workshop and the experiment implementations steps



Students were first tasked with preparing a list of groups of spatial resilience criteria and sub-criteria based on Alternative 1 (full implementation of the plan) through team discussions. The teams were the same as in the Error Harvest workshop – Teams A, B and C.

Professors encouraged the students to move away from standard groups of criteria from expert literature, which are typically applied to spatial planning problems (for example, economic, environmental, functional, social criteria), and to view the criteria through the lens of their knowledge about space acquired in the course of their current study program and their primary field of expertise, i.e. the degree acquired before enrolling in Urban Studies, as well as the topic they are researching for their final thesis. The results of the first task are presented in Figure 6: two teams developed 5, and one team developed 6 groups of criteria in total. Each team presented their own criteria, with an oral explanation of each criterion, facilitating a joint discussion where the criteria were aligned and consolidated as jointly defined criteria – *adopted criteria*.

Figure 6.
Criteria development



A guided discussion led to the conclusion that not all criteria (groups of criteria) have the same importance with respect to the goal of SPATIAL RESILIENCE, and each team was tasked with discussing the importance of individual (adopted) criteria with respect to the goal.

The students entered the adopted and jointly defined criteria and other key terms related to spatial planning alternatives developed in the Error Harvest methodological workshop into Midjourney (v5.1) as prompts.

Midjourney is a program and service that uses artificial intelligence to generate images from natural language textual descriptions called “*prompts*”. In addition to prompts, as additional information prior to image generation using Midjourney, photographs of the existing Campus were entered into the program as the background image for visualization. The students used photographs they took on-site or selected from the materials received at the university.

The visualizations are shown below (Figures 7, 8 and 9).

Figure 7.

DPU vs. *Heterogeneity Potential of Empty Space*, AI-generated illustration (Midjourney v5.1); Team A authors: Iva Peručić, Eva Mlinar, Mirta Stipeč



Figure 8.

DPU vs. *Year of the Pig*, AI-generated illustration (Midjourney v5.1); Team B authors: Ines Marasović, Ana-Marija Vašiček, Dorian Vujnović

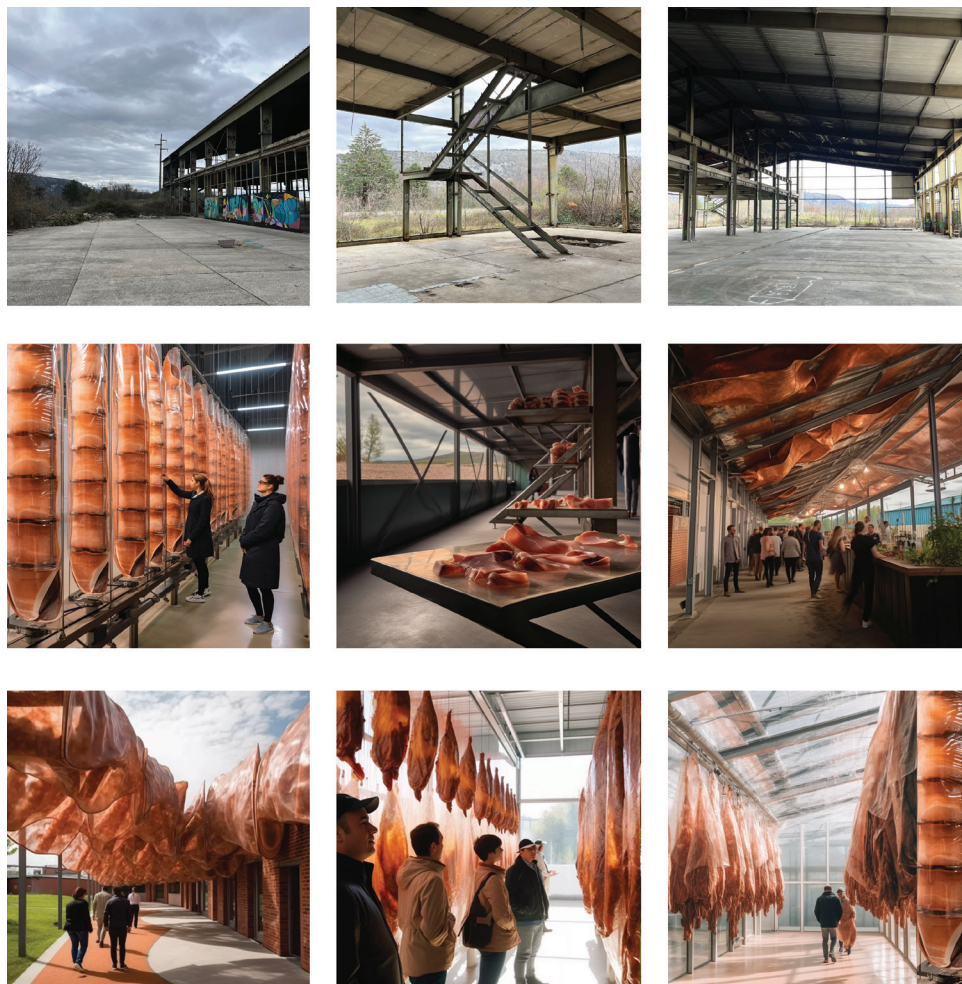


Figure 9.

DPU vs. *Win Your Own Campus*, AI-generated illustration (Midjourney v5.1); Team C authors: Ana Kliman, Ariana Sušan, Mateo Zonta



In the next step, the students compared and evaluated the importance (weight) of the adopted criteria together, using the AHP method. The final (adopted) weight of the selected criteria is shown in Table 2. On a scale of 0% to 100%, flexibility was assigned a weight of 30%, reflecting its importance with respect to the goal, i.e. spatial resilience, which means that it was identified as the most important criterion; interconnections was assigned a weight of 23%, efficiency 17%, diversity 15%, cost-effectiveness 10% and, finally, innovation 5%.

Table 2.

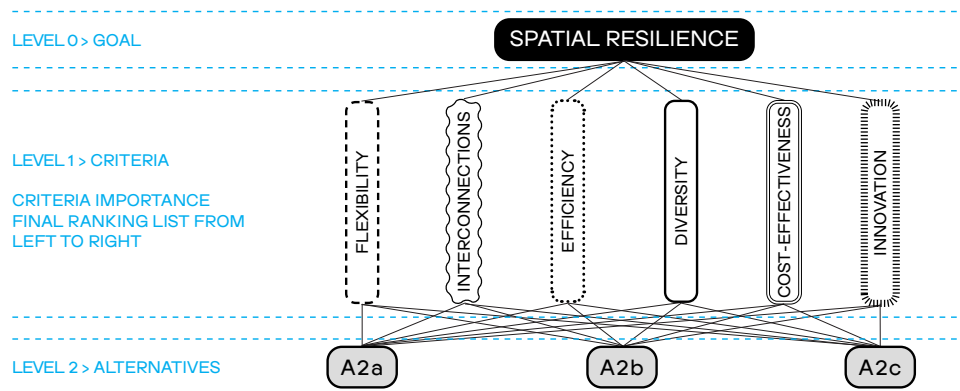
Result of the evaluation of the importance of criteria (groups of criteria) with respect to “spatial resilience” as the defined goal

GOAL	CRITERIA	FINAL (ADOPTED)WEIGHTS	%
SPATIAL RESILIENCE	FLEXIBILITY	0.300	30
	INTERCONNECTIONS	0.230	23
	EFFICIENCY	0.170	17
	DIVERSITY	0.150	15
	COST-EFFECTIVENESS	0.100	10
	INNOVATION	0.050	5

Based on adopted criteria and their weights, the student teams evaluated the proposed alternatives for the development of the Campus in Trsat (alternatives: A2a, A2b and A2c) using the AHP method in line with the hierarchy shown in Figure 10 and the pairwise comparison preferences in accordance with Table 1. In this step, a team consisting of professors (Team D) also performed the evaluation.

Figure 10.

Hierarchical structure

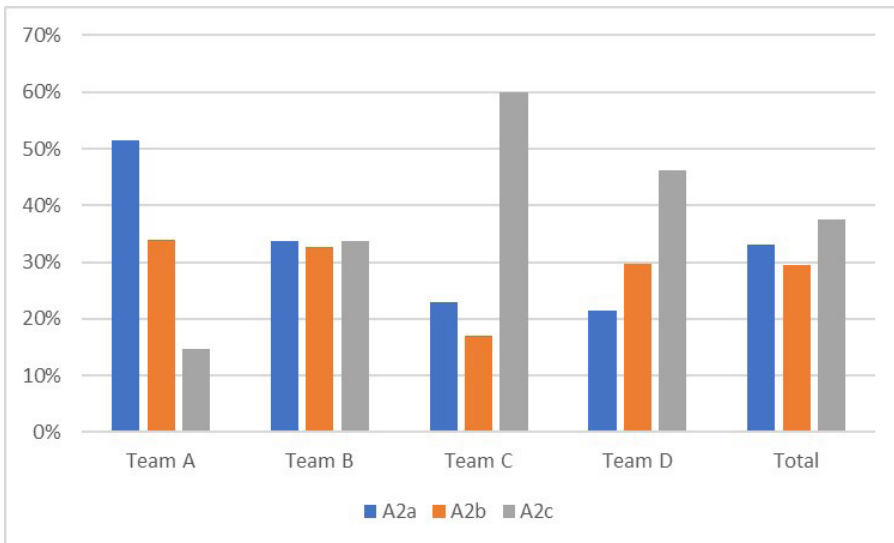


The AHP method was suitable for application in this case because, when the alternatives being compared are not elaborated in detail, it allows a comparison based on qualitative assessments, that is, a pairwise comparison of alternatives under each criterion. Each group, three student teams and the team composed of professors (Team D), performed pairwise comparisons of all solutions (alternatives A2a/A2b, A2a/A2c and A2b/A2c) to assess which alternative better satisfies each criterion with respect to the defined goal – **spatial resilience in the case study Resilient Campus**. The final result was the evaluation of the alternatives based on previously adopted weights of the criteria, as shown in Table 3 and Figure 11.

Table 3.
Ranking list

Rank	Team A	Team B	Team C	Team D	Total
1 st	A2a (51,4%)	A2a and A2c (33,7%)	A2c (59,9%)	A2c (46,2%)	A2c (37,5%)
2 nd	A2b (33,9%)	A2b (32,6%)	A2a (23,0%)	A2b (29,7%)	A2a (33,1%)
3 rd	A2c (14,6%)	-	A2b (17,1%)	A2a (21,4%)	A2b (29,5%)

Figure 11.
Result of the evaluation of alternatives using the AHP method (according to team preference and in total)



The results show that the teams assigned different priorities to different alternatives – speculative solutions. In the final ranking list (Table 3), A2c is ranked as the best, followed by A2a in the second and A2b in the last place; the list was created through joint evaluation of the three alternatives by all four teams, since the AHP method allows including more than one stakeholder in the MCA process.

The final ranking list differs from the ranking lists of individual teams, although it can be noted that A2c tops two of four teams' lists, while one team ranked A2a and A2c equally. Teams A and C ranked their own solutions higher than other alternatives, which may indicate a degree of assessment subjectivity, while Team B was more objective, assigning a slightly lower score to their own alternative, namely A2b, than to the other two. Through objective evaluation, Team D, the professors, ranked the alternatives as follows: A2c, A2b and A2a. The results of the experiment revealed both the

advantages and the disadvantages of the method used, which, although largely based on rational procedure, can be, depending on the evaluators, more or less subjective. In the end, the results of the experiment were discussed, raising the question of scope, limitations and possible applications of the method.

5. Conclusion

The aim of employing the multi-criteria analysis method in the methodological workshop for the joint course units Architecture and Infrastructure 2 and Project Studio 2 in Urban Studies was to present the application of the scientific method of multi-criteria analysis using a targeted task related to the thematic framework and case study of the University Campus addressed by the 1st generation of students – Resilient Campus, and to link the results to spatial planning solutions previously developed for the same targeted task.

Within the guided workshop, the students were tasked with developing and applying spatial resilience criteria to select the optimal solution among three speculative solutions for the development of the Campus. The experiment demonstrated that the chosen AHP method could be used to resolve such problems (ill-structured problems in uncertain conditions) and at the level of detail of available background materials (simple graphic and textual presentation of individual alternatives) since it facilitates qualitative assessment of the importance of criteria, or alternatives, through pairwise comparisons, without the need for quantification. The students worked in “expert” teams composed of 3 members with different academic backgrounds, allowing them to examine the goal (spatial resilience) and develop criteria by integrating the knowledge from their primary fields (architecture, landscape architecture, law, civil engineering) and the knowledge acquired in Urban Studies, related mainly to future development of urban spaces as complex systems.

Through discussion, both within individual teams and jointly, 6 resilience criteria were defined: flexibility, interconnections, efficiency, diversity, cost-effectiveness, and innovation. Using the AHP method, the students identified flexibility as the most important criterion. This criterion is difficult to achieve in the context of the existing spatial planning regulations in the Republic of Croatia, which rely on very formal procedures for adopting and amending spatial plans. To ensure spatial resilience, it would be **advisable to increase the flexibility of the formal spatial planning procedures in the future.**

A comparison of workshop results with analyzed scientific papers on spatial planning (Sharifi and Yamagata 2014; Sharifi and Yamagata, 2016; Datola and Marta, 2021; Masnavi et al., 2019) shows that the newly-developed criteria overlap with the criteria listed in expert literature: flexibility/adaptability; heterogeneity/diversity/variety; in-

terconnections/cohesion/coherence; efficiency (efficacy) and equity, confirming that the criteria developed by the students can be applied to spatial resilience problems not only in the example used, but more widely – as universal criteria for evaluating the resilience of any urban space.

It was also confirmed that the selected and described teaching methodology, and the application of the MCA or, more precisely, the selected AHP method, are suitable for encouraging students to develop a well-founded, comprehensive, and innovative approach to understanding and solving urban planning problems. Applying this method allowed the students to integrate their prior knowledge with the knowledge acquired in Urban Studies and raise new research questions.

Finally, **it can be concluded that the experiment is an example of successful integration of an artistic and scientific approach into urban spatial analysis** and planning, and that multi-criteria analysis should be regularly included in methodological workshops for future generations of students of Urban Studies.

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Kriteriji prostorne žilavosti kroz metodu višekriterijske analize

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Sažetak

Otpornost se može definirati kao sposobnost sustava da se prilagodi i organizira kako bi ublažio očekivane i neočekivane poremećaje i zadržao bitna svojstva. Višestruka dinamika urbanih sredina uz kontinuirane društvene i institucijske te ekonomske promjene, posljedice klimatskih promjena na prostor i resurse apostrofirala je potrebu njihovog sagledavanja i kroz prizmu otpornosti. U ovome radu je prikazana primjena metode višekriterijske analize (VKA) koja je primjerena za probleme kod kojih su ciljevi složeni, postoje brojne neizvjesnosti te se priroda problema mijenja i tijekom rješavanja problema, na složeni problem otpornosti prostora. Umjesto termina otpornosti korišten je pritom termin *žilavost* kao termin koji se direktnije može povezati na lokalni kontekst prostora koji je analiziran - Sveučilišnog kampusa u Rijeci. Studenti Urbanih studija Sveučilišta u Rijeci su kroz metodološku radionicu, na temelju osnovnog teoretskog razumijevanja metode višekriterijske analize, razvili kriterije žilavosti te iste primijenili na prostor i program koji nastanjuje/postoji na prostoru Kampusa, odnosno, koji je varijantno planiran za taj prostor - kroz Detaljni plan uređenja (Varijanta 1) ili razvijen na razini studentskih spekulativnih rješenja (Varijanta 2). Zaključci studentske metodološke radionice su potvrdili primjerenost odabrane metode za razvoj kriterija žilavosti prostora i dali doprinos ciljevima Urbanih studija - razvoju utemeljenog, cjelovitog i inovativnog pristupa planiranju prostora.

Ključne riječi: otpornost, žilavost, prostorno planiranje, urbani prostor, višekriterijska analiza.