Exploring the Impact of Urban Scale on User Perception for Identifying Public Bus Service Improvement Priorities in Morocco

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Abstract

Public bus services remain a cornerstone of urban mobility in Morocco, yet persistent challenges—such as uneven service coverage, low frequency, and safety concerns—undermine ridership and social inclusion. This study investigates the critical influence of urban scale on public bus service improvement priorities in Morocco, addressing a notable gap in user-centric transit research. Utilizing data from a large-scale national user survey across metropolises, large, medium, and small cities, the research employs a Revised Importance–Performance Analysis integrated with fuzzy c-means clustering. Results indicate that "Service Coverage & Frequency" emerges as a universal top priority across all urban scales, whereas other attributes—such as "Safety & Security," "Service Punctuality," "Vehicle Cleanliness & Maintenance", and "Passenger Comfort & Convenience" display significant variation by urban scale. These findings reveal that user perceptions and derived improvement priorities are highly context-dependent, challenging a "one-size-fits-all" approach to urban transport planning.

1. Introduction

In Morocco, rapid urbanization, population growth, and socio-economic changes have led to a significant increase in demand for urban mobility (World Bank, 2020). This rising demand, increased reliance on private cars and taxis, modes that contribute significantly to traffic congestion, air pollution, and road insecurity. To manage demand and alleviate these issues, the encouragement of public transport usage is recognized as an effective strategy. Despite the introduction of alternative systems in major metropolitan areas, such as tramways and Bus Rapid Transit networks, conventional buses remain the primary mode of public transport in Morocco due to their flexibility and low-cost implementation. However, bus services faces numerous challenges including poor service quality, limited network coverage, and insufficient supply resulting to their underutilization (Karim & Jawab, 2017). Recognizing these issues, the Moroccan government has recently launched an ambitious modernization initiative for 2025-

2029 with a substantial investment of MAD11 billion[1]. This comprehensive plan encompasses the deployment of 3,746 new high-standard buses across 84 cities, complemented by infrastructure enhancement and regulatory framework reforms. These efforts are strategically aligned with urban transport preparations for the 2030 FIFA World Cup.

It is recognized that effective service improvements should emerge from systematic analysis of user perceptions regarding service quality, rather than relying exclusively on capacity expansion or technology implementation strategies (Machado-León et al., 2017). However, transit authorities and bus operators in Morocco have demonstrated limited engagement with such analysises. Although existing research addresses various aspects of urban transport in Morocco, including technical efficiency assessments of public bus transport companies and service quality evaluations of tramway systems (Zehmed & Jawab, 2019, 2021), empirical academic studies examining user perceptions of bus service quality remain notably scarce. The comparative analysis conducted by Al Suleiman et al., (2025), which examines perceived quality and prioritized service attributes between Tangier, Morocco and Oviedo, Spain, provides valuable insights. However, it remains constrained by its focus on a single Moroccan city and limited sample size.

On the other hand, extensive literature examines the influence of several factors on service attribute prioritization for improvement based on user perceptions. These factors include transit mode (Abenoza et al., 2019; Machado-León et al., 2017; Zhang et al., 2017), traveler characteristics (Cheranchery et al., 2024; Esmailpour et al., 2020; Fang et al., 2021; Freitas et al., 2023; Tuan et al., 2022; Zheng et al., 2022), time period (Cheranchery et al., 2021; Zheng et al., 2021), and geographical location (Al Suleiman et al., 2025; Saleem et al., 2023). However, there is a significant gap concerning studies that explicitly explore the direct influence of urban scale on service attribute prioritization for improvement. This research directly addresses this critical knowledge gap by identifying priority intervention areas for public bus services and examine how these priorities differ across various urban scales in Morocco, specifically metropolises, large, medium, and small cities. This objective will be accomplished through comprehensive analysis of user perceptions regarding the importance of and satisfaction with various bus service attributes, utilizing data from a large-scale user survey. The analytical approach employs Revised Importance-Performance Analysis (Revised-IPA) integrated with fuzzy c-means clustering techniques.

The paper is structured as follows. Section 2 outlines the research methodology. Section 3 presents and discusses the analytical results. Section 4 summarizes the study's principal contributions and policy implications. Section 5 provides the concluding remarks

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[1] 11 billion Moroccan dirhams (MAD) is approximately 1.1 billion USD

2. Methodology

This section provides a brief outline of data analysis method (revised IPA), questionnaire design including service quality attributes considered in the research, survey implementation and database, and a descriptive profile of the respondents.

2.1 Revised IPA

To systematically identify priority areas requiring intervention and improvement based on user perceptions, this study employs the method of Revised IPA integrated with fuzzy c-means clustering algorithms (Cheranchery et al., 2018). This approach enhances traditional IPA technique originally developed by Martilla & James, (1977) while addressing inherent limitations through incorporation of three-factor theory principles (Matzler et al., 2004; Deng et al., 2008) and utilization of fuzzy c-means clustering techniques as suggested by Ban et al., (2016).

The theoretical foundations and methodological frameworks of revised IPA have received extensive documentation in existing literature (Cheranchery et al., 2021; Kar et al., 2022; Roy & Basu, 2020). Therefore, this research concentrates exclusively on analytical procedures following established protocol by Cheranchery & Maitra, (2017). Initially, a comprehensive survey instrument was developed to capture data regarding stated importance, perceived satisfaction of essential bus service attributes, and overall satisfaction utilizing Likert-type measurement scales. After data collection, three distinct phases encompassing six sequential steps were followed to identify priority improvement areas within each distinct urban context (Figure 1).

The initial analytical phase involves three sequential data processing steps to prepare variables for clustering analysis. First (step 1), perceived satisfaction scores for each service attribute undergo natural logarithm transformation to enhance data sensitivity. Second (step 2), partial correlations are computed between each log-transformed satisfaction score and overall satisfaction to obtain a partial correlation coefficient that represent a derived importance of service attribute. Finally (step 3), all key variables—derived importance, stated importance, and perceived satisfaction—are normalized to ensure scale consistency and cross-attribute comparability across different urban contexts.

The second phase applies the fuzzy c-means algorithm twice using different input combinations. First (step 4), we utilise normalized derived importance and normalized stated importance to classify attributes into factor structures (basic factors representing fundamental requirements, performance factors with direct linear satisfaction relationships subdivided into important and unimportant categories, and excitement factors that enhance satisfaction when present but do not cause dissatisfaction when absent). Second (step 5), we employ normalized derived importance and normalized perceived satisfaction to generate management schemes that organize attributes by improvement priorities (concentrate here, keep up good work, low priority, and possible

overkill categories). Both classifications visualized through two-dimensional graphs showing attribute placement within their respective frameworks.

The final phase (step 6) systematically compares factor structures with management schemes to identify priority areas for improvement. The priority ordering follows established hierarchical principles that prioritize basic factors in concentrate here categories, followed by basic factors in low priority categories, important performance factors in concentrate here categories, and excitement factors in concentrate here categories.
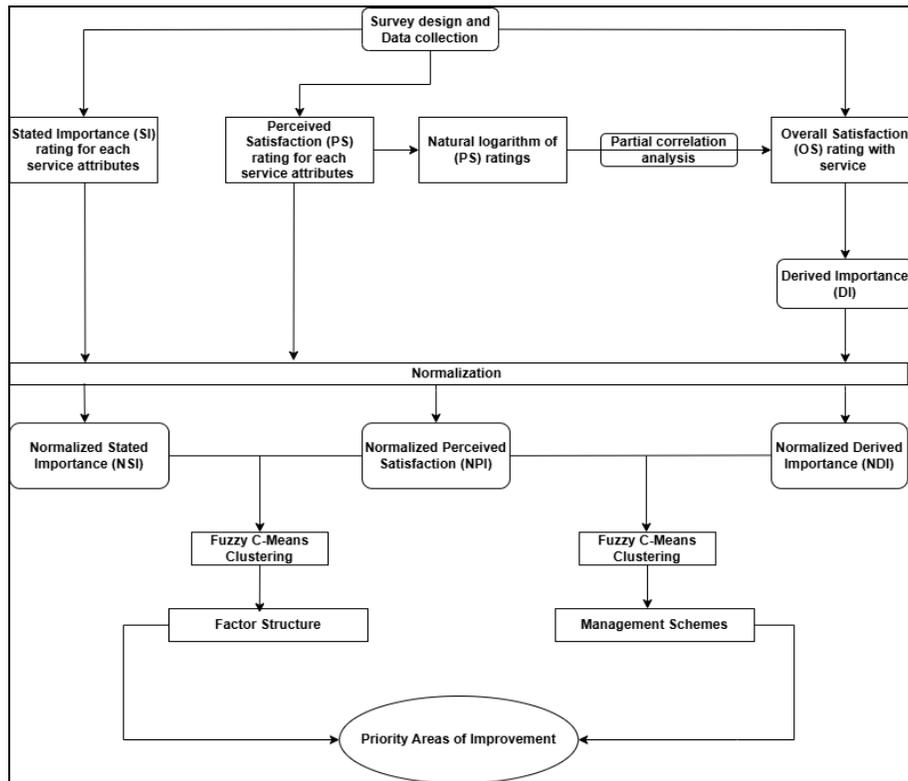

Figure 1. Methodology for identifying areas of improvement using Revised IPA

2.2 Service quality attributes and questionnaire design

Selecting relevant service quality attributes is crucial for accurately assessing bus service. While methods like focus groups, user interviews, or pilot surveys are often recommended (Cavana et al., 2007; Dell'Olio et al., 2018), the national scope of this study made such approaches prohibitively costly and logistically complex. Therefore, attribute selection was based on a comprehensive review of existing academic literature on public transport service quality (De Oña & De Oña, 2015; Dell'Olio et al., 2018; Van Lierop et al., 2018; Sogbe et al., 2024); Suman & Bolia, 2019). This process resulted in twelve core attributes representing key service aspects.

The selected attributes are: (1) Service Coverage & Frequency (SCF), (2) Service Information Provision (SIP), (3) Passenger Comfort & Convenience (PCC), (4) Service Punctuality (SP), (5)

Safety & Security (SS), (6) Fare Pricing (FP), (7) Passenger Accessibility (PA), (8) Vehicle Cleanliness & Maintenance (VCM), (9) Intermodal Connectivity (IC), (10) Driver Performance (DP), (11) Ticketing & Customer Service (TCS) and (12) Field staff Attitude (FSA). Table 1 provides an explanation of selected service quality attributes.

The questionnaire contained two sections. The first section recorded sociodemographic characteristics (age, gender, occupation, city of residence) and trip-related characteristics (usage frequency, purpose, route type). The second section asked bus users to rate importance of each service quality attribute on a five-point Likert scale (1 = not at all important, 5 = very important). Respondents also rated their perceived satisfaction with each attribute and overall service using a five-point scale (1 = very dissatisfied, 5 = very satisfied).

Table 1: Selected service attributes and explanations

No	Service attribute (Symbol)	Explanation
1	Service Coverage & Frequency (SCF)	Captures the extent of the geographic network, operating hours, and service frequency.
2	Passenger Comfort & Convenience (PCC)	Highlights factors such as crowding, noise levels, climate control, seating, and waiting facilities.
3	Service Information Provision (SIP)	Emphasizes the ready access to schedules, routes, fares, and related service details.
4	Safety & Security (SS)	Addresses both crime prevention and safeguards against accidents, fires, and collisions
5	Service Punctuality (SP)	Focuses on the adherence to planned departure and arrival times.
6	Fare Pricing (FP)	Relates to the cost incurred by passengers for tickets and subscriptions.
7	Passenger Accessibility (PA)	Covers the ease of boarding and disembarkation, ensuring inclusivity for all users.
8	Vehicle Cleanliness & Maintenance (VCM)	Refers to the internal cleanliness, external appearance, and mechanical condition of the buses
9	Ticketing & Customer Service (TCS)	Highlights the ease of acquiring tickets/subscriptions and the prompt handling of customer feedback.
10	Driver Performance (DP)	Encompasses the quality of driving, efficiency, and the overall conduct of the drivers.
11	Intermodal Connectivity (IC)	Describes how well bus lines integrate with one another and connect to other transport modes.
12	Field staff Attitude (FSA)	Reflects the overall attitude, respect, and helpfulness of all customer-facing personnel

2.3 Survey implementation and database

The study encompassed all Moroccan cities providing bus services and targeted passengers who used these services at least once a year. To accommodate its extensive scope, data were gathered

through a convenience online survey conducted between March and June 2019. The survey link was disseminated using a snowball sampling approach. Initially, it was shared with personal and professional contacts (family, friends, colleagues) via email and social messaging apps, accompanied by a request to forward the link. Next, the link was promoted through a dedicated Facebook page created specifically for this study, and finally, it was posted in relevant online groups such as university student groups and local community forums in the target cities. The data collection resulted in 15 219 initial responses across 29 cities.

Rigorous data cleaning was applied due to the uncontrolled nature of online surveys (Trompet et al., 2013). The survey platform prevented multiple submissions from the same device. Invalid responses were removed based on five criteria: (1) responses from IP addresses outside Morocco, (2) incomplete questionnaires missing key demographic or trip data, (3) respondents who never used bus transport, (4) unusually fast completion times suggesting lack of attention, and (5) invariant responses selecting the same answer for all questions.

After cleaning initial responses (591 responses deleted), cities with fewer than 200 respondents were also excluded (531 responses). This resulted in a final dataset of 14,097 responses across 16 principal Moroccan cities. These cities encompass 12,651,275 urban residents, representing 56.53% of Morocco's total urban population. The 16 cities were categorized by urban population into four scales as shown in table 2.

Table 2. Urban scale distribution

City	Number of survey participants	%	Urban Area (km²)	Urban Population	Urban Scale
Greater Casablanca	1591	11.29	1 387	4 835 767	Metropolises
Rabat-Salé-Temara agglomeration	860	6.10	950	2 337 602	
Fez	976	6.92	1 173	1 305 764	Large-sized cities
Greater Agadir	1499	10.63	1 144	1 360 035	
Tanger-Assilah	1618	11.48	766	1 279 581	
Marrakech	1131	8.02	946	1 089 300	
Meknes	917	6.50	492	807 963	Medium-sized cities
Kenitra	793	5.63	286	771 870	
Oujda	748	5.31	569	657 508	
Tétouan	785	5.57	172	435 806	
Khouribga	440	3.12	100	441 316	
El Jadida	393	2.79	87	410 035	
Safi	733	5.20	127	367 621	
Beni Mellal	730	5.18	53	372 924	
Settat	482	3.42	26	256 932	Small-sized cities
Taza	401	2.82	23	221 169	

Total	*14 097*	*100*	*12 651 275*

2.4 Respondent's profiles

This sub-section presents demographic and travel characteristics of survey respondents across four urban scales. The total number of respondents was 2,451 for Metropolises, 5,224 for large cities, 5,539 for medium cities, and 883 for small cities. Table 3 summarizes these characteristics.

Regarding Gender, Metropolitan cities show a higher proportion of male respondents (58.59%) compared to female respondents (41.41%). In contrast, large, medium, and small cities exhibit a more balanced or slightly female-leaning distribution, with females comprising 50.86%, 50.84%, and 53.00% respectively.

In terms of Age, there are notable differences across urban scales. Metropolitans have a relatively even split between young (< 25 years old) and adult (> 25 years old) respondents (48.59% vs. 51.41%). Large cities are predominantly represented by adults (73.60%). Conversely, Medium and Small cities show a significantly higher proportion of young respondents, accounting for 69.29% and 67.04% respectively. This suggests that bus services in medium and small cities are heavily utilized by the younger demographic.

The Occupation profiles also vary. In Metropolitans, working individuals constitute the largest group (47.41%), followed closely by students (44.84%), indicating a diverse user base. Large cities are notably dominated by students (76.24%), suggesting a strong reliance on bus services for educational commutes. Medium cities, however, show a majority of working individuals (70.72%), while small cities, similar to large cities, have a higher proportion of students (68.74%). The "Inactive" category remains a small percentage across all urban scales, consistently below 8%.

Frequency of use for bus services is consistently high across all urban scales, with daily users representing the majority: 69.85% in Metropolitans, 72.63% in large cities, 72.96% in medium cities, and 78.82% in small cities. This indicates that bus services are a regular and essential mode of transport for a significant portion of the population in all surveyed cities.

Finally, for the most used route type, urban routes are overwhelmingly preferred across all city sizes, accounting for 73.48% in Metropolitans, 84.42% in large cities, 77.43% in medium cities, and 100.00% in small cities. Suburban routes are utilized to some extent in Metropolitans (9.51%), Medium cities (10.54%), and to a lesser degree in large cities (2.53%). The "Both" category (indicating use of both urban and suburban routes) is also present in Metropolitans, Large, and medium cities, but notably absent in small cities, where only urban routes are reported. This suggests that bus services in smaller cities are exclusively focused on internal urban mobility, while larger urban areas cater to more diverse travel patterns including suburban connections.

Table 3: Respondent Characteristics by urban scale

Category	Sub-category	Metropolises	Large cities	Medium cities	Small cities
Gender	Male	1436 (58.59%)	2567 (49.14%)	2723 (49.16%)	415 (47.00%)
	Female	1015 (41.41%)	2657 (50.86%)	2816 (50.84%)	468 (53.00%)
Age	Young	1191 (48.59%)	1379 (26.40%)	3838 (69.29%)	592 (67.04%)
	Adult	1260 (51.41%)	3845 (73.60%)	1701 (30.71%)	291 (32.96%)
Occupation	Studying	1099 (44.84%)	3983 (76.24%)	1299 (23.45%)	607 (68.74%)
	Working	1162 (47.41%)	1041 (19.93%)	3917 (70.72%)	219 (24.80%)
	Inactive	190 (7.75%)	200 (3.83%)	323 (5.83%)	57 (6.26%)
Frequency of use	Daily	1712 (69.85%)	3794 (72.63%)	4,041 (72.96%)	696 (78.82%)
	Occasionally	739 (30.15%)	1430 (27.37%)	1,498 (27.04%)	187 (21.18%)
Most used route type	Urban	1801 (73.48%)	4410 (84.42%)	4,289 (77.43%)	883 (100.00%)
	Suburban	233 (9.51%)	132 (2.53%)	584 (10.54%)	-
	Both	417 (17.01%)	682 (13.06%)	666 (12.02%)	-
Total		***2451***	***5224***	***5539***	***883***

3. Results

This section identifies and discusses bus service improvement areas in order of priority for each urban scale using Revised IPA integrated with fuzzy c-means clustering. Table 4 presents the user perception data that forms the analytical foundation for this methodology. The stated importance (SI) and perceived satisfaction (PS) of service attributes were calculated as arithmetic means of Likert scale ratings. Derived importance (DI) was estimated through partial correlation analysis. The values show SI, PS and DI for each service attribute across urban scales and values in parentheses represent normalized scores used in the fuzzy c-means clustering analysis. Statistical significance of derived importance is indicated by asterisks (*** $p<0.001$, * $p<0.05$). The following subsections discuss the factor structure classification, management schemes, and key intervention areas for bus service improvement across different urban scales in Morocco.

Table 4. Summary of perception data across urban scales

Service Attributes	Metropolises			Large cities			Medium cities			Small cities		
	SI	DI	PS	SI	DI	PS	SI	DI	PS	SI	DI	PS
SCF	4,06 (0,93)	0,23** (1,00)	1,22 (0,03)	4,13 (0,80)	0,28*** (1,00)	2,37 (0,31)	3,92 (0,73)	0,32*** (1,00)	1,93 (0,17)	4,00 (0,69)	0,28*** (1,00)	2,20 (0,25)
PCC	3,96 (0,68)	0,11*** (0,53)	1,18 (0,00)	4,01 (0,62)	0,15*** (0,51)	1,88 (0,00)	3,88 (0,66)	0,20*** (0,60)	1,74 (0,02)	3,97 (0,66)	0,15*** (0,44)	2,06 (0,12)
SIP	3,66 (0,00)	0,02 (0,14)	1,46 (0,20)	3,63 (0,00)	0,04*** (0,09)	2,34 (0,30)	3,42 (0,00)	0,06*** (0,16)	1,87 (0,12)	3,43 (0,00)	0,06 (0,04)	1,92 (0,00)
SS	4,09 (1,00)	0,08*** (0,39)	1,27 (0,06)	4,24 (0,98)	0,07*** (0,21)	2,20 (0,21)	4,11 (1,00)	0,06*** (0,14)	2,15 (0,34)	4,25 (1,00)	0,05 (0,00)	2,75 (0,73)
SP	4,03 (0,85)	0,14*** (0,63)	1,26 (0,06)	4,09 (0,73)	0,11*** (0,35)	1,97 (0,06)	3,94 (0,75)	0,09*** (0,26)	1,71 (0,00)	4,01 (0,70)	0,15*** (0,43)	2,14 (0,20)
FP	3,93 (0,62)	0,03 (0,19)	2,63 (1,00)	4,02 (0,63)	0,07*** (0,20)	3,31 (0,93)	3,93 (0,73)	0,03*** (0,06)	3,03 (1,00)	3,90 (0,57)	0,10*** (0,22)	2,01 (0,08)
PA	3,83 (0,39)	0,09*** (0,42)	1,48 (0,21)	3,81 (0,29)	0,07*** (0,20)	2,15 (0,17)	3,72 (0,43)	0,06* (0,15)	2,13 (0,32)	3,78 (0,42)	0,07* (0,08)	2,53 (0,53)
VCM	3,84 (0,42)	0,19*** (0,83)	1,20 (0,02)	3,91 (0,45)	0,17*** (0,58)	2,68 (0,52)	3,82 (0,58)	0,21*** (0,65)	2,39 (0,51)	3,90 (0,57)	0,14*** (0,38)	3,07 (1,00)
TCS	3,82 (0,37)	0,10*** (0,50)	1,68 (0,35)	3,92 (0,47)	0,13*** (0,44)	2,62 (0,48)	3,82 (0,58)	0,11*** (0,33)	2,23 (0,40)	3,86 (0,53)	0,09*** (0,18)	2,37 (0,39)
DP	4,07 (0,9	-0,02 (0,00	2,38 (0,8	4,25 (1,0	0,02 (0,00	3,42 (1,0	4,11 (1,0	0,01 (0,00	3,03 (1,0	4,09 (0,8	0,11***	3,02 (0,9

	5)	)	3)	0)	)	0)	0)	)	0)	0)	(0,24)	6)
IC	3,89 (0,5 2)	0,02 (0,15)	2,35 (0,8 3)	3,91 (0,4 5)	0,08* ** (0,24)	3,09 (0,7 8)	3,74 (0,4 7)	0,04* ** (0,08)	2,69 (0,7 4)	3,72 (0,3 5)	0,06 (0,02)	2,82 (0,7 8)
FSA	3,92 (0,6 0)	0,10* ** (0,49)	1,86 (0,4 7)	3,98 (0,5 6)	0,14* ** (0,45)	2,80 (0,6 0)	3,87 (0,6 6)	0,15* ** (0,44)	2,47 (0,5 8)	3,88 (0,5 5)	0,12* ** (0,32)	2,43 (0,4 5)

3.1 Factor structure of bus users across urban scales

The fuzzy c-means algorithm was employed to classify service attributes into a coherent factor structure for each urban scale, utilizing values of normalized stated importance and normalized derived importance as inputs. This process categorizes attributes into four distinct groups: basic factors, important performance factors, unimportant performance factors, and excitement factors (as illustrated in Figure 1 and detailed in Table 5).

The analysis reveals significant variations in how users across different urban scales perceive and categorize service attributes. Most notably, the composition of basic factors—those fundamental requirements that cause dissatisfaction when unmet—differs substantially across urban contexts. Bus users in metropolises exhibit the most complex basic factor structure with four attributes (Safety & Security, Fare Pricing, Driver Performance, and Intermodal Connectivity), while users in small cities demonstrate the simplest structure with only Safety & Security as a basic factor. This suggests that user expectations become more sophisticated and demanding as urban scale increases.

A particularly striking trend is observed in the excitement factors category, where small cities show the highest number compared to metropolises. This indicates that users in smaller urban environments may find more service aspects delightful or surprising when performed well, possibly due to lower baseline expectations. Conversely, the important performance factors remain remarkably consistent across all urban scales, with Service Coverage & Frequency consistently identified as the primary performance driver, highlighting its universal importance regardless of city size.
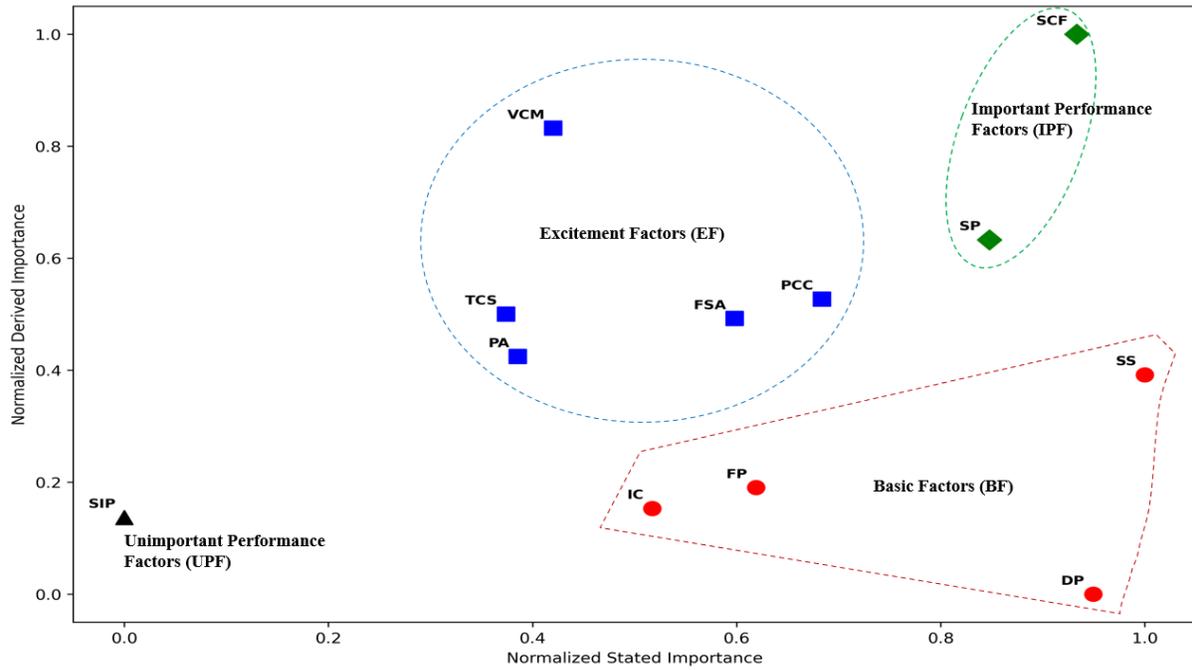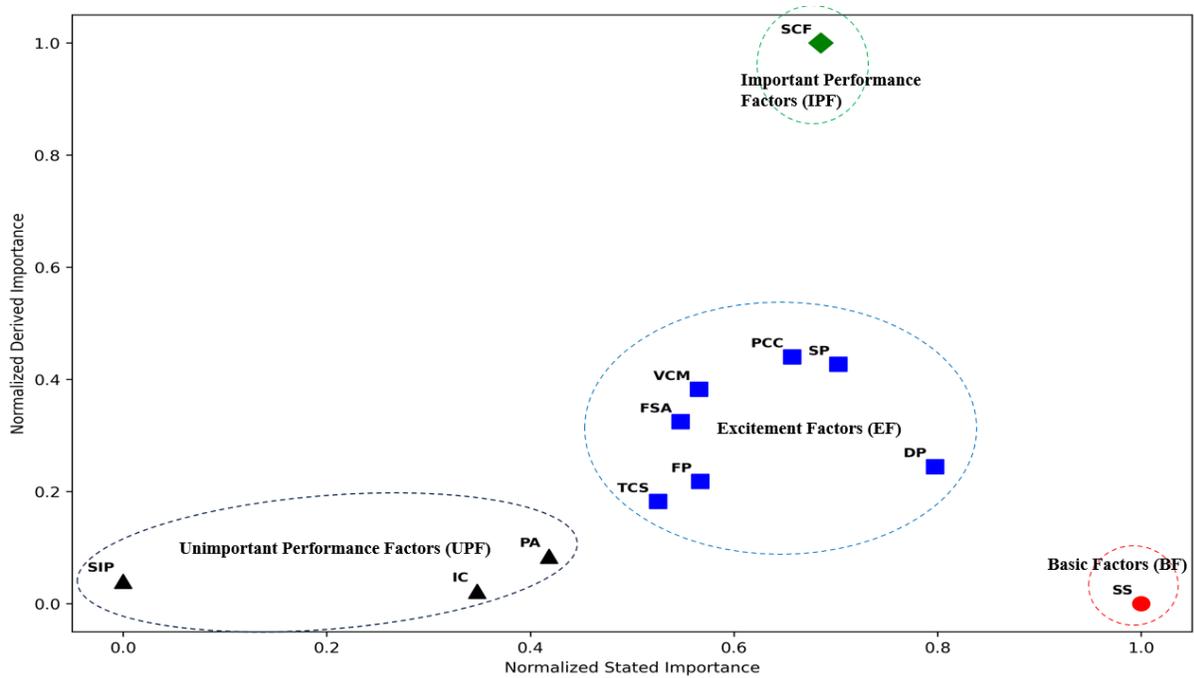
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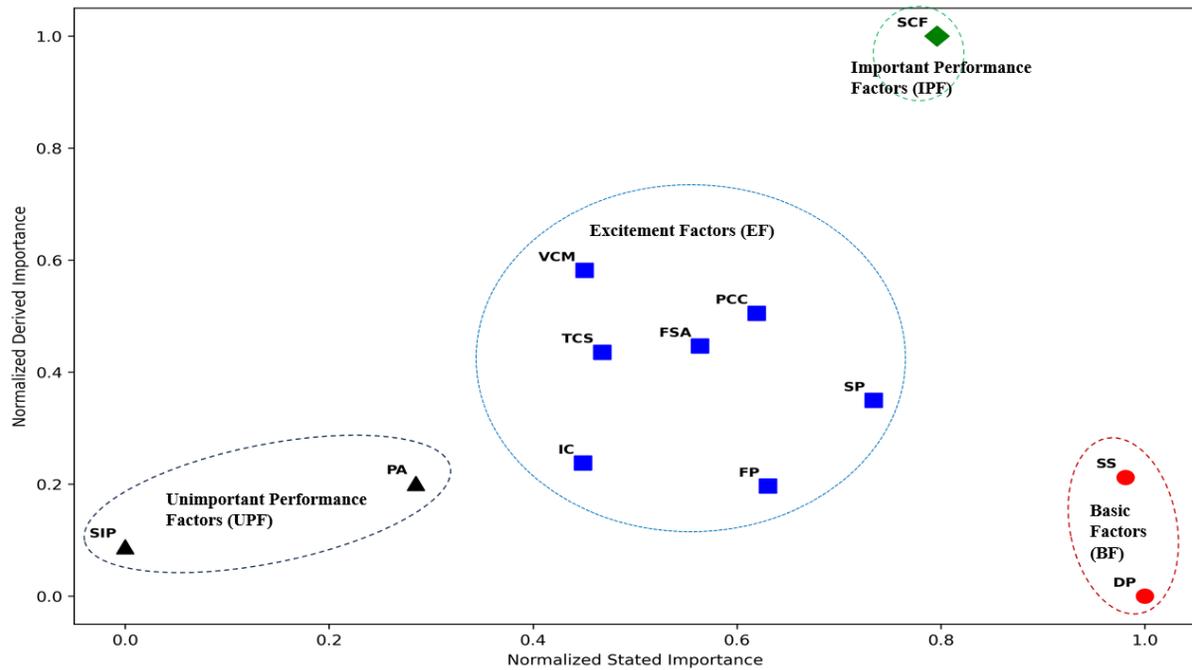
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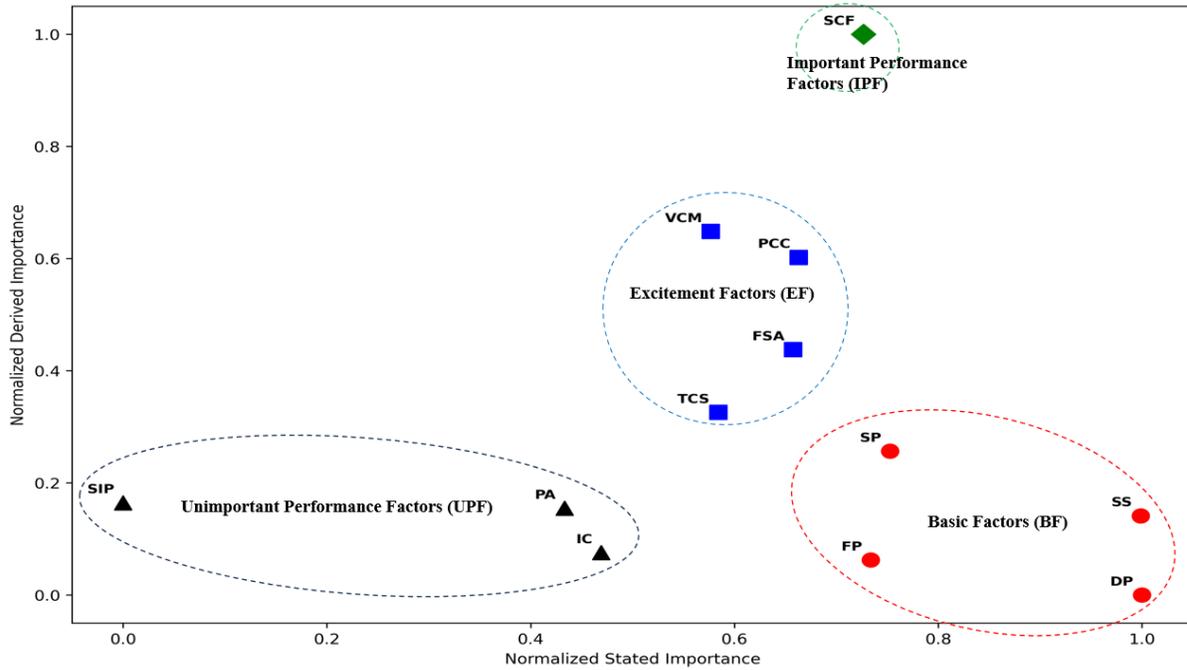
(c)

(d)

Fig.1. Factor structure of bus users in metropolises (a), large-sized cities (b), medium-sized cities (c) and small-sized cities (d).

Table 5. Comparison of factor structure across urban scales

Factor structure	Metropolises	Large cities	Medium cities	Small cities
Basic	SS (0,5491) FP (0,6041) DP (0,8434) IC (0,4150)	SS (0,940) DP (0,927)	SP (0,438) FP (0,662) SS (0,937) DP (0,924)	SS (0,989)
Excitement	VCM (0,4960) TCS (0,8548) FSA (0,3490) PCC (0,6561) PA (0,8289)	VCM (0,770) TCS (0,932) FSA (0,903) PCC (0,903) IC (0,565) FP (0,523) SP (0,624)	VCM (0,745) TCS (0,605) FSA (0,942) PCC (0,860)	VCM (0,959) TCS (0,627) FSA (0,845) PCC (0,878) SP (0,845) FP (0,798) DP (0,551)
Important performance	SCF (0,8851) SP (0,6468)	SCP (1,0E+00)	SCF (1,0E+00)	SCF (1,0E+00)
Unimportant performance	SIP (9,9E-01)	SIP (0,890) PA (0,829)	SIP (0,629) PA (0,967) IC (0,895)	SIP (0,752) IC (0,959) PA (0,792)

Note: Membership degree of service attributes to factor structure is between brackets

3.2 Management schemes for bus service across urban scales

Similarly, the fuzzy c-means algorithm was applied using values of normalized derived importance and normalized perceived satisfaction as inputs to generate distinct management schemes for each urban scale. This clustering process segments attributes into four categories: 'keep up the good work', 'concentrate here', 'low priority', and 'possible overkill' (as illustrated in Figure 2 and detailed in Table 6).

The management schemes reveal critical insights into current service performance across urban scales. Service Coverage & Frequency consistently appears in the "concentrate here" category across all city types, indicating universal dissatisfaction with this fundamental service aspect. However, the number of attributes requiring immediate attention varies significantly: metropolises and medium cities each have two attributes in this critical category, while large and small cities have only one.

An interesting pattern emerges in the "keep up good work" category, where small cities demonstrate the highest performance with five well-performing attributes, compared to just two in metropolises. This suggests that while users in smaller cities may have simpler service expectations, they are performing relatively better in meeting user satisfaction across multiple service dimensions. The "possible overkill" category shows consistent patterns across metropolitans, large, and medium cities (3 each), primarily involving Fare Pricing, Driver
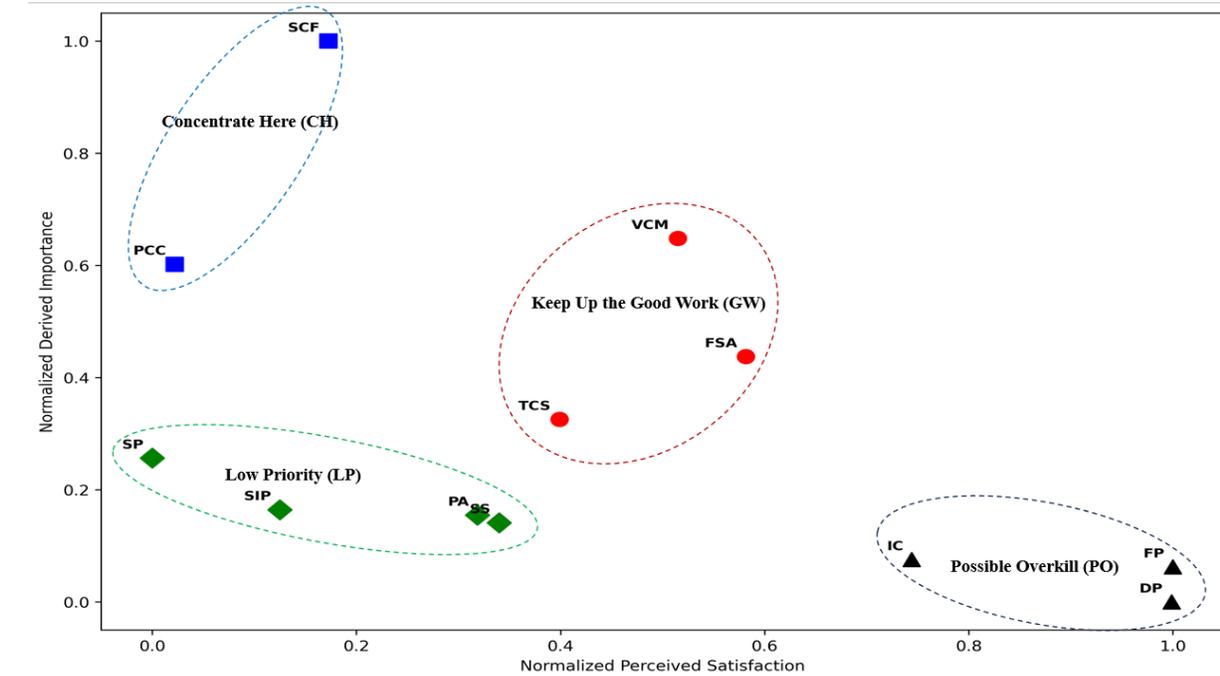
Performance, and Intermodal Connectivity, suggesting these aspects may be receiving disproportionate attention relative to their impact on user satisfaction.
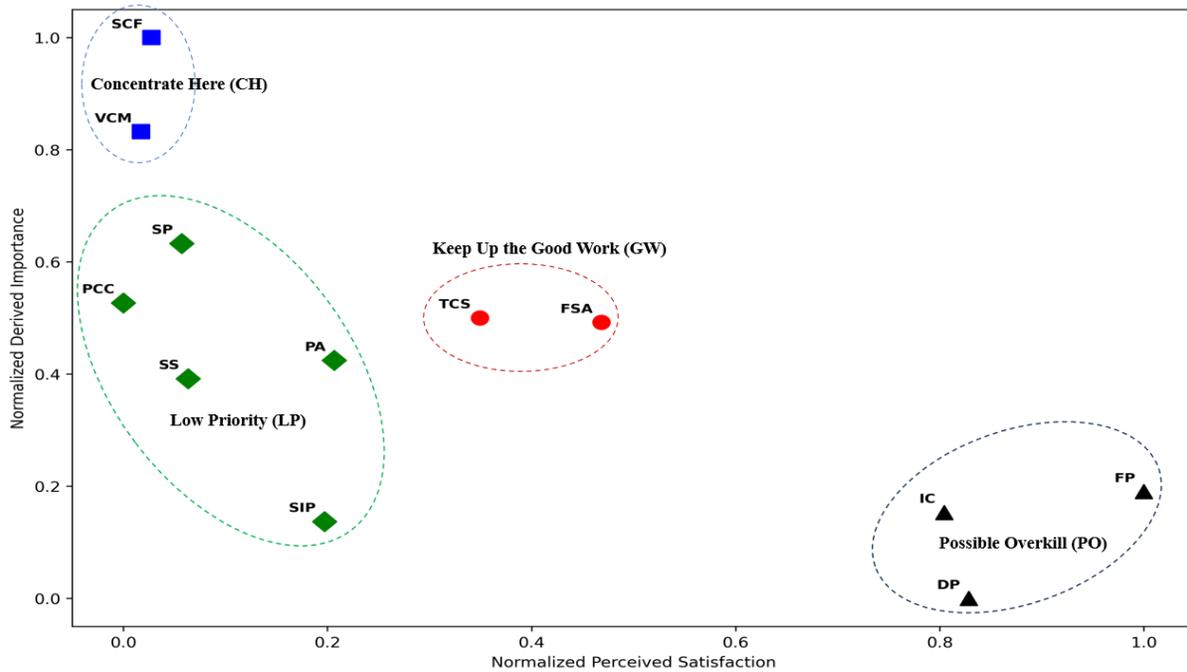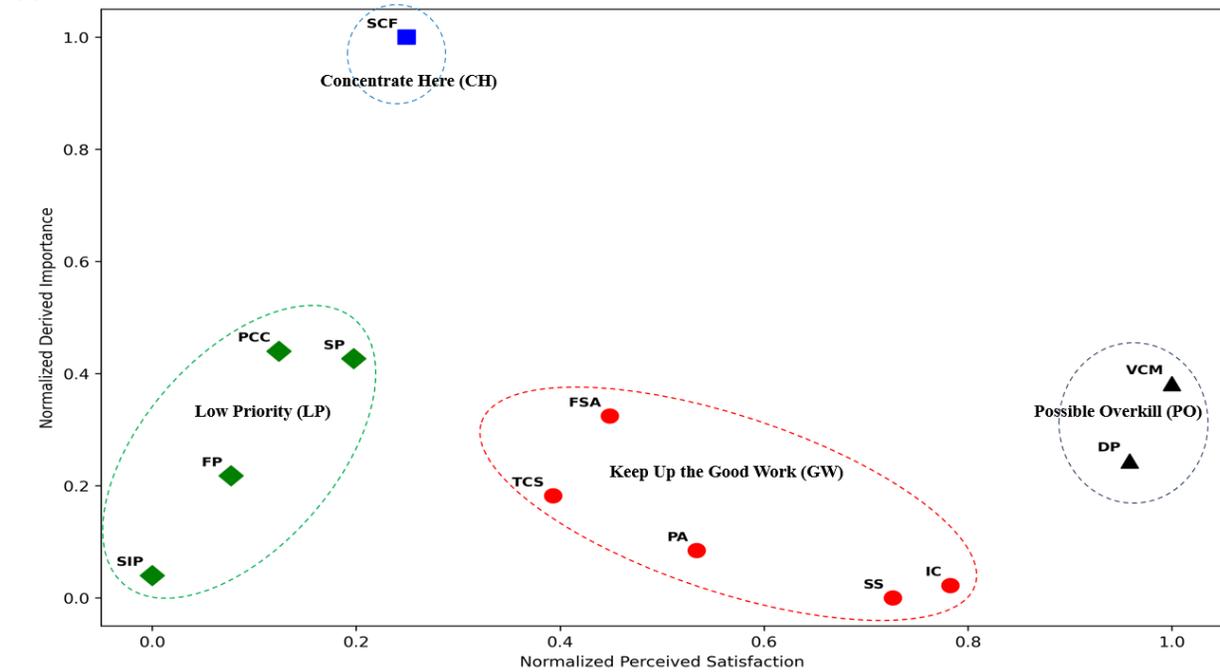

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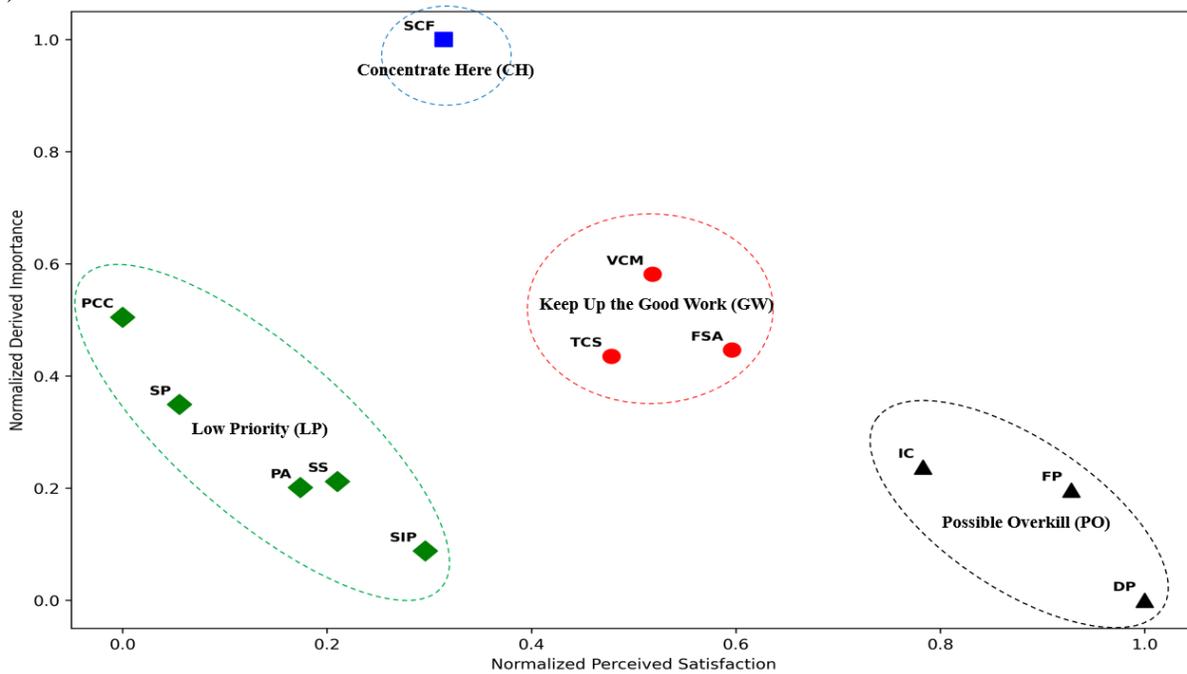
(b)

(c)

(d)

Fig.2. Management schemes for bus service in metropolises (a), large-sized cities (b), medium-sized cities (c) and small-sized cities (d).

Table 6. Comparison of management schemes across urban scales

Management Schemes	Metropolises	Large cities	Medium cities	Small cities
Concentrate here	SCF (0,9374) VCM (0,9552)	SCF (1,0E+00)	SCF (0,9607) PCC (0,4788)	SCF (1,0E+00)
Keep Up Good Work	TCS (0,9717) FSA (0,9031)	VCM (0,886) TCS (0,951) FSA (0,928)	TCS (0,5124) FSA (0,9246)	TCS (0,480) FSA (0,405) PA (0,930) SS (0,858) IC (0,743)
Low Priority	PCC (0,8185) SIP (0,4746) SS (0,9661) SP (0,5287) PA (0,6274)	PCC (0,583) SIP (0,721) SS (0,965) SP (0,860) PA (0,980)	SIP (0,9495) SS (0,8194) SP (0,7685) PA (0,8693)	PCC (0,859) SIP (0,728) SP (0,843) FP (0,952)
Possible Overkill	FP (0,9192) DP (0,9387) IC (0,9654)	FP (0,977) DP (0,899) IC (0,760)	FP (0,9811) DP (0,9774) IC (0,7478)	VCM (0,954) DP (0,968)

Note: Membership degree of service attributes to management schemes is between brackets

3.3 Improvement areas for bus services across urban scales

The primary objective of this study is to identify the most critical intervention areas for bus service improvement and to explore how these priorities differ across urban scales. By systematically comparing the factor structures with the management schemes (as outlined in Step 6 of our methodology), we derive a ranked list of intervention priorities for each city type (see Table 9). It is worth noting that no single attribute consistently holds the absolute first priority, which is designated for 'Basic factors falling in concentrate here', across all urban scales. This implies that while areas for improvement exist, none are categorized as both fundamentally deficient and critically urgent to that extreme.

The analysis reveals both universal priorities and scale-specific intervention needs across Morocco's urban bus systems. Service Coverage & Frequency (SCF) emerges as the third priority across all urban scales, representing a critical nationwide challenge. This consistency indicates that regardless of city size, Moroccan bus users are fundamentally dissatisfied with network extent, operating hours, and service frequency. This finding aligns with the broader challenges facing Morocco's urban transport sector, where insufficient supply fails to meet demand across all urban contexts.

However, several service attributes demonstrate a clear scale-dependent prioritization. For instance, Security & Safey (SS) appears as the second priority in metropolises, large, and medium cities, but notably absent from small cities' priority list. This pattern suggests that safety concerns intensify with urban complexity and population density. In larger urban environments,

factors such as higher crime rates, traffic density, and operational complexity may elevate safety as a critical user concern, while smaller cities may maintain more manageable safety conditions. It may be noted that Service Punctuality (SP) has a shared second priority in medium cities but entirely absent from other cities' priority lists.

Further variability is observed at Rank 4 where bus users in metropolises focus on Vehicle Cleanliness & Maintenance (VCM), while medium cities prioritize Passenger Comfort & Convenience (PCC), and both large and small cities report no attributes at this level of urgency. This pattern suggests that, while "excitement" improvements may elevate user experience in some contexts, they are not universally pressing across all city categories.

Table 7: Order of identified key intervention areas across urban scales

Priority order	Metropolises	Large	Medium	Small
(1) BF & CH	Any	Any	Any	Any
(2) BF & LP	SS	SS	SS-SP	Any
(3) IPF & CH	SCF	SCF	SCF	SCF
(4) EF & CH	VCM	Any	PCC	Any

4. Major contributions and policy implications

From a theoretical and methodological perspective, this research offers several major contributions. Firstly, it addresses a significant gap in the literature by explicitly investigating the direct influence of urban scale on the prioritization of bus service attributes for improvement, particularly within a developing country context like Morocco. Secondly, the study successfully demonstrates the effectiveness of combining Revised IPA with fuzzy clustering techniques for large-scale, multi-city analysis that can be replicated in other contexts.

From a policy perspective, the findings provide essential guidance for Morocco's ambitious bus modernization plan (2025-2029). The findings demonstrate that urban scale significantly affects both the complexity of user expectations and the prioritization of service improvements. While Service Coverage & Frequency emerges as a universal priority requiring immediate attention across all urban contexts, other improvement areas show distinct scale-dependent patterns. Metropolitan areas require comprehensive interventions addressing safety, availability, and vehicle conditions. Large cities should focus primarily on safety and availability issues. Medium cities need targeted attention to safety, ponctuality, availability, and comfort aspects. Small cities can concentrate only on availability aspect, with their naturally better safety conditions requiring less immediate attention.

For operating companies, these differentiated priorities should be embedded into contractual performance indicators, moving beyond uniform metrics to context-specific ones (e.g., focusing on safety incident rates and headway compliance in mtropolises/large/medium cities versus route-kilometers served in small cities). Regulators and funding agencies can leverage these insights to condition modernization fund disbursements on demonstrable improvements in the

highest-priority attributes for each urban scale, ensuring efficient allocation of public investment in Morocco's urban bus transport modernization.

5. Conclusion

This study successfully addressed a critical research gap by investigating how urban scale influences user perceptions and prioritization of bus service attributes in Morocco. Through comprehensive analysis of 14,097 responses from 16 cities using Revised Importance-Performance Analysis integrated with fuzzy c-means clustering, the research provides valuable empirical evidence for differentiated public transport improvement strategies.

The key finding that urban scale significantly affects both the complexity of user expectations and service improvement priorities has important implications for transport planning in developing countries. The identification of Service Coverage & Frequency as a universal priority, alongside scale-specific patterns in safety-security, punctuality, vehicle condition and comfot concerns, provides a nuanced understanding of how city size shapes public transport needs. This research contributes to both theoretical understanding and practical policy development. The methodological approach demonstrates the value of combining advanced analytical techniques for multi-city transport studies, while the findings offer concrete guidance for resource allocation in Morocco's ongoing bus modernization initiatives.

Despite its valuable contributions, this study has certain limitations. The reliance on an online convenience survey, while enabling a large sample size across diverse cities, may introduce some self-selection bias. Future research could benefit from integrating additional data collection methods, such as on-site surveys or focus groups, to further validate perceptions. Additionally, a longitudinal study could track changes in user perceptions over time, especially as new government initiatives are implemented. Further research could also delve deeper into the economic feasibility of implementing the proposed interventions for each urban scale and explore the potential impact of these improvements on ridership and modal shift.

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