



Proposal for a tool for analyzing the physical state and functionality of municipal built heritage for sustainable and proactive management of local infrastructure

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Summary: Municipalities' built heritage constitutes a strategic lever for the provision of basic public services. However, in many communities, its maintenance remains insufficiently structured, due to a lack of tools adapted to assessing its actual condition. This article proposes a simplified but robust analysis grid, focused on two essential dimensions: physical condition and functionality. The tool was designed to enable municipalities to detect deterioration, anticipate interventions, and prioritize corrective actions. It integrates an alert mechanism based on a rating system that classifies buildings into four critical levels. Finally, this research draws on the case of the municipality of Nikki in northeastern Benin and proposes a model transferable to other contexts in sub-Saharan Africa.

Keywords: Built heritage, infrastructure sustainability, multi-criteria assessment, local governance, territorial intelligence.

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1. Introduction

The viability of public services depends heavily on the quality of municipal buildings (schools, health centers, town halls, covered markets, community centers). However, in several Beninese municipalities, these infrastructures are rapidly deteriorating due to a lack of preventive maintenance, sporadic technical monitoring, and a lack of structured diagnostics.

The development of a simple, reproducible and low-cost tool thus appears to be a necessity to support the sustainable management of built heritage and assist local authorities in their maintenance obligations.

2. Methodology for developing the tool

The development of the municipal built heritage assessment tool is based on a hybrid methodological approach, combining theoretical grounding, local consultation, and field experimentation. This approach aims to ensure the scientific rigor, contextual relevance, and operational feasibility of the tool.

The main goal of this research is to provide municipalities with a rapid, reliable and reproducible diagnostic tool for the physical condition and functionality of built infrastructure in order to promote proactive, transparent and sustainable management. Specifically, it has enabled:

- Assess the actual state of the municipal built heritage through a structured, rapid and objective diagnosis of the physical condition and functionality of municipal buildings, in order to detect deterioration, malfunctions and inadequacies of use.
- Prioritize intervention priorities in providing communities with a decision-making tool to plan maintenance, rehabilitation or replacement actions, taking into account the urgency, criticality and actual use of the equipment.
- Strengthening local governance and technical traceability through support for the establishment of a regular monitoring and evaluation mechanism for built heritage, integrated into municipal tools (Development Plan, municipal budget, activity report), in compliance with



legal frameworks (territorial administration code, decree on building permits).

To achieve these objectives, the construction of the tool is inspired by several conceptual frameworks from intersecting disciplines (urban planning, engineering, sociology, public management):

- Preventive maintenance theory: based on ISO 15686 standards for the durability of structures. It posits that the performance of an infrastructure depends on its regular and anticipated maintenance. The tool thus aligns with a logic of anticipating deterioration rather than reacting to disasters.
- Originating from the sociology of public services, the theory of use value, which opposes a purely commercial or technical logic of facilities, considers that a public facility is only worth its actual use, its ability to adapt to needs, and its actual use. The integration of a "functionality" component is based on this social reading of infrastructure.
- Derived from the work of CEREMA and UN-Habitat, the systemic grid of infrastructure quality is an approach which proposes an integrated multi-criteria evaluation, combining technical (physical) factors and accessibility or usage factors (functionality), with a view to sustainability.
- Based on urban resilience (Gbaguidi, 2019), Holling's (1973) theory of alert systems and adaptive governance on ecological systems postulates that territorial systems must integrate mechanisms for alerting and graduating responses to infrastructure degradation. The tool translates this into codified critical thresholds (green, yellow, orange, red).

Based on these different theories, the development of the tool followed five major stages, organized in a progressive manner.

A critical review of international (UN-Habitat, UNDP, AFD, CEREMA, ISO standards), national (Territorial Administration Code, decree on building permits) and scientific work references initially made it possible to identify existing analysis models and their limitations for the Beninese municipal context.

A classification of the relevant infrastructure was then carried out. These include administrative buildings, schools, health centers, markets, and cultural centers. Each type was described according to its primary use, average size, and frequency of use.

The validation of the physical and functional criteria selected (infrastructure, framework, roof, accessibility, attendance) was carried out with the various stakeholders in order to ensure their readability by non-experts.

For the construction of the multi-criteria evaluation grid that followed this stage, the selected criteria were organized into two parts (physical and functional), each structured around 4 key indicators, rated on a scale of 0 to 3. A simplified rating method, inspired by the "rapid scoring" approach which aims to produce synthetic, reliable and easily mobilizable information, even by non-specialist or poorly equipped actors, was chosen to ensure the reproducibility and universality of the tool.

During the validation phase, the tool was tested on a sample of 10 buildings. The assessment was carried out by local technical staff after brief training. The feedback made it possible to adjust certain criteria, such as the readability of functional capacity, and to calibrate alert thresholds.

This methodology illustrates a contextualized, empirical and transversal approach, making it possible to create a tool that is robust, accessible and scalable, thus contributing to reestablishing a technical and political relationship of trust between citizens and their collective facilities.

3. Results

3.1. State of the art and conceptual foundations

There are several approaches to evaluating public infrastructure:

- Standardized technical audits (ISO 15686, CEREMA, UN-Habitat) offer detailed methodologies, but are often costly for municipalities to deploy;
- Inventory systems (UNDP, AFD) list the equipment but provide little depth on its actual condition;
- Participatory scoring tools, tested in certain municipalities of Burkina Faso and Niger, are based on user perception but sometimes lack technical rigor.

This tool seeks to combine technical rigor and accessibility for local agents by integrating a dual physical and functional entry as well as a simple alert system. In this article, we intend to define the main concepts as follows:

- Municipal built heritage: All buildings belonging to or managed by the municipality, used to provide public services (education, health, administration, culture, security, etc.).
- Physical state: Visible material and structural quality of the building (roof, walls, floors, integrated equipment).
- Functionality: Ability of the building to fulfill its initial function (accessibility, capacity, availability, actual use).
- Alert mechanism: System integrated into the diagnostic grid which automatically signals the critical level of a building and triggers corrective measures.

3.2. Design of the analysis grid

The analysis of municipal built heritage is based on a cross-reading of two fundamental dimensions: the physical state of the building (which reflects its material viability) and its functionality (which expresses its capacity to fulfill its social mission).

In order to allow a simplified but structured reading of built municipal infrastructures, which can be used both for diagnoses and for political decisions, the evaluation grid was developed in two parts: section A which covers the physical state and section B relating to functionality.

Table No. 01: Section A: Physical state

Criteria	Observable indicators	Rating scale (0–3)
Walls and foundations	Cracks, collapses, humidity	0 = critical; 3 = healthy
Roofing	Infiltrations, missing sheet metal, deformation	0 to 3
Floors and coverings	Degradation, holes, slipperiness	0 to 3
Carpentry and equipment	Doors, windows, lighting, ventilation	0 to 3

This first section provides a quick assessment of the physical robustness of the infrastructure. The selected criteria cover essential structural elements (walls, roof, floors) and basic equipment (doors, windows, lighting), the failure of which could affect the safety or commissioning of the building. A low score (0

or 1) on one or more criteria should alert to a potential risk of accelerated deterioration or future disuse, especially during the rainy season or in areas subject to climatic hazards. This structural diagnosis therefore constitutes the basis of any rehabilitation strategy.

Table No. 02: Section B: Functionality

Criteria	Observable indicators	Rating scale (0–3)
Accessibility	Ramp, staircase, opening, signage	0 to 3
Attendance/use	Actual use by users	0 = abandoned; 3 = heavily used
Functional capacity	Relationship between theoretical capacity and attendance	0 to 3
Service availability	Schedules, continuity, assigned staff	0 to 3

The "Functionality" component complements the technical analysis by introducing the dimension of actual use, often neglected in traditional audits. Assessing accessibility, attendance, and availability helps highlight social dysfunctions, such as an underutilized school, an inactive health center, or an occupied but inadequate building.

Thus, an infrastructure may be in good physical condition but poorly functional; which can call into question its legitimacy and its place in the territorial network. This aspect therefore questions the use value of the equipment in its community.

3.3. Rating system and alert mechanism

To make the results of the assessment more immediately usable by municipal decision-makers, the physical and functional scores are aggregated into a Synthetic Functioning Index (ISF). This global indicator allows the overall state of a building to be represented in a single value, thus facilitating the reading, comparison and prioritization of intervention needs at the municipal level.

The Synthetic Operating Index (ISF) is calculated as follows:

$$\text{ISF} = \text{S}_{\text{physics}} + \text{Functionality} / 2$$

With :

- $\text{S}_{\text{physical}}$ = average of the scores in section A
- $\text{S}_{\text{functionality}}$ = average of the scores in section B

The synthetic operating index (ISF) serves as the basis for the alert level, whose color coding (green, yellow, orange, red) constitutes a powerful visual tool for prioritizing interventions. This mechanism promotes a culture of preventive maintenance that is still not very anchored in built heritage management practices.

3.4. Alert levels

The alert level provides a visual and normative prioritization system, facilitating decision-making in technical and budgetary arbitrations resulting from the ISF. Ranging from green (proper operation) to red (critical situation), according to a simple grid, it also makes it possible to monitor the evolution of the condition of buildings over time, and to identify equipment requiring immediate, planned or preventive intervention.

Table No. 03: Alert system and recommended action

ISF	Color	Interpretation	Recommended action
2.5 – 3.0	Green	Good general condition	Regular monitoring
1.5 – 2.4	YELLOW	Average condition	Preventive maintenance to be scheduled
0.5 – 1.4	Orange	Degraded state	Urgent rehabilitation to be planned
0.0 – 0.4	Red	Critical condition	Immediate closure or reconstruction

The implementation of the graduated alert system transforms a simple technical assessment into a strategic management tool. It not only allows for the detection of risks of obsolescence or collapse, but also for the inclusion of public buildings in a planned maintenance dynamic, which is too often absent from municipal management.

Table No. 04: Results of the tool test

Value of the ISF	Alert color	Number of infrastructures	Action envisaged
0.2-0.4	Red	2	Immediate danger, close
0.5-1.4	Orange	3	Urgent rehabilitation
1.5-2.4	Yellow	4	Requires a maintenance plan
2.6	Green	1	Regular monitoring

4. Discussion

The development and implementation of the tool for analyzing the physical state and functionality of municipal built heritage raises several strategic, operational and political issues, which deserve to be discussed in light of local realities and the theoretical frameworks used.

4.1 A suitable response to the weakness of maintenance systems

In many Beninese municipalities, built heritage is poorly monitored, poorly maintained, and often overlooked in budget planning. Infrastructure silently deteriorates to the point of becoming dangerous or unusable. The use of international normative tools, although technically robust, often remains inaccessible due to cost, technical complexity, or human resource constraints. The tool proposed in this article, with its simplicity, local roots, and readability, constitutes a realistic and operational alternative.

4.2 An innovation at the crossroads of technology and governance

The tool developed is not limited to a technical diagnostic approach. It also initiates a transformation in the local governance of public facilities. By making the condition of buildings visible and generating a comprehensible alert system, it promotes more transparent, equitable, and justifiable decision-making. It also restores meaning to the actions of municipal technical services, often reduced to reacting to emergencies, and strengthens their role in the preventive management of the territory.

4.3 A strengthened capacity for anticipation and planning

By combining physical diagnosis and functional analysis, the proposed system not only allows action on the most critical buildings, but also allows the necessary interventions to be scheduled over time (light maintenance, rehabilitation, reconstruction). It constitutes a valuable aid to municipal planning, particularly in the development or updating of Municipal Development Plans (PDC), Annual Investment Plans (PAI) or Public Heritage Maintenance Programs.

3.5. Experimental results

The tool was tested in the municipality of Nikki on a sample of 10 buildings where the ISF was calculated. The results obtained are summarized as follows:

4.4 Limitations and areas for improvement

Despite its potential, the tool has certain limitations:

- It is based on subjective observations. Although standardized, calibration through training or visual guides is necessary.
- The grid does not currently take into account the economic costs of rehabilitation or environmental impacts.
- Large-scale deployment requires institutionalization of the mechanism and sustained political mobilization.

Ultimately, digitalized and interoperable versions of the tool could be considered, integrated into municipal management platforms or geographic information systems (GIS), with an automated alert, a dynamic dashboard and an evolving database.

Finally, the proposed tool contributes to rebuilding trust between the population and its public infrastructure.

Conclusion and perspectives

Municipal built heritage constitutes an essential vector of local public action and a material support for territorial citizenship. However, in many municipalities, this heritage remains insufficiently known, poorly maintained, and rarely valued in planning mechanisms. Faced with this situation, the tool proposed in this article offers a pragmatic and innovative methodological response, through a cross-analysis grid of the physical condition and functionality of public buildings.

Built on scientific references, technical standards, and local experiments, it allows municipalities to diagnose, prioritize, and plan the necessary actions for their housing stock. It facilitates the implementation of a structured alert system, essential in a context where resources are limited but responsibilities are growing.

Beyond the technical aspect, the tool lays the foundations for a paradigm shift: thinking of public facilities no longer as fixed assets or technical objects, but as living, evolving resources to be maintained, adjusted and inhabited.

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