DOI: 10.22616/j.landarchart.2022.21.08

Multicriteria assessment of landscape architecture projects: the sustainability perspective

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Abstract. Cities are implementing numerous projects for improving their urban landscapes. The quality of planned landscape interventions is critical for the users and that depends on proper assessment of the projects. After theoretical and empirical research, the paper proposes the framework for quality assessment of landscape architecture projects in relation to sustainability principles. By using the set of pre-determined criteria and relevant indicators the paper offers triple-level multicriteria decision-making tool for assessing the projects aiming at refurbishing, regenerating or conserving the existing parks and gardens, urban open spaces, cultural landscapes and urban infrastructure landscapes by the professional experts. The results of assessing the urban open space refurbishment projects have demonstrated that the proposed solution is fit for setting the participatory quality assessment platform with involvement of stakeholders for comparing the proposals, identifying their advances and shortages, also figuring out the dominating design trends. The results suggest that each phase of project development has a significant impact on the quality of the process and the overall assessment result. Authors and clients should pay special attention to landscape perception values.

Keywords: landscape architecture; projects, quality assessment; criteria; indicators

Introduction

Responding to the global environmental challenges and high public expectations, cities are implementing numerous projects for modifying their urban landscapes and investing immense public resource. Quality of the planned landscape interventions is critical for the citizens and other users and that depends on proper analysis of the possible options and selection of the best proposals. For this reason, cities are actively procuring projects for landscape modifications by organising open or invited contests and variety of public purchase procedures. Professional community is also presenting their work to public in exhibitions and publications where the best proposals receive prizes and awards. Organisers in the process of contests, procurement, awards and other professional evaluation use different methods and varying sets of criteria, which then gives a hint for further professional activities. Therefore, it is important to use a balanced comprehensive method for assessing the quality of landscape architecture projects, especially minding the current sustainability requirements.

By performing thorough analysis of the most recent literature, numerous design cases and variety of implementation practices, by building up on previous research by the author, the paper aims to present a comprehensive solution for aesthetic, environmental, socio-economic and operational assessment of landscape architecture projects. This paper discloses the findings of an experimental research illustrating how to apply in practice and pilot-test the methodology of quality assessment of landscape architecture projects based on sustainable development principles.

The major concerns of recent landscape implementations relate to the loss of biodiversity in cities, urban heat islands appearing because of abundant sealed surfaces, the quality of air, soil and water, urban noise and may other impacts of speedy and short sight urbanisation. For this reason, we have taken environmental, socio-economic and operational aspects as a framework for quality measure for landscape architecture projects. We understand landscape as a multi-faceted self-organised system that can be static, self-supporting, selective, protective, contextual, self-reproducing, conscious, and other [1].

Aesthetic value is essential quality feature of landscape architecture, and in a wide sense, it includes individual visual perception, spectator's subjective experience and other specifics and therefore is a fluctuating category by its nature in time, in space and in context. As regard to sustainability, vernacular and traditional design stands out as the inspiration for sustainable design form and content [2].

Multicriteria decision-making analysis is used when the final decision should be made based on several criteria with multiple indicators, also when the list of options has to be narrowed. In the case of landscape architecture projects, the usual application could be selecting one proposal of many in the process of a contest or procurement for further development and implementation.

Literature review

Re-examining the understanding of urban policies on international and national scales requires more than reviewing the procedures of dealing with the variety of urban phenomena that we face but to rethink the way we see the city and in this context the philosophy of approach to urban issues becomes a priority goal [3]. All built environment projects have to mind multiple quality criteria and make right decision to meet a task delivered by client. Especially, the projects dealing with the natural and built environment have to account, analyse, conceptualise, develop and technically deliver the proposals that are optimally addressing the multiple problems of the place. Therefore, we have attentively analysed the multiple criteria decision-making (MCDM) methodology as regard to landscape planning, design and management tasks in particular. Analytic Hierarchy Process (AHP and ANP) turns to be one of the most suitable methods and the efficient tool for prioritising multiple quality criteria of urban landscape [4].

AHP and ANP methods are designed to evaluate factors using a pairwise comparison when one criterion is more dominant over another [5]. The AHP method can solve difficult-to-define problems that use experience and intuition (i.e., expert's evaluation) next to mathematical calculations [6]. Researchers underline the AHP method conveys the human interpretive thinking process [7] better than the logical sequence in Design thinking. This is why the AHP method developed by the American scientist T. Saaty [8] is used. The AHP method is suitable for research and evaluation of various types of applied art objects, building maintenance process [9] or for selecting the best landscape architecture design. The AHP approach provides not only the opportunity to find the best evaluation solution, but also to quantify the prioritization of ranking tools. In the AHP method, priorities are set using the pairwise comparison method, which has a certain relative importance or a hierarchical structure of the most valuable elements. The AHP methodological tool relies more on intuition and expertise than on objectivity in prioritizing decisions [10]. In this study, the method is chosen by solving the task of selecting the design solutions of the presented landscape architecture projects, which are the most favorable for the needs of both the society and the city municipality. The AHP approach sets the structure of the model by presenting the problem in a hierarchical structure, provides comparison of criteria and (or) alternatives, finally it gives prioritization of criteria and (or) alternatives.

Research discloses that MCDM is efficiently used to assess sustainability of buildings, and in this process, it uses the conventional sustainability criteria as site features and transport, energy and materials, waste and pollution, and other, depending on the applied assessment scheme. Combining the existing MCDM methods authors introduce a Proportional Judgement Scale for pairwise comparisons of different assessment criteria [11]. Engaging stakeholders into the assessment process is the global trend in sustainability assessment, even though these schemes require definite professional background. Dale et al. underlines importance of the coordinated process for engaging stakeholders, starting with scope and objectives, setting and prioritising the indicators that alert pending concerns, setting the target, obtaining indicator values, drafting the trends and finally developing good practices [12]. MCDM methods and their combinations are used to assess different aspects of landscape performance. While assessing the safety of urban public parks AHP method can efficiently rank the factors of urban parks safety [13] by using the crime prevention through environmental design tools. Another application of MCDM for landscape assessment employs AHP method that is independent from current building's sustainability rating schemes [14]. The method allowed for determining importance of assessment factors with Site context, Soil and vegetation, and Maintenance as the most important ones. The question is raised weather AHP assessment is more fit for evaluating landscape architecture projects than green building rating systems as BREEAM, LEED and others that are creatd to assess buildings. While aiming to evaluate the rationality of urban river landscape design project by AHP tool researchers identify numerous landscape elements (24 elements) without structuring them to the bigger criteria groups and subsequent indicators and found it suitable for measuring their performance [15]. Researchers use Analytic Network Process (ANP) method in cases when a feedback effect exist between multicriteria factors [16]. In such case, ANP is frequently used method to resolve multi-index comprehensive evaluation problems. Literature review indicates that quality assessment of landscape architecture projects is multi-criteria by nature, and pairwise comparisons of criteria and relevant indicators may be used along with the set of pre-determined criteria and assigned indicators.

Methodology

We use the set of pre-determined criteria and indicators for quality assessment landscape architecture projects developed in the recent research [17]. In order to have a balanced initial approach to aesthetic, environmental, socio-economic and operational assessment the pre-determined set of criteria and their indicators was upgraded: the number of indicators was equalised and social and economic criteria were split to

TABLE 1
Composition of expert's group for multicriteria assessment of landscape architecture projects [Source: by the authors]

No.	Areas of landscape architect's professional activity	Experts involved
1	Designing parks and gardens	Landscape architect
2	Designing urban open spaces	Landscape architect, urban planner, sustainability specialist
3	Planning cultural landscape	Landscape architect, urban planner, conservation specialist
4	Designing landscape of infrastructure	Landscape architect, urban planner
5	Team member in building's design	Landscape architect, urban planner, architect

separate groups. Human memory has a limited capacity to process complicated information and keep in mind multiple responses [18], therefore each criterion initially was assigned an equal number of indicators.

As prosperous, healthy and equitable society is the general goal of all strategies and policies towards sustainable development, the social aspect of quality assessment is central and it is shielded by environmental (biosphere) aspects of sustainability, on one hand, and it has an economic kernel with relevant economic development issues [19] (Fig. 1). In this context, we need to define the wider frame of research needed to develop the methods and processes to assess urban accessibility, especially for the elderly citizens, as an important aspect of social sustainability of modern cities and measure the planned interventions by using the information technology tools [20].

In order to demonstrate the complex quality assessment of landscape architecture project we will use the example of renovation project contest for Vokiečių Street in Vilnius City Old Town. The previously created set of criteria and relevant indicators represent the quality features of different kinds of landscape architecture project, from parks and gardens, urban open space, cultural landscape and infrastructure landscape, as well as for a supporting role in building's design projects.

We may admit several scenarios for quality assessment of landscape architecture projects: quality assessment aiming to determine quality degree (low to high), assessing against the baseline scenario project, comparison of several projects in case of a contest, and rating several proposals in the process of public procurement. In this paper, we test the assessment for the quality degree of landscape architecture projects submitted for an open design contest. The quality of projects whose assessment result is above 80% will be entitled exclusive, from

Fig. 1. Economic, social and biosphere aspects of sustainability [Stockholm 2020]

65 % to 80% – very good, from 45% to 60% – good, from 30% to 45% – medium, and below 30% – low.

The composition of expert's group plays an important role in the whole assessment process. It depends on the site and the nature of the intervention, type, phase and other specific features of the process and usually comprises professionals and academics, landscape architects and urbanists including building architects, depending on the local education system. Researchers debate about the contradictive nature of aesthetics and sustainability, arguing that these two are of the opposite nature. If we draw the parallel with landscape development, then the aspects of anamnesis, flow, space sequencing and context may be the matching points between the quality of landscape architecture and its sustainability [21].

Depending on that, expert's group should preferably include professionals bearing all competences needed for assessing the particular landscape architecture project. In this case, experts represent the full scope of expertise and competences (Tab. 1). As all experts were involved in assessment of all project entries we expect that they have assessed in all aspects and perspectives as drafted by Stauskis, including aesthetics and sustainability, urban coherence and ecology and other specific fields of urban landscape quality [17]. Five experts assessed the criteria, the indicators and the submissions by testing the created assessment tool. All involved experts are practicing in landscape architecture planning or design, two of them are teaching and researching. For this study, experts contributed free, but they were provided with transport and office service.

The AHP rating scale for the matrix was ranging from one to 9 where 1 is Equal Importance, 3 – Moderate importance, 5 – Strong importance, 7 – Very strong importance, 9 – Extreme importance (2,4,6,8 values are intermediate). The assessment was at first performed on the criteria level and then – on the indicator's level. On the first level,

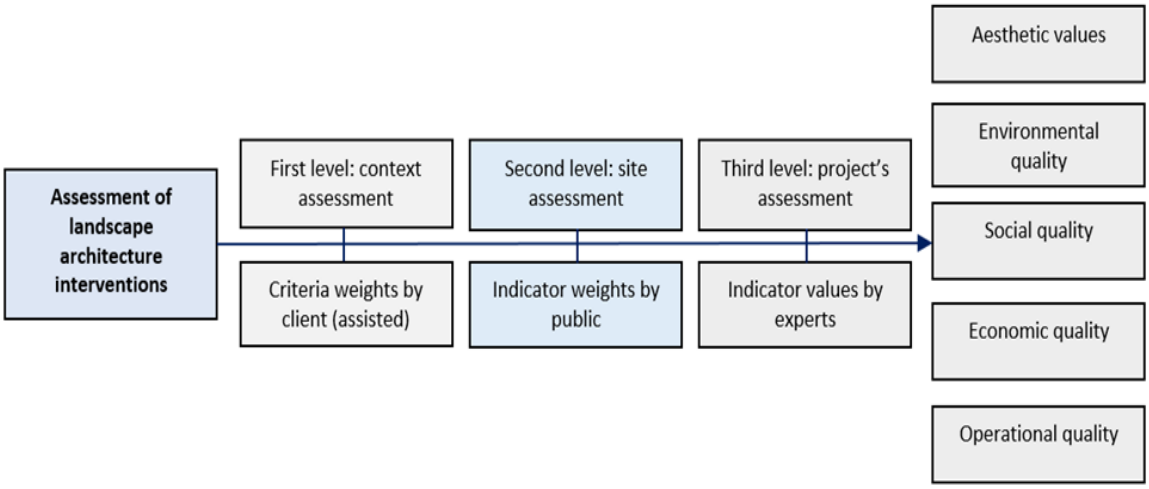

Fig. 2. Multiple assessment scales addressing the context, the site and the proposals [created by authors]

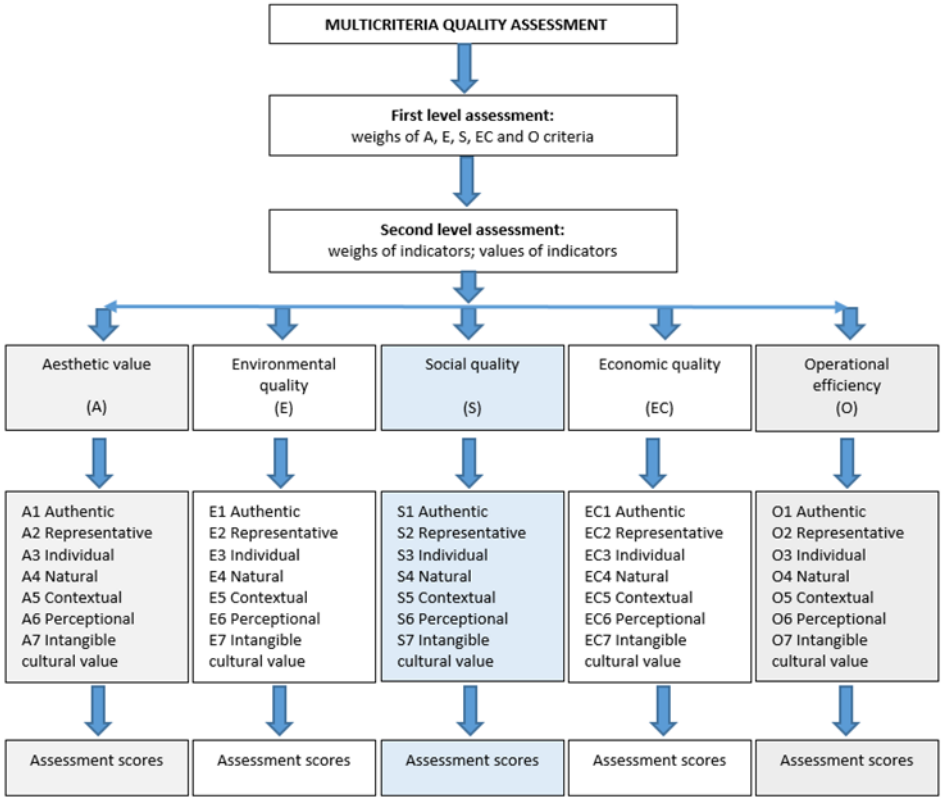

Fig. 3. Triple-level multicriteria quality assessment process [created by authors]

each expert determined the weighs for the following quality criteria as relevant for the concrete contest site and programme: aesthetic value, environmental quality, social quality, economic quality and operational efficiency, that were named respectively as A, E, S, EC and O (Fig. 2). When applied in real life situation, the client will perform this assessment level by expressing his expectations and vision of the planned project. On the second level, the experts determined the weighs for all indicators of the assessed criteria. In real life situation, community representatives will perform this assessment by discussing the goal, the use and the performance of the planned landscape intervention. On a tertiary level, five experts gave scores to each project entry against each indicator. The weighs of the first level represent the surrounding and proximal urban and natural context specifics and nature of the project arising from its aim. The second level weighs represent site specifics, and the scores of the third level represent quality of the submitted project entries. By submitting the assessment scores, the

Fig. 4. The aerial photographs of Vilnius Old Town and Vokiečių Street 2009 (a), 1944 (b) [Vokiečių 2015

experts have reported the extent to which the assessed project addresses each of the aesthetic, environmental, social, economic and operational qualities as displayed by relevant indicators (Fig. 2, Fig. 3). The triple-layer structure allows using the proposed method for assessing landscape interventions in the planning, design and management aspects.

The authors provided the automated Analytic Hierarchy Process operation system (AHP OS) for assessing the priority weights of the selected criteria and indicators on the first and the second assessment levels, Fig. 2 [22]. The experts performed tertiary level assessment by giving numeric scores to each contest project.

Fig. 5. Process for assessing the quality of landscape architecture projects [created by authors]

The site, the task and the projects

Eighteen projects for refurbishment of Vokiečių Street in Vilnius City are analysed by the proposed method. We selected this project's contest as its task it covers refurbishment of infrastructure (two streets), it is an urban open space, it includes park elements, in addition, it lays in a protected cultural area of Vilnius Old Town (Fig. 4). As presented in the task programme [23], some roles of this place are more evident (a street) than the others (a park), but the task includes drafting the future vision for this site as an integral part of Vilnius Old Town. The site blends the typologies of urban open space, linear greenway and infrastructure with definite traits of cultural landscape as it is within a protected heritage area.

Prior to the open contest, the municipality planning company has developed several proposals for the refurbishment of Vokiečių Street, but because of very active public debate and high expectations of the citizens the international open contest was organised by Vilnius City Municipality and the Lithuanian Association of Architects in 2020 [24]. Eighteen entries were submitted, and the projects proposed different pathways towards the refurbishment of this urban open space. The international jury has elected three winning projects, and, as it came from the public announcement, it was stated that none of them has fully responded to the raised issues. In the context of this research, the main question is about the applicability of the methodology for the assessment and ranking of the proposals as regard to the programme of the contest, and local regulation. The secondary goal is to check the methodology on ability to figure out the general trends and gaps of current landscape design. The tertiary goal is to inform the landscape architect's continuous professional development process to deepen knowledge and skills in the identified gap areas.

After the Second World War, following the drastically destructive urban plan drafted by the Soviets a wide motorway for connecting Vilnius City and Minsk, the capital of Belarus, was planned to cut through the medieval old town. The plan was to demolish many urban blocks and valuable architectural monuments to empty the space for the "needed motorway", luckily, the process stopped in 1960 after retreat of soviet dictator. Still as a result, the space of medieval Vokiečių Street was drastically widened from 8–10 m to 40–50 m by demolishing several urban blocks on the North East side (Fig. 4).

TABLE 2

Results of the criteria and indicator weighing by the experts [created by authors]

Phase	**A** weighing the criteria %					**B** weighing the indicators %	**C** scores for indicators
Expert	A	E	S	EC	O		
Expert 1 Landscape architect	25,5	28,0	16,6	16,6	13,3	7 indicators	For all 35 indicators
Expert 2 Landscape architect	28,3	25,4	17,1	14,2	15,0	7 indicators	For all 35 indicators
Expert 3 Landscape architect	26,1	30,3	16,7	16,7	10,2	7 indicators	For all 35 indicators
Expert 4 Architect, urban designer	34,4	24,4	15,8	15,8	9,6	7 indicators	For all 35 indicators
Expert 5 Architect	37,0	25,0	14,1	14,1	9,8	7 indicators	For all 35 indicators
Result:	**30,3**	**26,6**	**16,1**	**15,5**	**11,5**	7 indicators	
A- aesthetic; E – environmental; S – social; EC – economic; O – operational.							

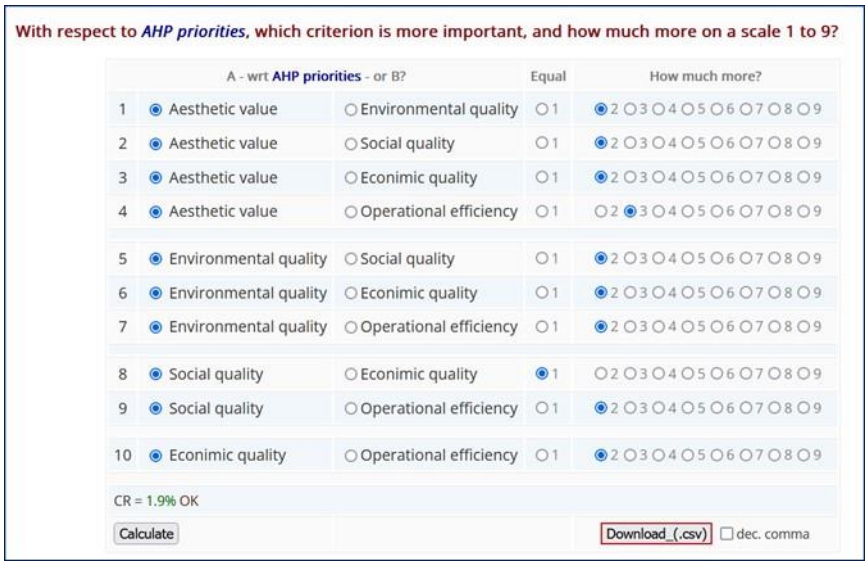

Fig. 6. Pairs of criteria comparison [as example by Expert 4]

After collecting the pool of indicators for environmental, socio-economic qualities and aesthetical values in the operation context, we structure them into five criteria groups (Fig. 3). The importance of the indicators should be determined, because project aim, location, type, lifespan and other specific features are usually different. For this reason, we create the weighing tool to give priority to the most important ones, and as given above, the AHP method is used in a subsequent process (Fig. 5)

Results and Discussion

By extracting the averages from the first level and the second-level assessment data, we have obtained the criteria and indicator priority weighs (Tab. 2). The sequence of the first and the second-level assessment is illustrated on the example of the results provided by Expert 4 (Fig. 6, 7, 8, 9, 10).

We have checked if the property is transitive by the performed consistency ratio (CR) check. Literature recommends that within 10 % the CR is acceptable [22], and in all tested cases CR is within the acceptable 2%–6,1% margin. Therefore, we consider all assessment scores as valid. In order to analyse the average assessment results of all projects in aspect of the selected criteria we have obtained the average assessment scores by five experts for all projects. The professional experience of each expert indicated (Tab. 3 and Fig. 10 a) played certain role in the assessment results. The expert architect with longer professional experience has assigned the lowest average score, and the expert architect with shorter professional experience has assigned the highest average score.

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons:

Cat		Priority	Rank	(+)	(-)
1	Aesthetic value	34.4%	1	7.8%	7.8%
2	Environmental quality	24.4%	2	6.6%	6.6%
3	Social quality	15.8%	3	2.6%	2.6%
4	Econimic quality	15.8%	3	2.6%	2.6%
5	Operational efficiency	9.6%	5	2.0%	2.0%

Number of comparisons = 10
Consistency Ratio CR = 1.9%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix:

	1	2	3	4	5
1	1	2.00	2.00	2.00	3.00
2	0.50	1	2.00	2.00	2.00
3	0.50	0.50	1	1.00	2.00
4	0.50	0.50	1.00	1	2.00
5	0.33	0.50	0.50	0.50	1

Principal eigen value = 5.088
Eigenvector solution: 4 iterations, delta = 1.3E-8

Fig. 7. The first-level priority calculation results and discriminant matrix data [as example by Expert 4]

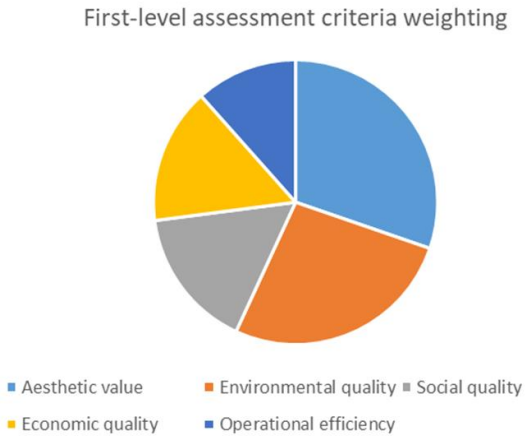

Fig. 8. First-level assessment criteria priority weights by all experts [created by authors]

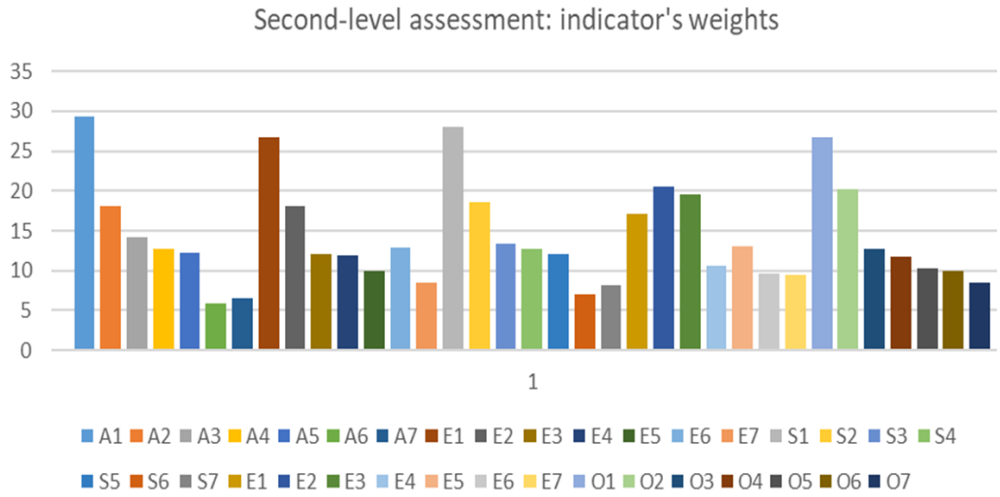

Fig. 9. Second-level assessment of aesthetic indicators priority weighs by all experts [created by authors]

The results of assessing each landscape architecture project from the perspective of sustainable development indicate different degree of achieved quality in aesthetic, environmental, social – economic and operational aspects. Analysis of the average assessment scores show that the average quality of all assessed projects was highest in the social aspect (Fig. 10 a) and lowest – in the operational aspect (Fig. 10 b). Aesthetic value, environmental and economic quality were assessed on the average levels. The overall average of five assessment criteria is 32,29 % (Fig. 10 b) which is "satisfactory" quality level following the assessment grades on Tab. 4.

TABLE 3

Project assessment results by the experts [without criteria weights]

Expert	Aesthetic	Environm	Social	Economy	Operation	Average	In practice
Architect	6,41	6,42	6,67	6,85	7,04	**6,68**	<20
LA	5,04	5,42	5,66	6,21	5,39	5,54	**>40**
LA	6,72	6,15	7,25	6,67	6,26	6,61	<20
Architect	3,49	3,24	3,87	3,81	3,46	**3,57**	**>40**
LA	5,08	5,14	5,91	4,85	2,03	4,60	<20
Average	5,35	5,28	**5,87**	5,68	**4,83**	5,40	
LA - landscape architect							

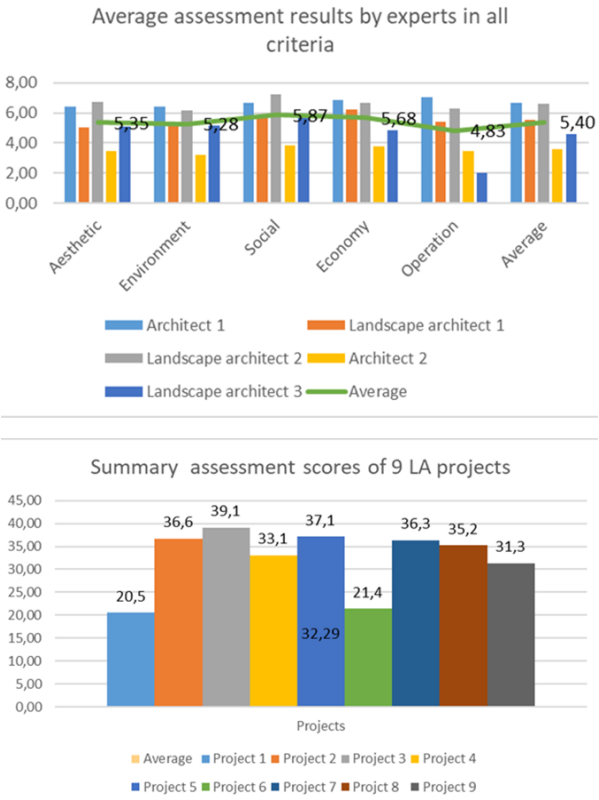

Fig. 10. Average assessment results in all criteria by different experts (a); Summary assessment scores of 9 selected landscape architecture projects (b)

TABLE 4

The standard and the assessed project's quality level [created by authors]

Assessment degree	Standard thresholds	Assessed projects
Low	< 30 %	Projects 1; 6;
Satisfactory	30 % – 40 %	Projects 2; 3; 4; 5; 7; 8; 9
Good	40 % – 55 %	-
High	55 % – 70 %	-
Very high	70 % – 85 %	-
Exclusive	> 85%	-

The results show that regular landscape architecture projects prepared following the standard contest programme by landscape architects without special qualification in sustainability can hardly compete for high quality levels. In order to achieve high, very high and exclusive quality levels (55% onwards) the contest programme and the specific tasks should incorporate the sustainable development quality goals from the very initial phase of its development. Through intermediate assessment of a preliminary design, through public consultation and legal quality check the project should be improved as to advance its artistic value, environmental, socio-economic and operational qualities to the highest level. Certainly, each project should select the quality goals that it is going to pursue regarding the site specifics, needs of the users, the strategic development goals that should be a part of high-standard task programme for any type of local, regional or international landscape architecture contest.

As we see from the assessment results on Fig. 10 b, all reviewed projects offered their way for solving many environmental challenges: protecting existing trees and designing new ones, reduce impermeable pavement, respecting the existing and restoring the erased relief features. In social aspect, authors addressed numerous issues important to local community: recreation, safe and comfortable mobility, and totally rejecting any memorialisation offers. The reviewed projects pay small attention if any to operation and management constrains and the related costs. All reviewed project paid great attention to creating new aesthetic value and made use of the existing cultural heritage and its value. Minimalistic design trend is prevailing, but some proposals employ decorative, restorative, even eclectic design. Nevertheless, all proposals tried integrating multiple cultural layers and blend landscape with urbanism. Reasoning on operational efficiency is essentially missing in all projects as authors fail to address management of the designed facilities even less than formally required. We may summarise that design by the authors of the analysed proposals has good aesthetic quality but sustainability aspects are hard to find in any form. Results demonstrate that the authors clearly miss numerous sustainability-oriented applications as renewable energy, local materials, waste and pollution management, SUDS, SUMP and others. Even more, the analysed proposals differ quite a lot from requirements for landscape architecture projects that we outlined in the reviewed research where sustainability-oriented goals and concrete solutions dominate over the conventional technogenic functionality. For this reason, the quality assessment framework that we present hereby is useful for practicing landscape architects as a practical guide to achieve higher quality of design especially in sustainability perspective.

By looking on the results from human motivation perspective, we see that authors often overestimate physical elements of environment in design because of the high potential to impress and motivate people, and perception variables as openness, smoothness and locomotion, are underestimated. Therefore, landscape perception is a critical component in landscape architecture design and authors should take it as priority for any landscape intervention.

Conclusions

The performed research brings more transparency to the process of project's quality assessment to facilitate professional discussions and public debates. It can improve quality of the landscape architecture projects through continuous professional development schemes. Landscape architects shall attentively treat the high degree of motivation brought by the perception variables integrating it with sustainable of performed tasks for designing new or refurbishing the existing landscape.

Three-step cycle of project's quality assessment illustrates that in spite of the presented list of indicators, in each case assessor has to set their priority and individual weight as to reflect on the specific goal, site, context and other project variables.

Acceptance by the public is a key for measuring quality of any project, and in this case citizens had an opportunity to vote for the best project [25], unfortunately their opinion was not taken into consideration when the winners of the contest for the analysed site were announced. The presented assessment method and tools may be used to make the landscape architecture project's contests more comprehensive for all stakeholders, including the client – municipality, the public – citizens and the specialists. In our case, selection of the jury differed from the preferences of the citizens, whereas application of the presented system would allow matching this different preferences and adding coherence to the contest process and more transparency to its results.

Different stakeholders can use this tool: firstly, the clients – public, private, local(municipalities) or central (agencies, ministries) governments – who commission the project; second, the public non-for-profit institutions and associations willing to assess the quality of the presented proposals in the framework of efficient public participation. In this case, it can work as an alternative for the different methods or conditions used by the client. Third, the contest or tender assessors can use it for entries assessment as a supporting tool next to their professional experience and subjective opinion.

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Kopsavilkums. Pilsētas īsteno daudzus projektus savu pilsētu ainavu uzlabošanai. Plānoto ainavu iejaukšanos kvalitāte ir kritiska lietotājiem, un tas ir atkarīgs no projektu pareizas novērtēšanas. Pēc teorētiskās un empīriskās izpētes darbā tiek piedāvāts ietvars ainavu arhitektūras projektu kvalitātes novērtēšanai saistībā ar ilgtspējības principiem. Izmantojot iepriekš noteiktu kritēriju kopumu un atbilstošos rādītājus, darbs piedāvā trīs līmeņu daudzkritēriju lēmumu pieņemšanas rīku, lai novērtētu projektus, kuru mērķis ir atjaunot, atjaunot vai saglabāt esošos parkus un dārzus, pilsētas atklātās vietas, kultūrainavas un pilsētas infrastruktūras ainavas. Rezultāti liecina, ka katrs projekta izstrādes posms būtiski ietekmē procesa kvalitāti un kopējo novērtējuma rezultātu. Autoriem un pasūtītajiem īpaša uzmanība jāpievērš ainavas uztveres vērtībām.