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Framework for the Design of a Small Transport Hub as an Interdisciplinary Challenge to Implement Sustainable Solutions

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Abstract: The numerous effects of climate change on the urban environment over the past decades have urged many planning professionals to implement the United Nations' Sustainable Development Goals (SDGs). Higher education institutions (HEIs) bear particular responsibility for sustainability-aware designers able to implement specific measures in this field. This paper presents a typology of design solutions for urban contexts intended to implement Sustainable Development Goal 11, which refers to making cities and human settlements inclusive, safe, resilient, and sustainable, which can be included in university curricula. The study presents a comprehensive source base of possible interpretations of sustainability guidelines in architectural, landscape, and transport solution design and can be used to guide and assess projects in these fields. Solutions identified and analyzed were grouped into four dimensions related to sustainability aspects (accessibility, ecology, functionality, and identity). The framework proposed was developed based on the teaching experience of thesis design projects and practice-based workshop course projects featured in the curricula of first and second cycle Architecture, Landscape Architecture, and Transport programs taught at the Cracow University of Technology, Poland. The projects were prepared as a part of workshop-based public consultations for a real-world project—the construction of a transport hub in Hrubieszów, Poland. The most complex implementation of various individual sustainable design solutions was linked to the interdisciplinarity of the design team and the broadest public participation spectrum.

Keywords: small public transport hub; landscape architecture; architecture; green design solutions; sustainable transport; environmental education; SDG; multidisciplinary workshop; small city transport exclusion

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1. Introduction

Recent decades have brought increasing awareness of the need to educate professionals in many fields to enable them to deal with multifaceted sustainability challenges. Also, architects and landscape architects have to respond to rapidly occurring demographic, social, economic, environmental, and technological changes [1] in order to improve the resilience of various types of landscapes, buildings, and settings. In creative disciplines such as architectural design and landscape architecture, research by design [2,3] and multidisciplinary teamwork to address environmental and societal challenges are highly valued, as noted by Giorgi et al. [4]. Attempts to develop an adequate pedagogy for design studio curricula aim to tackle interactions between objects, systems, and actors,

including architecture and locally specific environments that are sometimes referred to as performance-oriented architecture [5]. Due to the complexity of sustainable green solutions-related issues, many educators recommend case-based teaching [6]. A comprehensive manual has been developed to facilitate their introduction into teaching [7].

Another approach stressing the importance of multidisciplinary and collective design efforts is Geodesign, introduced by Dangermond [8] and popularized by many famous landscape architects, e.g., Carl Steinitz [9]. Regardless of the frameworks applied, it is obvious that the complexity of the issues to be addressed exceeds the competencies of any single profession [10].

1.1. Sustainable Development Goals in the Literature

The United Nations 2030 Sustainable Development Goals [11] set ambitious yet necessary objectives that create a framework for achieving sustainability in many fields. A comprehensive review of how the SDGs were formulated and how their implementation can be monitored using remote sensing was presented by Estoque [12]. Monitoring SDG implementation was also investigated by Allen et al. [13], who used multicriteria analysis (MCA) to assess SDG application levels in 22 Arab countries, using criteria such as urgency, systemic impact, and policy gaps. A much wider study of how SDGs interact with each other was undertaken by Pradhan et al. [14], who isolated synergies and compromises in this field and concluded that SGD application must focus on entire systems instead of singular goals.

While many SDGs are linked with the landscape, urban planning, and architecture, SDG 11—"Make cities and human settlements inclusive, safe, resilient and sustainable"—seems to be the most relevant and comprehensive for addressing urban design challenges as it refers to making cities and human settlements inclusive, safe, resilient, and sustainable.

This study was carried out at the Faculty of Architecture of the Cracow University of Technology, Poland. SDGs are featured in its curriculum in many fields. The seventeen detailed SDGs are referenced by curricula at all study levels of Architecture and Landscape Architecture programs [15]. SDGs are seen as an element that can inform projects and policies, including various bottom-up and top-down approaches [16], and can be applied to multiple areas [17]. SDGs have also been explored from a perspective of applicability in education [18], including higher education [19]. In this context, it has been reported that there are still steps that need to be taken toward their integration at the university level. Ferguson and Roofe explored SDG 4 [20]—"Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". In addition, Maruna [21] presented the integration of SDGs in planning education, specifically focusing on SDG 11, and noted that further research into SDG integration in education was necessary, especially the collection of experiences of students and instructors, which this study partially sets out to do. Apart from being faced with theoretical problems, students are also invited to engage in projects that solve actual problems relating to real-world sites on multiple scales. Such design assignments are often supplied by local governments with which the university cooperates as part of various programs. As authors, we believe that such assignments are a good case of practice-based environmental education and contribute to demonstrating the necessity of practical knowledge application. In addition, contact with local communities develops social competencies and casts students as ambassadors of green solutions that can be said to be beneficial to those communities and are introduced to satisfy their needs.

Research has also shown that SDGs cannot be funneled into a set mold in education, and that a diverse range of designs and patterns should be applied to them [7] requiring the participation of professionals from multiple disciplines [10]. This study aims to contribute to this diversity by exploring and displaying how SDGs can inform the multidisciplinary education of future design and planning professionals, in order to further enhance sustainability [22]. Studies that fit into the general theme set out in SDG 11 include the research by Del Serrone et al. [23] which presented a project intended to reduce the urban heat island effect in a historical square in Rome, and by Carlorosi et al. [24] which presented a proposal

of multifunctional nodes that would form social spaces in Moscow, following the notion of the 15 min city and combining transport systems with blue-green infrastructure.

Barbier and Burges explored the relations between a systems approach to sustainability and the SDGs, dividing systems into environmental, economic, and social, with the conclusions being that areas for compromise need to be identified [25]. The annual progress of countries in the implementation of SDGs is tracked and the results are published online, with the 2022 version of the report prepared by Sachs et al. [26]. Concerning SDG 11 specifically, its implementation in Germany, as a representative of the global north, was surveyed by Koch and Krellenberg [27], while in the global south it was studied by Petrillo and Bellaviti [28]. SDG was explicitly linked to nature-based solutions (NBS) and the Habitat III new urban agenda by Conti et al. [29]. A review of participatory methods was conducted by Geekiyanage et al. [30], demonstrating that communities mostly participate in urban development sustainability projects in their initial stages, and only then. This participation is mostly based on being given access to information, and consultation, with few projects facilitating involvement and actual cooperation.

1.2. Sustainability Solutions in Small Transport Hub Design

While there are attempts in the literature and in design practice to create catalogues of modular elements suitable for the design of small sustainable transport hubs, these studies tend to focus on technical elements of ensuring accessibility and on major hubs instead of small ones [31]. Although they promote flexible and reusable solutions, thus extending the life cycle of the facility, there is limited specific guidance on the provision of green infrastructure and climate change mitigation solutions based on nature-based solutions for urban heat island effect reduction or rainwater management. One such approach was proposed by Marando et al. [32] who proposed a model that reports ecosystem services (ES) for microclimate regulation, targeting the urban heat island effect via simulating temperature differences between baseline scenarios and scenarios without vegetation. This study proposed a practical, quantitative indicator that can be used by decision-makers and municipal administrators, as it allows them to assess the volume of urban greenery necessary to bring down summer temperatures by a set amount. Solutions of this kind are already being used in large-scale transport hubs and interchange center projects in metropolitan areas around the world, but they are creative responses to site-specific problems by highly competent design firms and reflect the financial leverage of their project sponsors.

Examples include the complex transformation of the Amsterdam Zuid railway interchange [33] prepared by architectural studio ZJA [34], Team V Architectuur, and BoschSlabbers Landschapsarchitecten (in progress) or the project the new Kaohsiung railway station designed by Mecanoo in Taiwan [35]. So far, while many recommendations regarding green and sustainable transport organization and prioritization have been advertised [36], no comprehensive catalogue of guidelines has been developed to support designers and strategic decision-makers in resource-constrained situations, such as those where small transport hubs are built, as well as those specifically tailored to such hubs. Such situations are faced by people in locations considered remote, far away from large cities, as indicated by Charnavalau et al., who investigated transport exclusion and observed that the groups most disadvantaged by this are the elderly and people with disabilities, especially in small towns [37]. The transport-related social exclusion of the elderly was explored by Shergold and Parkhurst [38], who also found this group to be particularly vulnerable when their transportation needs are not met.

A typology of transport hubs was proposed by Weustenenk and Mingardo [39], who divided them using a combination of user numbers, location within a city, and the number/types of modes of transport or ancillary facilities such as parking, carpooling, or access to micro-mobility. Transport networks that consist of small cities and towns and the factors that affect the use of public transport by commuters were presented by Rasca and Saeed [40], alongside a set of policy implications for transport use in such networks. Tennøy [41] investigated how changes in public bus services (route number, course duration,

route geometry) can affect patronage in smaller cities, based on eight municipalities in Norway, the smallest having a population of 12,000.

1.3. Objective of the Study

This paper presents a typology of design solutions intended to implement SDG 11 in the design of a small transport hub dedicated to a small city. This typology is based on cases of thesis design and practice-based workshop course projects featured in the curricula of first and second cycle Architecture, Landscape Architecture, and Transport programs. The projects were prepared as a part of workshop-based public consultations for a real-world construction project—the construction of a transport hub in Hrubieszów, Poland. The projects were informed by input from local stakeholder groups and experts on transport planning, landscape architecture, and urban design, as well as sustainability principles—the four pillars of sustainable development. The typology proposed is a comprehensive source base of possible interpretations of sustainability guidelines in architectural, landscape, and small-scale transport solution design. It can be used to guide and assess projects in these fields, with potential use in design praxis and education. The projects were also intended to gauge the synergy of cooperation between students from different programs and fields (Figure 1).

The study's findings can be applied to the sustainability-focused design of transport hubs in small cities with deficiencies in public transport. The problem of transport exclusion in such cities [42] is universal [37,43–45] and has been approached in our study in a manner that can be easily adapted to local, case-specific conditions in most cultures and climates.

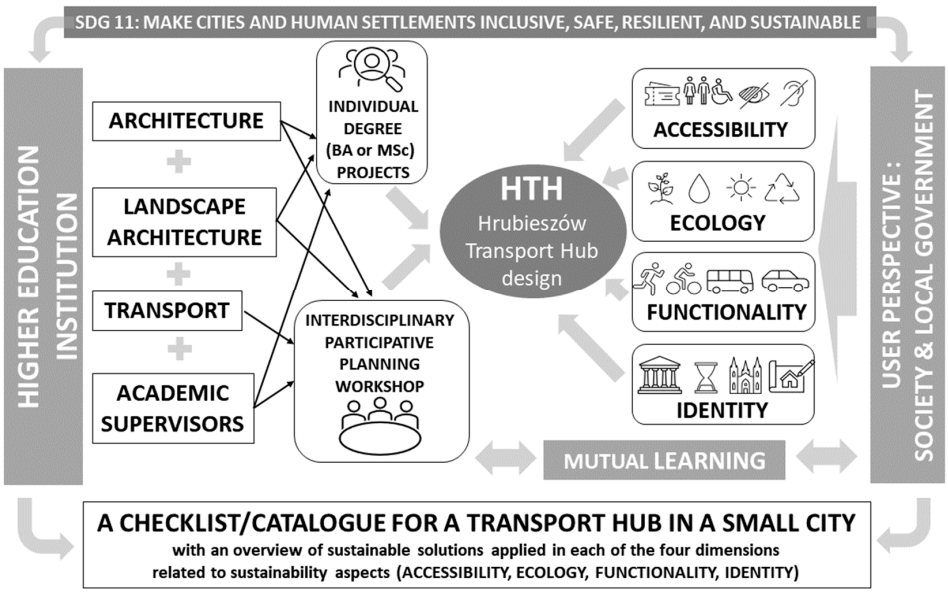

Figure 1. Graphic abstract of the paper (drawing by Anna Staniewska).

2. Materials and Methods

2.1. Methodology

The study was based on an assessment of student projects by a panel of ten experts in sustainable architectural and landscape design and transport solutions, who also oversaw the development of the projects and who acted as tutors to the students who prepared them. The experts were selected as a purposive sample and had to meet the following criteria:

- Master's degree in either Architecture and Urban Design, Landscape Architecture, or Transport,
- A Ph.D. degree,
- Participation in sustainability-focused research projects.

The panel inspected the student projects and screened them for the presence of sustainable and environmentally friendly solutions, which were then used to formulate a typology of pro-sustainability solutions that are aligned with SDG 11 and that can prove useful to course instructors in formulating curricula and conducting project assessments. The sustainable solutions catalogued were then referenced to the four 'dimensions' of the design proposal of the transport hub, the first three of which—accessibility, ecology, and functionality—reference the three pillars of sustainability (environmental, economic, and social sustainability), while the fourth is local identity (genius loci).

The projects, their background, and the environment of their creation are presented in Section 2.1.

2.2. Case Presentation

The projects assessed by the panel were prepared as a part of a partnership between the Cracow University of Technology (CUT), Poland, and the Municipality of Hrubieszów, Poland, within the framework of the "Hrubieszów's Local Development—From Participation to Implementation" development project, funded as a part of the "Local Development" Program of the European Economic Area 2014–2021 Financial Mechanism. The subject of the design assignment was the redevelopment of an existing transport hub, dubbed the Hrubieszów Transport Hub (HTH). The projects were prepared in the summer semester of the 2021/2022 academic year, by first- and second-cycle students of Architecture, Landscape Architecture, and Transport programs taught at the Cracow University of Technology. Initially, the projects were developed as design proposals during a workshop held in Hrubieszów, 25–27 May 2022.

The workshop consisted of four distinct stages:

- Workshop-based consultations with students from two of Hrubieszów's high schools. The high-school students expressed their opinions of the current state of the transport hub site and their wishes and expectations concerning the area and its potential future redevelopment;
- Public consultations with local stakeholder groups: persons with special needs and representatives of local passenger transport companies who operated bus lines that made use of the transport hub;
- A design workshop section, during which students prepared their projects under the supervision of expert tutors;
- A final presentation, during which a summary of the consultations and the projects were shown to the public in Hrubieszów and feedback was collected from stakeholders.

The feedback from the final stage went on to be used to inform an actual design proposal that was used to prepare design documentation for the construction of the HTH later in the development project.

The student projects featured a range of design proposals that facilitated the public space's accessibility and inclusivity, including the introduction of solutions that minimize negative environmental impact and are intended to counter contemporary climate threats. The solutions were also designed to enhance the attractiveness of public transport by affecting its perception as a friendly space that can stimulate and integrate local communities. Proposing solutions that minimize nuisance experienced by local residents and that improve user comfort was also significant, as were references to Hrubieszów's local identity in symbolic, functional, and formal terms, as well as via material and plant selection.

The new small transport hub was to act as a replacement for the one at Marszałka Józefa Piłsudskiego Street, which consisted of a makeshift bus stop organized due to the shutting down of the previous main bus station in the city center. The previous bus station's closure was motivated by its peripheral location within Hrubieszów, which led to the transport exclusion of people who were unable to reach it. The makeshift stop that replaced it was seen as dysfunctional as it was not equipped with the necessary facilities and amenities, i.e., it did not have proper stops for buses, canopies, ticketing solutions, or restrooms.

The new site development, apart from enhancing the small transport hub, was also intended to facilitate the integration of Hrubieszów's residents and to be a site of environmental education. The expert tutors from the Cracow University of Technology also saw the transport hub as an opportunity to promote good practices in sustainability solutions that reference sustainability's three pillars. The enhanced facilities of the new HTH were also intended to attract bus operators and improve the accessibility of Hrubieszów as a whole, improving the standing of both the city and its immediate area as a tourist destination. The project was carried out under the motto "Together for a green, competitive and socially inclusive Europe".

2.2.1. The City of Hrubieszów—Local Context

Hrubieszów is Poland's easternmost city. It is located in the Lublin Voivodeship and is the seat of Hrubieszów county (Figure 2). Hrubieszów's peripheral location conditioned its historical development and has influenced its image and functioning [46]. Elements from the city's history are prominent features of local identity, which contributed to the solutions finally implemented in the hub and are present among the solutions featured in the framework.

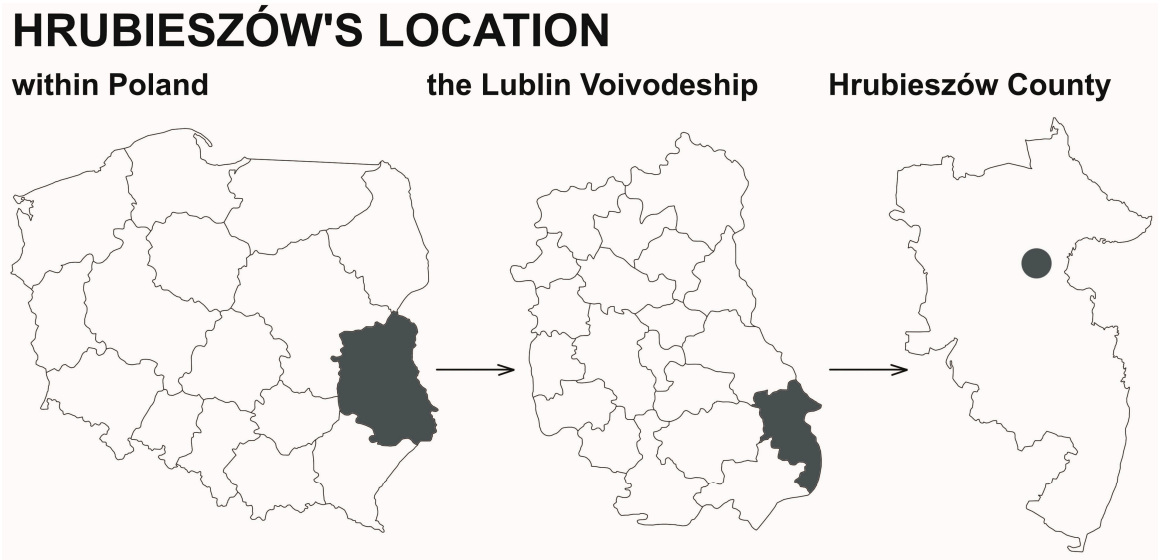

Figure 2. Hrubieszów's location (black dot in the right hand picture) within Poland, the Lublin Voivodeship, and Hrubieszów county (drawing by Magdalena Marasik).

Hrubieszów has a very long history that dates to the Palaeolithic Period [47]. In the Middle Ages it first operated as an open gord, located along important salt-trading routes. In 1366, the settlement became part of the Polish Crown and was seen as having immense strategic and economic significance. In 1400, the town was officially called Rubieszów and received town rights modeled after the Magdeburg rights [48]. The area around the town was a royal hunting ground, a fact referenced in the city's coat of arms, which depicts a deer's head.

Due to its location, Rubieszów attracted a diverse population, which consisted of Poles, Jews, and Ruthenians, who contributed greatly to its development [46]. In 1809, the town was renamed to Hrubieszów. The town suffered greatly during the Second World War, with the vast majority of its Jewish population falling victim to the Holocaust [49].

After the war, Hrubieszów became an important center for its region, where agriculture developed owing to the area's fertile soils and entrenched farming traditions. After the fall of the communist government in the 1980s and 90s, agriculture lost its significance, while Hrubieszów began to stagnate, a situation it shared with most of Eastern Poland, which suffered due to a lack of well-developed large cities and its overall peripheral location within the country.

At present, 16,885 people live within the city's limits, which cover an area of 33 km^2, which makes Hrubieszów a small city with a decreasing population (10.7% in years 2020 and 2021) and a negative migration rate (until the start of the Russo-Ukrainian War) [50].

2.2.2. Accessibility

The city's situation worsened due to its progressively deteriorating accessibility, especially after its main bus station was shut down in 2018. A temporary bus stop was set up near a makeshift marketplace in the city's center, which was revitalized in 2019 and converted into the 'Green Market' regional bazaar.

Afterwards, the bus stop was relocated yet again to its current location, at Marszałka Józefa Piłsudskiego Street, which is a historical Eastern trade route (Figure 3). Hrubieszów's rail transport situation is likewise suboptimal to the city's development and the quality of life of its residents.

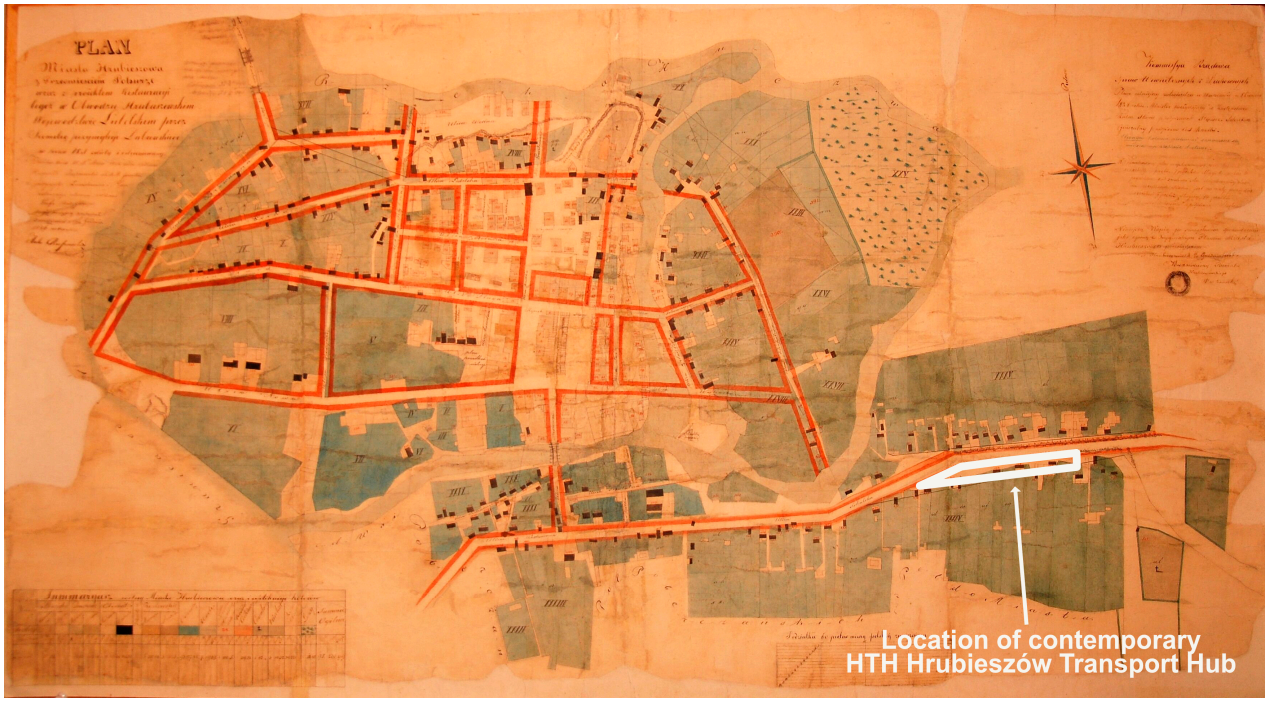

Figure 3. Archival regulatory plan of Hrubieszów from 1896 with the HTH site indicated at Marszałka Józefa Piłsudskiego Street—a historical trade route from Zamość towards the East—marked (source: collection of Maria Fornal/Lubelskie Voivodeship Monuments' Conservator Office in Zamość).

The existing railway network is mainly of significance to cargo transport, as it connects with Ukraine (courier services, transshipment, customs office, narrow-to-wide-gauge transfer). In summary, as a result of the restructuring and elimination of most of its transport linkages, Hrubieszów suffers from transport exclusion and faces numerous problems due to its borderland location, which makes it unattractive to investors although the city is an important urban and administrative node for the rural county (powiat). This situation also hampers tourism, for which there is potential due to the city's rich cultural heritage based on the centuries-long interweaving of three cultures: Polish, Ruthenian (Ukrainian), and Jewish.

2.2.3. Project Site

The site of the HTH is located along the southern boundary of the historical Old Town, a close distance away from the relief channel on the Huczwa River (Figure 4) which is an important local river corridor. The site is currently used as a makeshift bus terminal. It features an array of loosely arranged bus stops with a few benches and garbage cans, and

a restroom in a shipping container. The size of the canopies above the stops are clearly insufficient for the number of users and the passengers of the buses that stop here. The existing pedestrian zone abuts the access road and parking lot used by the residents of the nearby multi-family buildings, and offers a lane only 4 m wide, which is much too narrow for its current use and does not offer safety to pedestrians. The site also features a car park that is often used by people who are not direct users of the bus stop.

Figure 4. Location of existing bus stop and future HTH within a wider context (drawing by Magdalena Marasik).

The result is significant transport and circulatory chaos. The site used as the bus stop and as the future transport hub does not offer a sufficient number of safe and clearly marked pedestrian crossings, which leads to numerous traffic conflicts. Other diagnosed problems include a lack of a waiting space shielded from rain, wind, and cold, the absence of a proper restroom—the current one is substandard and closes after 4 p.m., the absence of a passenger service facility—tickets are sold at a nearby chain discount department store, a handful of loosely placed bus shelters, no common information table, and departure times posted in different places. The site also features a small vegetable kiosk that clients often crowd around.

As a result, numerous different uses are packed in a very limited space [Figure 5]. The stop facilitates local and regional transport lines (intercity and even international lines, e.g., to Ukraine or Berlin in Germany). The area acts as a public space that attracts residents from nearby housing estates due to its concentration of commercial uses (supermarkets, discount department stores).

Figure 5. Current view of the HTH site: a makeshift local transport terminal and a bus stop in Hrubieszów on the road from the east to the city center (photo: Izabela Sykta).

Hrubieszów's transport hub was relocated to this area as it previously had been largely inaccessible due to there being no public transport in the city and the fact that it was located ca. 1.5 km from the center. As a result, prospective passengers had to travel three times the acceptable distance to a bus stop on foot to reach the hub [51]. This factor significantly affects how mass transport is perceived [52]. The old location was not integrated with the train station, as the distance between them was ca. 400 m, which is significantly greater than the distance accepted by transferring passengers [53]. This was coupled with the decreasing significance of rail transport in intercity passenger traffic to and from Hrubieszów. The old bus station's infrastructure was also outdated and suffered from significant wear and negligence. Thus, creating a modern transport hub closer to the city center was seen as highly justified, as it could enhance the attractiveness and competitiveness of bus transport relative to the car. This is crucial in cities and towns with historical urban layouts, where satisfying growing demand for parking spaces from residents and visitors is not possible.

It was observed that the most numerous groups of users consisted of travelers boarding mass transport vehicles (mostly provided by private operators) and the clients of nearby stores. Pedestrians made up a small percentage of users.

The site has a zoning plan in effect, labelled "Polna-Basaja" [54] which legally defines the properties of any prospective use (an act of local law). Plot no. 1164/9 has its use defined as transport infrastructure with the main use being a bus station along with non-nuisance commercial and gastronomic uses. The main site development metrics were defined as follows:

- Minimum share of biologically active surfaces—20%;
- Maximum share of land occupied by building footprints—40%;
- Development density—0.1–1.5;
- Maximum development height—11 m.

The provision that allows for the use of roofs with biologically active surfaces was seen as a significant asset in terms of introducing sustainable solutions and increasing the share of the surfaces within the site's surface schedule. In light of the limited size of the plot, this was seen as the preferred form of introducing green surfaces and addressing the dominance of paved surfaces, a necessity in the development of a bus station.

2.3. Sustainability-Focused Solutions

To assess the sustainability of solutions in the student projects under study, we developed a tool that would enable quick assessment and that could be a useful framework for similar projects in the future. We created a checklist/catalogue with an overview of sustainable solutions applied in each of the four dimensions related to sustainability aspects: I—ACCESSIBILITY, II—ECOLOGY, III—FUNCTIONALITY and IV—IDENTITY (Figure 6).

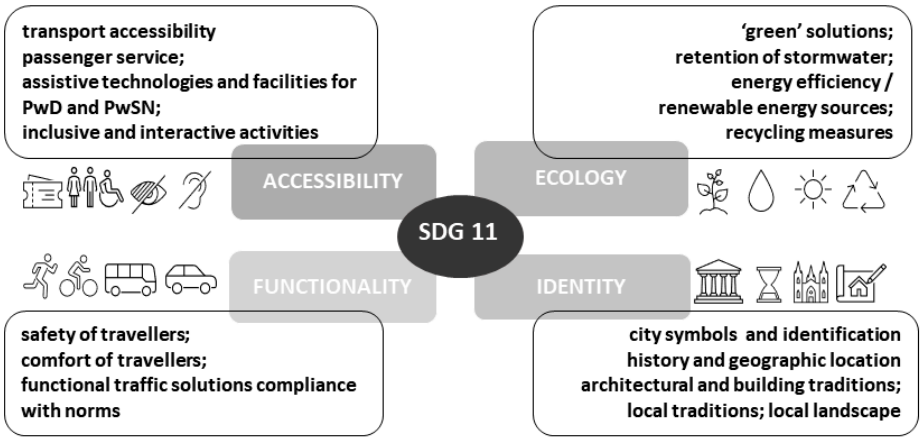

Figure 6. Four dimensions related to sustainability aspects of SDG-11 that were used as a base for the catalogue of sustainable solutions developed with reference to the case study of Hrubieszów Transport Hub (HTH) (drawing by Anna Staniewska).

2.3.1. Accessibility

Sustainable solutions in the aspect of accessibility applied to contemporary designs of public spaces are particularly related to sustainable transportation and the elimination of architectural barriers that impede the mobility of travelers. The choice of elements was determined by the scale of the site, the size of Hrubieszów, and the number of potential users.

Well-established international guidelines [55] emphasize that all people regardless of any kind of disability have the undisputable right to use the whole built environment, and this will lead to important improvements in the comfort and safety of the whole population. Although universal design principles were published decades ago [56], recent reports [57] indicate that the issue of accessibility in a rapidly urbanizing world is still of the highest importance and accessibility is linked with numerous aspects of social inclusion in cities

of all scales. The provisions of the Convention for the Rights of Persons with Disabilities from 2006 have been included in 2015's 2030 Agenda for Sustainable Development. The 17 Sustainable Development Goals include explicit references to people with disabilities [58]. However, we are still far from full inclusiveness in design, which is often explained by the lack of data on people with disabilities and concepts linked to social inclusion such as gender urbanism [59,60]. Therefore, it is very important to collect and systematize such data [61]. Higher levels of accessibility are generally linked to participation in various activities, so by improving social inclusion in society, they fulfil global sustainability goals.

Our checklist includes the following elements presented in Table 1 below:

Table 1. A checklist/catalogue with an overview of sustainable solutions applied in dimension I—ACCESSIBILITY in four categories: TA, transport accessibility; PS, passenger service; FD, assistive technologies and facilities for persons with disabilities (PwD) and special needs (PwSN); IA, inclusive and interactive activities.

Dimension I—ACCESSIBILITY			
TA	**transport accessibility**	**PS**	**passenger service**
BS	allocated bus stands	WR	waiting room building
CS	cab stands	OB	possibility to observe bus stands from the waiting room
DP	diversified parking lots, incl.:		
PP	public parking lots	WC	toilet for travelers
K&R	kiss and ride stands	TS	traveler service point
P&R	park and ride parking	TO	ticket office
PP	pedestrian priority, incl.:	TM	ticket machines
PS	pedestrian sidewalks	IB	information board with timetables
PC	designated and marked pedestrian crossings	RS	roofed bus shelters
IC	infrastructure for cyclists, incl.:	LL	luggage lockers
BP	bicycle or pedestrian & bicycle path	CS	comfortable seats and street furniture
BR	bicycle rugs	OL	outdoor lighting
CB	city/electric bicycle/scooter stations	MO	monitoring
OS/ TA	other solutions to improve transportation accessibility	WG	waste garbage cans
		OS/ PS	other solutions to improve passenger service
FD	**assistive technologies and facilities forPwDand PwSN**	**IA**	**inclusive and interactive activities**
MT	multimedia info terminal adapted to the needs of PwD [1)]	TI	tourist information point
		TF	tactile city plan
SN	dedicated space for non-neurotypical persons and accompanying persons	AE	advertising and outdoor exhibition stands
HS	horizontal stripes on glazing to protect the visually impaired	SF	street furniture/seats/ benches/parklet
		WF	water fountain
WC D	toilet adapted to the needs of PwD	FP	kiosk/food service point
		LG	landscaped greenery
WC C	toilet adapted to the needs of a parent with a child	OS/ IA	other solutions to improve inclusive and interactive activities
SD	signage adapted to the needs of PwD, incl.:		
TM	tactile markings of pedestrian crossings/bus stands		
TP	tactile pavements and guidance lanes		
BS	signage in Braille		
AD	audio description signage		
AI	information/audible signals		
IL	induction loop		
LC	no or lowered curbs		
PD	parking lot for the disabled		

Table 1. *Cont.*

Dimension I—ACCESSIBILITY	
OS/FD	other solutions to improve assistive technologies and facilities for PwD and PwSN

[1)] MT multimedia info terminal adapted to the needs of persons with disabilities (PwD), including those in wheelchairs, children (height of info display), persons with visual and auditory dysfunctions (size of signs, contrast, tactile markings, tactile graphics, audio information).

2.3.2. Ecology

Sustainable solutions in ecology, specifically urban ecology applied to contemporary designs of public spaces, particularly related to protection of the residential environment from air pollution (smog), traffic noise, light, negative effects of climate change, and the urban heat island effect by using pro-environmental and green technologies (GT), blue and green infrastructure (BGI) and nature-based solutions (NbS), are presented in Table 2 below. While using the framework, care must be taken to employ eco-friendly utility solutions such as rainwater, stormwater, and greywater reuse in accordance with the relevant national standards and best practices. One vital aspect is connectivity with local environmental networks and integration of nature-based solutions (NbS) in urban policy and planning [62].

Table 2. A checklist/catalogue with an overview of sustainable solutions applied in dimension II—ECOLOGY in four categories: GS, 'green' solutions; RS, retention of stormwater; RE energy efficiency/renewable energy sources; RC, recycling.

Dimension II—ECOLOGY			
GS	**'green' solutions**	**RS**	**retention of stormwater**
BAI	biologically active area increase [1)]	RG	rain garden
		RT	retention tank/basin
GP	'green' partitions, incl.:	RR	RP use of rainwater for watering plants, RR use of water from green roofs in the building's water cycle (e.g., greywater, rainwater, and stormwater reuse) [2)]
GR	green roofs		
GW	green walls		
GS	green bus shelters/green canopies	RP	use of rainwater for watering plants
GL	greening and landscaping incl.:	PP	permeable or unsealed pavements (overgrown with vegetation)
TG	tall greenery (trees)		
MG	medium-high greenery (shrubs, tallgrasses, etc.)		
LG	low vegetation (lawns, flower meadows, perennial plants, grasses, etc.)	OS/RS	other solutions conducive to retention
CP	climbing plants		
PC	plants in containers		
OS/GS	other solutions to increase the amount of greenery		
RE	**energy efficiency/renewable energy sources**	**RC**	**recycling**
SF	solar or photovoltaic panels/rooftops	RM	recycled and/or recyclable building materials
SL	solar lighting	RW	recycled waste containers
EI	energy-efficient electrical/thermal installations	OS/RC	other recycling solutions
OS/RE	other solutions to foster energy efficiency and self sufficiency		

[1)] An index of biologically active area (BAI), whose minimum value is specified in the local zoning plan. For the HTH site, its value was to be no less than 20% of the site. [2)] RR reuse of rainwater, stormwater, and greywater (wastewater without fecal matter and urine) in the building's water cycle, i.e., for watering plants [63,64].

2.3.3. Functionality

Functionality, understood as a building's use performance, can be seen as supporting sustainability, as noted by Li et al. [65] and by Jo and Gero [66], who applied genetic algorithms to minimize travel times and reduce project complexity. Functionality can also significantly contribute to wellbeing, itself seen as an ultimate goal of sustainable development, as argued by Helne and Hirvilammi [67].

Examples of sustainable solutions in functionality applied to contemporary designs of public spaces, particularly related to sustainable transport, are presented in Table 3 below.

Table 3. A checklist/catalogue with an overview of sustainable solutions applied in dimension III—FUNCTIONALITY in two categories: TS, safety of travelers; TC, comfort of travelers.

III Dimension—FUNCTIONALITY			
TS	**safety of travelers**	**TC**	**comfort of travelers**
PP	priority for pedestrians	TM	ticket machines
RC	reducing the number of pedestrian crossings	WC	public toilet
		SB	weather-sheltered bus stops
RP	raised platforms/lack of curbs/raised pedestrian crossing	PC	protective canopies against sun and rain
NS	non-slip pedestrian surfaces and pavements	CS	comfortable seats and street furniture
BP	separated bicycle path	LG	landscaped greenery
SV	chicanes and humps to slow down vehicle traffic	CI	infrastructure for cyclists (stands, city cycle station)
OS/TS	other solutions to improve safety of travelers	WF	water fountains
		OS/TC	other solutions to improve comfort of travelers

2.3.4. Identity

Culture and heritage contribute to the sense of wellbeing of individuals and communities; hence, they can be considered sustainability-related concepts [68]. The adaptive reuse of heritage sites has also been linked to enhancing sustainability, as argued by Radziszewska-Zielina and Śladowski [69]. The relation between cultural values, a component of identity, was investigated by Zheng et al., who noted that they explained 26% of the variations in SDG achievement, with the links being strikingly divergent across cultural traits and SDGs [70]. Lerario [71] also linked sustainability practices with heritage conservation and re-use, while Orr, Richard and Fatorić [72] explored the impact of environmental factors on intangible heritage, of which identity is a major element.

Sustainable solutions based on identity, applied to contemporary designs of public spaces, particularly related to city symbols, geographic location, history, and local traditions, linked to contemporary land use and the local landscape, are presented in Table 4 below. Identity-related elements featured in the workshop's consultation stage. Elements listed in Table 4 may become an integral part of the hub itself (local materials, typical colors, logo, city coat of arms) and its landscape arrangement (landmark/totem, local vegetation) or be displayed in a micro-museum (depending on the available area of the construction site).

Table 4. A checklist/catalogue with an overview of sustainable solutions applied in dimension IV—IDENTITY in six categories: CSI, city symbols and identification; GL, geographic location; HT, history; AT, architectural and building traditions; LT, local traditions; LL, local landscape.

Dimension IV—IDENTITY			
CSI	**city symbols and identification**	**GL**	**geographic location**
CC	city crest *(in Hrubieszów: deer head motif)*	GT	geographical positioning/identifying 'totem' sign *(in Hrubieszów: the easternmost city in Poland, 'eastern gate of Poland')*
CF	city flag *(in Hrubieszów: red and green colors)*		

Table 4. *Cont.*

Dimension IV—IDENTITY			
CI	city logo/official identification of the city *(in Hrubieszów: 'Hrubieszów—Miasto z Klimatem'—a City with Climate)*	CG	bus station as 'the city gate'
HT	**history**	**AT**	**architectural and building traditions**
MC	Multiculturalism *(in Hrubieszów: Polish, Ukrainian, and Jewish culture—'Hrubieszów—Polish city of three cultures')*	WA	traditional architectural forms and details *(in Hrubieszów: wooden architecture)*
HR	historic roads *(in Hrubieszów: wooden architecture)*	LM	local building materials *(in Hrubieszów: wood, brick, natural plasters)*
		TC	traditional colors in architecture *(in Hrubieszów: white, green, a range of earth colors)*
LT	**local traditions *(listed here in the context of HTH location)***	**LL**	**local landscape**
CW	first city well	NV	native vegetation, including:
RB	residents' notice board	MV	field and meadow vegetation
VK	local vegetable kiosk	RV	roadside vegetation
		GP	garden plants
		TH	trees compatible with the natural habitat

3. Results

Presentation of Results

A total of nine projects were prepared as a part of the HTH project, both during the workshop and as thesis designs prepared at the CUT FoA. The authors of the projects and their tutors/supervisors are listed in the Acknowledgements. The projects were screened for use of sustainable solutions (SS). A breakdown of the projects is presented below in Table 5.

Table 5. A breakdown of the projects and frequency of application of sustainable solutions concerning accessibility in HTH design proposals.

Students' Designs of HTH		**Application of Sustainable Solutions in I Dimension—ACCESSIBILITY**													
project type	degree of studies 1B/2M curriculum A/LA/T [1)]	WR	OB	RS	K&R	BP	PD	WC D/C	TP/TM	MT	SN	TI/TF	IC	number of sustainable solutions depending on the project type	
BD—bachelor thesis design/MD—master thesis design															
1BD	1B/LA	✓		✓	✓	✓	✓		✓	✓		✓		9	out of 9
2BD	1B/LA	✓				✓		✓					✓	4	
3BD	1B/A	✓	✓	✓	✓		✓	✓	✓					7	
4MD	2M/LA	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	11	
5MD	2M/LA	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	11	
6MD	2M/A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	11	
WD—workshop designs															
1 WD	1B/2M A/LA/T	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	10	
2 WD		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	11	
3 WD		✓	✓	✓		✓		✓	✓	✓		✓	✓	9	

Table 5. *Cont.*

Students' Designs of HTH	Application of Sustainable Solutions in I Dimension—ACCESSIBILITY											
summary of results —number of applied sustainable solutions	9	7	7	6	8	4	7	8	7	5	6	8
	out of 12											

[1)] A curriculum: Architecture; LA curriculum: Landscape architecture; T curriculum: Transport.

Six of the projects were thesis designs prepared for Architecture (A) and Landscape Architecture (LA) courses in the 2021/2022 academic year. Of these, three were bachelor thesis designs (BD, two as part of the A program and one as part of the LA program) and the other three were master thesis designs (MD, two as a part of the A program and one as a part of the LA program). The remaining three projects were workshop design proposals developed by interdisciplinary teams formed by students of A, LA, and T (Transport) programs in the participatory workshop held in Hrubieszów in May 2022.

The list of sustainable solutions from Tables 1–4 was narrowed down to those applied in HTH student projects. The choice of solutions was also dictated by site-specific conditions and the HTH's use program. The legend for the acronyms used is included in Tables 1–4 and their headings.

The usage of sustainable solutions in each of the four dimensions of sustainability—accessibility, ecology, functionality, and identity—in the projects under study is presented in Tables 6–8.

A summary of the sustainable solutions applied in students' designs of HTH in each of the four dimensions is graphically displayed in bar graphs in Figures 7–10.

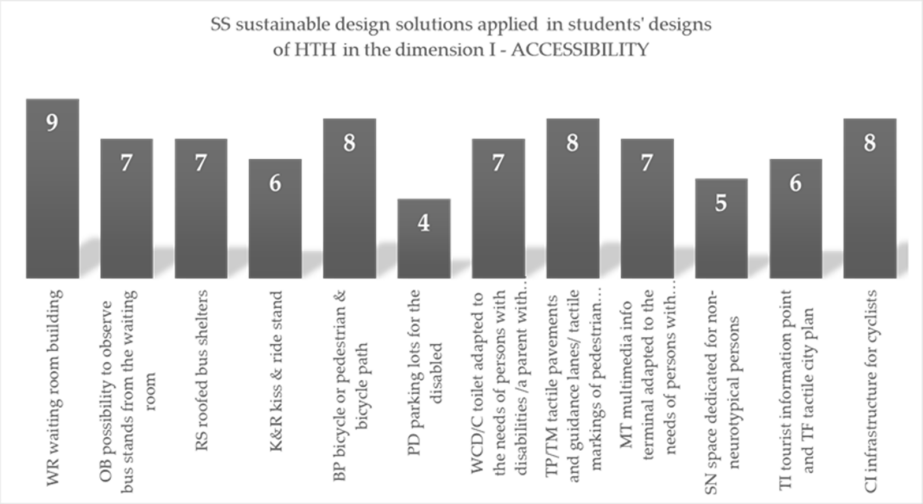

Figure 7. Summary of the sustainable solutions applied in students' designs of HTH in dimension I—accessibility.

Table 6. Application frequency of sustainable solution concerning ecology in HTH design proposals.

Students' Designs of HTH		Application of Sustainable Solutions in II Dimension—ECOLOGY												
project type	degree of studies 1B/2M curriculum A/LA/T	RG	RT	BAI	GR	GW	GS	TG	MG	LV	CP	SF	RW	number of sustainable solutions depending on the project type

Table 6. *Cont.*

Students' Designs of HTH		Application of Sustainable Solutions in II Dimension—ECOLOGY													
BD—bachelor diploma design/MD—master diploma design															
1BD	1B/LA			✓	✓		✓	✓	✓	✓	✓		✓	8	out of 9
2BD	1B/LA	✓		✓	✓	✓			✓	✓	✓		✓	8	
3BD	1B/A			✓	✓		✓	✓		✓			✓	7	
4MD	2M/LA	✓		✓	✓	✓		✓	✓	✓	✓		✓	9	
5MD	2M/LA	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	10	
6MD	2M/A			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10	
WD—workshop designs															
1WD	1B/2M A/LA/T	✓		✓	✓		✓	✓	✓	✓			✓	8	
2WD		✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	10	
3WD				✓	✓	✓		✓	✓	✓	✓	✓		8	

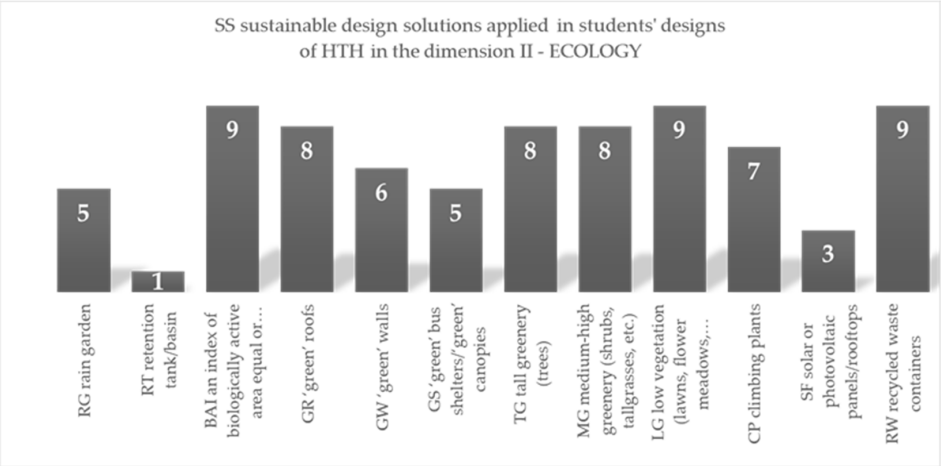

Figure 8. Summary of the sustainable solutions applied in students' designs of HTH in dimension II—ecology.

Table 7. Application frequency of sustainable solution concerning functionality in HTH design proposals.

Students' Designs of HTH		Application of Sustainable Solutions in III Dimension—FUNCTIONALITY													
project type	degree of studies 1B/2M curriculum A/LA/T	PP	RC	BP	SV	RP	TM	WC	SB	PC	CS	WF	LG	number of sustainable solutions depending on the project type	
BD—bachelor diploma design/MD—master diploma design															
1BD	1B/LA	✓			✓	✓		✓	✓	✓	✓		✓	8	out of 9
2BD	1B/LA		✓		✓	✓		✓		✓	✓		✓	7	
3BD	1B/A	✓				✓	✓	✓	✓	✓	✓		✓	8	
4MD	2M/LA	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	10	
5MD	2M/LA	✓			✓	✓		✓		✓	✓		✓	7	

Table 7. *Cont.*

Students' Designs of HTH		Application of Sustainable Solutions in III Dimension—FUNCTIONALITY												
6MD	2M/A	✓		✓	✓		✓	✓	✓	✓	✓		✓	9
WD—workshop designs														
1WD	1B/2M A/LA/T	✓				✓	✓	✓	✓	✓	✓		✓	8
2WD		✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	10
3WD		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	11
summary of results —number of applied sustainable solutions		8	4	4	7	8	4	9	7	9	9	0	9	out of 12

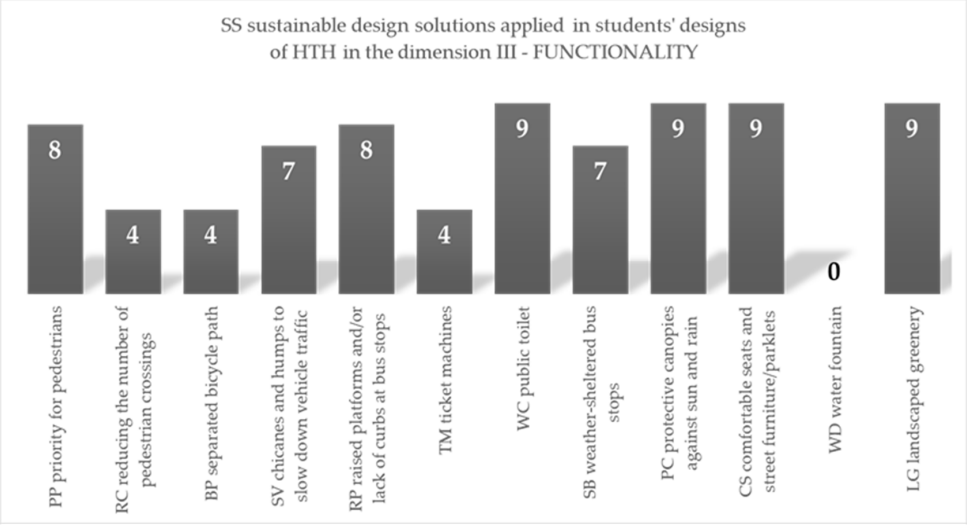

Figure 9. Summary of the results of the sustainable solutions applied in students' designs of HTH in dimension III—FUNCTIONALITY.

Table 8. Application frequency of sustainable solution concerning identity in HTH design proposals.

Students' Designs of HTH		Application of Sustainable Solutions in III Dimension—FUNCTIONALITY												
project type	degree of studies 1B/2M curriculum A/LA/T	CC	CF	CI	GT	CG	MC	WA	LM	CW	RB	VK	NV	number of sustainable solutions depending on the project type
BD—bachelor diploma design/MD—master diploma design														
1BD	1B/LA						✓		✓				✓	**3**
2BD	1B/LA	✓							✓			✓		**3**
3BD	1B/A				✓	✓						✓		**3**
4MD	2M/LA					✓	✓	✓	✓		✓	✓	✓	**7**
5MD	2M/LA	✓		✓	✓	✓		✓		✓	✓		✓	**8**
6MD	2M/A				✓	✓			✓		✓	✓	✓	**6**
WD—workshop designs														out of 9

Table 8. *Cont.*

Students' Designs of HTH		Application of Sustainable Solutions in III Dimension—FUNCTIONALITY												
1WT	1B/2M A/LA/T				✓	✓	✓	✓	✓	✓	✓	✓	✓	**9**
2WT			✓			✓			✓		✓	✓	✓	**6**
3WT		✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	**10**
summary of results —number of applied sustainable solutions		**3**	**1**	**2**	**5**	**7**	**4**	**4**	**7**	**3**	**6**	**6**	**7**	
		out of 12												

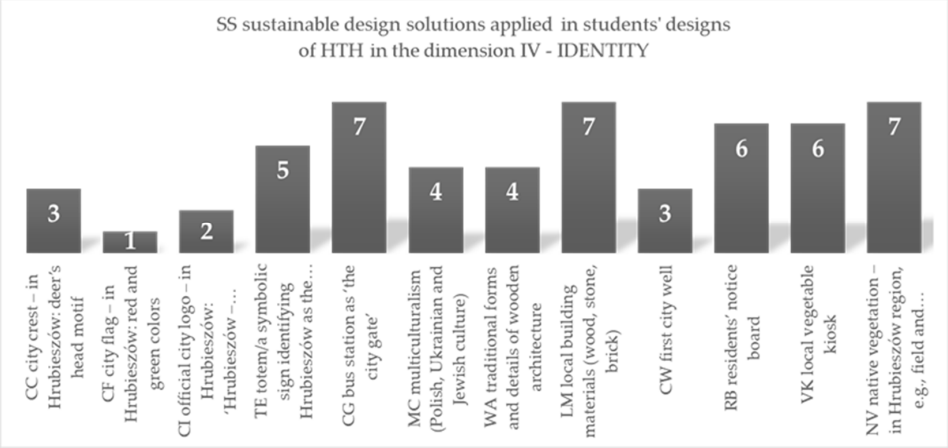

Figure 10. Summary of the results of the sustainable solutions applied in students' designs of HTH in dimension IV—IDENTITY.

Based on the analysis presented in the tables above, the following can be said of the application of sustainable design solutions in the projects under study:

- The lowest number of applications was observed in first cycle (bachelor's) thesis projects, prepared at the very start of the HTH development project, when the knowledge of students and tutors/supervisors concerning site-specific conditions was incomplete, namely based only on one site inspection, or was not preceded by such an inspection;
- A greater number of applications was observed in the projects prepared as part of the participation workshop held in May 2022 in Hrubieszów, during which students worked in interdisciplinary groups under the supervision of tutors who represented three design specializations (architecture, landscape architecture, transport), and participated in site inspections and consultations with representatives of persons with disabilities and special needs and with representatives of municipal services;
- The greatest number of instances of sustainable design solution application was observed in second cycle (master's) thesis designs, whose authors had participated in the workshop;
- A notably greater number of application instances was observed for projects whose co-authors included landscape architecture students. In addition, it was noted that the LA program curriculum featured sustainable design solutions in a greater number of instances than the curricula for the other two programs.
- Most of the sustainable solutions applied by students referred to features often required in contemporary design, such as green technologies, ergonomic efficiency, proper space arrangement, public transport priority, cycling, and e-mobility. The novelty of the approach lies in solutions applied only to a limited extent, such as the careful choice of planting material adjusted to local environment specifics (only native

plants), arrangement of space for non-neurotypical users, and varied interpretations of cultural identity.

Table 9 presents a summary of the number of applications of each sustainability solution in the projects under study.

Table 9. Summary of the results of the sustainable solutions applied in students' designs of HTH in four dimensions: I—accessibility, II—ecology, III—functionality and IV—identity.

		Sustainable Solution (SS) Applied in Students' Designs of HTH	Frequency of Application	
			Number	%
dimensions	I—ACCESSIBILITY	WR waiting room building	9	100
		OB possibility to observe bus stands from the waiting room	7	78
		RS roofed bus shelters	7	78
		K&R kiss & ride stand	6	67
		BP bicycle or pedestrian & bicycle path	8	89
		PD parking lots for the disabled	4	44
		WCD toilet adapted to the needs of persons with disabilities WCC toilet adapted to the needs of a parent with a child	7	78
		TP tactile pavements and guidance lanes TM tactile markings of pedestrian crossings/bus stands	8	89
		MT multimedia info terminal adapted to the needs of persons with disabilities	7	78
		SN space dedicated for non-neurotypical persons	5	56
		TI tourist information point TF tactile city plan	6	67
		CI infrastructure for cyclists	8	89
	II—ECOLOGY	RG rain garden	5	56
		RT retention tank/basin	1	11
		BAI an index of biologically active area equal or higher than that specified in the local development plan (20%)	9	100
		GR 'green' roofs	8	89
		GW 'green' walls	6	67
		GS 'green' bus shelters/'green' canopies	5	56
		TG tall greenery (trees)	8	89
		MG medium-high greenery (shrubs, tallgrasses, etc.)	8	89
		LG law vegetation (lawns, flower meadows, perennials, grasses, etc.)	9	100
		CP climbing plants	7	78
		SF solar or photovoltaic panels/rooftops	3	33
		RW recycled waste containers	9	100
	III—FUNCTIONALITY	PP priority for pedestrians	8	89
		RC reducing the number of pedestrian crossings	4	44
		BP separated bicycle path	4	44
		SV chicanes and humps to slow down vehicle traffic	7	78
		RP raised platforms and/or lack of curbs at bus stops	8	89
		TM ticket machines	4	44
		WC public toilet	9	100

Table 9. *Cont.*

	Sustainable Solution (SS) Applied in Students' Designs of HTH	Frequency of Application	
		Number	%
	SB weather-sheltered bus stops	7	78
	PC protective canopies against sun and rain	9	100
	CS comfortable seats and street furniture/parklets	9	100
	WD water fountain	0	0
	LG landscaped greenery	9	100
IV—IDENTITY	CC city crest—in Hrubieszów: deer's head motif	3	33
	CF city flag—in Hrubieszów: red and green colors	1	11
	CI official city logo—in Hrubieszów: *'Hrubieszów—Miasto z Klimatem'*	2	22
	TE totem/a symbolic sign identifying Hrubieszów as the easternmost city in Poland, 'eastern gate of Poland'	5	56
	CG bus station as 'the city gate'	7	78
	MC multiculturalism (Polish, Ukrainian and Jewish culture)	4	44
	WA traditional forms and details of wooden architecture	4	44
	LM local building materials (wood, stone, brick)	7	78
	CW first city well	3	33
	RB residents' notice board	6	67
	VK local vegetable kiosk	6	67
	NV native vegetation—in Hrubieszów region, e.g., field and meadow vegetation, trees compatible with the natural habitat, etc.	7	78

4. Discussion

Environmental education and implementing SDGs at the level of university courses means working on the ability to implement pro-environmental solutions in practical conditions highly similar to the reality of one's profession. The International Federation of Landscape Architects (IFLA) [73] and the International Union of Architects (UIA) [74] clearly state the significance of this problem. Architects, landscape architects, and transport specialists whose designs use vegetation as a material and that implement GBI solutions can have a significant impact on pro-environmental public behaviors. The HTH project focused on a varied range of problems and is aligned with holistic planning in the spirit of sustainability and the inclusion of nature-based solutions (NbS), although project exercises need more empirical validation of their outcomes.

Based on the analysis of solutions applied in students' projects, we also examined the relationship between the four dimensions of the targets of SDG 11: Make cities inclusive, safe, resilient and sustainable. Each of the aspects with the associated solutions can contribute in some way to reaching the specific targets (Figure 11).

Enhancing qualifications and providing education linked with exploring landscape assets and their significance is highlighted in the European Landscape Convention (ELC). The ELC places the landscape in all its variety at center stage as "a key element of individual and social well-being". It emphasizes the need to define landscape policies based on formulated landscape quality and refers also to everyday or degraded landscapes. This means that the design intervention in the substandard area of the provisory bus station in Hrubieszów is in line with the Convention's aims, understood as providing society with a quality landscape for everyday utility.

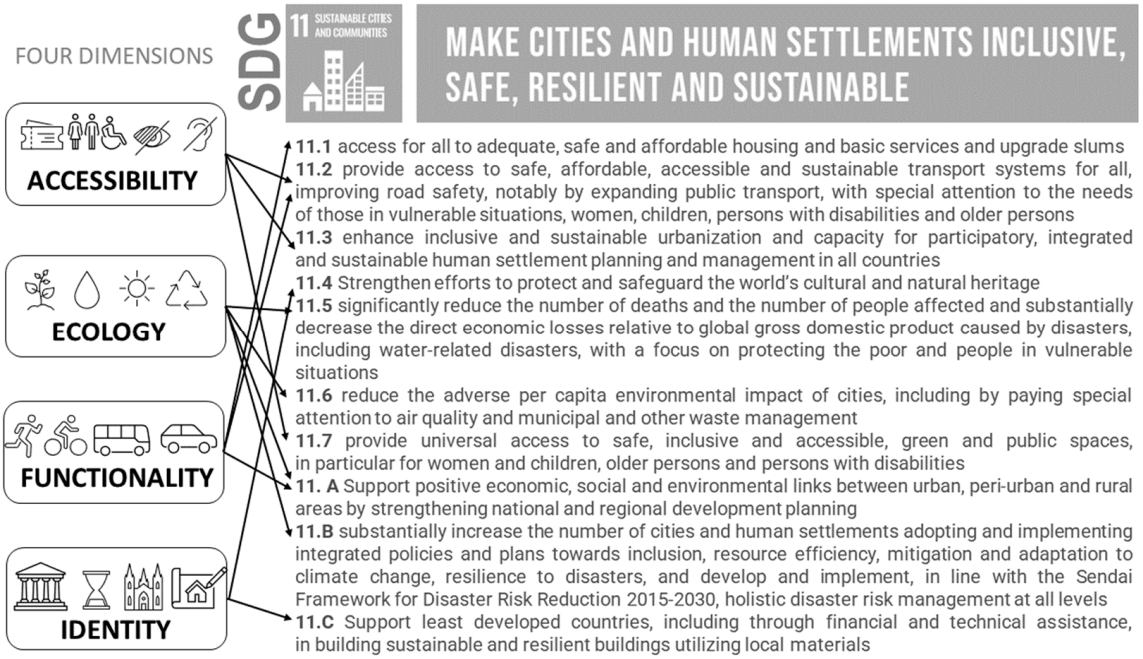

Figure 11. Links between four dimensions of sustainability and specific targets related to SDG 11: Make cities inclusive, safe, resilient, and sustainable (drawing by Anna Staniewska, targets after [75]).

Moreover, in Article 6, the ELC imposes specific measures such as training and education at various levels and awareness raising aimed at not only professionals but also members of civic society and the public authorities. This strongly justifies linking university curricula to real-life problems and situations and encouraging students to take part in workshops organized in cooperation with local governments.

Carl Steinitz states that preparing landscape designs that respond to contemporary challenges requires wide collaboration and education of not only skilled "soloists" but also "conductors" to understand the complexity of the issues addressed and to lead interdisciplinary teams capable of solving contentious and significant problems [76]. Collaborative landscape design and organizing workshops on the topic of HTH involving interdisciplinary student groups has been a priority since the beginning of the project to address the most pertinent issues resulting from the problems typical of the site.

Landscape architects are also members of interdisciplinary teams that design transport infrastructure and their role may go far beyond merely providing aesthetic solutions, although scenic beauty [77] and the legibility of roads are important aspects [78–80], especially for road design. Some researchers indicate that landscape design can improve safety since roadside landscape improvements may be positively correlated with traffic incident reductions [81,82]. In the context of stations within urban settings, landscape design can be integrated with many other aspects that contribute to accessibility and the safety of passengers and create an image of the city that underscores its genius loci [83].

"At its most basic level, public participation is a way of ensuring that those who make decisions that affect people's lives have a dialogue with that public before making those decisions. From the perspective of the public, public participation increases their influence on the decisions that affect their lives. From the perspective of government officials, public participation provides a means by which contentious issues can be resolved" [84]. While preparing degree projects related to HTH relied mostly on observation and studying secondary materials, during workshops teams carried out social research on the needs of young people and took part in a meeting with people with disabilities. Moreover, workshop design results were presented to the general public on the project website and were subject to internet voting on the city's participation platform. Paper questionnaires

were available at Hrubieszów Community Center—the most important and frequently visited local cultural institution.

While in some cases participatory planning extends the preparatory phase of the design, it is often a means of facilitating change implementation and helps to make efficient and acceptable decisions regarding new land use or implementation of the new design [85].

As shown in the Results section, design workshops organized to facilitate participatory design can significantly contribute to improving the quality of projects in terms of effective and aesthetically appealing implementation of solutions (Figure 12) in the four categories or pillars of sustainability assessment. In comparison, projects prepared by students who had not taken part in the workshop displayed their authors' narrower outlook on sustainable solutions. This is crucial from the standpoint of educational outcomes.

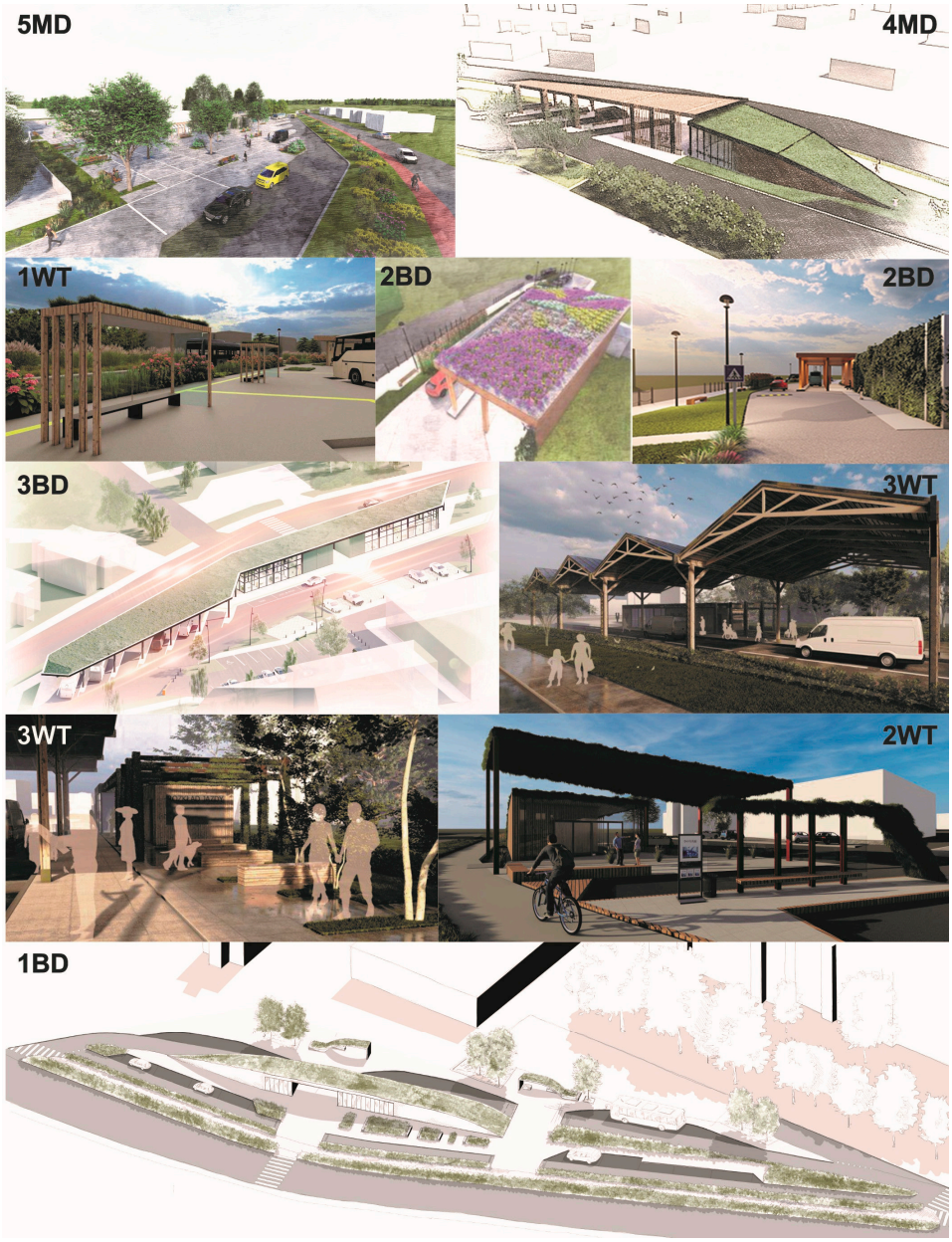

Figure 12. Visual representation of sustainable solutions (SS) implemented in degree projects and participatory workshop design showing the most commonly introduced elements to improve the sustainability of the Hrubieszów Transport Hub [drawings from the archives of the CUT, authors of design concepts listed in the Acknowledgements section of this paper].

The results are all the more notable as the workshop, aptly named "cooperation" by Paszkowski [86], had no observable negative impact on final project quality. Intense work in three student groups under the supervision of a multidisciplinary expert team of researchers from the CUT was assessed as an effective design tool. The significance of interdisciplinarity in teaching was highlighted by Schneider-Skalska [87], who argued that architectural and urban design projects cannot be confined to a single discipline and may concern a wide spectrum of problems and abilities. This is why ensuring proper substantive support is a significant factor in enhancing the effectiveness and quality of student projects.

As mentioned above, due to the complexity of the issues involved in implementing the SDGs, as well as their uniqueness in each project case, case-based teaching works best here. The framework presented fits into this trend, and its development gained objectivity and universality due to the participation of many students.

Jagiełło-Kowalczyk noted the benefit of being close to the "matter" of a project as an essential factor of improving student design quality [88]. In situ inspections, first-hand experience of the problem (by touch and sight), and listening to remarks by future users and the developer can greatly contribute to increasing a project's quality. Direct feedback reduces design time by eliminating proposals that do not meet the most frequently reported expectations. Mutual learning, as noted by Paszkowski and Gołębiewski [86], takes place within design groups during workshops and facilitates better knowledge gain—which here was further magnified by the stimulating short project deadline.

Obtaining and developing social competencies is also crucial. The ability to listen and approach user groups with proper sensitivity, attention, and mindfulness can effectively improve design determinant diagnoses [89]. The observation by Sas-Bojarska that a wide spectrum of social determinants can produce a place that is desirable from the perspective of public space design policies was supported by this study's findings.

4.1. Possible Influence Factors

Tables 10–14 present a synthetic and simplified overview of the results, along with potential influential factors that may have contributed to the application of each individual SS in the student projects.

Table 10. Analysis of factors that may have affected SS application rate in design proposals—SSs applied in all HTH design proposals.

Analysis of Factors That May Have Affected SS Application Rate in Design Proposals					
% of SS	**pillar**	**SS application in design proposals in the four pillars: I—accessibility, II—ecology, III—functionality, IV—identity**	**Factors that may have affected SS application in HTH design proposals**		
			1	2	3
100%	**SSs APPLIED IN ALL HTH DESIGN PROPOSALS—7 SS**				
	I	WR waiting room building			
	II	BAI an index of biologically active area in the local development plan			
		LV low vegetation			
		RW recycled waste containers			
	III	WC public toilet			
		PC protective canopies against sun and rain			
		LG landscaped greenery			

To facilitate analysis, the SSs were categorized into three groups based on the perceived reason behind their application rate. Group 1 included SSs prominently featured in university LA, A, and T program curricula. Group 2 included SSs associated with site-

and project-specific conditions. Group 3 included SSs that are highly general/vague or included a very high level of detail from a project-wide perspective.

The categorization is presented in Tables 10–14 and explained in the legend below.

Table 11. Legend for Tables 10 and 12–14.

Factors That May Have Contributed to SS Application Rates in HTH Design Proposals					
1	**SS featured in Architecture, Landscape Architecture, or Transport program curricula**				
	Architecture		Landscape architecture		Transport
2	**Site- and project-specific factors**				
	Mandatory element, featured in the HTH use program				
	Biological area index specified				
	Discussed during tutor presentations in the workshop				
	Discussed during consultations with PwDs				
	Discussed during consultations with transport operators				
	Local problem visible/explained during site visit				
Factors that may have negatively contributed to SS application					
3	**Excessive generality (multidimensionality) or level of detail (complicatedness) or a given solution requiring disproportionate attention relative to design task duration**				
	Excessive vagueness/difficulty to apply in the project				
	Problem much too detailed/difficult to apply in the project				

Table 10 shows SSs applied in all HTH design proposals, which were mainly those solutions which were mentioned in A, LA, or T program curricula and a mandatory element of the functional program of the workshop or were presented by tutors during the workshop.

The accumulation of factors from group 1, namely those that stem from the presence of a given problem or SS in A, LA, or T program curricula, included SSs applied either in all or most (78–89%) HTH design proposals, which may be an indication of the authors' practical application of the knowledge gained via education.

For group 2, which includes factors based on site- and project-specific assumptions and problems discussed either during teaching or participatory activities, all design proposals included mandatory elements of the HTH use program, namely the waiting room and the biologically active index ratio from the zoning plan, which may indicate that students were aware of the need to follow regulations and the project brief in all projects. All the design proposals featured low vegetation and landscaped greenery, whose design is taught solely during the Landscape Architecture program, which may point to the influence of the program's students on the application of green solutions in the proposals. However, it may be assumed that students of other programs are also aware of the significance of introducing landscaped greenery into public spaces and do so in their design practice.

The vast majority (78–89%) of the HTH design proposals [Table 12] had the highest number of SS applied (16), which may have been caused by both the presence of many related issues in relevant curricula and the fact that almost all (except one) of the SSs applied were discussed during workshop presentations. A probable cause of not applying these solutions in bachelor thesis designs was that they were prepared before the workshop, at the very start of the project, and only one design was preceded by its author's visit to the site.

Table 12. Analysis of factors that may have affected SS application rate in design proposals—SSs applied in most of the HTH design proposals.

Analysis of Factors that May Have Affected SS Application Rate in Design Proposals			
% of SS	**pillar**	**SS application in design proposals in the four pillars: I—accessibility, II—ecology, III—functionality, IV—identity**	**Factors that may have affected SS application in HTH design proposals** 1 2 3
		SSs APPLIED IN MOST HTH DESIGN PROPOSALS	
78–89%	I	OB possibility to observe bus stands from the waiting room	
		RS roofed bus shelters	
		BP bicycle or pedestrian and bicycle path	
		WCD/WCC toilet adapted to the needs of PwD/a parent with a child	
		TP tactile pavements and guidance lanes	
		IC infrastructure for cyclists	
	II	GR green roofs	
		TG tall greenery	
		MG medium-high greenery	
		CP climbing plants	
	III	PP priority for pedestrians	
		SV chicanes and humps to slow down vehicle traffic	
		RP raised platforms & pedestrian crossing/lack of curbs	
		SB weather-sheltered bus stops	
	IV	CG bus station as 'the city gate'	
		NV native vegetation	

Most HTH design proposals (78–89% and 56–67%) featured SSs that enhanced accessibility to PwD and which were discussed with representatives of the group during the workshop. Here, as above, the probable cause of failing to apply the solutions was that the projects that did not feature them were prepared before the workshop and the PwD accessibility issue had not been 'tangible' enough to the authors. The SSs in question were implemented most effectively in two master thesis designs whose authors had been workshop participants.

Table 13. Analysis of factors that may have affected SS application rate in design proposals—SSs applied in more than a half of HTH design proposals.

Analysis of Factors That May Have Affected SS Application Rate in Design Proposals			
% of SS	**pillar**	**SS application in design proposals in the four pillars: I—accessibility, II—ecology, III—functionality, IV—identity**	**Factors that may have affected SS application in HTH design proposals** 1 2 3
		SSs APPLIED IN MORE THAN HALF HTH DESIGN PROPOSALS	
56–67%	I	K&R kiss & ride stands	
		SN space for non-neurotypical persons and accompanying persons	
		TI tourist information point/tactile city plan	
	II	RG rain garden	

Table 13. *Cont.*

Analysis of Factors That May Have Affected SS Application Rate in Design Proposals			
		GW green walls	
		GS green bus shelters/green canopies	
		TE totem/a symbolic sign	
	IV	RB residents' notice board	
		VK local vegetable kiosk	

Fewer than half (11–44%) of the HTH design proposals featured the highest number of factors that may be expected to both facilitate and hinder SS application—they belong to three groups (1, 2, 3) with the exception of those SSs that were mandatory in the HTH use program and/or were mandated by the zoning plan and were implemented in all the proposals. One factor that did not appear in the results was the problem discussed during consultations with transport operators—a local problem both visible and explained on site concerning a specific SS, namely TM. Its application was not possible at the time, due to the organization of bus transport in Hrubieszów, which is why students eliminated this problem as unaddressable in their projects due to being excessively detailed.

Table 14. Analysis of factors that may have affected SS application rate in design proposals—SSs applied in less than half of HTH design proposals.

Analysis of Factors That May Have Affected SS Application Rate in Design Proposals			
% of SS	**pillar**	**SS application in design proposals in the four pillars: I—accessibility, II—ecology, III—functionality, IV—identity**	**Factors that may have affected SS application in HTH design proposals** 1 2 3
	SSs APPLIED IN LESS THAN HALF HTH DESIGN PROPOSALS		
11–44%	I	PD parking lots for the disabled	
	II	RT retention tank/basin	
		SF solar or photovoltaic panels/rooftops	
	III	RC reducing the number of pedestrian crossings	
		BP separated bicycle path	
		TM ticket machines	
	IV	CC city crest	
		CF city flag	
		CI official city logo	
		MC multiculturalism	
		WA traditional architectural forms and details	
		CW first city well	
0%	**SSs NOT APPLIED IN ANY HTH DESIGN PROPOSAL**		
	III	WF water fountains	

One surprising development was the low incidence of PD application (4 out of 9 proposals, none of which were workshop projects), even though the issue of parking lots for the disabled is an element that is present in all the analyzed curricula and had been discussed during workshop presentations and mentioned as crucial during consultations with PwD representatives. The group of least-applied SSs were those associated with place-based identity (CC, CF, CI, CW), which may be justified by their local nature and level of detail—implementing them required a much deeper involvement with the wider project determinants, which was difficult, especially so during short workshops. The application of RT only once, in an LA master's thesis design, was an interesting development, which may be justified by it being a highly specialist matter that requires professional hydro-technical

consultations and a larger plot outside the HTH, which could therefore be introduced only at the level of an LA master's thesis design.

The element that did not appear in any of the proposals was WF—which was probably a much too detailed issue concerning other more pressing problems that the students had to face.

In a summary of the factors that may have affected the application of selected SSs in the HTH design proposals, we can note the following observations:

The first group of factors that stemmed from program curricula, the SSs analyzed were those that featured most prominently in the LA program (11 out of 20). LA students were also the most numerous group among all HTH project participants (among candidates: four LA students and two A students; among workshop participants: five LA students, three A students, and five T students), which means that LA students can be considered to have made the fullest and most effective application of SSs in their proposals.

The second group of factors concerned the HTH's site-specific conditions, the design itself, and participatory activities—the leading contributing factor to SS use was the overview of selected problems by tutors during workshop presentations (36). This may mean that it was the most effective tool for applying SSs in the projects due to the interactive cooperation between students, tutors, and stakeholders directly on site.

In the third group of factors, which concerned the level of detail of each solution, and which may have contributed to their application rate, problems that were at the highest detail level predominated (10 out of 14), as their design was not essential to the task and scope of the project.

4.2. Limitations

The main limitation of this study is that it was based on a pool of exercise projects associated with only one particular site, and as such constituted only a single case. Although from a qualitative standpoint a catalogue of sustainability-focused solutions could be formulated on its basis, it cannot be seen as definitive and must be seen as open to additions. That is why the checklist based on this study prepared as Supplementary Material for the local authorities and designers also includes aspects that did not appear in students' projects and were not particular issues in the case study. The projects analyzed did not feature energy, water, or waste solutions, nor did they have any sound-insulation features. There was also very little space to include any type of micro-museum, and aspects of identity and heritage probably had to be displayed on screen. Depending on site-specific conditions for other projects, individual elements from the catalogue may not be possible to implement, or their significance may vary—this is an aspect that was not investigated here and should be validated in further studies. This is why it is necessary to test the solutions catalogued and rate them by significance.

4.3. Potential Applications

The main area for the potential application of our catalogue is the ecological education of design professionals, such as landscape architects, architects, urban designers and planners, or transport planners. The possibilities of using the research presented in this article go far beyond didactic aspects. Small cities often face the problem of significant exclusion in terms of public transport accessibility—as an element of connections with larger urban centers, but also the functioning of the network within the city itself [90] and its vicinity. This is a problem specific to some European regions, and also to developing countries [91]. Access to regional transport, mainly by bus, determines a number of social functions in terms of access to education, culture, entertainment, and health.

There is a noticeable deficit in the modeling of small transport hubs whose scalability would result in a greater potential for replication, while the problem has mainly been investigated in context of big cities. The development of a number of recommendations may determine the potential of the solutions developed by an interdisciplinary team. So far, no comprehensive catalogue of guidelines has been developed to support designers, local authorities, interested stakeholders, and those making strategic decisions in situations

of typically limited resources. Their importance for smaller urban units, as shown by team members' experience in smaller Polish cities, seems to be significant. Small towns may become important nodes for public transport in typically rural regions with significant disparities in mobility options [92] and transport-based social exclusion [93].

Another use can be that of a tool for raising awareness of specific sustainability-focused solutions, as some policies may be seen as vague and nebulously worded, which is why we think there is substantial value in having a clearer, more concrete picture of what form sustainability can take in the urbanscape. This vagueness may be seen as an obstacle to the wider implementation of sustainability guidelines, especially in horizontal organizational environments where the distance between policymakers and those who implement the policies is reduced and plain communication is valued.

We assume that the solutions developed within the text can also be applied as a number of guidelines that could be used to create functional and spatial concepts of small mobility hubs with an extended environmental approach. The potential applications include the assessment of policies and proposals, involving coupling with multi-criteria decision-making support methods (MCDM), by facilitating more objective comparisons of design alternatives and planning decisions. The final checklist can be used for self-auditing, encouraging small communal units to apply sustainable, ecological solutions in mobility hubs.

5. Conclusions

The solutions proposed by the students are compliant with SDGs in the four main areas defined in this paper as accessibility, urban ecology, functionality, and identity. The results demonstrate the value of students working within interdisciplinary teams and that a wide palette of eco-friendly solutions from architectural and landscape design can be applied to public transport infrastructure projects to be implemented in a small borderland city that suffers from transport exclusion.

This paper uses a case study from a small town in a provincial area in Poland and is based on an analysis of nine design concepts, but it focuses on a broad spectrum of problems for which little funding is available. The proposed framework was developed with the intention of maximizing contemporary opportunities for creating sustainable space and architecture. Its defining feature is its interdisciplinary approach, which is intended to reflect a holistic view of transport, and also the urban, natural, and socio-cultural context of the transport hub location. A novelty in our study is the prominence of the identity thread, which can enhance the quality of public space and offer a sense of place and community. In our opinion, it is legitimate to formulate a preliminary framework based on the nine design concepts for the described case study and to present it in order to allow a wider range of researchers to further research towards its universal applicability.

Future research into the catalogued solutions should focus on testing them with a different project in order to better rate the universality of each solution. In addition, the possible link between sustainability-focused projects sited in small cities and towns and the attractiveness of those localities as tourist destinations merits investigation, especially in the context of equipping them with small transport hubs. Presumably, Hrubieszów's transport exclusion may profoundly affect the utilization of its cultural assets. Insofar as the general satisfaction of tourists is tied to better accessibility even to places as renowned as UNESCO World Heritage Sites [94], it is difficult to analyze these dependencies in separation from general efforts to promote tourist attractions and cultural heritage of local and regional significance in provincial areas. It should be noted that the HTH site is quite comfortable from the standpoint of its distance to the city center (it is compliant with 15 min city guidelines), it has limited surface area, and it is quite far from the train station.

It should also be noted that both the scope of the participation, namely the workshop, and the site covered by the project suffered from time constraints imposed by the development project. As authors, we hope that the project can contribute to building trust in participative processes among Hrubieszów's community.

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