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Primary School Outdoor Spaces Analysis and Evaluation Case Study—City of Osijek (Croatia)

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Abstract

This paper investigates spatial characteristics and functional capacities of primary schools' outdoor spaces in the City of Osijek (Croatia), with the purpose of identifying potential for their qualitative improvement. The study investigates fifteen primary schools in Osijek, analysed through a comparative framework that includes criteria such as school plot area, plot disposition, design, programmatic content (facilities), and relationships with the surrounding urban context. Rather than measuring educational outcomes, the analysis evaluates the spatial conditions and affordances that may enable or constrain a broader range of outdoor educational, recreational, and social activities. The results indicate that, although spatial capacity is generally sufficient, outdoor school areas are significantly underdeveloped. Across the sample, outdoor environments are generally characterised by limited spatial and programmatic diversity, weak direct connections between ground-floor classrooms and outdoor areas, and a predominance of sports grounds, open grassy areas, and school squares over dedicated outdoor-learning settings. In conclusion, we propose strategic design guidelines aimed at enhancing the multifunctionality, accessibility, and pedagogical value of school outdoor spaces, as well as their integration into everyday educational practice and the broader community context. While the study proposes evidence-based design priorities for retrofitting existing school grounds, it explicitly distinguishes observed spatial conditions from actual patterns of use or educational effects.

Keywords: primary school; outdoor spaces; city of Osijek; spatial characteristics; evaluation

1. Introduction

Primary school (elementary school) is an educational, social, and cultural institution that, in Croatia, must be attended by all children from the age of six and a half (or seven) until the age of fifteen [1] (p. 32). The concept of primary school in Croatia is equivalent to compulsory education and lasts eight years, while across Europe and worldwide there are various approaches to the duration of primary and compulsory education, as well as to the design of educational buildings, specifically primary school facilities.

School outdoor spaces refer to areas outside the school building, specifically the unbuilt parts of the school site, and include all open spaces associated with the school building, such as terraces, atriums, porches, and flat roofs. In the literature, they may also be referred to as external school spaces, school grounds, schoolyards, school surroundings, or the school environment. These are the areas of the school site not occupied by the school building [2] (p. 61) and within Croatian legislation they are classified according to their function

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into general-use spaces and teaching-area spaces [3] (pp. 15–16). Studies and various pedagogical concepts have demonstrated that well-designed school outdoor environments contribute to pedagogical practice by enabling inquiry-based learning, environmental education, collaborative work, movement-based learning, informal social learning and interdisciplinary teaching. Outdoor classrooms, gardens, naturalised schoolyards and differentiated play environments have consistently been associated with increased opportunities for experiential learning, higher teacher willingness to conduct outdoor lessons and richer educational affordances, although evidence regarding direct effects on learning outcomes remains heterogeneous.

1.1. Outdoor Space as Part of the Educational Environment

In the pedagogical literature, school outdoor spaces, especially the schoolyard, have an important educational function as a bridge between the natural environment and the school building [4]. Active learning in outdoor settings stimulates all aspects of children's development more easily than indoor environments [5], while some researchers emphasise outdoor play as exceptionally important for the development of social skills, fine and gross motor skills, and the release of excess energy [6]. Research on outdoor pedagogy further emphasises that well-designed school landscapes can significantly enhance the quality and frequency of outdoor learning by transforming schoolyards into active pedagogical environments [7].

School outdoor spaces were the focus of various pedagogical concepts that emerged at the beginning of the 20th century, such as Open-air schools, Forest schools, the Work-school movement, the Jena Plan, the Winnetka Plan, the Dalton Plan, and the Waldorf School [8]. Harris examines the role of outdoor spaces in learning through the example of the Forest school [9]. The emergence of the Pavilion school, which resulted from the need for integration of outdoor spaces into active learning environments during the first half of the 20th century and the Open-Air Education Movement, significantly influenced the architectural syntax of the modern school building and the programming of curricular and extracurricular activities [10]. The importance of outdoor spaces in schools has been an explicit part of legislation regulating school construction, and after the Second World War most countries had developed guidelines for their provision [11]. Today's public health concerns are among the reasons that place the importance of outdoor space at the centre of school construction in general. The architectural articulation of educational facilities can contribute to the prevention of obesity by increasing traditional recreational areas, providing covered outdoor spaces protected from the weather at the boundaries between indoor and outdoor environments, and creating diverse outdoor settings that allow students to choose activities best suited to them [12]. Certain studies also indicate that outdoor spaces are highly beneficial for children with autism [13].

The recent pandemic acutely highlighted the importance of fresh air and availability of outdoor teaching spaces. The quality of interaction between indoor and outdoor school spaces has thus become increasingly important again, with growing opportunities for using outdoor spaces that allow outdoor activities for most of the year according to climatic conditions [14] (p. 19). The current design and programming of schools, viewed in light of historic and emergent health requirements, triggers a renewed look into the necessity of articulating educational space which integrates the aim to raise healthy citizens with an awareness of their role in the environment [15] (p. 187). Contemporary schools worldwide are more frequently conceived together with their outdoor spaces as an integrated whole and, as educational instruments, represent models for learning about the relationship between humans and nature or the environmental impact of buildings [16]. Recent architectural research further supports this shift, noting that sustainable school design increasingly

integrates outdoor and indoor learning environments through flexible spatial concepts that extend teaching beyond the traditional classroom [17], while modern approaches to school planning emphasise the integration of outdoor pedagogical spaces as a core component of educational infrastructure [18].

1.2. Spatial Qualities and Contemporary Research

School outdoor spaces are, directly or indirectly, connected to the teaching process; therefore, the school site must, in addition to the area for constructing the school building, also allow for the creation of appropriate outdoor spaces [2] (p. 14). Relatively few international studies have addressed the use of school outdoor spaces. Blatchford described schoolyards and outdoor play areas as "forgotten spaces" of schools [19]. Recent environmental justice research highlights that access to green school environments is not evenly distributed, showing that green school outdoor environments are unequally distributed and often reflect underlying socio-economic inequalities in access to environmental quality around primary schools [20]. School grounds are becoming increasingly important for environmental learning [21], yet the design and development of green areas, natural quiet zones, and play areas are often neglected [22]. In recent years, however, research from various fields such as pedagogy, psychology, sociology, medicine, ecology, and geography that investigates school outdoor spaces has increased, while fewer studies originate from architecture and urban planning. Additionally, comparatively few architectural studies propose an operational framework that evaluates an entire urban school network using consistent spatial criteria applicable to both existing and future school retrofits.

The design of school outdoor environments should incorporate a variety of durable surface materials, including paved areas, sandpits, running tracks, jumping facilities, and courts for sports such as basketball and volleyball, together with covered outdoor structures that allow continued use in adverse weather conditions [22]. Many outdoor elements can be designed to serve multiple functions, thereby increasing spatial flexibility and accommodating a broad range of formal and informal learning activities. Examples include covered porches adjacent to classrooms, art and science rooms, outdoor dining areas, seating spaces, amphitheatres, pavilions, terraces, planters, benches, and movable furniture, all of which can support teaching, social interaction, recreation, and independent learning [23]. Outdoor learning spaces should be student-centred, developmentally appropriate, safe, comfortable, accessible, flexible, equitable, and economically sustainable [24,25]. Such environments may comprise a diverse range of spatial elements, including circulation paths, play areas, gardens, sand and water zones, seating areas of different sizes, ball courts, wooded areas, or covered pavilions and porches [23].

A recent research paper underscores the critical role of spatial layout in shaping children's physical activity behaviours during recess, identifying key spatial factors such as the proximity and accessibility of the playground to school buildings [26]. Useful evaluation dimensions include the diversity of activity zones, accessibility, circulation and connectivity, vegetation, spatial complexity, and the distribution of equipment.

Despite increasing research on outdoor learning environments, green schoolyards, and school landscape design, and their connection to children's behaviour [27], physical activity or psychological needs [28], comparatively few architectural studies evaluate an entire urban school network through a common spatial framework. Recent enquiries likewise note that evidence linking specific design features to specific learning or health outcomes remains limited, particularly for urban schools with constrained sites [29]. In this type of school environment, the design needs to incorporate expansive green terraces, designed to meet children's developmental needs and located in close proximity to the classrooms for convenient access to outdoors [30].

The contribution of the present study is therefore spatial and diagnostic: it compares existing primary-school grounds in one city using the same quantitative and qualitative dimensions and identifies recurrent retrofit priorities without claiming to measure learning outcomes. This study thus addresses the following research questions: What quantitative and qualitative spatial characteristics define the outdoor environments of the analysed primary schools in Osijek? To what extent do these grounds provide the spatial and programmatic conditions identified in Croatian standards and the literature as supportive of diverse outdoor educational use? Which recurrent spatial limitations and opportunities can be identified across the school network, and what design priorities can reasonably be derived from them?

It is worth noting that the study belongs to architectural design research rather than educational evaluation. Its purpose is to analyse the spatial conditions that enable or constrain different forms of outdoor educational use, not to measure educational outcomes or behavioural frequencies. Following Gibson's concept of affordances [31], architectural space does not determine behaviour but enables or constrains potential actions. Accordingly, the present study evaluates the affordances offered by school outdoor environments. While the study focuses on a single city, its goal is not localized, but aims at developing transferrable parameters which can be operationalized in other settings. The broader contribution is to develop a transferable architectural evaluation framework and a methodology for retrofit interventions contributing to diversified school outdoor environments.

2. School Outdoor Spaces in Croatia

2.1. Legislative Framework

The development of school architecture in Western culture has historically focused primarily on indoor educational spaces, while school outdoor spaces were not considered a functional part of educational environments until the emergence of modern pedagogical theories in the late 18th and 19th centuries. Therefore, the design of schools in Croatia, as well as the role of their outdoor space, can be analysed from the 19th century onwards, when the traditional school model was established [32] (p. 5). School outdoor spaces in Croatia became more systematically regulated in regard to their pedagogical and recreational role only during the second half of the 20th century, although traces can be found in the progressive modernist projects of the 1930s designed under the influence of progressive pedagogies and mentioned in legislation regulating their construction [3]. While the importance of outdoor space has been an integral part of guidelines for planning and designing schools established and refined continuously after 1945, the explicit articulation of all the various functions these spaces should provide developed during the 1970s. Outdoor areas of mid-century schools were ample but often had playgrounds which remained under-equipped because design processes did not adequately consider the various needs of schools and other users [33].

The current framework for school building dimensioning and design, as well as spatial conditions for primary schools in the Republic of Croatia, is regulated by several laws, regulations, standards, and technical codes (Act on Education in Primary and Secondary Schools, National Pedagogical Standard for the Primary Education System in the Republic of Croatia, hereinafter: NPS 2008 [34], etc.). The NPS from 2008 describes the necessary differentiation of school outdoor spaces, as well as the plot total area. This provided the basis for preliminary research. For the purposes of this inquiry, the most relevant are the Standards for Dimensioning Primary School Space in the Republic of Croatia, 2022 (hereinafter: Standards 2022), as they describe the spatial affordances of outdoor spaces in most detail and serve as the current relevant guidelines against which a precise evaluation can be determined.

Standards 2022 applies to the construction of new buildings and the reconstruction of existing buildings that provide educational work in a single shift (half-day, extended, or full-day schooling) depending on the number of class sections and students [3]. They were developed to support the transition to the concept of the full-day school, the expanded role of social spaces in learning and all-day use, and to enable adequate spatial conditions for longer and more diverse stays of children in schools, pedagogical forms, educational processes, and teaching and learning methods [3]. They were designed as a revision of existing standards in order to optimally adapt school spaces to the new concept of the full-day school.

In Standards 2022, school outdoor spaces are classified into general-use spaces and teaching-area spaces, with criteria for their sizing defined.

According to Standards 2022, general-use spaces are divided into:

1. Pedestrian access paths—dimensioned according to the capacity of the school building and site organisation requirements.
2. School square—minimum 40 m^2 plus 0.4 m^2 per student.
3. Vehicular access—dimensioned according to site organisation requirements.
4. Parking spaces—defined according to parameters set by local spatial planning documents.
5. Service yard—defined according to the capacity of service areas within the school building.

Teaching-area spaces are divided into:

1. Outdoor teaching spaces—minimum 2 m^2 per primary school student.
2. Nature-based teaching space—depends on the type and capacity of the school and the characteristics of the area in which the school is located, as well as site-specific conditions.
3. Schoolyard—minimum 0.5 m^2 per student for schools with up to eight class sections (14 students per section), or at least 0.35 m^2 per student for schools with eight or more class sections (28 students per section).
4. School park/garden—150 m^2 plus 1 m^2 per student.
5. School exercise area—4 m^2 per student, depending on the number of class sections (up to eight sections with 14 students per section, 8–22 sections with 28 students per section, and more than 22 sections).

The total land area required for primary school construction in Croatia (including built and outdoor spaces), as defined by Standards 2022, is 30 m^2 per student. If it is not possible to place all school functions on a single plot, the distance between related facilities used by the school should be within a five-minute walk [3]. The minimum area of a school plot and building depends on various factors, including the number of students; whether the school is located in a rural or urban area, in a city center or on the periphery; national policy; and demographic, economic, and other conditions.

In urban planning, the most commonly defined measurable parameters are the maximum distance between school locations and residential areas, the minimum school site area, and the building coverage ratio, from which the minimum area of school outdoor spaces can be derived. Site conditions such as sunlight exposure, protection, distance from roads, surrounding greenery, and proximity to facilities are discussed in the professional and scientific literature, while legally binding guidelines that incorporate these site conditions for primary schools remain difficult to find.

2.2. Characteristics of Facilities

While the legislative framework primarily addresses numerical parameters, dimensions, and spatial requirements, the ambient and experiential qualities of outdoor spaces are often overlooked, even though the scientific literature emphasizes that the design and configuration of school outdoor spaces are equally important. This section therefore

identifies and describes several spatial features of facilities that significantly contribute to the educational process through characteristics that support and enhance learning. Some spaces are included in the legislative framework (outdoor classrooms as learning spaces, paths as circulation spaces, and playground and exercise areas as activity spaces), but we also researched the design of school ground borders and transitional spaces as connecting and edge spaces between indoor and outdoor school spaces, and between the school ground and the urban area.

2.2.1. Outdoor Classroom

The outdoor classroom emerged as one of the earliest forms of outdoor learning at a time when outdoor spaces increasingly became part of public discourse on school design. Initially, the outdoor classroom was fully arranged like a traditional classroom—furniture, blackboard, seating arrangement, and teaching methods mirrored those of the indoor classroom, but in an open-air setting [35,36]. It is most commonly associated with lower primary education classrooms, which are typically located on the ground floor and make more active use of outdoor spaces than subject-based teaching. However, there are also notable examples of outdoor classrooms located on upper floors, such as Duiker's Open Air school in Amsterdam.

The outdoor classroom is often designed as a semi-covered space that can be used in rainy weather or provides protection from sun exposure; however, the concept is much broader than a conventional classroom. Its design can extend across the entire school site, effectively turning the whole outdoor area into a learning space. Moreover, vertical and space-efficient school models demonstrate how outdoor learning environments can be incorporated on multiple levels, including rooftops and terraces, as part of a broader strategy to maximize limited urban space while maintaining access to nature and outdoor activity [17]. An outdoor classroom can therefore be any external environment such as a park, forest, field, garden, terrace, courtyard, or other open space, with the main aim of offering students a new dimension of learning that includes close contact with nature and promotes health and well-being through physical activity and time spent outdoors. The classroom thus evolves from a closed unit into an integrated spatial model of outdoor learning.

2.2.2. Paths

Paths connect individual components of outdoor spaces. Moore and Cosco identify three types of paths in outdoor environments—primary, secondary, and tertiary—each serving different functions with specific design characteristics. Primary paths should be straight and smooth, designed as wide curves without sharp angles, narrow sections or dead ends; they may include niches for group interaction and exploration, and are preferably made of concrete [25,37]. Secondary paths form an independent circulation system intersecting with the primary network, connecting spaces for more intimate play and learning environments, and are preferably made of crushed gravel or wooden decking [37]. Tertiary paths allow short exploratory movement by children and may branch directly from primary or secondary paths. They are smaller in scale and use the same surfacing as secondary paths [37].

Paths can also reshape existing spaces in several ways. Walkways or nature trails can divide or enclose undifferentiated outdoor areas. These paths can also connect smaller play environments designed for different developmental levels. The main goal is for each path to provide a clear context for small group play and to offer activities that may not be supported by larger spaces [12].

2.2.3. Transitional Spaces

Transitional spaces are areas where indoor space and outdoor spaces meet and can extend learning activities. Though they do exist in practice, they are rarely explicitly mentioned in programming beside covered entries or covered open classrooms, possibly due to insufficient collaboration between teachers, architects, and landscape architects, as well as a lack of awareness of their importance [37]. Some studies describe transitional spaces as neither fully indoor nor outdoor [38], or as areas suitable for messy activities that encourage experimentation [38,39]. They are considered particularly beneficial for children and older adults compared to other adult groups [38,40].

Monsur provides a definition of transitional spaces with examples of their design: *If one or more wall elements or the roof are fully or partially removed to expose an interior space to the outdoors, such a partially enclosed space becomes a transitional space* [38]. Examples include verandas, open vestibules, covered passages, and garden pergolas [38]. The importance of transitional space in the context of school buildings has been extensively explored by Herman Hertzberger, and the concept of thresholds follows the influences of Aldo van Eyck and Hans Scharoun, who extend the meaning of transitions in school spaces to reflect not only physical thresholds but also those related to belonging, age, or urban simulations [41]. In Hertzberger's elaboration as well as design, interaction between the interior and exterior are expressed through the thresholds as essential elements in the interaction with the environment [42].

2.2.4. Playground and Exercise Areas

The school playground area is an outdoor space primarily used for physical education. Its size and number depend on the number of class sections, the curriculum, elective activities, and sports activities within the local community [34]. In addition to adequate area, its location and safety must be considered; it is recommended that it be located adjacent to the kindergarten or school building, protected from strong winds and negative street influences, enclosed on all sides by appropriate fencing, provided with sufficient sun and shade [43] (p. 23), not placed in front of classrooms or specialised rooms, and preferably oriented along a north–south axis [2] (p. 10).

In contemporary school design, playgrounds are differentiated by age, type of play, and social interaction (group or individual), and are no longer used exclusively for physical education but also for other outdoor activities. Their role is expanding in line with modern living and working conditions, incorporating new functions and uses.

Playgrounds are the only legally required elements of school outdoor spaces that must be included in school design, and they are also the most frequently used outdoor spaces by the local community. Many examples exist worldwide and in Croatia of activating and redesigning unused asphalt schoolyards to encourage their use. Activation methods often include new play equipment, painted ground graphics, and adapted urban furniture that can also serve as outdoor classroom elements.

2.2.5. Borders

Although school fences primarily serve physical purposes, their design can affect how individuals feel and connect with the local community. A key characteristic of school security fences is that they not only function as boundaries but also shape the environment by influencing how people move, communicate, and connect with others and the surrounding context [44]. Fences act as a form of control, creating lines of separation within the wider environment and regulating movement both within and outside the school grounds [44]. Recent research highlights school boundary conditions as significant spatial elements that mediate interactions between educational facilities and their surrounding

urban environments, suggesting that permeable and adaptable boundary designs can contribute to improved spatial connectivity, increased community participation, and the transformation of schools into more integrated civic assets [45]. In many schools, fences are uninspiring, generic, and standardised, mostly low in height, and serve more as psychological than physical protection. Designing the boundary between private school space and public urban space can be an important pedagogical tool, enabling interaction and active educational use; however, increasing security requirements are making school fences more closed and higher.

The uniformity of fences used in many schools creates the impression that they serve the same purpose in every context. In reality, these environments vary greatly—from remote communities to medium-sized towns and dense urban areas—each with its own specific needs and context [44]. Therefore, the boundary of the school site can be designed not only as a fence but also as part of the built environment (such as buildings), the existing context and surrounding structures or greenery.

3. Materials and Methods

This research adopts a mixed qualitative-comparative case study approach to investigate the spatial characteristics and functional capacities of primary school outdoor spaces in the City of Osijek, Croatia. The methodological framework integrates a systematic comparative approach based on measurable site indicators obtained through documentation analysis, field observation, graphic and comparative analysis and evaluates them according to their role in defining common characteristics, spatial deficiencies and opportunities for improvement within existing school outdoor environments. It is a diagnostic tool designed for comparison of spatial conditions of outdoor spaces in Osijek's primary schools rather than a validated performance index dealing with educational outcomes.

The research sample consists of all fifteen primary schools currently operating within the City of Osijek and included in the study database. These schools span different construction periods, urban contexts, plot sizes, and architectural typologies. Primary schools in suburban areas that belong to the city proper are not of particular importance for urban and architectural aspects in terms of establishment, organisation and law, and are therefore excluded from the research. Schools for children with special needs and schools for national minorities are also excluded because of the different pedagogical programmes implemented in each school and the limited possibilities for comparing the data obtained from the research. Most analysed schools were constructed during the intensive urban development period following the implementation of the Urban Plan of Osijek by Radovan Miščević [46], while several older schools were subsequently expanded or adapted to accommodate changing educational standards and demographic requirements [47].

The methodological process was organised into four phases:

1. Data collection;
2. Field observation;
3. Graphic and comparative analysis;
4. Evaluation.

The study combines data from different periods: enrollment and class-section data, as well as the contextual staff survey, are from 2021, while the field observation documents spatial conditions are from 2023. The evaluation protocol, indicator definitions and coding rules were established before field observations commenced, based on the literature review, Croatian standards from 2008 and the predefined catalogue structure. Field observations were then recorded according to these predefined categories. For the comparison of existing spatial capacity with current requirements, the 2022 Standards are used as the contemporary regulatory benchmark.

In the first phase, basic information for each school was collected from publicly available cadastral records, planning documentation, school archives, and previous research. The collected data included the year of construction, location within the urban structure, plot area, building footprint area, number of floors, roof configuration, and the relationship between built and unbuilt surfaces. Particular attention was given to calculating building coverage ratios and available outdoor space per student, enabling comparison with the requirements defined in National Pedagogical Standard for the Primary Education System in the Republic of Croatia from 2008 and spatial planning regulations.

Additionally, in September 2021, a short survey was conducted among teachers, professional staff, and principals of all 15 selected primary schools in Osijek and was retained as contextual evidence [48]. It addressed reported use of outdoor spaces before and during the COVID-19 pandemic and perceptions of desirable improvements. The survey was conducted via Google Forms and comprised nine questions in total: two questions concerning respondents' data, and seven questions concerning school outdoor spaces. Out of the seven questions, four were open-ended questions or included the option for comments. Survey addressed the following topics: (1) types of outdoor spaces available within the school grounds (multiple-choice); (2) types of outdoor spaces used prior to the COVID-19 pandemic (multiple-choice); (3) reasons for using or not using outdoor spaces prior to the COVID-19 pandemic (open-ended); (4) types of outdoor spaces currently used for educational activities (multiple-choice); (5) changes in the frequency of outdoor-space use during the COVID-19 pandemic (yes/no, with an option for comments); (6) intentions to increase the use of outdoor spaces in the future (yes/no, with an option for comments); and (7) types of additional outdoor spaces considered necessary for future use (open-ended).

The survey link was distributed to all 15 primary schools in Osijek on two occasions. No restriction was imposed on the number of respondents who could participate from each school. Between September 3 and 13, a total of 34 respondents representing 13 schools completed the survey. The majority of respondents were teachers (73.6%), followed by school principals (17.6%). The remaining respondents were school psychologists and educational rehabilitators.

According to the survey, the most frequently used outdoor elements were sports playgrounds for physical education and green areas for nature-related teaching. The results indicate that, during the pandemic, school staff became more aware of the potential of outdoor spaces; however, this did not lead to a significant increase in their use, mainly due to the shift to online teaching in most schools. Respondents also highlighted insufficient guidelines and tools to support the development, reconstruction, and optimal use of outdoor spaces, as well as uninspiring environments. In future, respondents plan to use outdoor spaces more extensively, with outdoor classrooms identified as a particularly desirable element. This survey highlighted the need for additional analyses of school outdoor spaces in order to determine their actual condition in relation to data from the literature and collected documentation. Detailed survey results, with statistical and graphical analysis, are presented in Krajnović, M, Lončar-Vicković, S. *School Outdoor Spaces in COVID-19 Pandemic Restrictions—Osijek's Primary Schools' Analysis*, BAB21 [48].

Although the staff survey was conducted in 2021, prior to the publication of the 2022 Standards, its relevance is not affected by this temporal difference. The 2022 Standards represent a revision and expansion of the existing Croatian regulatory framework rather than the introduction of a fundamentally new concept of school outdoor spaces. Earlier legislation, particularly the National Pedagogical Standard for Primary Education—NPS 2008/National Gazette 63/2008 [34], already recognised school outdoor spaces as integral educational environments requiring differentiated sports areas, green areas, gardens and

outdoor teaching opportunities. The 2022 Standards primarily provide greater differentiation of outdoor-space typologies and support the transition towards full-day schooling. Consequently, the 2021 survey remains an appropriate contextual source regarding teachers' perceptions and patterns of outdoor space use.

The second phase involved detailed field observation and school site visits. Site visits were conducted during 2023 to observe the physical characteristics and current condition of outdoor spaces. Direct observation was complemented by photographic documentation, drone photography, and satellite imagery obtained through Google Maps. These methods enabled accurate identification of outdoor space elements, circulation patterns, landscape features, boundary conditions, and connections between indoor and outdoor environments. Field observations focused on the presence, condition, accessibility, and spatial organisation of educational, recreational, and service-related outdoor facilities.

The third phase included graphic analysis and mapping of external spaces, a description of the spatial characteristics of school external spaces, and comparative analysis based on collected data (project documentation, drone footage, satellite images and field observations). For each school, a catalogue sheet was developed to ensure a consistent analytical approach. Each catalogue sheet contained:

- General school data;
- Description of the spatial characteristics of the site;
- Outdoor spaces graphical analysis;
- Photographs of existing conditions.

Outdoor spaces were classified as general-use spaces and teaching-area spaces, as defined in Standards 2022. Additional categories identified through a literature review were incorporated into the analysis, including outdoor classrooms, transitional spaces, circulation paths, covered areas, playgrounds, and site boundaries (borders). Also, for each school, spatial characteristics were described.

An example is used to demonstrate the catalogue structure and the application of the assessment criteria. The illustrative example is OS03 (Primary School Frana Krste Frankopana), presented in Table 1 as well as Figures 1 and 2. The findings reported in this paper are derived from the comparative analysis of the complete dataset.

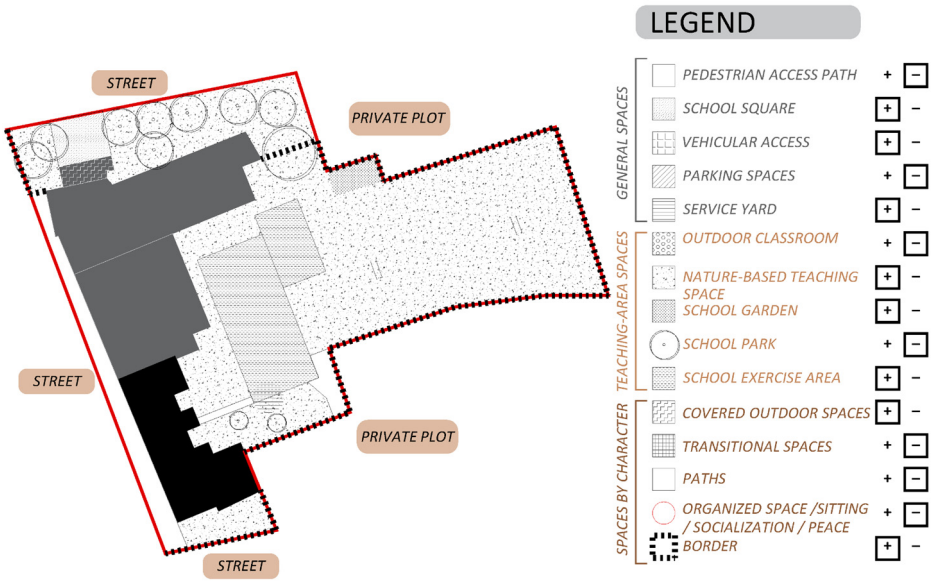

Figure 1. Catalogue example—Outdoor spaces graphical analysis (Fran Krsto Frankopan Primary School).

Table 1. Catalogue example—General School data and spatial characteristics (Fran Krsto Frankopan Primary School).

General School Data			
Location	Fran Krsto Frankopan Street 64		
Construction year	1925.	1957./58.	1988./89.
Author/architect	unknown author	Kralik Josip	Milenko Musović
Site area	**School building area**	**Outdoor spaces area**	**BCR**
9092 m^2	2437 m^2	6655 m^2	0.268 (0.27)
Location in the city	Center	Wider Center	Periphery
Floors	Ground floor + 2		
Roof	Pitched	Combined	Flat
Spatial Characteristics			
Parameter	**Description**		
Size/area	The area of the school's outdoor spaces is larger than that of the school building, dominating the site. The BCR is 0.27. The outdoor spaces allow development of outdoor facilities.		
Design	The design of the outdoor spaces is generic with limited quality, diversity, or usability. Asphalt playground and undeveloped green areas predominating. A school garden is present. Material diversity is missing.		
Disposition	The school building with a sports hall forms the boundary of the plot towards the public space on the west and north sides. Although the outdoor spaces are protected from street influence and border private plots to the south and east, the school square with a porch is accessible to the public and not fenced.		
Facilities	There is an average provision of outdoor facilities, including a small exercise area, an open grassed surface, a small school garden, and a school square. The covered space available for free use serves as an entrance colonnade. Most facilities exist but have limited quality, diversity, or usability.		
Connections/relations	There is a weak visual and spatial connection between indoor and outdoor spaces, as there is no direct access from ground-floor classrooms to the exterior. The façade is dominated by windows with a high parapet. The outdoor spaces are physically and visually separated from the surrounding urban environment. The boundary to public space consists of opaque or high fencing and walls, or the school building. Public use of outdoor spaces outside school hours is either not possible or heavily restricted, and there is no pedestrian permeability.		

Field observations were not directly converted into numerical performance scores but were systematically recorded using predefined indicators. Each school was analysed with the same evaluation framework, allowing comparison between cases.

The process consisted of four steps:

1. Data collection: spatial measurements, photographs, cadastral analysis, and field observations were gathered for each school.
2. Indicator assessment: each observed characteristic was assigned a value according to the predefined coding rules.
3. Parameter interpretation: individual indicators were grouped into five main parameters (area, design, disposition, facilities, and connections).
4. Comparative evaluation: the resulting parameter profiles were used to identify the strengths, limitations, and spatial potentials of each school's outdoor space.



Figure 2. Catalogue example—Photographs of existing conditions (Fran Krsto Frankopan Primary School).

This approach enabled the qualitative characteristics of school outdoor spaces to be systematically compared while maintaining the complexity of architectural and spatial conditions that cannot be fully represented through quantitative measurements alone.

The fourth phase was a comparative evaluation. To evaluate the quality and functional capacities of school outdoor spaces, a comparative analytical framework was developed based on five key parameters: plot size, design, disposition, content/facilities, and connections/relations (Figure 3).

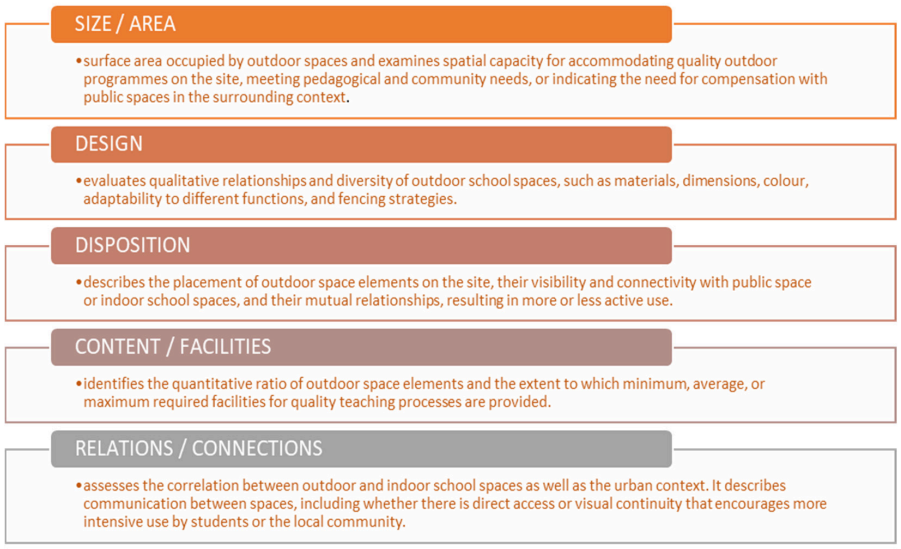

Figure 3. Parameters for school outdoor spaces analysis.

Quantitative indicators are reported in their original units and against regulatory thresholds where applicable. Qualitative indicators are coded according to their categories or as presence/absence based on field observation, photographic documentation, and the standardised catalogue sheets. The five dimensions have equal analytical status, but since no empirical evidence is available for assigning differential weights, they are not aggregated into a single composite quality score. This avoids implying a level of validation which the present dataset cannot support, but rather provides a basis for future research.

3.1. Size/Area

The size parameter assessed the quantitative capacity of outdoor spaces through measurements of site area, site area per student, outdoor area per student, and building coverage ratio. Quantitative values were obtained from cadastral data and graphical

analysis, and site area per student was compared with the minimum values defined by the Croatian Standards 2022 (30 m^2/student for the total school site).

Results were coded into three categories:

A. Area $\geq$ 30 m^2/student: the outdoor space allows the development of diverse educational and recreational functions and meets or exceeds recommended standards.
B. Area 20–30 m^2/student: the outdoor space is usable but requires careful organisation, multifunctional use or support from surrounding public spaces.
C. Area < 20 m^2/student: the available outdoor space does not allow adequate implementation of educational and recreational functions and requires compensation through external resources.

3.2. Design

The design parameter evaluates the qualitative characteristics, diversity and adaptability of outdoor spaces, and examines the physical character of the outdoor environment, including materials, vegetation, spatial diversity and the presence of covered or shaded areas. Each variable was evaluated through qualitative observation using a three-level scale.

- 0—absent: element is not present or spatial quality does not support the intended function.
- 1—partially developed: element exists but has limited quality, diversity, or usability.
- 2—developed: element is clearly present, appropriately designed, and supports multiple uses.

3.3. Disposition

Disposition refers to the spatial arrangement of outdoor elements within the school plot and their relationship with the surrounding urban context. Outdoor spaces were classified by typology:

- Introverted type (I): outdoor spaces are protected from public influence and primarily oriented toward internal school use.
- Extroverted type (E): outdoor spaces are directly connected with the surrounding public environment and visually accessible.
- Integrated type (IN): outdoor and public spaces are spatially interconnected, creating a continuous learning environment.

3.4. Content/Facilities

The content/facilities parameter evaluates the presence and diversity of outdoor space functions relevant to contemporary educational processes. Outdoor spaces were classified by general-use spaces and teaching-area spaces. Additional categories identified through the literature review that are not included in Standards 2022 were incorporated into the analysis, including transitional spaces, circulation paths, covered areas and site boundaries (borders). Facilities were recorded using presence/absence coding:

Not Present
Present

3.5. Connections/Relations

The connections and relations parameter examined visual, physical, and functional links between indoor and outdoor environments, as well as the degree of integration between school grounds and the wider urban setting.

The relationship between indoor and outdoor spaces was evaluated as:

0—weak connection: no direct access or visual relationship between indoor and outdoor environments.

1—moderate connection: visual connection exists or limited access is possible.

2—strong connection: direct access, spatial continuity and active interaction between indoor and outdoor environments.

The relationship with the public context was evaluated using the same approach:

0—closed boundary: Outdoor spaces are physically and visually separated from the surrounding urban environment. Opaque or high fencing and walls, school buildings or dense vegetation block visibility and accessibility. Public use of outdoor spaces outside school hours is either not possible or heavily restricted, and there is no pedestrian permeability.

1—partially permeable boundary: Clear physical boundary that allows limited visual and physical interaction with the surrounding neighbourhood. Low or transparent fencing, outdoor facilities (playgrounds or school square) occasionally accessible outside school hours, with the boundary interrupted only at designated access points.

2—open and interactive boundary: Transparent or minimal boundary elements; direct visual continuity between school grounds and public space; pedestrian routes passing through or along the school site; publicly accessible outdoor facilities; school square or playground functioning as part of the neighbourhood public space outside teaching hours.

4. Results

The results presented in this section are based on a comprehensive mixed qualitative-comparative analysis of the outdoor spaces of fifteen primary schools in the city of Osijek. The analysis follows the methodological framework established in the previous section and evaluates each school according to five principal parameters: size/area, design, disposition, content/facilities, and connections/relations between indoor and outdoor environments. These parameters were selected because they collectively describe both the quantitative and qualitative characteristics of school outdoor spaces and their capacity to support contemporary educational practices.

The results are presented through a combination of quantitative indicators and qualitative spatial evaluation. Quantitative data, including building coverage ratios, plot dimensions, outdoor space per student, and compliance with national standards, provide an objective assessment of spatial capacity. These findings are complemented by qualitative observations concerning the spatial organisation, landscape design, diversity of outdoor facilities, accessibility, and the relationship between school grounds and the surrounding urban environment. Rather than evaluating schools individually, the emphasis is placed on identifying common spatial patterns that characterise primary school outdoor spaces in Osijek and assessing their physical capacity to support different outdoor activities. The analysis evaluates spatial conditions and spatial affordances; it does not measure actual use frequency, student experience, teaching quality, or learning outcomes. Accordingly, statements below refer to the presence, absence, diversity, or accessibility of spatial features rather than to demonstrated educational effects.

The following sections present the results for each evaluation parameter separately. This structure enables a detailed examination of the strengths and limitations of the existing school environments while establishing the basis for the discussion and strategic recommendations proposed in the subsequent section.

4.1. Size/Area Results

The first element of the analysis is the examination of outdoor space areas, school plot sizes, and building coverage ratios to determine capacities for developing outdoor programmes (Table 2).

Table 2. Osijek Primary Schools—construction year, plot and school building area, building coverage ratio, outdoor spaces area, number of students and class sections (data from 2021), plot area per child and outdoor area per child.

No.	Primary School (PS)	Construction Year	Site Area (m^2)	School Building Area (m^2)	Building Cover Age Ratio (BCR)	Outdoor Spaces Area (m^2)	Students	Site Area per Child (m^2)	Outdoor Spaces Area per Child (m^2)
OS01	PS Jagode Truhelke	1790	7934	2384	0.30	5550	453	17.51	12.25
OS02	PS Svete Ane	1863	1538	1355	0.88	183	356	4.32	0.51
OS03	PS Frana Krste Frankopana	1925	9092	2437	0.27	6655	507	17.93	13.13
OS04	PS "Dobriša Cesarić"	1939	5235	2183	0.42	3052	326	16.06	9.36
OS05	PS Vladimira Becića	1961	9270	1775	0.19	7495	292	31.75	25.67
OS06	PS Vijenac	1963	8327	1464	0.18	6863	235	35.43	29.20
OS07	PS Ljudevita Gaja	1963	13,494	1639	0.12	11,855	244	55.30	48.59
OS08	PS Franje Krežme	1964	1695	1394	0.82	301	350	4.84	0.86
OS09	PS Ivana Filipovića	1967	11,684	1588	0.14	10,096	483	24.19	20.90
OS10	PS "August Šenoa"	1968	13,224	1528	0.12	11,696	259	51.06	45.16
OS11	PS "Grigor Vitez"	1968	12,493	1683	0.13	10,810	291	42.93	37.15
OS12	PS "Tin Ujević"	1972	36,514	2547	0.07	33,967	422	86.53	80.49
OS13	PS Antuna Mihanovića	1977	3420	1620	0.47	1800	360	9.50	5.00
OS14	PS "Mladost"	1981	10,110	2738	0.27	7372	468	21.60	15.75
OS15	PS "Retfala	1985	20,208	2746	0.14	17,462	540	37.42	32.34

Eight of the 15 schools (53.3%) have building coverage ratios below 0.2, and ten (67.7%) are below 0.3, indicating generally satisfactory outdoor space availability. Two schools (OS02, OS08), located in the city centre with high building coverage ratios (>0.8), have very limited or no potential to use their own site resources for educational or other purposes and therefore rely on surrounding public urban spaces. In such cases, the quality of the surrounding context or the vertical organisation of content plays a significant role in the teaching process.

Eight out of fifteen schools have a smaller site area per child than the 30 m^2 prescribed by Standards 2022. In exceptional cases (e.g., dense urban fabric, multi-storey buildings, or use of the surrounding context), the minimum area may be reduced but not below 20 m^2 (NPS 2008); however, six schools fall below this minimum threshold (Table 3), which is the threshold considered necessary for a quality educational process. According to the standards from 2022, in these cases compensation should be found in the neighbouring area in immediate proximity to the school, within a five-minute walk. Four schools exceed 40 m^2 per child (OS07, OS10, OS11, OS12), all located in peripheral areas with very low building coverage ratios.

Table 3. Size/Area parameter evaluation: A—≥30 m^2/student; B—20–30 m^2/student; C—<20 m^2/student.

Size/Area	OS 01	OS 02	OS 03	OS 04	OS 05	OS 06	OS 07	OS 08	OS 09	OS 10	OS 11	OS 12	OS 13	OS 14	OS 15
A—≥30 m^2/student					A	A	A			A	A	A			A
B—20–30 m^2/student									B					B	
C—<20 m^2/student	C	C	C	C				C					C		

Although the building coverage ratios indicate very satisfactory spatial capacity, data on school site area per child show that fewer than 50% of schools meet the threshold set out in Standards 2022. Across the sample, mean plot area per student is 30.42 m^2 (SD 22.11; median 24.19), while mean outdoor area per student is 25.09 m^2 (SD 21.54; median 20.90). The large dispersion confirms that the sample is spatially heterogeneous and that a statement of generally 'sufficient' spatial resources would be misleading. These cases illustrate why building coverage must be interpreted together with per-capita site area, outdoor area, configuration, and surroundings rather than used as a proxy for outdoor-space quality.

4.2. Design Results

The design parameter demonstrates that the outdoor spaces of primary schools in Osijek generally exhibit a low to moderate level of spatial diversity, with considerable variation among individual design elements. There is no clear differentiation or zoning by colour or materials, nor significant variation in height or covered areas (Table 4).

Table 4. Design parameter evaluation: 0—absent; 1—partially developed; 2—developed.

Design	OS 01	OS 02	OS 03	OS 04	OS 05	OS 06	OS 07	OS 08	OS 09	OS 10	OS 11	OS 12	OS 13	OS 14	OS 15
Materials diversity	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0
Vegetation	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1
Spatial diversity	1	0	1	2	1	1	1	0	1	1	1	1	1	1	1
Covered or shaded areas	0	0	1	1	1	0	0	0	2	0	0	0	0	0	1

Material diversity received the lowest scores of all evaluated indicators. Most schools were assessed as 0 (absent), indicating that outdoor spaces are predominantly characterized by a limited range of surface materials, typically consisting of asphalt playgrounds and grassed areas with little variation in paving, texture, or functional zoning. With few exceptions, such as OS09—Primary school Ivan Filipović, which achieves diversity through vegetation and materials, asphalt playgrounds and open grassy areas predominate.

Partially developed vegetation reflects the consistent presence of lawns and mature trees, suggesting that vegetation is generally limited to conventional landscaping and does not provide diverse educational, ecological, or sensory functions.

Similarly, spatial diversity was predominantly evaluated as 1 (partially developed), indicating that most school sites contain some differentiation of outdoor spaces but lack clearly articulated zones with distinct functions or spatial identities. Elements exist but have limited quality, diversity, or usability.

The weakest performance was observed in the provision of covered or shaded areas. Nine of the fifteen schools received a score of 0 (absent), indicating that outdoor spaces generally provide limited protection from rain or excessive solar exposure. Only five schools have covered or shaded areas, also partially developed. The suitability of the space for pedagogical activities is therefore only possible through additional design interventions that increase the variety of didactic tools for outdoor learning. No horizontal or vertical interweaving of indoor and outdoor spaces has been identified. These observations indicate differing spatial affordances for outdoor activity and should not be interpreted as direct evidence of teaching quality or frequency of pedagogical use.

4.3. Disposition Results

The spatial disposition of outdoor elements in Osijek's primary schools follows post-World War II planning principles, with the school building centrally positioned on the plot and outdoor spaces surrounding it, reflecting the period of construction. The site layout of all 15 schools is shown in Figure 4. The accessibility and visibility of outdoor spaces from the urban context, as well as their protection from external influences, were analysed, and they are classified as extroverted, introverted, or integrated types.

Most outdoor spaces (13) are classified as extroverted type, serving as transitional zones between public urban space and the school building. Fewer schools have some elements of outdoor spaces organised as atriums or located further from public areas, resulting in more introverted qualities and partial integration with indoor spaces. However, fully integrated types, with spatially interconnected outdoor and public spaces, creating a continuous learning environment, were not identified (Table 5). The introverted type is found in centrally located schools (OS02 and OS08), where the school building occupies the school site and defines the boundary with the public space, protecting the outdoor spaces from the street. In both cases, there is insufficient capacity in the outdoor spaces.

Table 5. Typological classification of school outdoor spaces in Osijek.

Typological Type	Number of Schools
(I) Introverted type	2 (OS02 and OS08)
(E) Extroverted type	13
(IN) Integrated type	0

On highly compact sites with very high building coverage ratios, the use of outdoor spaces depends on the quality of nearby public spaces or the possibility of using school rooftops. This is particularly evident in the two centrally located schools—OS02 (Primary School Sveta Ana) and OS08 (Primary School Franje Krežme)—which rely heavily on adjacent public spaces and have unused flat roof potential. However, the present research

does not assess rooftop structural capacity, fire safety, evacuation, accessibility, management arrangements, or the suitability of neighbouring public spaces for school use, so no claim of immediate convertibility is therefore made.

Field research and graphical analysis also showed that, in most cases, outdoor elements are arranged to avoid mutual interference, although some conflicts arise where service yards or staff parking areas are adjacent to educational spaces. This is visible in the OS01 example (PS Jagode Truhelke), where the school square is used as a parking space with a garbage can adjacent next to it. These findings highlight the need to reconsider existing school sites through a more flexible approach that balances safety, accessibility, and the spatial potential of outdoor spaces to support contemporary pedagogical practices.

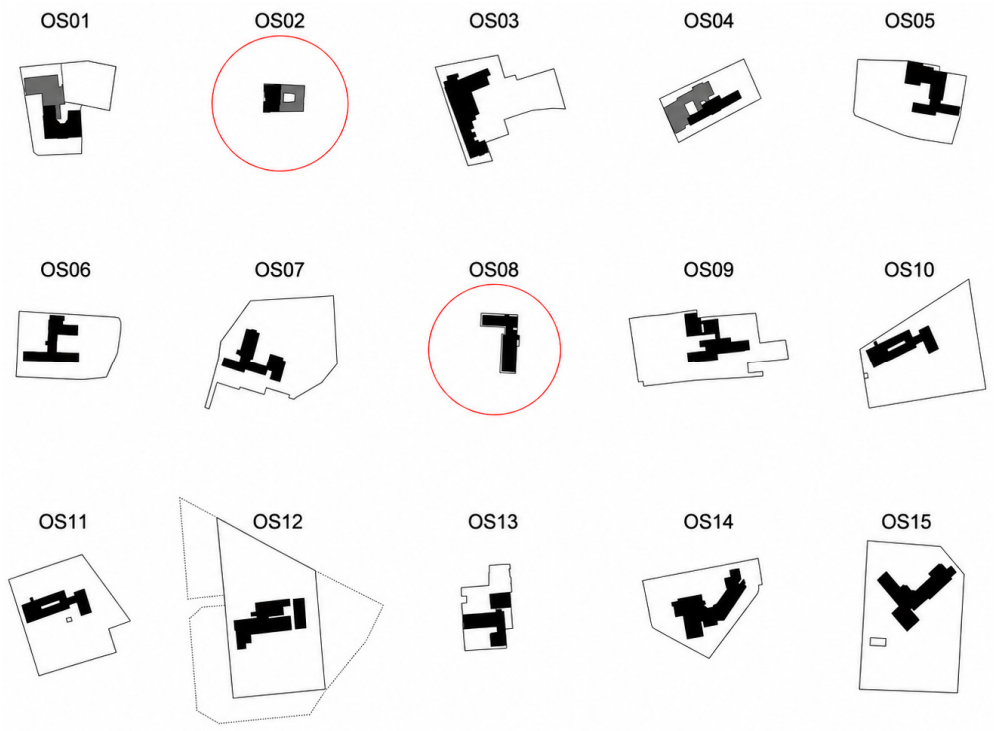

Figure 4. Analysed primary school plots—built (black—original school building, grey—annex addition) and unbuilt (white) areas; the introverted type is marked red (source: authors).

4.4. Content/Facilities Results

School outdoor facilities were analysed based on the division into general-use spaces and teaching-area spaces. Based on the literature review and defined characteristics, an additional analysis of outdoor spaces was conducted according to their character, i.e., whether they include covered zones, private areas, transitional spaces or circulation paths (Figure 5).

Primary schools in Osijek generally provide most required general-use spaces; however, there is an imbalance in teaching-area spaces, with a lack of key elements such as outdoor classrooms or school gardens for nature-based teaching. Playgrounds, open grassy areas, and school squares are the most common teaching-area elements. While they support physical activity and social interaction, there is a clear lack of outdoor classrooms, which limits the use of outdoor spaces for group work, experiential learning, and activities during poor weather. Other elements such as flowerbeds, school gardens, and parks are only partially represented but have strong potential to enhance environmental quality, biodiversity, and the aesthetic value of school grounds.

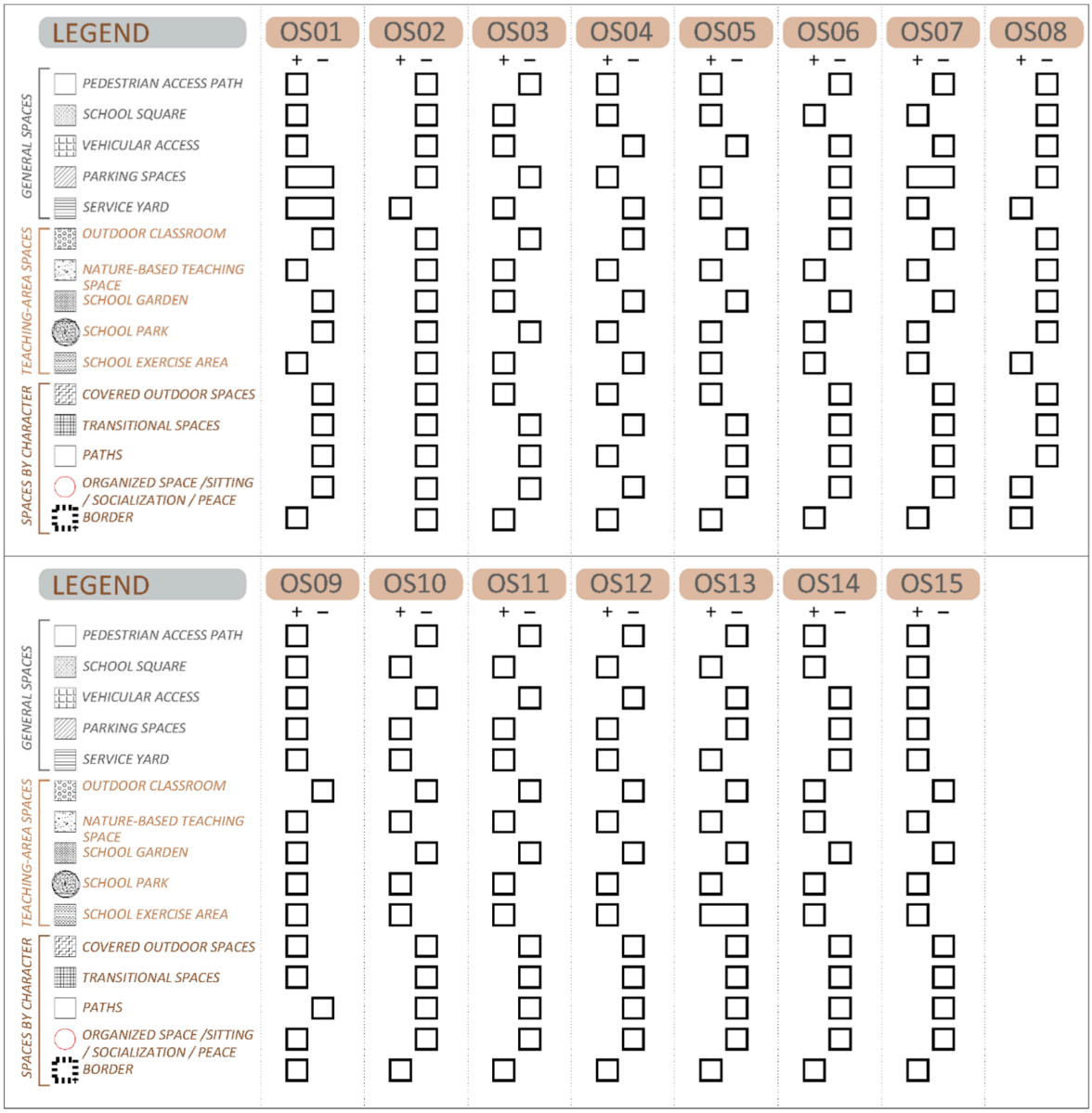

Figure 5. School outdoor spaces facilities overview/Facilities were recorded using presence/absence coding.

This analysis revealed a very low level of spatial elements like covered zones, private areas, transitional spaces or circulation paths, despite their importance in full-day schooling models (Table 6). There is significant potential for improvement given the generally sufficient land area available in most cases. However, given the substantial variation in per-capita site area, opportunities for intervention differ considerably between schools and must be assessed case by case.

Table 6. Content/Facilities parameter evaluation: minimum, average or maximum required facilities.

Content/Facilities	OS01	OS02	OS03	OS04	OS05	OS06	OS07	OS08	OS09	OS10	OS11	OS12	OS13	OS14	OS15
General use spaces (max. 5)	5	1	3	3	4	1	3	1	5	3	3	3	2	2	5
Teaching area spaces (max. 5)	2	0	3	2	3	3	3	1	4	3	3	3	3	4	3
Spaces by character (max. 4)	0	0	1	2	1	0	0	1	3	0	0	0	0	0	0

4.5. Connections/Relations Results

The connections and relations parameter examined visual, physical, and functional links between indoor and outdoor environments, as well as the degree of integration between school grounds and the wider urban setting. In all cases, there is a noticeable lack of strong physical and functional integration between outdoor school spaces and ground-floor classrooms. Openings in school façades do not provide direct access from classrooms to outdoor spaces, and parapets prevent direct visual and physical connections between indoor and outdoor environments (Table 7, Figure 6).

Table 7. Connections/Relations parameter evaluation: The relationship between indoor and outdoor spaces: 0—weak; 1—moderate; 2—strong.

Connection/Relation	OS01	OS02	OS03	OS04	OS05	OS06	OS07	OS08	OS09	OS10	OS11	OS12	OS13	OS14	OS15
Weak	0	0	0					0							
Moderate				1	1	1	1		1	1	1	1	1	1	1
Strong															



(**a**) (**b**)

Figure 6. The most common form of connection between indoor classrooms and school outdoor spaces: (**a**) PS Vladimir Becić. (**b**) PS Ivan Filipović.

Four examples demonstrate a weak spatial relationship between indoor and outdoor environments, characterised by the absence of direct access and limited visual connectivity. In these cases, classrooms are mainly oriented towards public spaces or streets, with fewer façade openings, which further restricts visual interaction and permeability between interior and exterior areas.

This creates challenges for using outdoor spaces, particularly for teaching activities that could engage with them directly or during breaks between lessons. Therefore, it is important to design solutions that ensure easier access to outdoor spaces from indoor environments, including possible façade modifications to improve spatial continuity and user flow between interior and exterior areas, considering that any façade modification intended to improve access would require case-specific assessment of structure, accessibility, fire safety, supervision, and heritage constraints.

The relationship between school sites and adjacent public spaces does not demonstrate a pronounced tendency towards introversion, except in cases where the school building itself constitutes the primary boundary element. Site perimeters are predominantly defined by low, visually permeable metal fences or vegetated barriers, which are often discontinuous or partially open, enabling varying degrees of public visibility and physical access (Figure 7, Table 8).



(**a**) (**b**)

Figure 7. Transparent low-rise fence as a border and play area: (**a**) PS Retfala. (**b**) PS Mladost.

Table 8. Connections/Relations parameter evaluation: The relationship with the public context: 0—closed boundary; 1—partially permeable boundary; 2—open and interactive boundary.

Connection/Relation	OS01	OS02	OS03	OS04	OS05	OS06	OS07	OS08	OS09	OS10	OS11	OS12	OS13	OS14	OS15
0—closed boundary		0						0	0				0		
1—partially permeable boundary	1		1	1	1	1	1			1				1	1
2—open and interactive boundary											2	2			

Four examples have closed boundaries with outdoor spaces physically and visually separated from the surrounding urban environment. The boundary is a school building, high fence or wall, or placement within a block of private plots. Most examples (9) are characterised by a partially permeable boundary that allows limited visual and physical interaction with the surrounding neighbourhood, occasionally providing access to outdoor facilities (playgrounds or school square) outside school hours, with the boundary interrupted only at designated access points. These boundary characteristics contribute to increased spatial permeability and, in some cases, facilitate movement through school grounds; however, they do not, in themselves, indicate social integration or sustained community use.

Several examples exhibit characteristics of enhanced spatial integration between the school and the public realm. In these cases, specific elements of the school's outdoor environment, such as the school square in OS01, extend beyond a strictly institutional function by allowing public accessibility and serving as transitional gathering spaces before classes. These areas act as intermediate zones between the urban context and the school environment, strengthening the spatial continuity between public and educational spaces (Figure 8).

Similarly, pedestrian routes crossing school sites, as observed in OS11 (Primary School Grigor Vitez) and OS12 (Primary School Tin Ujević), indicate a degree of spatial continuity with the surrounding urban fabric, where school grounds contribute to the local pedestrian network, partially contributing to the permeability and connectivity of local pedestrian networks. In addition, although school sports fields are generally enclosed by fences, their frequent use by the local community outside school hours suggests potential for shared use and a broader social role of school outdoor spaces within the neighbourhood.



(**a**) (**b**)

Figure 8. School square without a fence, accessible to the public: (**a**) PS Vladimir Becić. (**b**) PS Jagode Truhelke.

5. Discussion

Based on the findings of this study, several key issues and opportunities regarding primary schools' outdoor spaces in Osijek can be identified for future planning, design, and management of school outdoor spaces (Figure 9). The findings are therefore interpreted through the relationship between quantitative capacity, spatial diversity, connectivity, and urban context.

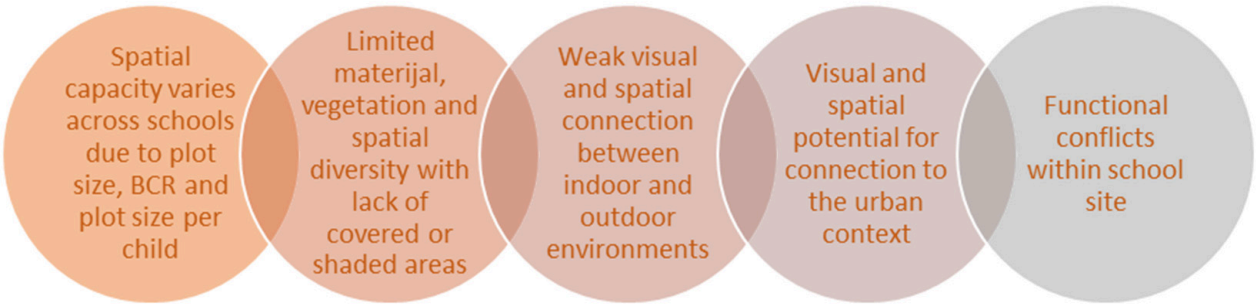

Figure 9. Key issues identified with research.

The results indicate that the spatial capacity of primary school outdoor areas varies considerably, with some schools experiencing limitations related to plot size, building coverage, and the availability of outdoor spaces. In cases where the area of the school plot restricts the provision of diverse outdoor elements, opportunities should be explored through a broader interpretation of the school environment and its relationship with the surrounding urban structure. Also, in compact urban locations, where horizontal outdoor space is limited, roof areas may represent additional spatial resources that could complement existing outdoor environments. Their transformation requires detailed assessment of structural capacity, accessibility, safety requirements, and technical constraints. The potential conversion of these areas should therefore be considered as a spatial planning opportunity rather than an immediately applicable intervention.

Second, the analysis reveals that the spatial diversity of existing outdoor environments is generally limited. Many school grounds are characterised by large, undifferentiated outdoor areas with insufficient variation in surface materials, vegetation structures, shading elements, and spatial subdivisions. Increasing the diversity of outdoor elements could improve the range of spatial conditions available within school grounds. This includes introducing different landscape typologies, smaller-scale spatial units, multifunctional areas, shaded zones, and flexible outdoor structures. Such interventions should be understood

as spatial adaptations that increase the functional capacity and environmental quality of school grounds without assuming specific patterns of use.

The connection between indoor and outdoor spaces is weak due to limited façade articulation, restricted visual connections, and the absence of direct transitional spaces. Classroom façades facing outdoor areas often provide insufficient permeability between interior and exterior environments, reducing the potential for spatial continuity. Improvements to the building envelope, including larger openings, transparent elements, covered transitional zones, and direct connections to outdoor areas, could strengthen the physical relationship between learning spaces and external environments.

In contrast, the relationship between school sites and the surrounding urban context demonstrates greater potential for spatial integration. Fences are low and transparent, and school areas are clearly visible within the neighbourhood. Where adjacent public spaces demonstrate suitable spatial characteristics, such as accessibility, safety, proximity, and adequate spatial quality, they may represent a potential extension of the school's outdoor environment. However, such integration requires contextual assessment and appropriate management frameworks to define accessibility, ownership, and spatial responsibilities. Additionally, by analysing and grading outdoor space contents according to required security levels, it is possible to determine which areas could be made accessible to the local community. This broader interpretation of the school environment could support greater spatial integration between schools and their neighbourhoods while maintaining appropriate levels of safety, management, and control.

Finally, the spatial organisation of school grounds reveals conflicts between educational, service, and circulation functions. In several cases, service yards, vehicle access routes, and staff parking areas are positioned adjacent to or within spaces intended for outdoor educational functions, reducing the clarity of spatial organisation and limiting the potential flexibility of these areas. As a result, the use of school squares is often compromised due to vehicle occupancy. Future interventions should prioritise clearer functional zoning by separating service-related activities from student-oriented outdoor areas and improving pedestrian continuity within school sites. The relocation or reorganisation of parking and service infrastructure could increase the availability of outdoor areas with appropriate spatial qualities and support a more coherent arrangement of school grounds.

Based on these findings, several strategic recommendations are proposed:

- Increase the spatial diversity of school outdoor spaces by introducing a wider range of outdoor typologies including gardens, outdoor classrooms, and flexible learning zones;
- Improve material and vegetation diversity through planting, shading, and multifunctional surfaces;
- Strengthen spatial continuity between indoor and outdoor environments by improving façade permeability, providing direct physical access, and creating transitional spaces that connect classrooms with external areas;
- Optimise the spatial organisation of school sites by separating educational, service, and vehicular functions through clearer zoning and circulation patterns, thereby reducing spatial conflicts between service and educational functions;
- Improve the integration of school grounds within the surrounding urban context by identifying outdoor spaces that can accommodate controlled public access.

The spatial characteristics identified in Osijek's primary school outdoor spaces reflect broader patterns observed in post-war school planning across Central and Eastern Europe, where educational facilities constructed during the second half of the 20th century were typically developed as freestanding buildings within relatively generous plots, surrounded by outdoor spaces separated from the public realm. However, they often result in limited

spatial integration with contemporary urban structures and reduced adaptability to changing spatial requirements. The predominance of low and visually permeable fences reflects a common planning approach from the socialist period, where school sites were physically separated but remained visually connected to neighbourhoods. Visual permeability does not necessarily correspond to functional integration, and contemporary approaches increasingly distinguish between physical openness, shared access, and community-oriented spatial organisation.

Recent international approaches to school design conceive outdoor environments as interconnected spatial systems rather than residual areas around buildings, demonstrating spatial diversity through the integration of varied landscape structures, ecological elements, flexible outdoor areas, and transitional spaces between buildings and outdoor spaces. In contrast, the analysed schools in Osijek show limited differentiation of outdoor typologies. Outdoor spaces are predominantly characterised by larger open surfaces with limited subdivision, modest vegetation structures, and a smaller range of spatial conditions. This indicates a design legacy in which outdoor spaces were primarily considered as a functional requirement of the school plot rather than a complex spatial environment with multiple affordances.

Although developed through the case of Osijek, the proposed framework is intended to be transferable. The five evaluation parameters are independent of Croatian legislation and may be adapted to other urban contexts by replacing the regulatory thresholds while retaining the comparative structure. The framework may therefore support future evaluations of existing school networks in other cities and facilitate comparative architectural research into educational environments.

The findings from Osijek can therefore contribute to broader discussions on the transformation of existing educational infrastructure in European cities, where the focus has shifted from constructing new school buildings towards adapting and upgrading existing sites. Rather than replacing established school structures, many urban contexts are exploring incremental spatial interventions, such as improving landscape quality, increasing functional diversity, introducing climate-responsive elements, and strengthening connections between indoor and outdoor areas. In this view, Osijek's school grounds represent a significant spatial resource, where relatively stable urban locations and existing outdoor spaces provide a basis for gradual transformation. Future interventions should therefore focus not on replicating new school models, but on reinterpreting existing spatial structures through context-specific strategies that enhance diversity, connectivity, and adaptability.

6. Conclusions

This research confirms that primary school outdoor spaces in the City of Osijek are an essential but insufficiently developed part of the educational environment. Although the analysed schools have outdoor areas of varying capacities, their current spatial organisation, configuration and degree of differentiation limit their potential to function as adaptable, multifunctional environments.

The findings reveal a consistent lack of spatial diversity, limited programmatic content beyond standard sports facilities, and weak visual, functional and spatial links between indoor and outdoor environments. Opportunities to expand the use of existing spaces, such as rooftops or transitional zones, remain largely unexplored. Functional conflicts, especially between educational and infrastructural uses, further reduce the quality and usability of these spaces. Outdoor spaces, predominantly sufficient in size, demonstrate considerable unrealised spatial potential.

Addressing these challenges requires a systematic, interdisciplinary approach that integrates architectural design, educational practice, and urban planning. Interventions should

focus on enhancing spatial diversity, improving environmental quality, strengthening indoor–outdoor continuity, and reorganising site functions to create clearer and more adaptable spatial structures. Rather than increasing outdoor space solely through expansion, priority should be given to improving the quality, configuration, and range of spatial affordances within existing school grounds. This would significantly support the goal of creating inviting outdoor spaces that facilitate outdoor learning. The transformation of primary school outdoor spaces should be approached as a process of incremental spatial adaptation, in which existing structures are reinterpreted and optimised rather than replaced. By enhancing spatial diversity, connectivity, accessibility and flexibility, school grounds can evolve into resilient spatial systems that integrate more effectively with contemporary urban contexts and accommodate the changing requirements of educational environments.

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Abbreviations

The following abbreviations are used in this manuscript:

PS	Primary School
NPS2008	National Pedagogical Standard for the Primary Education System in the Republic of Croatia

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