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A Contextual Prioritization Index for Solid Waste Collection in Low-Resource Urban Areas: Kinshasa

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Abstract

Prioritizing solid waste collection is a key issue for cities in low-resource countries, where logistical, health, social, and institutional constraints make operational decisions particularly complex. In Kinshasa, a megacity marked by rapid population growth and highly fragmented sanitation actors, prioritization mechanisms remain largely informal and reactive. This article offers an empirical analysis of the decision-making criteria used in waste collection planning, with a view to formulating a contextual prioritization index adapted to challenging urban realities. The methodology is based on a qualitative and empirical approach combining 22 semi-structured interviews with institutional, operational, community, and informal actors, as well as 14 field observation grids covering different types of urban areas. The data were analyzed using thematic coding assisted by NVivo 14, followed by empirical weighting of the criteria and systematic triangulation with the observations. The results highlight the dominance of health and logistical criteria in a reactive management approach, modulated by social, economic, and political factors. On this basis, a contextual prioritization index (CPI) is proposed, inspired by multicriteria approaches but distinguished from them by its empirical construction of weights. This index also provides a relevant foundation for integrating context-aware decision rules into smart waste management systems, particularly IoT-based approaches. The CPI is an operational decision-making tool that can be transferred to other comparable urban contexts and paves the way for future inter-urban analyses.

Keywords

Solid Waste Collection, Multi-Criteria Prioritization, Contextual Index, Low-Resource Cities, Kinshasa

1. Introduction

Urban solid waste management represents one of the major challenges faced by cities in low-income countries, where rapid population growth, unplanned urbanization, and chronic infrastructure deficits place sustained pressure on already fragile collection systems [1] [2]. The term low-resource urban areas refers to urban environments characterized by limited financial capacity, inadequate infrastructure, weak institutional coordination, and high levels of informality affecting service delivery [3]. At the global scale, annual municipal solid waste generation exceeds two billion tons, with particularly rapid growth observed in African cities, where collection rates remain structurally low and spatially uneven [4]. In such constrained urban environments, the central issue is no longer limited to expanding collection capacity, but rather concerns the prioritization of interventions under severe logistical, financial, and institutional constraints.

The city of Kinshasa, capital of the Democratic Republic of the Congo, provides an emblematic illustration of these systemic limitations. With an estimated population of approximately 17 million inhabitants [5], the metropolis generates daily volumes of solid waste that far exceed effective collection capacities. In several peripheral municipalities, collection rates remain below 40% [1] [6] [7]. Weak road infrastructure, uncontrolled urban sprawl, institutional fragmentation, and low recovery of sanitation fees have transformed waste collection into a predominantly reactive activity, driven by the management of sanitary and social crises rather than preventive planning [4] [8]-[10].

In this context of uncertainty and resource scarcity, determining which urban areas should be prioritized for waste collection becomes a strategic issue of urban governance. Actors involved in the waste management chain (whether institutional, private, community-based, or informal) are required to make daily trade-offs between multiple and often conflicting criteria [4].

Conventional approaches to waste collection planning, largely developed in high-income countries, rely on assumptions of infrastructure stability, data availability, and service continuity that are rarely met in African cities. Logistic optimization models and multicriteria decision-making methods, such as the Analytic Hierarchy Process, provide robust theoretical frameworks for decision prioritization. However, their direct application in low-resource urban contexts is constrained by limited data reliability, strong spatial heterogeneity, and the pervasive informality of collection practices [10]-[12].

Building on recent work on the contextual selection of multi-criteria decision analysis (MCDA) methods in resource-constrained environments [10], which

proposed a comparative framework to identify the most suitable methods for such contexts, the present article follows an empirical operationalization logic. This prior work highlighted the relevance of approaches such as the Analytic Hierarchy Process (AHP), due to their ability to operate with limited data, remain accessible to decision-makers, and fit within fragile institutional environments.

However, this methodological contribution did not explicitly address how these approaches can be translated into operational tools grounded in real-world decision-making situations. In particular, the way decision criteria emerge from actors' practices and can be structured into a context-adapted tool remains insufficiently explored.

Recent literature highlights a lack of prioritization models that are genuinely grounded in observed decision-making practices and capable of simultaneously integrating sanitary, logistical, social, and institutional dimensions specific to cities in the Global South [13] [14].

This study addresses the following research question: How can implicit prioritization mechanisms derived from real-world practices in solid waste management be formalized into a decision-support tool adapted to low-resource urban environments?

The main contribution lies in the development of a contextual prioritization index (CPI) based on empirically derived weights from actor practices and field observations, providing an operational alternative to MCDA/AHP approaches based on normative expert judgment.

2. Methodology

2.1. General Approach

This study adopts a qualitative analytical approach aimed at identifying and structuring the prioritization criteria mobilized in solid waste collection within low-resource urban environments. This methodological choice is justified by the inherently contextual, situated, and often informal nature of decision-making processes observed in urban systems of developing countries [8].

The adopted approach follows an inductive logic, allowing prioritization criteria to emerge directly from actors' practices and discourses rather than imposing an exogenous normative framework. This orientation is particularly appropriate for contexts characterized by high operational and institutional uncertainty, where conventional planning models have demonstrated significant limitations [15] [16].

To address the limitations of a purely qualitative analysis, the study incorporates a semi-quantitative structuring of results inspired by the principles of multicriteria decision-support methods, particularly the Analytic Hierarchy Process. However, it departs from classical applications by relying on an empirical weighting of criteria grounded in field data. This methodological hybridization seeks to enhance the operational transferability of the results while preserving their strong contextual anchoring [10].

2.2. Data Collection

2.2.1. Semi-Structured Interviews

A total of twenty-two semi-structured interviews were conducted with key actors involved in solid waste management in Kinshasa. The interviewed profiles covered the entire decision-making chain, including institutional decision-makers, public and private operators, collection workers, informal actors, local authorities, and civil society representatives. RASKIN refers to the "Régie d'Assainissement de Kinshasa", the public agency responsible for coordinating waste management operations at the metropolitan level [17].

Table 1 presents a synthetic profile of the study participants in terms of function, decision-making level, and actor category. This diversity was intended to ensure a balanced representation of strategic, operational, and social logics underlying prioritization practices.

The selection of participants followed a purposive sampling strategy aimed at capturing the diversity of decision-making contexts across Kinshasa. Interviewees were selected from municipalities representing contrasted urban configurations, including central districts, densely populated areas, and peripheral underserved zones.

Inclusion criteria required direct involvement in waste management decision-making, operational activities, or community-level engagement. This approach ensures representation of the institutional, operational, and socio-territorial diversity characterizing the city.

The interviews were guided by a thematic framework focusing on prioritization criteria, encountered constraints, decision trade-offs, and effective collection practices. Thematic saturation was reached before the end of the data collection process, indicating a stabilization of the analytical categories.

Table 1. Profile of interview participants (n = 22).

Actor Category	Number	Primary Role
Provincial authorities	4	Strategic orientation, political arbitration
RASKIN senior staff	3	Resource allocation, planning
Municipal officials	4	Local operational management
Private waste collection operators	2	Contractual service execution
Drivers and waste collectors	5	On-site operational decision-making
Informal actors	2	Pre-collection in hard-to-access areas
Civil society/associations	2	Advocacy, public health

The interviews were conducted in French and Lingala, audio-recorded with participants consent, and fully transcribed for analysis.

2.2.2. Field Observation Grids

In addition to interview data, field observation grids were applied at selected waste collection sites to represent the morphological and functional diversity of Kinshasa's urban space, including residential areas, markets, institutional sites, and

peripheral neighborhoods.

The selection of observation sites followed a similar purposive logic, aiming to reflect the morphological and functional diversity of Kinshasa. Sites were chosen to include high-density commercial areas, residential neighborhoods, institutional zones, and peripheral areas with limited accessibility, ensuring coverage of diverse operational conditions.

The observations systematically documented operational variables such as site accessibility, waste accumulation levels, sanitary risks, mobilized resources, and effective collection frequency. These observational data played a central role in the empirical validation of the criteria identified through interviews, thereby strengthening the robustness of the analysis through systematic triangulation.

2.3. Data Analysis

Interview data were analyzed using NVivo 14 software, which is widely used for computer-assisted qualitative data analysis in the social sciences [18] [19].

The analytical process was structured in three main stages:

- open coding of interview transcripts to identify the full range of prioritization criteria mentioned by participants;
- grouping of codes into thematic categories corresponding to major families of criteria;
- hierarchical structuring of criteria according to their relative importance in actor discourses and their consistency with field observations.

As shown in **Box 1**, the qualitative analysis protocol summarizes the main steps followed in this study.

Box 1. Qualitative analysis protocol.

1. Full transcription of interview recordings
2. Inductive coding of meaning units
3. Thematic aggregation of criteria
4. Analysis of inter-actor frequency and recurrence
5. Triangulation with field observation data

The empirical weighting of criteria is based on the combination of their frequency of citation in interviews and their perceived importance within actor discourses. This approach makes it possible to qualitatively translate the decision-making centrality of a given criterion into a relative weight that can be analytically exploited [20].

Perceived importance was assessed using a five-level ordinal scale (**Box 2**), ranging from marginal mention to dominant criterion. The relative weight w_i of a criterion is calculated according to the following Equation (1) [11] [20]:

$$w_i = \frac{F_i \cdot I_i}{\sum_{j=1}^{n} \left(F_j \cdot I_j \right)} \tag{1}$$

where:

- F_i: represents the frequency of citation of the criterion,

- I_i : denotes its perceived importance score,
- n : is the total number of criteria.

Box 2. Scale for rating perceived importance.

1. Low importance or marginal mention
2. Low but recurrent importance
3. Moderate importance in actor discourses
4. High importance and frequently cited
5. Very high importance, dominant criterion

The coding process was applied to interview transcripts, focusing on meaning units expressing prioritization criteria and their perceived importance.

Codes were assigned inductively to segments of discourse reflecting actors' decision-making practices. Divergences in interpretation occurred mainly in the identification of the underlying criterion and in the assessment of its relative importance.

These discrepancies were discussed and resolved through iterative comparison and consensus among the researchers, in line with established qualitative analysis procedures.

Observation grid data were used to verify the concrete manifestation of the criteria identified through interviews. This triangulation made it possible to adjust the weightings when certain criteria, although frequently cited in actor discourses, proved to be weakly determinant in observed situations, or conversely when less frequently cited criteria played a decisive operational role.

Triangulation was used to qualitatively adjust the criterion weights: criteria frequently cited but weakly supported by field observations were slightly down-weighted, while criteria strongly observed but less frequently cited were moderately up-weighted. Observation data were converted into normalized scores ranging from 0 to 1 based on predefined qualitative rating levels reflecting the intensity or presence of each criterion (e.g., low, moderate, high). These scores were directly used as input values in the CPI calculation.

2.4. Ethical Considerations

Ethical principles governing qualitative research were strictly respected. All participants provided informed consent after receiving a clear explanation of the study's objectives, the scientific purposes of the data, and measures to ensure confidentiality and data protection. Anonymity was ensured through the use of identification codes (P1-P22), in accordance with ethical guidelines in the social sciences.

2.5. Methodological Limitations

The limited sample size restricts the generalizability of the results to other urban contexts. However, the diversity of interviewed profiles and the achievement of thematic saturation strengthen the internal validity of the analysis. Systematic tri-

angulation between interviews and field observations also helps to mitigate declarative biases and enhances the credibility of the findings, in line with established quality standards in qualitative research [21].

In addition, the empirical weighting process involves a degree of subjectivity, as it relies on the qualitative interpretation of actor discourses.

Although triangulation with field observations enhances robustness, the resulting weights remain context-specific. Therefore, the CPI requires recalibration before being applied to other urban settings with different institutional, infrastructural, or socio-economic conditions.

3. Results

3.1. Identification of Decision Criteria

The combined analysis of semi-structured interviews and field observation grids led to the identification of a limited yet structuring set of criteria mobilized in decisions related to the prioritization of solid waste collection in Kinshasa. These criteria recur consistently across the discourses of institutional, operational, and community actors, as well as in observed field situations, reflecting a convergence between declared perceptions and effective practices.

As summarized in Table 2, five main criteria structure the decision-making process: sanitary risk and environmental concerns, logistical constraints, socio-community factors, institutional influences, and implicit economic considerations related to cost and operational efficiency.

Each criterion is further operationalized into specific subcriteria reflecting its concrete manifestation in field situations. For instance, sanitary risk includes factors such as waste overflow, proximity to sensitive sites, and drainage obstruction.

Their identification is grounded in the thematic saturation achieved during qualitative analysis, confirming their transversal and systemic character within the studied urban context.

Table 2. Waste collection prioritization criteria identified in Kinshasa.

Code	Prioritization Criterion	Operational Definition	Empirical Sources
C1	Sanitary and environmental	Disease risk, waste overflow, proximity to water bodies, odors, organic waste, runoff, pollution, flooding, erosion	Interviews, observation grids
C2	Logistical	Accessibility, road condition, distance, vehicle availability	Interviews, observations
C3	Socio-community	Complaints, local mobilization, community participation	Interviews
C4	Institutional and political	Administrative pressure, visibility, imposed priorities	Interviews
C5	Implicit economic	Operational cost, collection efficiency, financial availability	Interviews

These criteria constitute the analytical foundation of the empirical weighting

developed in the following section, which aims to estimate their relative importance and to formalize their integration into a contextual prioritization index.

3.2. Typology and Empirical Weighting of Criteria

The empirical analysis reveals a clear hierarchy among the prioritization criteria mobilized in solid waste collection in Kinshasa. This hierarchy is based on both the frequency of criterion citation in interviews and their concrete manifestation in observed field situations. The adopted typology distinguishes dominant, structuring, and secondary criteria according to their effective role in decision-making processes.

Table 3 presents the typology of the identified criteria and their relative importance, expressed through their frequency of mobilization in actor discourses and their observed presence at the studied sites.

Table 3. Typology and empirical weighting of waste collection prioritization criteria.

Criterion Category	Prioritization Criterion	Synthetic Description	Citation Frequency
Sanitary / Environmental	Direct sanitary risk	Presence of overflowing waste, epidemic risks, proximity to schools and health centers	19
	Drainage obstruction	Waste blocking drainage systems, flood risk	17
Logistical	Site accessibility	Vehicle access feasibility (road condition, width, slope)	18
	Collection time	Estimated intervention duration and vehicle turnaround	15
	Resource availability	Vehicle type and condition, available workforce	14
Economic	Operational cost	Cost per collected ton, route profitability	12
	Generated volume	Estimated quantity of waste produced by the area	13
Social	Resident complaints	Community reports, local conflicts	11
	Community importance	Markets, high-activity-density areas	10
Institutional / Political	Hierarchical pressure	Administrative or political instructions	9
	Urban visibility	Main roads, symbolic areas	8

Based on this typology, an empirical weighting was applied in order to translate the relative importance of the criteria into quantitative form. The assigned weights result from the combination of citation frequency and perceived importance level, in accordance with the methodology described in Section 2.3. The results of this weighting are summarized in Table 4, which constitutes the quantitative foundation of the contextual prioritization index proposed in the subsequent section.

Table 4. Empirical weighting of waste collection prioritization criteria in Kinshasa.

Code	Prioritization Criterion	Category	F_i	I_i	W_i
C1	Direct sanitary risk	Sanitary	0.86	4.8	0.17
C2	Drainage obstruction	Sanitary	0.77	4.5	0.14
C3	Site accessibility	Logistical	0.82	4.6	0.16
C4	Collection time	Logistical	0.64	4.0	0.11
C5	Generated waste volume	Economic	0.68	3.9	0.11
C6	Operational cost	Economic	0.55	3.6	0.08
C7	Resident complaints	Social	0.50	3.4	0.07
C8	Community importance	Social	0.52	3.3	0.07
C9	Institutional pressure	Institutional	0.41	3.1	0.05
C10	Urban visibility	Institutional	0.36	2.9	0.04

Figure 1 graphically illustrates the weighted distribution of the criteria, highlighting the predominance of the sanitary criterion, followed by logistical constraints and socio-community factors. This visualization facilitates comparative interpretation of the relative weights and underscores the multidimensional nature of prioritization decisions.

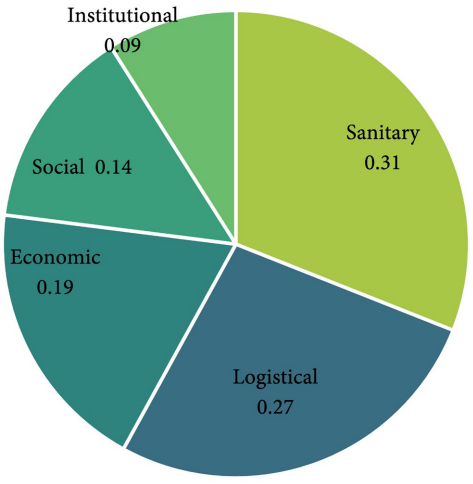

Figure 1. Weighted distribution of waste collection prioritization criteria.

3.3. Interactions among Prioritization Criteria

The results indicate that the prioritization criteria operate within a system of dynamic interactions rather than an additive logic. As illustrated in Figure 2, the sanitary criterion serves as the primary trigger for decision-making, linked to epidemic risks and the obstruction of drainage infrastructure, which are frequently associated with emergency situations. However, this sanitary priority is not systematically translated into immediate action, as it is conditioned by logistical constraints, notably site accessibility and road conditions.

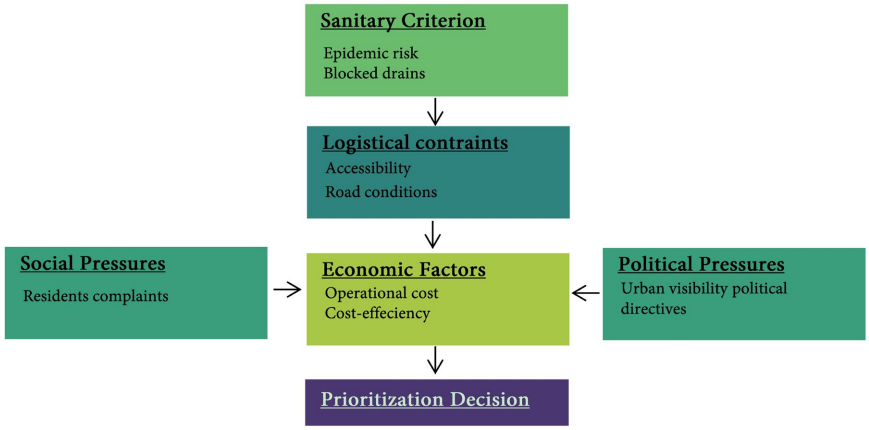

Figure 2. Conceptual Interactions among Waste Collection Prioritization Criteria in Kinshasa.

Economic factors occupy a central position in the final trade-off, modulating operational feasibility and the sustainability of interventions in a context of limited resources [22] [23]. Additionally, social and political pressures act as adjustment mechanisms, potentially reconfiguring established priorities on a case-by-case basis [22] [24]. Altogether, these interactions confirm that prioritization decisions in Kinshasa result from a contextual compromise between sanitary urgency, operational constraints, economic viability, and institutional influences [7].

Overall, the results reveal a fundamentally reactive prioritization system, dominated by sanitary urgency but strongly constrained by operational and institutional factors [17] [22]. Waste collection decisions thus appear as the product of a continuous compromise between the severity of risk, logistical feasibility, and social or political pressures [22] [24].

This synthesis highlights the need for a formalization tool capable of simultaneously integrating these heterogeneous dimensions. It justifies the development of a contextual prioritization index, presented in the final section, aimed at objectifying decision-making while remaining compatible with the operational realities of low-resource cities.

4. Discussion

4.1. Dominance of the Sanitary Criterion in a Reactive Logic

The results confirm that waste collection prioritization in Kinshasa is primarily triggered by the perception of an immediate sanitary risk, particularly in cases of visible overflow, proximity to drainage channels, or epidemic threats. This logic reflects a reactive governance of the service, in which action is mainly undertaken when unsanitary conditions reach a critical threshold. As expressed by one operational agent: "*As long as it does not overflow or block a drainage channel, it is not considered urgent*" (P7). This finding aligns with observations reported in other African cities, where waste management is mobilized as a response to sani-

tary crises rather than as a planned service [7] [8] [25] [26].

However, the centrality of the sanitary criterion does not systematically guarantee effective intervention. The data show that sanitation functions more as an alert signal than as an autonomous decision-making determinant. Sanitary priority remains conditioned by operational feasibility, which limits its normative scope and confirms the contingent nature of decision-making in low-resource urban contexts [23].

4.2. Weight of Logistical Constraints in Operational Feasibility

Logistical constraints emerge as the main filter between the recognition of a priority need and its effective treatment. Road conditions, site accessibility, and vehicle availability strongly condition the implementation of decisions. This reality is clearly expressed by a truck driver: "*Even if the truck is full, if the road is bad, we cannot risk the vehicle*" (P10). Such constraints, widely documented in the literature on urban services in sub-Saharan Africa, contribute to the structural exclusion of certain neighborhoods [2] [27].

In the case of Kinshasa, logistics therefore do not constitute a secondary criterion but a central determinant of action. The observed prioritization reflects less a normative choice than a pragmatic trade-off under constraint, which explains the recurrent gaps between declared priorities and those actually implemented [28] [29].

4.3. Emergence of Social Factors as Contextual Modulators

Social factors, notably residents' complaints and community tensions, play a modulating role in the hierarchy of priorities. Although they do not constitute dominant criteria, they can accelerate or delay intervention when unsanitary conditions become a source of local conflict. A neighborhood leader thus emphasizes that "*when neighbors start arguing because of waste, action is needed quickly, even if it was not planned*" (P17). This social dimension of prioritization is also highlighted in studies on informal urban governance [8] [30].

These results show that prioritization decisions cannot be reduced to a strictly technical rationality. They are embedded in a compromise between logistical feasibility and social acceptability, reinforcing the idea of a hybrid governance of waste collection services.

4.4. Institutional and Political Influences on Decision-Making

Institutional and political influences intervene mainly through ad hoc injunctions related to urban visibility, official events, or media exposure of specific sites. These interventions can lead to temporary reorientation of priorities, sometimes in contradiction with the identified sanitary or logistical criteria. One institutional official states: "*When there is an official visit, everything changes, even if it is dirtier elsewhere*" (P21). This phenomenon corresponds to what the literature describes as image-based prioritization [8].

In Kinshasa, such pressures do not structure the entire system, but they introduce decision-making instability [31] [32]. The results confirm that technical planning remains partially vulnerable to institutional power relations, which limits the long-term coherence of the service [28] [33].

4.5. Toward a Formalization of Decision Criteria

The analysis highlights the absence of a formal framework coherently integrating sanitary, logistical, social, and institutional dimensions of prioritization. This fragmentation reinforces dependence on subjective judgments and short-term trade-offs. As summarized by one planner: "*We mostly decide based on experience, not with a tool*" (P20). Similar findings are reported in studies advocating for multicriteria tools adapted to low-resource cities [23] [34].

In this perspective, the proposed contextual prioritization index aims to empirically formalize criteria already implicitly mobilized. The scientific interest of the index lies in its capacity to objectify decision-making without denying contextual complexity, while offering operational support for planning.

5. Proposal of the Contextual Prioritization Index

5.1. Conceptual Logic of the Index

The Contextual Prioritization Index (CPI) aims to formalize trade-offs between heterogeneous criteria involved in solid waste collection decisions in low-resource urban environments. It relies on a multicriteria approach that aggregates sanitary, logistical, social, and institutional dimensions empirically identified through multi-actor interviews and field observations. The CPI thus fits within a decision-support logic intended to objectify operational choices historically guided by urgency, constraint, and subjectivity.

Methodologically, the CPI adopts a multicriteria structuring logic by organizing complex decisions around weighted criteria, while departing from conventional weighting approaches. Instead of relying on pairwise comparisons and normative expert judgments, the CPI derives its weights from a systematic qualitative analysis of stakeholder discourses, subsequently reinforced through triangulation with field observations. This approach enables the development of a context-sensitive decision-support tool adapted to environments characterized by high uncertainty, limited quantitative data, and strong operational constraints, making the CPI both analytically robust and pragmatically relevant [10].

5.2. Mathematical Formulation of the CPI

Formally, the Contextual Prioritization Index is defined as a weighted combination of normalized criteria, according to the expression (2):

$$\mathrm{ICP}_j = \sum_{i=1}^{n} w_i \cdot S_{ij} \tag{2}$$

where:

- CPI_j is the priority index of site or zone *j*;
- w_i represents the empirical weight of criterion *i*, derived from the qualitative analysis (Section 2.3);
- S_{ij} corresponds to the normalized score of criterion *i* for zone *j*, obtained from the observation grids;
- n is the total number of criteria retained.

The weights w_i are normalized (Table 5) such that:

$$\sum_{i=1}^{n} w_i = 1 \tag{2}$$

5.3. Illustrative Application Example

In order to demonstrate the operational relevance of the CPI, an illustrative application example is proposed based on four representative zones selected from the sites observed during the fieldwork. These zones reflect contrasting configurations frequently encountered in Kinshasa.

Zones considered

- Zone A: Gambela Market (dense commercial area, chronic overflow)
- Zone B: Camp Luka neighborhood (enclaved residential area, very low accessibility)
- Zone C: Kasa-Vubu Avenue (structuring urban axis, high accessibility)
- Zone D: Kinshasa General Hospital (sensitive institutional area)

The weights retained, derived from the analytical weighting process (Table 3), are as follows (Table 6):

Table 5. Normalized scores from observation grids.

Criteria	Zone A	Zone B	Zone C	Zone D
Sanitary and environmental risk	1.00	1.00	0.50	0.80
Logistical feasibility	0.60	0.20	0.90	0.30
Socio-territorial factors	0.90	0.70	0.60	0.80
Institutional constraints	0.80	0.30	0.80	1.00

Table 6. Empirical weights of criteria.

Criterion	Weight (w_i)
Sanitary and environmental risk	0.31
Logistical and economic feasibility	0.45
Socio-territorial factors	0.20
Institutional constraints	0.10

Calculation of the CPI based on Table 5.

$ICP_A = (0.31 \times 1.00) + (0.45 \times 0.60) + (0.14 \times 0.90) + (0.09 \times 0.80) = 0.78$

$ICP_B = (0.31 \times 1.00) + (0.45 \times 0.20) + (0.14 \times 0.70) + (0.09 \times 0.30) = 0.53$

$ICP_C = (0.31 \times 0.50) + (0.45 \times 0.90) + (0.14 \times 0.60) + (0.09 \times 0.80) = 0.73$

$ICP_D = (0.31 \times 0.80) + (0.45 \times 0.90) + (0.14 \times 0.50) + (0.09 \times 1.00) = 0.59$

Resulting ranking

- Zone A – Gambela Market (CPI = 0.78)
- Zone C – Kasa-Vubu Avenue (CPI = 0.73)
- Zone D – General Hospital (CPI = 0.59)
- Zone B – Camp Luka (CPI = 0.53)

This ranking clearly illustrates that the CPI does not reflect sanitary risk alone, but also integrates feasibility constraints, explaining, for example, why a highly risky but poorly accessible area may be temporarily deprioritized.

5.4. Interpretation and Operational Relevance of the CPI

The CPI is not intended to replace human decision-making, but rather to objectify the trade-offs faced by waste collection managers in a context of resource scarcity. It makes explicit choices that are often implicit or contested, by showing how different criteria interact in the final prioritization of interventions.

When integrated into an urban information system (GIS–IoT), the CPI could support both daily and strategic planning of waste collection, enhance decision-making transparency, and facilitate dialogue among technical actors, public authorities, and local communities. Its flexibility also allows adaptation to other African cities facing similar constraints, subject to empirical recalibration of the weights.

6. Conclusions

This study aimed to analyze, through an in-depth empirical investigation, the criteria effectively used to prioritize solid waste collection in low-resource urban settings, and to propose an operational formalization adapted to the context of Kinshasa. The qualitative analysis of 22 semi-structured interviews, combined with 14 field observations, revealed a decision-making structure based on a limited but robust set of criteria. The results indicate a clear dominance of sanitary risk, followed by logistical constraints, and then socio-territorial and institutional factors. The empirical weighting of the criteria confirms a predominantly reactive management logic, oriented toward the prevention of immediate sanitary crises rather than toward long-term preventive and equitable planning.

From both a methodological and operational perspective, the study demonstrates the contribution of a structured qualitative triangulation approach to overcoming the limitations of normative planning models, which are often poorly adapted to the realities of cities in the Global South. The systematic coding of stakeholder discourses, their empirical weighting, and their confrontation with field observations made it possible to construct a Contextual Prioritization Index (CPI) grounded in actual practices. Conceived as a contextualized extension of multicriteria approaches such as the Analytic Hierarchy Process, the CPI explicitly incorporates operational feasibility, institutional asymmetries, and everyday constraints. Its illustrative application to fictitious zones in Kinshasa highlights its

capacity to differentiate priority levels in a transparent and reproducible manner, while offering a transferable framework for future comparative analyses and for adapting the tool to other urban contexts facing similar constraints.

In addition, the CPI provides a relevant decision-support foundation for the integration of context-aware mechanisms into smart waste management systems, particularly those based on Internet of Things (IoT) technologies. By embedding locally grounded and multi-dimensional criteria into decision rules, it contributes to improving the adaptability and operational relevance of IoT-based collection strategies in resource-constrained urban environments.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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