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MEASURING WALKABILITY THROUGH THE URBAN WALKABILITY EVALUATION TOOL (UWET): INTEGRATING URBAN DESIGN QUALITY AND OPEN DATA APPROACHES

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Abstract: This study examines walkability as a critical component of sustainable urban development and quality of life in post-industrial cities. The focus area is Ostrava, a Czech city characterized by extensive panel housing estates and ongoing socio-economic transition. The Urban Walkability Evaluation Tool (UWET) is presented as an innovative open-source assessment instrument built on the Urban Design Quality (UDQ) framework. UWET operationalizes seven key dimensions of pedestrian environments: Imageability, Enclosure, Human Scale, Transparency, Complexity, Safety and Sensations, and Cleanliness. The tool combines objective physical-environment audits with participatory data collection on subjective user perceptions. Built on the open-source KoboToolbox platform with an integrated interactive dashboard, UWET offers three distinctive advantages. First, it eliminates acquisition costs through its open-source foundation. Second, it allows flexible deployment across diverse urban morphologies, from city-wide assessments to specific street segments. Third, it remains accessible for non-specialist users, including municipal planners and community organizations. The framework proves particularly relevant for large-scale housing estates where push factors such as degraded public spaces, monofunctional land use, and perceived insecurity discourage walking and contribute to spatial exclusion. A pilot application in Ostrava illustrates the tool's capacity to generate actionable insights for evidence-based planning in resource-constrained contexts. The study contributes to understanding how accessible walkability assessment can support health equity, social cohesion, and inclusive urban revitalization in Central European post-industrial settings.

Keywords: walkability; Urban Design Quality; post-industrial cities; housing estates; street audit; KoboToolbox; Ostrava

1 INTRODUCTION

Walkability is increasingly recognized as a core component of urban quality of life and sustainable development because it links health outcomes, social cohesion, local economic vitality, and environmental performance (Pacione, 2003; Lovasi et al., 2011; Westenhöfer et al., 2023). Yet the benefits of walkable environments are unevenly distributed. In post-industrial Central European cities, aging infrastructure, depopulation, territorial stigma, and long-term underinvestment often concentrate in large housing estates and other residential areas shaped by socialist-era urbanization (Cysek-Pawlak and Pabich, 2021; Schemschat, 2021; Xu et al., 2025). In such disadvantaged settings, pedestrian movement is influenced not only by the location of destinations, but also by whether everyday routes feel safe, legible, comfortable, and well maintained.

This distinction between formal spatial accessibility and the experienced quality of the route is important because relatively good accessibility does not automatically produce a walkable environment in practice. Streets may remain formally connected while still discouraging walking through inactive frontage, monotonous built form, poor maintenance, traffic stress, noise, or a weak sense of safety. For planning practice, the key question is therefore not only whether destinations can theoretically be reached on foot, but also whether the journey itself supports routine pedestrian use. This route-based perspective is consistent with urban-design approaches that emphasize the experiential quality of the space between origins and destinations rather than proximity alone (Jacobs, 1961; Ewing and Handy, 2009; Gehl, 2010).

Although walkability research has grown substantially, several limitations remain especially relevant in these contexts. Many existing tools were developed for metropolitan cores or newly built neighborhoods and are therefore less sensitive to the morphology and everyday conditions of post-socialist residential environments. In addition, implementation often depends on proprietary software, specialist expertise, or costly data sources, while many approaches still privilege either rapid scoring or detailed auditing without combining both in a transparent and operational workflow (Huang et al., 2025; Telega et al., 2021). In many Central European post-industrial cities, routinely available datasets are also not detailed enough to capture micro-scale conditions such as facade transparency, crossing quality, maintenance, or sensory discomfort (Huang et al., 2025; Telega et al., 2021; Cysek-Pawlak and Pabich, 2021).

For analytical clarity, walkability tools can be distinguished between outcome-oriented and process-oriented approaches. The former provide rapid and intuitive summaries, exemplified by accessibility indices such as Walk Score-type measures (Carr et al., 2010; Duncan et al., 2011). The latter emphasize systematic data collection, analysis, and interpretation and are therefore better suited to diagnosis and longer-term planning (Huang et al., 2025; Telega et al., 2021). In post-industrial urban settings, where route quality often diverges from simple measures of accessibility, the second approach is particularly important.

To respond to these challenges, this article introduces the Urban Walkability Evaluation Tool (UWET), an open-source framework that operationalizes Urban Design Quality (UDQ) for field deployment. UWET combines objective street-environment audits with participatory input on perceived comfort and safety and links these observations to an interactive dashboard. In this way, it is designed to support segment-level diagnosis while remaining accessible to non-specialist users and municipal practice. Building on the implementation gap outlined above, the central research question of this study is: *How effectively can an open-source, low-cost, UDQ-based audit-and-dashboard workflow capture interpretable walkability differences across street segments in post-industrial Central European cities*?

Two sub-questions specify this focus: (1) Which indicators are most suitable for capturing walkability deficits in post-industrial Central European urban structures? and (2) How effectively can an integrated audit-and-dashboard workflow support evidence-based prioritization of local interventions?

The aim is to develop and pilot the Urban Walkability Evaluation Tool (UWET) as an integrated workflow that combines field auditing, transparent indicator-based scoring, and interactive data visualization. Rather than presenting a citywide benchmark, the pilot in Ostrava is used to test the feasibility and sensitivity of the framework under real municipal conditions.

2 THEORETICAL FRAMEWORK

The analysis is grounded in the Urban Design Quality (UDQ) framework, which is not treated here as a new theory. We adopt an established framework developed in earlier urban-design research, especially by Ewing and Handy (2009) and Ewing and Clemente (2013), and apply it to post-industrial Central European contexts.

The contribution of UWET is methodological rather than conceptual: we operationalize UDQ into auditable field indicators, define a transparent weighting structure, and integrate the results into an open-source collection-and-dashboard workflow. The conceptual dimensions are therefore literature-based, while their operationalization, calibration, and implementation are developed in this study.

Following prior UDQ literature, we assess five core design dimensions (Imageability, Enclosure, Human Scale, Transparency, and Complexity). To better reflect conditions in large housing estates and streets under transformation, UWET complements these with two implementation-oriented dimensions: Safety & Sensations and Cleanliness/Maintenance.

In the broader walkability literature, UDQ is best understood as complementary to accessibility-based measures rather than as a substitute for them. Macro-scale indicators can estimate whether destinations are reachable on foot, but they are less capable of explaining why two streets with comparable locational advantages may feel radically different to pedestrians. Recent reviews therefore distinguish between tools that privilege proximity and network efficiency and tools that diagnose the experiential quality of the route itself (Huang et al., 2025; Telega et al., 2021). This distinction is especially important in post-industrial urban areas, where equal access to services may coexist with visible degradation, weak active frontage, traffic stress, and territorial stigma (Cysek-Pawlak and Pabich, 2021; Schemschat, 2021; Xu et al., 2025). UWET adopts UDQ precisely because it offers a conceptually coherent basis for examining these route-level differences at the street-segment scale.

The decision to extend the canonical five-dimension UDQ model is also theoretically motivated. Classic urban-design literature has shown that pedestrian behavior depends not only on formal spatial composition, but also on perceived safety, environmental stress, and the signals of care or neglect embedded in ordinary streetscapes (Jacobs, 1961; Appleyard and Lintell, 1972; Gehl, 2010, 2012). Research on walkable streets likewise shows that noise, traffic exposure, route attractiveness, maintenance, and sensory comfort affect whether a route is interpreted as inviting, stressful, or avoidable (Brown et al., 2007; Mehta, 2008; Moura et al., 2016; Bereitschaft, 2017). In large housing estates and other post-socialist urban environments, these factors are often decisive because public space may remain formally open and navigable while still discouraging walking through poor upkeep, monotonous frontage, or unpleasant environmental conditions. For this reason, Safety & Sensations and Cleanliness/Maintenance are treated in UWET not as ad hoc additions, but as implementation-oriented extensions that adapt the UDQ framework to the lived realities of post-industrial Central European neighborhoods.

- **Imageability – uniqueness and memorability of a place**
  Imageability captures how easily a street is remembered and recognized through distinctive visual cues (Lynch, 1960; Ewing and Handy, 2009). In UWET, it is represented mainly by historic buildings and significant landmarks because these elements support orientation, local identity, and perceived place character (Ewing and Clemente, 2013; Brown et al., 2007; Yoshimura et al., 2022).
- **Enclosure – spatial demarcation and street structure**
  Enclosure refers to how clearly public space is defined by building frontages, trees, and other vertical edges. It is operationalized through contiguous street wall and the building-height-to-street-width relation, both linked to perceived comfort, orientation, and pedestrian friendliness (Jacobs, 1961; Appleyard and Lintell, 1972; Ewing and Clemente, 2013).
- **Human Scale – pedestrian-proportionate urban space**
  Human Scale expresses whether the environment corresponds to pedestrian perception and movement. UWET captures this through street furniture and other small-scale elements that support staying and everyday use, while also accounting for barriers such as spatial dominance of parking or monotonous oversized frontages (Gehl, 2010; Ewing and Clemente, 2013; Brown et al., 2007).
- **Transparency – visual connection between ground floor and street**
  Transparency measures visual and functional interaction between ground floors and public space, especially active frontages and storefront visibility.

Following the "eyes on the street" logic, higher transparency generally supports perceived safety, sociability, and street vitality (Jacobs, 1961; Ewing and Clemente, 2013; Mehta, 2007).

- **Complexity – visual and functional diversity**
  Complexity reflects the diversity of forms, functions, and stimuli present in a street environment. In UWET, it is represented by architectural variation, public art, street performers, and outdoor activity nodes, because mixed and active settings are usually perceived as more attractive and engaging for pedestrians (Jacobs, 1961; Gehl, 2010; Whyte, 1981; Bereitschaft, 2017).
- **Safety & Sensations – perceived safety and sensory comfort**
  This dimension addresses perceived safety and sensory experience beyond purely visual form. UWET tracks crossings and pedestrian infrastructure, traffic intensity/speed, and negative or positive sensory exposure (noise and smells), as these factors directly influence willingness to walk and stay in place (Mehta, 2008; Gehl, 2012; Brown et al., 2007; Appleyard and Lintell, 1972).
- **Cleanliness – maintenance and environmental condition**
  Cleanliness/Maintenance captures physical upkeep of sidewalks, buildings, greenery, and litter conditions. Poor maintenance reduces perceived quality and can signal insecurity, while well-maintained environments support routine walking and inclusive everyday use of public space (Brown et al., 2007; Moura et al., 2016; Bereitschaft, 2017). In UWET, this theoretical insight is operationalized through observable audit indicators that record the condition of sidewalks, buildings, greenery, and visible disorder at the street-segment level.

Table 1 summarizes the final mapping between dimensions, indicators, and key literature.

Table 1 Mapping of UDQ dimensions, UWET indicators, and key literature sources

Dimension	Indicator	Key literature
Imageability	Historical buildings	Ewing and Clemente, 2013; Lynch, 1960; Yoshimura et al., 2022
	Important landmark	Fonseca et al., 2022; Yoshimura et al., 2022
Enclosure	Contiguous street wall	Appleyard and Lintell, 1972; Gehl, 2010; Jacobs, 1961
	Road width to building height	Carmona, 2019; Ewing and Clemente, 2013
Human Scale	Street furniture	Carmona et al., 2021; Gehl, 2010; Jacobs, 1961
	Parking	Carmona, 2019; Yoshimura et al., 2022
	Advertising smog	
	Street vendors	Florida, 2002; Fonseca et al., 2020
Transparency	Building with storefront	Bosselmann, 2018; Ewing and Handy, 2009

	Building with active storefront	Ewing and Clemente, 2013; Jacobs, 1961; Yoshimura et al., 2022
Complexity	Building design	Carmona et al., 2021; Fonseca et al., 2022; Gehl, 2010
	Outdoor dining room	Florida, 2002; Fonseca et al., 2022
	Public art	Naughton, 2022; Yoshimura et al., 2022
	Street performers	Fonseca et al., 2022; Mack et al., 2017
Safety & Sensations	Crosswalks & pedestrians infrastructure	Adkins et al., 2012; Bereitschaft, 2017; Mehta, 2008
	Noise	Brown et al., 2007; Fonseca et al., 2022; Mehta, 2008
	Smells	Appleyard and Lintell, 1972; Bozovic, 2025
	Traffic density & speed	Ewing and Clemente, 2013; Yoshimura et al., 2022
Cleanliness	Condition of buildings	Bereitschaft, 2017; Carmona, 2019
	Condition of sidewalks	Ewing and Clemente, 2013; Fonseca et al., 2022
	Cleanliness of street	Appleyard and Lintell, 1972; Dičiūnaitė-Rauktienė et al., 2018
	Condition of vegetation	Brown et al., 2007; Gehl, 2010
	Graffiti	Appleyard, 1980; Bereitschaft, 2017

Source: elaborated by authors

3 DATA AND METHODS

This section presents the methodological workflow in three components: (1) UWET field-data collection design and indicator operationalization; (2) dashboard architecture for analysis and visualization; and (3) pilot application in Ostrava. Data were collected in September 2024.

To evaluate walkability in post-industrial contexts, we developed UWET based on the UDQ framework introduced above. The tool translates abstract design dimensions into measurable indicators and applies explicit weights for transparent scoring and comparison across sites. In the present article, UWET is applied primarily to Ostrava, which provides the empirical basis for a pilot analysis. UWET was developed within a wider TACR (Technology Agency of the Czech Republic) project that also included Most, another Czech post-industrial city characterized by exten-sive panel housing development and a distinct post-socialist urban structure. This broader project context informed questionnaire adaptation, conceptual refinement, and early testing, especially in relation to the types of residential environments characteristic for such cities. However, the analysis reported in this article is centered on Ostrava rather than on a comparative assessment of the two cities. The emphasis is on methodological transferability under real municipal constraints, with Most retained only as part of the wider project background. The pilot should therefore be understood as a place-based methodological test rather thanan attempt to derive universally valid scores. Ostrava's specific combination of industrial legacy, socialist-era housing estates, fragmented public-space quality, and on-going regeneration makes it a suitable but locally distinctive setting to examine whether UWET can capture route-level differences that are often missed by accessibility measures alone.

Table 2 summarizes the seven dimensions, group weights, key indicators, and normalization rules used in UWET. In the current dashboard implementation, group weights sum to 10.0 and local indicator weights within each dimension sum to 1.0, so the aggregate result is directly interpretable as a ten-point score. Transparency receives the highest group weight (1.8), followed by Complexity and Human Scale (1.5 each), Imageability/Uniqueness and Enclosure (1.4 each), and Safety & Sensations and Cleanliness/Maintenance (1.2 each). The final walkability score is calculated as a weighted aggregation of dimension scores:

$$S_{total}=\sum_{j=1}^{7}\Omega_j\left(\sum_{i=1}^{n_j}\omega_{j,i}\,v_{j,i}\right)$$

where Ω_j denotes the global weight of dimension j, $\omega_{j,i}$ the local weight of indicator i within that dimension, and $v_{j,i}$ the normalized indicator value. In practice, most field-audit items are translated from ordered condition categories (good, average, poor) into coefficients of 1.0, 0.66, and 0.33. Two indicators – street furniture and graffiti – are treated as density measures per 100 m of audited street length, while selected segment-level characteristics are derived from the street-characteristics form. In the dashboard interface, the label Uniqueness is used as a shorter operational label for the Imageability dimension.

Table 2 UWET operationalization framework: dimensions, weights, indicators, and normalization rules

Dimension	Group Weight	Key Indicators	Indicator Weight	Normalization rule
Transparency	1.8	Building with storefront, Building with active storefront	0.50--0.50	Good: 1.0; Average: 0.66; Poor: 0.33
Complexity	1.5	Building design, Public art, Street performers, Outdoor dining room	0.20--0.30	Qualitative assessment mapped to coefficients
Human Scale	1.5	Street furniture, Street vendors, Parking	0.10--0.65	Density-based scoring / Ordinal mapping
Imageability	1.4	Historical buildings, Important landmark	0.40--0.60	Presence/Condition coefficients
Enclosure	1.4	Road width to building height, Contiguous street wall	0.50--0.50	Geometric proportion thresholds
Safety & Sensations	1.2	Traffic density & speed, Crosswalks & pedestrians infrastructure, Noise, Smells	0.15--0.50	Bipolar scales (-0.5 to +0.5) and 0--1 coefficients
Cleanliness	1.2	Condition of buildings, Condition of sidewalks, Graffiti, Condition of vegetation	0.20--0.20	Visual condition audit coefficients

Source: elaborated by authors

The weighting scheme was specified ex ante as a transparent operational calibration rather than estimated statistically from a large validation dataset. The present article does not directly transfer expert-derived weights from earlier work because the UWET version implemented here is not identical to the earlier conceptual model: it works with an adapted indicator set, a seven-dimension structure, and a field-and-dashboard workflow tailored to post-industrial Central European street and housing-estate environments. For this reason, previously elicited weights were treated as background methodological input rather than imported mechanically into the current scoring model.

The present weighting scheme should therefore be read as a transparent operational calibration for pilot deployment rather than as a definitive claim about the true relative importance of all dimensions and indicators. The specific values were assigned according to three principles: (1) the relative centrality of each dimension in the UDQ and walkability literature, (2) their expected relevance in post-industrial Central European street environments, and (3) the need to distinguish between core and supporting indicators within an auditable dashboard structure. Global weights thus reflect the relative salience of each dimension in the literature and in the pilot's applied context, while local indicator weights were assigned within each dimension to express the relative importance of individual observable features while keeping the sum of indicator weights equal to 1.0.

This normalization was adopted to keep the dimensional structure legible and the dashboard computation auditable, but it may also introduce structural bias by giving proportionally greater influence to indicators located in smaller groups. Equal weighting was also considered, but it was not adopted as the primary specification because it would itself impose a strong assumption of substantive equivalence across all dimensions and indicators, which neither the literature nor the pilot design supported. The resulting structure should therefore be understood as an explicit operational starting point designed for auditability and practical deployment, not as a universally fixed parameterization. At this stage, the weights represent a reasoned methodological choice rather than the output of formal expert elicitation or statistical optimization. Future refinement should therefore compare the current specification with expert-derived and equal-weight alternatives through sensitivity analysis and validation against external criteria such as pedestrian counts, route choice, or user-reported walking comfort. The purpose of the present formulation is to make the computational logic explicit and reproducible while preserving flexibility for later recalibration.

3.1 Data collection tool: Implementation in KoboToolbox environment

KoboToolbox was selected for field implementation because it combines flexible form design, usability across different technical skill levels, and zero acquisition costs. As an open-source environment for survey deployment, data management, and basic visualization, it is suitable not only for research teams but also for municipalities and local organizations operating under tight budget and capacity constraints.

The technical core of UWET is the XLSForm standard, which enables structured survey logic to be created in standard spreadsheet software and deployed as a mobile questionnaire (McLester and Piel, 2021). For UWET, this was especially useful because it supports georeferenced data collection, conditional logic, and straightforward export for later analysis. A further advantage is interoperability: XLSForm is not tied to one software ecosystem and can be deployed across multiple compatible tools, which preserves openness while allowing sufficient methodological complexity.

In mobile data-collection practice, XLSForm is widely used because it converts structured survey logic into a format readable by mobile applications (McLester and Piel, 2021). For our purposes, this wider compatibility mattered because it preserved the openness of the method and reduced dependence on one proprietary software environment.

Two form variants were developed: one for traditional urban structures and one for prefabricated housing-estate morphologies. This distinction was important because several indicators commonly used in compact urban fabric research are less relevant or structurally absent in large post-socialist housing estates.

In practice, the XLS templates are uploaded into KoboToolbox and rendered as operational digital questionnaires. The final structure includes branching and conditional items so that auditors evaluate only indicators relevant to the observed urban form. Field data can then be collected through the web interface or KoboCollect, with each record geotagged at the time of entry. Because civilian GPS typically operates within roughly 3 – 10 meters of positional uncertainty, selected point features were manually refined in the mapping interface when needed.

Compared with paper-based protocols, this digital workflow provides an immediate spatial record of each observation. Positional uncertainty cannot be eliminated entirely, but direct inspection and occasional manual refinement improve the usability of the resulting dataset for later analytical processing and dashboard-based visualization.

This is particularly important when mapped observations are later linked to segment-level scores and comparative dashboard outputs.

3.2 Advantages of using a digital form and XLSForm

Digital data collection reduced transcription errors and shortened processing time compared with paper-based methods tested in preliminary fieldwork (Taber et al., 2020). It also allowed iterative questionnaire refinement without programming, while GPS geotagging and in-form photo attachment supported real-time quality control.

The export structure (CSV/Excel) was directly compatible with subsequent statistical and visualization workflows. At the same time, the method still depends on trained observers and cannot eliminate subjectivity entirely, so calibration, pilot pretesting, and supervisory review remained necessary; inter-rater reliability was not formally quantified in the pilot. An important advantage of the framework is transparency: because indicator logic and scoring structure are explicit, researchers and practitioners can document interpretive uncertainty and revise the survey design in a traceable way.

The same openness also allows iterative refinement of the questionnaire based on empirical feedback from field campaigns. In this sense, the human component introduces variability, but it also adds contextual richness and local interpretive depth that fully automated systems often miss.

As noted above, the form is first prepared in XLSForm and then rendered in KoboToolbox as a mobile survey interface (Figure 1 and Figure 2).

After receiving access rights, field users open the appropriate project version and start data entry in the mobile interface (Figure 3 and Figure 4). Selecting the correct project version remains important because indicator availability differs between traditional and prefabricated morphologies. Once the correct form is selected, auditing proceeds according to the UWET protocol, and the resulting dataset can be exported directly for dashboard-based analysis.

In practical terms, KoboToolbox is organized around projects, each containing one survey configuration. For quality assurance, project administrators can control permissions and review incoming submissions, while field users work with the version appropriate to the audited urban form.

Selecting the correct project version is especially important in panel-estate contexts, where some enclosure or design-specific items are structurally inapplicable. Once the appropriate form is selected, variables are recorded on predefined scales.

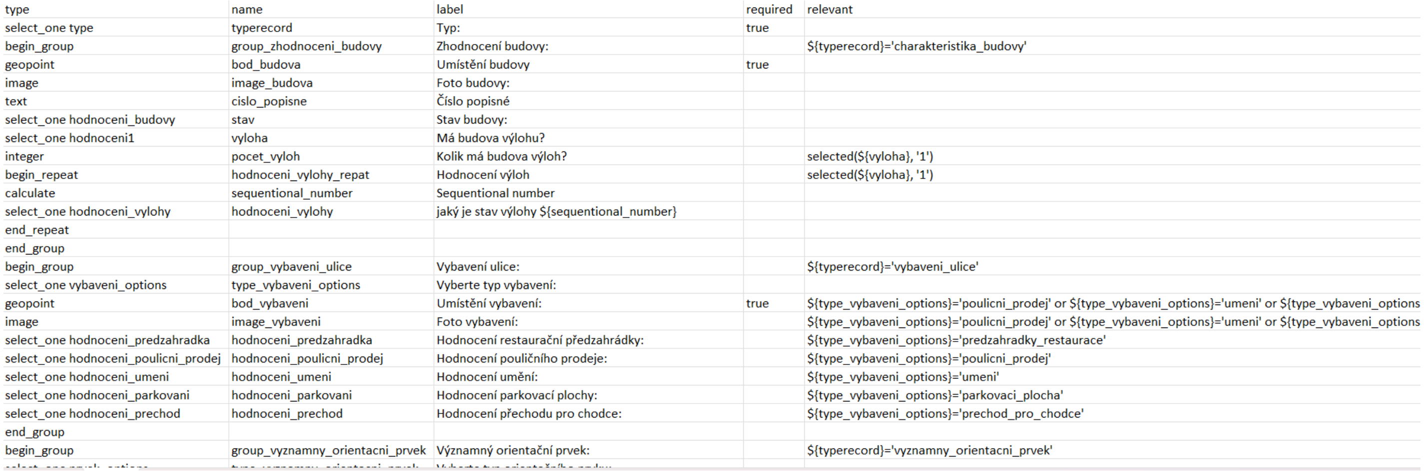
The platform also provides immediate basic summaries and visual checks before the data are exported for advanced analysis. This supports rapid quality control in the field and shortens the transition from data collection to interpretation.

To strengthen the connection between field collection and practical planning, UWET includes an interactive dashboard that translates KoboToolbox exports into maps, summary indicators, and comparative charts usable in everyday decision-making. Users upload an Excel export, after which the application standardizes variables, recalculates indicators and group scores, and renders outputs designed for municipal officers, planners, community organizations, students, and other non-specialist users. This makes it easier to identify where walkability problems cluster, how different streets perform in relation to one another, and which issues may deserve priority in planning or maintenance.

The interface is designed to prioritize readable outputs over specialist GIS procedures, thereby extending walkability assessment beyond specialist research teams and supporting broader planning dialogue.

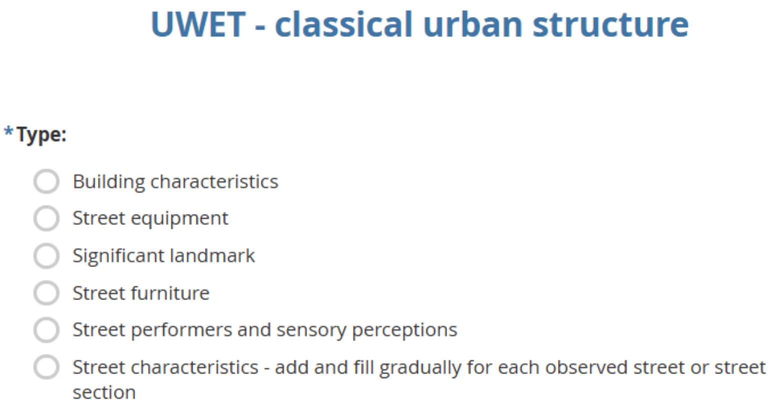
The dashboard remains an open part of the UWET workflow rather than a closed platform. Source code and user documentation are publicly available through the UWET repository and archived release, which supports transparency, reuse, and local adaptation.

In this way, the dashboard links data collection, interpretation, and communication within one coherent process.



type	name	label	required	relevant
select_one type	typerecord	Typ:	true	
begin_group	group_zhodnoceni_budovy	Zhodnocení budovy:		${typerecord}='charakteristika_budovy'
geopoint	bod_budova	Umístění budovy	true	
image	image_budova	Foto budovy:		
text	cislo_popisne	Číslo popisné		
select_one hodnoceni_budovy	stav	Stav budovy:		
select_one hodnoceni1	vyloha	Má budova výlohu?		
integer	pocet_vyloh	Kolik má budova výloh?		selected(${vyloha}, '1')
begin_repeat	hodnoceni_vylohy_repat	Hodnocení výloh		selected(${vyloha}, '1')
calculate	sequentional_number	Sequentional number		
select_one hodnoceni_vylohy	hodnoceni_vylohy	jaký je stav výlohy ${sequentional_number}		
end_repeat				
end_group				
begin_group	group_vybaveni_ulice	Vybavení ulice:		${typerecord}='vybaveni_ulice'
select_one vybaveni_options	type_vybaveni_options	Vyberte typ vybavení:		
geopoint	bod_vybaveni	Umístění vybavení:	true	${type_vybaveni_options}='poulicni_prodej' or ${type_vybaveni_options}='umeni' or ${type_vybaveni_options
image	image_vybaveni	Foto vybavení:		${type_vybaveni_options}='poulicni_prodej' or ${type_vybaveni_options}='umeni' or ${type_vybaveni_options
select_one hodnoceni_predzahradka	hodnoceni_predzahradka	Hodnocení restaurační předzahrádky:		${type_vybaveni_options}='predzahradky_restaurace'
select_one hodnoceni_poulicni_prodej	hodnoceni_poulicni_prodej	Hodnocení pouličního prodeje:		${type_vybaveni_options}='poulicni_prodej'
select_one hodnoceni_umeni	hodnoceni_umeni	Hodnocení umění:		${type_vybaveni_options}='umeni'
select_one hodnoceni_parkovani	hodnoceni_parkovani	Hodnocení parkovací plochy:		${type_vybaveni_options}='parkovaci_plocha'
select_one hodnoceni_prechod	hodnoceni_prechod	Hodnocení přechodu pro chodce:		${type_vybaveni_options}='prechod_pro_chodce'
end_group				
begin_group	group_vyznamny_orientacni_prvek	Významný orientační prvek:		${typerecord}='vyznamny_orientacni_prvek'

Figure 1 XLSForm structure: questions and response options used in UWET.
Source: XLSForm



UWET - classical urban structure

*Type:

○ Building characteristics
○ Street equipment
○ Significant landmark
○ Street furniture
○ Street performers and sensory perceptions
○ Street characteristics - add and fill gradually for each observed street or street section

Figure 2 UWET questionnaire rendered in the KoboToolbox interface.
Source: KoboCollect

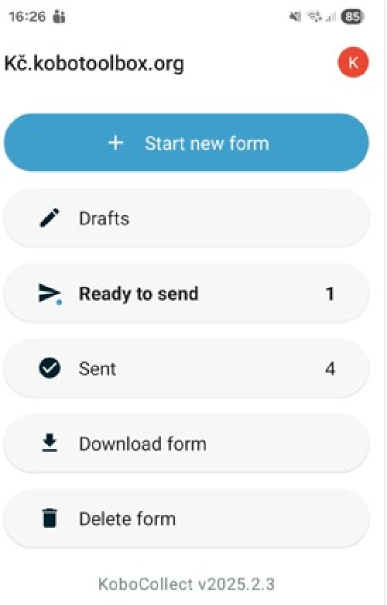
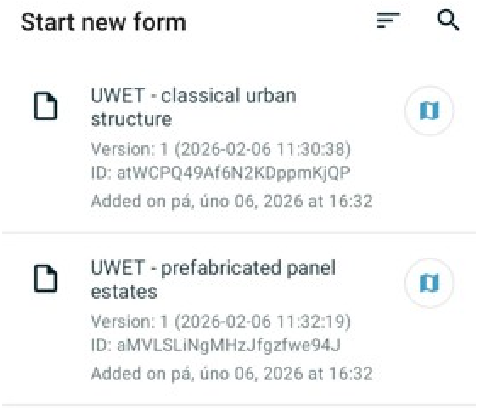


Figure 3 Starting field collection in KoboToolbox via the Start new form workflow.
Source: KoboCollect



Start new form

UWET - classical urban structure
Version: 1 (2026-02-06 11:30:38)
ID: atWCPQ49Af6N2KDppmKjQP
Added on pá, úno 06, 2026 at 16:32

UWET - prefabricated panel estates
Version: 1 (2026-02-06 11:32:19)
ID: aMVLSLiNgMHzJfgzfwe94J
Added on pá, úno 06, 2026 at 16:32

Figure 4 Project selection according to urban-structure form type. Source: KoboCollect

3.3 Dashboard workflow and transparency

Rather than functioning as a specialist analytical environment reserved for expert users, the dashboard is designed as a practical interface that transforms field observations into interpretable planning outputs.

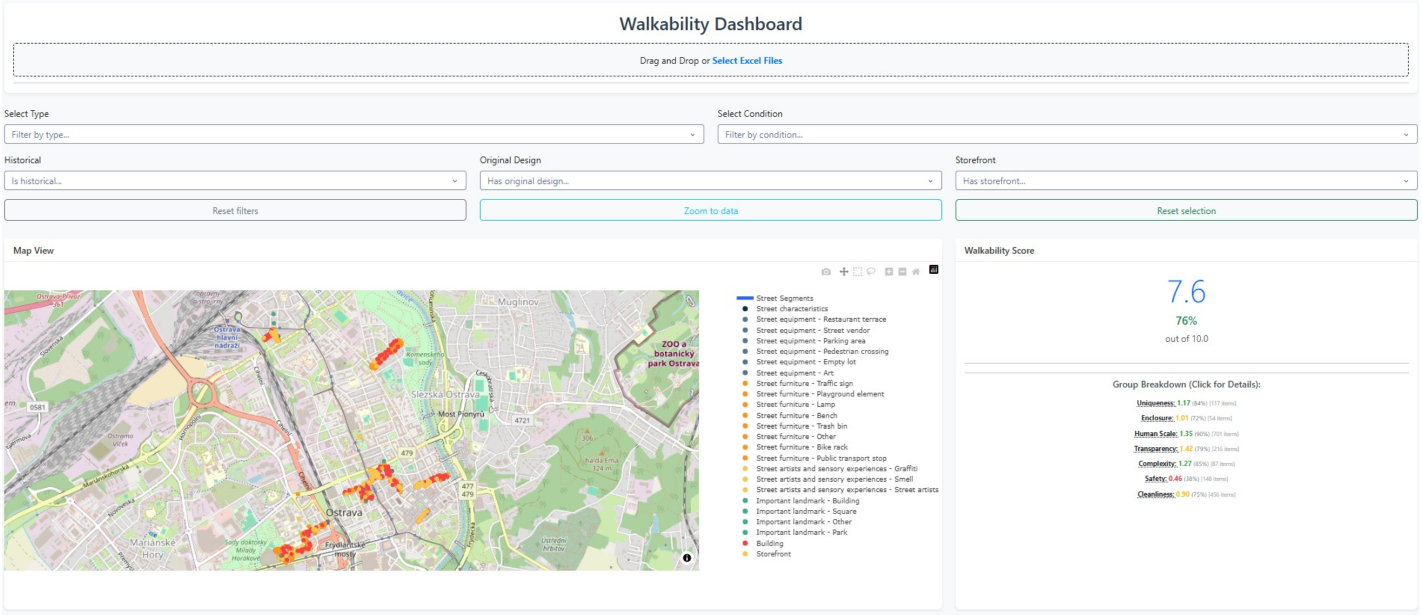
Transparency is a central design principle. Users can filter variables, compare streets or neighbourhoods, inspect the partial results behind the overall assessment, and move from city-scale overview to segment-level diagnosis. The walkability score should therefore be understood as a structured summary of the field audit rather than as an isolated number without context. This is particularly important in post-industrial settings, where similar overall scores may reflect different combinations of strengths and weaknesses.

By allowing users to move between the overall assessment and its component parts, the dashboard supports a more careful reading of local conditions (Figure 5).

The interactive map enables direct selection of individual streets and areas, while linked charts update according to the visible or chosen subset. This helps identify concrete deficits such as missing street furniture, poor sidewalk condition, weak active frontage, or visible maintenance problems and supports comparative interpretation across locations.

Users can also isolate indicators, focus on selected zones, and observe how the distribution of conditions changes across the city or within a smaller sample of streets. This creates a grounded basis for identifying priorities and discussing interventions (Figure 6).

Beyond analysis, the dashboard also serves as a communication interface between researchers, municipal officers, and other non-specialist users by making indicator differences more understandable in planning practice. Its value lies not only in producing comparable indicators, but also in making them easier to use in planning discussion. The workflow was subsequently tested in the pilot application in Ostrava discussed in the following section.



Walkability Dashboard

Drag and Drop or Select Excel Files

Select Type: Filter by type...

Select Condition: Filter by condition...

Historical: Is historical...

Original Design: Has original design...

Storefront: Has storefront...

Map View

Walkability Score

7.6

76%

out of 10.0

Group Breakdown (Click for Details):

Uniqueness: 1.17 (84%) [117 items]

Enclosure: 1.01 (72%) [54 items]

Human Scale: 1.35 (90%) [701 items]

Transparency: 1.42 (79%) [216 items]

Complexity: 1.27 (85%) [87 items]

Safety: 0.46 (38%) [148 items]

Cleanliness: 0.90 (75%) [456 items]

Figure 5 Dashboard interface showing the map view, filters, and summary outputs.
Source: UWET – Dashboard

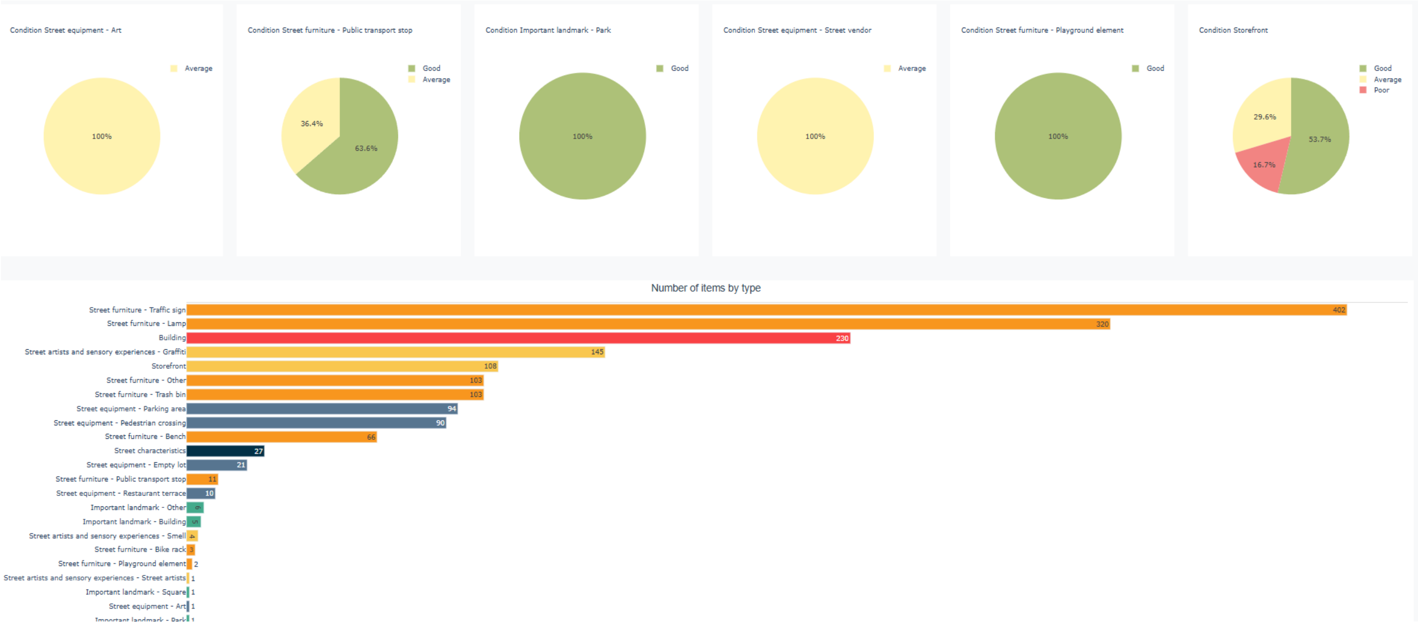


Figure 6 Interactive charts showing the condition of urban elements and their frequencies. Source: UWET – Dashboard

4 PILOT APPLICATION AND ILLUSTRATIVE RESULTS

To pilot-test UWET under real field conditions, we designed the pilot as a methodological test rather than as a representative city-wide audit. The purpose was twofold: first, to examine whether the tool can capture meaningful differences across distinct urban morphologies; and second, to assess whether a supervised team of non-expert collectors can produce data of sufficient consistency for comparative interpretation. In this sense, the pilot tested not only the questionnaire itself, but also the broader workflow linking field observation, quality control, and dashboard-based presentation.

Although the broader development of UWET also drew on pretesting outside Ostrava, the validation results reported in this section are restricted to an Ostrava-only analytical subset derived by geographic filtering. In this subset, the two audit workbooks (urban street environments and housing-estate environments) yield 1,521 georeferenced observations in total, including 1,430 primary audit records and 91 linked storefront assessments. In substantive terms, the Ostrava subset comprises 861 street-furniture records, 256 building records, 142 street-equipment records, 142 sensory-experience records, 8 landmark records, 91 storefront assessments, and 21 street-segment forms. These segment forms correspond to 17 unique street labels, because several streets were audited in more than one segment, most notably Na Hradbách and Nemocniční. This Ostrava-focused subset provides a clear empirical basis for testing how UWET performs across different urban environments, including housing-estate settings, without claiming city-wide representativeness.

The Ostrava field campaign was carried out by a supervised team of ten master's-level geography students in September 2024 under favourable weather conditions. All participants completed prior training organized by the research team responsible for developing and administering UWET. This training combined a theoretical introduction to the Urban Design Quality framework with practical calibration exercises, trial observations, and discussion of ambiguous cases. In line with recommendations for visual-assessment training in urban design research, the instruction also used photographic examples and visual illustrations of higher and lower values for selected indicators to support more consistent interpretation across raters (Ewing and Clemente, 2013). Each student worked with a methodological manual containing standardized criteria, photographic examples, and instructions for using KoboToolbox in the field. This training did not eliminate subjectivity, but it reduced inter-observer inconsistency and made subsequent supervision more systematic. Within the pilot, the students served as supervised field auditors, allowing the project to test whether UWET can be implemented reliably by trained non-expert users under real survey conditions.

This sampling strategy was purposive rather than statistically representative. Within Ostrava, segments were selected to cover central mixed-use streets, historic block environments, broad modernist streets, and residential areas associated with prefabricated housing-estate morphology. Priority was given to streets where everyday pedestrian experience could be observed directly and where visible contrasts in maintenance, traffic stress, frontage activity, and public-space quality were expected. The choice of several locations was discussed with the Moravská Ostrava a Přívoz district municipality, which was already aware of specific spatial deficiencies and interested in evidence that could support future interventions. The urban structures themselves were identified with reference to established typological classifications in urban morphology literature (Hudeček and Hnilička 2018).

For transparency, the Ostrava validation subset includes 21 audited street segments distributed across 17 named streets. Several labels occur more than once because visibly different parts of the same street were audited as separate segments rather than collapsed into a single record. In this sense, the effective unit of analysis is the audited street segment, not the street name alone.

As Figure 7 suggests, the Ostrava sample was intentionally assembled to cover contrasting street environments rather than a single neighbourhood type. This diversity is important because the value of the pilot lies less in producing a definitive ranking of urban structures and more in demonstrating how UWET differentiates between favourable and problematic pedestrian conditions at the segment level. In the Ostrava-only analytical subset (filtered by geographic coordinates), 1 521 georeferenced observations were retained for evaluation. Of these, 952 records (62.6%) were coded as good, 310 (20.4%) as average, and 259 (17.0%) as poor. At the aggregate dashboard level, this subset yields a walkability score of 7.25/10. The strongest dimension-level contributions are Complexity (1.31/1.50), Imageability/Uniqueness (1.26/1.40), Human Scale (1.17/1.50), and Transparency (1.14/1.80), while Safety remains the weakest dimension (0.46/1.20). The street-segment forms sharpen this picture further: high traffic was recorded in 5 of 21 segments (23.8%), elevated noise in 3 segments (14.3%), and missing or poorly maintained greenery in 10 segments (47.6%), whereas missing or poor sidewalks appeared in only 1 segment (4.8%).

From a validation perspective, these descriptive results support four main conclusions. First, they confirm operational feasibility: the tool can be deployed in real field conditions by a supervised team of trained non-expert auditors and can generate a structured dataset of 1 521 georeferenced observations plus 21 street-segment forms in the Ostrava-only subset. Second, they demonstrate discriminatory sensitivity: the mixture of good, average, and poor ratings, together with variation in traffic, noise, greenery, and cleanliness indicators, shows that the framework does not collapse contrasting streets into the same profile. Third, they demonstrate interpretability: the aggregate score can be decomposed into dimensions and then further into specific indicators such as transparency, maintenance, crossings, or sensory conditions, which is essential if the tool is to support planning decisions rather than merely produce a ranking. Fourth, the pilot clarifies current methodological limits, especially observer subjectivity, purposive sampling, and the fact that the present application should be read as methodological validation rather than as a representative benchmark of Ostrava as a whole. To present this contrast without relying on dashboard graphics alone, Table 3 summarizes two filtered examples from Ostrava: one relatively strong-performing street segment and one lower-performing local cluster in the Přívoz district.

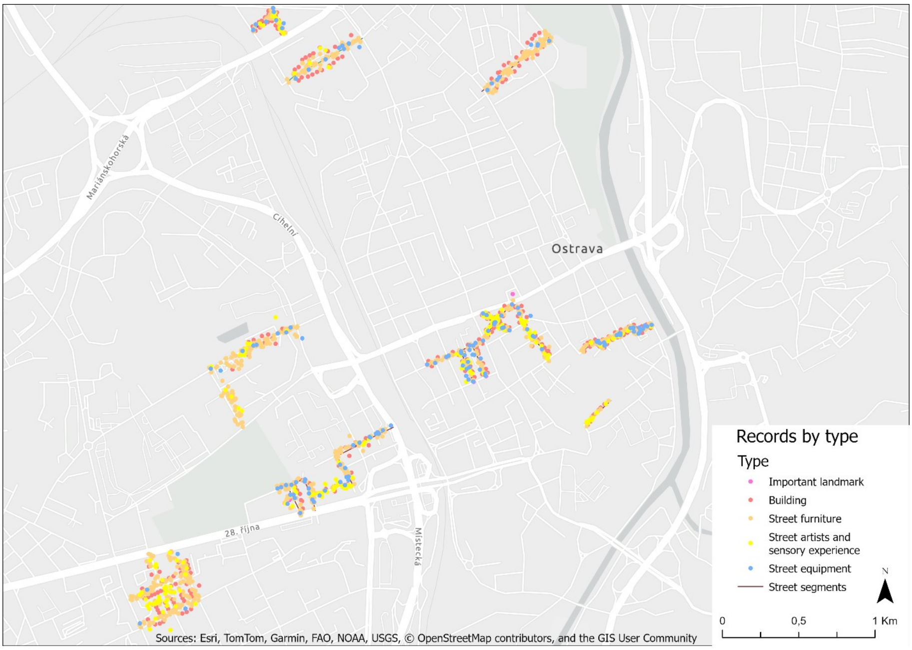


Figure 7 Spatial distribution of UWET pilot records collected in Ostrava, illustrating the range of street segments included in the validation dataset. Source: ArcGIS Pro, data collected from KoboCollect

Table 3 Contrasting dashboard cases from the Ostrava pilot. The lower-performing Přívoz example reflects the combined dashboard filter applied to the adjacent Chopinova and U Tiskárny segments; dimensional labels follow the dashboard terminology used in the UWET interface

|p3.0cm|p3.4cm| p4.0cm| Case	Walkability profile	Street context	Interpretation
Vítězná Street	6.0/10; strongest: Transparency 1.16, Cleanliness 1.09; weakest: Safety 0.35	High traffic; good sidewalks; average cleanliness; maintained greenery; average enclosure; noisy; no advertisement pollution	Active frontage, maintained greenery, and overall maintenance support walking, but traffic stress, limited crossings, and noise reduce comfort
Přívoz district	5.1/10; strongest: Transparency 1.11, Enclosure 0.92, Human Scale 0.82; weakest: Complexity 0.39, Safety 0.39, Cleanliness 0.72	Average traffic; average-to-good sidewalks; average cleanliness; poor greenery; average enclosure and noise; minimal advertisement pollution	Readable street structure and partial frontage activity are present, but weak complexity, safety deficits, and lower comfort reduce walking attractiveness

Source: elaborated by authors

Vítězná Street. Vítězná Street produced one of the stronger outcomes in the pilot sample, reaching 6.0/10 in the dashboard output summarized in Table 3. Its strongest results were Transparency (1.16) and Cleanliness (1.09), consistent with active ground-floor uses and relatively maintained public space. Its main weakness concerned Safety (0.35), as traffic exposure, limited crossings, and noise still reduce pedestrian comfort. The case therefore suggests that a relatively well-performing street would benefit most from traffic calming and safer pedestrian crossings. At eye level, the street illustrates a mixed but legible pedestrian environment: active frontage and maintained greenery support the UDQ's design dimensions of Transparency, Human Scale, and Cleanliness, while the carriageway, traffic noise, and limited crossing infrastructure create a sensory and safety barrier along the route.

At the same time, the example shows that relatively strong overall scores do not remove the need for targeted intervention at the segment level (Figure 8).

Figure 8 Eye-level view of Vítězná Street, illustrating active frontage, main-tained greenery, and usable sidewalks alongside traffic exposure and limited crossing opportunities. Source: Vítězná street, own picture

Přívoz district. At the opposite end of the comparison is the lower-performing Přívoz example summarized in Table 3. Here the dashboard filter was applied jointly to the adjacent Chopinova and U Tiskárny segments, so the result should be read as a small local cluster. The combined score is 5.1/10. Enclosure (0.92), Transparency (1.11), and partly Human Scale (0.82) remain acceptable, but Complexity (0.39), Safety (0.39), and Cleanliness (0.72) are weaker. Although some active ground-floor uses are present, limited activation and lower comfort reduce the attractiveness of walking.

This street segment therefore illustrates how legible urban structure alone does not guarantee a comfortable pedestrian environment. Eye-level observations help explain this result. The route contains a recognizable street structure, but the pedestrian experience is weakened by sparse or poorly maintained greenery, monotonous edges, weaker visual complexity, and a lower sense of care in the public realm. In UDQ terms, the cluster therefore illustrates how Enclosure and partial Transparency can coexist with weak Complexity, Safety & Sensations, and Cleanliness/Maintenance; a legible urban structure alone does not guarantee a comfortable pedestrian environment (Figure 9).

Figure 9 Eye-level view of the Přívoz example, showing weaker greenery, limited visual complexity, and maintenance-related deficits that reduce pedestrian comfort despite a readable street structure. Source: Přívoz district, own picture

These two examples should not be read as a definitive ranking of whole neighbourhoods or development types. Rather, they show that UWET can move from a general city overview to a more precise diagnosis of particular street segments grounded in mapped observations and dimension-level scores.

5 DISCUSSION

The Urban Walkability Evaluation Tool addresses a recurring gap in walkability assessment, especially in resource-constrained post-industrial contexts. In some of these settings, the urban fabric is also shaped by large-scale prefabricated housing estates, which may present specific challenges for walkability integration. Recent reviews show a persistent trade-off between analytical depth, transparency, and operational simplicity: some tools provide rapid GIS-based outputs, while others offer richer environmental diagnosis but require specialist software, proprietary systems, or labor-intensive processing (Huang et al., 2025; Telega et al., 2021). UWET is designed to narrow this divide. Built on open-source technologies and explicit indicator logic, it lowers implementation costs while keeping the analytical pathway auditable. Municipalities, community organizations, and research teams can adapt the questionnaire, inspect the scoring logic, and export the data without dependence on a commercial platform. This is particularly valuable in post-industrial Central European settings, where constrained planning budgets coexist with substantial needs for everyday environmental improvement (Pacione, 2003; Lovasi et al., 2011; Westenhöfer et al., 2023; Cysek-Pawlak and Pabich, 2021).

A second contribution lies in the type of evidence the tool produces. The pilot suggests that walkability depends not only on destination proximity or network accessibility, but also on microscale route experience. Active frontage, enclosure, human-scale elements, traffic exposure, maintenance, and perceived safety jointly shape willingness to walk (Jacobs, 1961; Ewing and Handy, 2009; Ewing and Clemente, 2013; Gehl, 2010; Appleyard and Lintell, 1972; Brown et al., 2007; Mehta, 2008; Bereitschaft, 2017). The contrast between stronger and weaker pilot segments shows that divergence emerged from combinations of these conditions rather than from any single variable. UWET therefore translates broad urban-design principles into evidence usable for targeted planning discussion.

This is also where the tool may be particularly useful for post-socialist and shrinking-city contexts. In such settings, pedestrian environments are often shaped by inherited modernist layouts, uneven maintenance, and territorially stigmatized neighborhoods that standard accessibility metrics capture only imperfectly (Schemschat, 2021; Xu et al., 2025). Two places may be similarly close to services but differ substantially in whether residents perceive them as safe, legible, and worth walking through. By combining objective auditing with perception-oriented inputs, UWET makes these otherwise diffuse qualities more visible and easier to discuss with local actors, including in participatory settings (Moura et al., 2016).

At the same time, the pilot highlights several limitations. The method depends on training and calibration, and observer subjectivity cannot be fully removed even with explicit criteria (Ewing and Handy, 2009; Bereitschaft, 2017). The present pilot did not include duplicate independent audits of the same segment, so formal interrater reliability could not yet be estimated. The sample is purposive rather than statistically representative, and walkability is temporally unstable because traffic, noise, weather, vegetation, and social activity vary across times of day and seasons (Mehta, 2008; Westenhöfer et al., 2023). The current weighting specification should likewise be treated as provisional until sensitivity testing compares the present calibration with both an equal-weight baseline and an expert-derived alternative. These limits do not invalidate the framework, but they mean the results should be interpreted as support for diagnosis, prioritization, and comparative learning rather than as a definitive ranking of urban quality.

For planning practice, this balance between ambition and caution matters. UWET is most valuable as a transparent decision-support instrument that can identify where local intervention may matter most, clarify which dimensions drive weaker performance, and document change over time if repeated measurements are introduced. Its open-source basis, digital workflow, and compatibility with standard exports make it suitable for iterative municipal use. Future development should focus on broader testing, stronger inter-observer calibration, repeated measurement across seasons and times of day, and possible integration with complementary image-based or GIS-derived datasets (Huang et al., 2025; Telega et al., 2021). Under these conditions, UWET can function not only as a pilot research instrument, but as a practical bridge between urban-design theory, everyday pedestrian experience, and evidence-based local planning.

Furthermore, as intended in our methodological design, the current weighting specification should be treated as a provisional operational starting point tested within a specific local context. As recent studies indicate, the relative importance of walkability indicators is highly context-dependent and varies significantly across different geographical and cultural settings, particularly when comparing Central and Eastern European cities with Western urban environments (Bartzokas-Tsiompras et al., 2023; Cysek-Pawlak and Pabich, 2021). Future research must therefore include sensitivity testing to assess the influence of weighting on the final scores. This should involve comparing the current tool's calibration with both an equal-weight baseline and alternative context-specific models based on rigorous local expert elicitation.

6 CONCLUSION

This study was motivated by the following research question:

How effectively can an open-source, low-cost, UDQ-based audit-and-dashboard workflow capture interpretable walkability differences across street segments in post-industrial Central European cities? In general terms, the pilot suggests that it can do so effectively enough to support diagnosis and priority-setting under real municipal conditions, even if further validation and calibration are still needed. UWET addresses this challenge by combining a transparent Urban Design Quality indicator framework, mobile field auditing in KoboToolbox, and an interactive dashboard that supports comparison and communication of results. In this way, the tool responds to the implementation gap identified in the literature, especially in settings where financial and technical barriers constrain the practical use of walkability assessment.

Its main methodological contribution lies in translating an established conceptual framework into an auditable workflow adapted to post-industrial Central European conditions. The combination of open-source data collection, explicit weighting logic, and dashboard-based presentation is intended not only to measure walkability, but also to make the assessment process understandable and reusable for actors outside highly specialized research teams. The broader development process in Ostrava, together with the pilot presented here, suggests that the tool can capture meaningful differences between street environments and identify localized deficits in maintenance, active frontage, pedestrian infrastructure, traffic stress, and sensory comfort. The findings should nevertheless be read as a proof of concept: the pilot sample was purposive, the number of audited segments limited, and some indicators remain sensitive to observer training and contextual variation.

The broader implication is that improving walkability in post-industrial cities does not depend only on major transport investment or abstract accessibility targets. Many deficits identified by UWET concern ordinary but actionable conditions at the street-segment scale, including crossings, greenery, traffic stress, and the continuity of active frontage. The framework can therefore help municipalities prioritize incremental interventions, document change over time, and structure more evidence-based discussion with residents and local institutions. It may also strengthen participatory planning by providing a shared and legible basis for discussing why some routes are avoided while others support routine pedestrian use. Future development of the tool we discussed should focus on wider application, stronger inter-observer calibration, repeated measurements, and possible integration with complementary image-based or spatial datasets.

Acknowledgements

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Code availability for final non-anonymized version

The UWET questionnaire, scoring logic, dashboard materials, and related project outputs are archived in Zenodo and can be accessed via DOI 10.5281/zenodo.19513176.

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Měření pěší dostupnosti pomocí nástroje pro hodnocení pěší dostupnosti v městech (UWET): Integrace kvality městského designu a přístupů založených na otevřených datech

Souhrn

Článek se zabývá otázkou, jak navrhnout a prakticky použít otevřený a finančně nenáročný nástroj pro hodnocení walkability v postindustriálních městech střední Evropy. Vychází z předpokladu, že běžně používané ukazatele dostupnosti nebo jednoduché indexy založené na blízkosti služeb nedokážou dostatečně zachytit kvalitu samotné walkability ve městech. V prostředí velkých sídlišť, modernistické zástavby a transformujících se čtvrtí totiž o ochotě chodit pěšky nerozhoduje pouze vzdálenost k cíli, ale také čitelnost prostoru, úroveň údržby, dopravní zátěž, vizuální pestrost, pocit bezpečí a celkový senzorický komfort. Text tak reaguje na implementační mezeru mezi teoretickou debatou o walkability a každodenní plánovací praxí.

Studie je ukotvena v rámci Urban Design Quality, který byl původně rozpracován v angloamerickém urbanistickém výzkumu. Tento rámec článek nepředstavuje jako novou teorii, ale jako ověřený koncept, jenž je dále metodicky operacionalizován pro potřeby terénního auditu. Nástroj UWET převádí pět základních dimenzí UDQ – imageability, enclosure, human scale, transparency a complexity do soustavy konkrétních indikátorů a doplňuje je o dvě dimenze zvlášť důležité pro post-socialistická sídliště a transformační území: bezpečnost a smyslové vjemy a čistotu a údržbu. Cílem článku je proto vyvinout a pilotně ověřit workflow, které propojí terénní sběr dat, transparentní výpočet skóre a jejich srozumitelnou prezentaci v interaktivním dashboardu.

Metodická část popisuje konstrukci nástroje, jeho implementaci v prostředí KoboToolbox a následné zpracování dat v otevřeném dashboardu. UWET kombinuje objektivní audit fyzického prostředí s participativním zaznamenáváním subjektivních vjemů uživatelů. Hodnocení probíhá na úrovni ulic či jejich segmentů a využívá explicitní váhy jak pro celé dimenze, tak pro jednotlivé indikátory uvnitř těchto dimenzí. Díky tomu je výsledné skóre auditovatelné a jeho konstrukce není skryta v proprietárním softwaru. Digitální formulář zároveň zjednodušuje sběr dat v terénu, umožňuje geolokaci záznamů a zrychluje následné zpracování. Dashboard pak převádí shromážděná data do map, grafů a souhrnných ukazatelů využitelných jak ve výzkumu, tak v plánovací praxi.

Empirická část článku je založena především na pilotní aplikaci v Ostravě, zatímco širší vývojový kontext nástroje zahrnuje také město Most. Obě města představují typické příklady postindustriálních urbánních struktur s rozsáhlou panelovou výstavbou, rozdílnou kvalitou veřejných prostranství a významnými sociálně-prostorovými nerovnostmi. Pilotní šetření v Ostravě bylo záměrně koncipováno jako důkaz proveditelnosti a citlivosti nástroje, nikoli jako reprezentativní městský benchmark. Analýza ukázala, že UWET dokáže rozlišit rozdíly mezi tradičnější kompaktní zástavbou, modernistickými strukturami a prefabrikovanými sídlišti. Vyšší hodnoty walkability se objevovaly tam, kde byl aktivnější parter, lepší kontinuita uliční stěny, větší vizuální rozmanitost a kvalitnější veřejný prostor; slabší výsledky byly spojeny s nízkou transparentností, monotonní zástavbou, horším stavem chodníků, dopravním stresem, zápachem či hlukem a s nedostatečnou údržbou zeleně a mobiliáře.

Výsledky potvrzují, že v postindustriálních městech nelze kvalitu pěšího prostředí redukovat pouze na dostupnost cílů. Dvě lokality se mohou jevit podobně z hlediska prostorové dostupnosti služeb, avšak pro chodce nabízejí zásadně odlišný každo-

denní zážitek. Právě na tuto rozdílnost je UWET citlivý, protože kombinuje měřitelné vlastnosti uličního prostoru se subjektivně vnímanými aspekty komfortu a bezpečí. Pro plánovací praxi je důležité, že takto získané informace mohou podpořit cílenou prioritizaci lokálních zásahů, například zlepšení přechodů, zkvalitnění parteru, úpravy zeleně, údržbu povrchů nebo dopravní zklidnění na problematických úsecích.

Článek současně otevřeně pojmenovává limity pilotní aplikace. Terénní audit vždy obsahuje interpretační složku, takže výsledky do určité míry závisejí na kvalitě školení, kalibraci hodnotitelů a na jednotném chápání kritérií. V prezentovaném pilotu nebyla testována formální inter-rater reliability na základě duplicitních auditů totožných segmentů a walkability je navíc časově proměnlivá, protože intenzita dopravy, hluk, počasí i vegetační podmínky se mění podle denní doby a ročního období. Autoři proto zdůrazňují, že UWET má být využíván především jako transparentní nástroj pro diagnózu, srovnávání a prioritizaci intervencí.

Celkově článek ukazuje, že hodnocení walkability lze zpřístupnit i mimo úzce specializované výzkumné týmy a že otevřené digitální workflow může sloužit jako praktický most mezi urbanistickou teorií, každodenní zkušeností chodců a lokální rozhodovací praxí. Největší přidaná hodnota nástroje UWET spočívá v jeho transparentnosti, přenositelnosti a opakovatelnosti. Pokud bude metodika dále rozvíjena v dalších městech a doplněna o opakovaná měření a přísnější testování mezi hodnotiteli, může se stát užitečnou oporou pro dlouhodobé sledování kvality pěšího prostředí.