The Practices of an Integrated Infrastructure Planning in Ethiopian Metropolitan Cities, the Case of Addis Ababa and Sheger Cities

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Article

The Practices of an Integrated Infrastructure Planning in Ethiopian Metropolitan Cities, the Case of Addis Ababa and Sheger Cities

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Abstract: Integrated infrastructure planning between two cities is a coordinated approach that aligns infrastructure systems such as transportation networks, waste management, water supply, and digital connectivity across municipal boundaries. This type of regional planning creates synergy between neighboring cities, helping achieve broader economic, environmental, and social objectives. In particular, it emphasizes improved connectivity, resource sharing, and resilience, all of which support regional growth, reduce redundancies, and ensure that infrastructure systems work efficiently for both cities. On the other hand, disjointed approaches to infrastructure development could lead to unsustainable urban sprawl, traffic jams, poor public service delivery, environmental degradation, inefficiencies, and inequality. The study used a mixed-methods approach, using convenience sampling techniques and collected data through questionnaires, surveys, interviews, and focus group discussions, which was analyzed using Microsoft Excel, ArcGIS, and SPSS. The study examines infrastructure systems and planning practices in Addis Ababa and Sheger, focusing on efficiency improvements in sewerage and drainage management, waste management, and transportation networks. It also analyzes challenges and provides recommendations for effective inter-city coordination.

Keywords: integrated infrastructure planning; metropolitan cities; Addis Ababa; Sheger; urban development; sustainable cities; and stakeholder collaboration; and transport; waste

Introduction

Growing cities increasingly recognize urban infrastructure planning as a critical element in their sustainable development [1]. As cities' populations grow, they face increased demands on transportation, water supply, energy, sanitation, and telecommunications networks [2,3]. In the face of rapid urbanization, aging infrastructure and growing environmental challenges, siloed planning and fragmented decision-making are losing to integrated infrastructure planning, a comprehensive and sustainable approach to forward-thinking corridor development [4,5]. Integrated infrastructure planning (IIP), a comprehensive approach to infrastructure planning, coordinates a variety of infrastructure systems to ensure the efficient use of resources, reduce environmental impacts, and establish cohesive urban environments[6]. This holistic perspective encourages cities to align their infrastructure goals with broader societal objectives, such as economic growth, social equity, and environmental sustainability, providing a robust framework for long-term urban development [7,8]. Rather than planning each system in isolation, integration aims to connect them, creating efficiencies and improving service delivery. In urban contexts, integration also extends to considering the interdependencies between infrastructure and land use, social services, and economic development [9,10].

The integration of infrastructure systems offers significant benefits in terms of resource efficiency, environmental impact reduction, and economic viability[11,12]. When infrastructure planning is integrated, it promotes synergies that reduce redundancies such as shared energy grids or water management systems thereby lowering costs. Environmental benefits also arise when integrated systems help reduce emissions, decrease land disturbance, and conserve resources[13].

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Economically, integration can foster innovation, create jobs, and increase the appeal of cities to investors[14].

Ethiopia's capital, Addis Ababa, and Sheger are collaborating to address urban expansion, population growth and interdependencies. They are implementing integrated planning to address shared concerns like transportation networks, water resources, and waste management. The goal is to create a balanced urban development trajectory that aligns with both cities' goals. Public transportation initiatives aim to reduce traffic congestion, improve accessibility, and enhance mobility. Road network developments support economic activities and smoother travel between the two cities. There are also efforts underway to enhance water supply infrastructure, including the expansion of wastewater treatment plants and distribution networks, ensuring reliable access to clean water and proper sanitation facilities, water distribution networks, wastewater treatment, parks, green spaces, and urban forestry initiatives that are integrated into urban planning for residents.

In metropolitan regions where cities are physically or economically interconnected, the concept of integration takes on a regional dimension[15–17]. Integration across urban boundaries implies that cities collaborate to manage shared resources and develop joint infrastructure solutions[18,19]. This is crucial in areas where urban expansion has led to overlapping infrastructure needs, such as transportation corridors or water systems. In the case of Addis Ababa and Sheger, regional integration enables both cities to manage growth more effectively, addressing issues like traffic congestion, environmental degradation, and resource scarcity. Cross-boundary integration enhances the resilience of the region by allowing for more coordinated responses to challenges that affect both cities [20,21]. Despite ongoing efforts to address integrated infrastructure needs, there are concerns about the effectiveness of integrated infrastructure planning and collaboration between Addis Ababa and Sheger metropolitan cities. Fragmented approaches to development and infrastructure investment could lead to inefficiencies, inequality, and unsustainable urban expansion [22].

Therefore, we chose Addis Ababa and Sheger, Ethiopia's capital and peri-urban area, for a study on integrated infrastructure planning due to their strategic importance, rapid urbanization, and interconnected development needs. These cities form an essential urban corridor, addressing challenges like housing shortages, transportation congestion, water supply, and waste management. Integrated planning can create economic synergies, reduce commuting times, facilitate trade, and improve job market access. Addressing the lack of integrated infrastructure planning requires a collaborative framework between policymakers, urban planners, and stakeholders.

This study underscored the potential of integrated infrastructure planning to enhance sustainable urban development and resilience between Addis Ababa and Sheger. By investigating the practice and feasibility of coordinated infrastructure approaches, this study seeks to pave the way for improved urban management and inter-city cooperation that can serve as a model for other regions facing similar growth challenges. Therefore, the aim of this article is to create cohesive, sustainable, and well-connected urban environments that benefit the public across both metropolitan regions on three different cases, namely transport and road networks, sewerage and drainage systems, and solid waste management”

2. Materials and method

2.1. Study area

Addis Ababa, as Ethiopia's capital city, serves as its political, economic, and cultural hub [23] and [24]. According to the latest estimates, the population of Addis Ababa, the capital city of Ethiopia, is approximately **5,704,000[25].** The city has experienced rapid growth in recent years, driven by urbanization, economic development, and migration from rural areas[26,27]. However, population numbers can vary depending on the source, as official censuses may lag behind real-time growth. Rapid population growth has created opportunities for economic development in the developing world, but it has also created social, environmental, and cultural challenges, leading to a mismatch between the demand and the supply of services [23]. Understanding the dynamics of urbanization

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and infrastructure development in Addis Ababa is crucial for assessing the effectiveness of integrated planning efforts.

Its social and physical infrastructure has increased quantitatively in the past few decades, but it is still in need of significant improvement in terms of quality and distribution [24]. The government's strategies behind its extensive urban investments, which integrate the improvement of the urban environment with the creation of economic opportunities, especially for urban youth, have shown some promising results [24]. However, we need to evaluate, modify, or replace the policies and strategies based on their contribution to alleviating the chronic problems of the city [24].

Sheger, like the Addis Ababa metropolitan area, is experiencing significant population growth and urban expansion, leading to increased pressure on infrastructure and services. Examining the integration of planning processes and infrastructure investments across the Sheger Metropolitan Area provides insights into regional development dynamics and interdependencies. It consists of several satellite cities and towns that surround the capital. The Oromia Spatial Planning Team estimates Sheger City's total population at 1,657,228 (2022). It is one of the Oromia National Regional State's late-established cities and consists of 12 sub cities and towns. From this, we purposefully selected three of these sub cities, namely Burayu, Sebeta/Furi, and Galan, as case study sites (Fig. 1). We selected these cities because they are the economic powerhouses in Ethiopia and Oromia regions, are actively expanding their gray infrastructure to support the economy, and are experiencing rapid population growth, which is placing significant pressure on green spaces.

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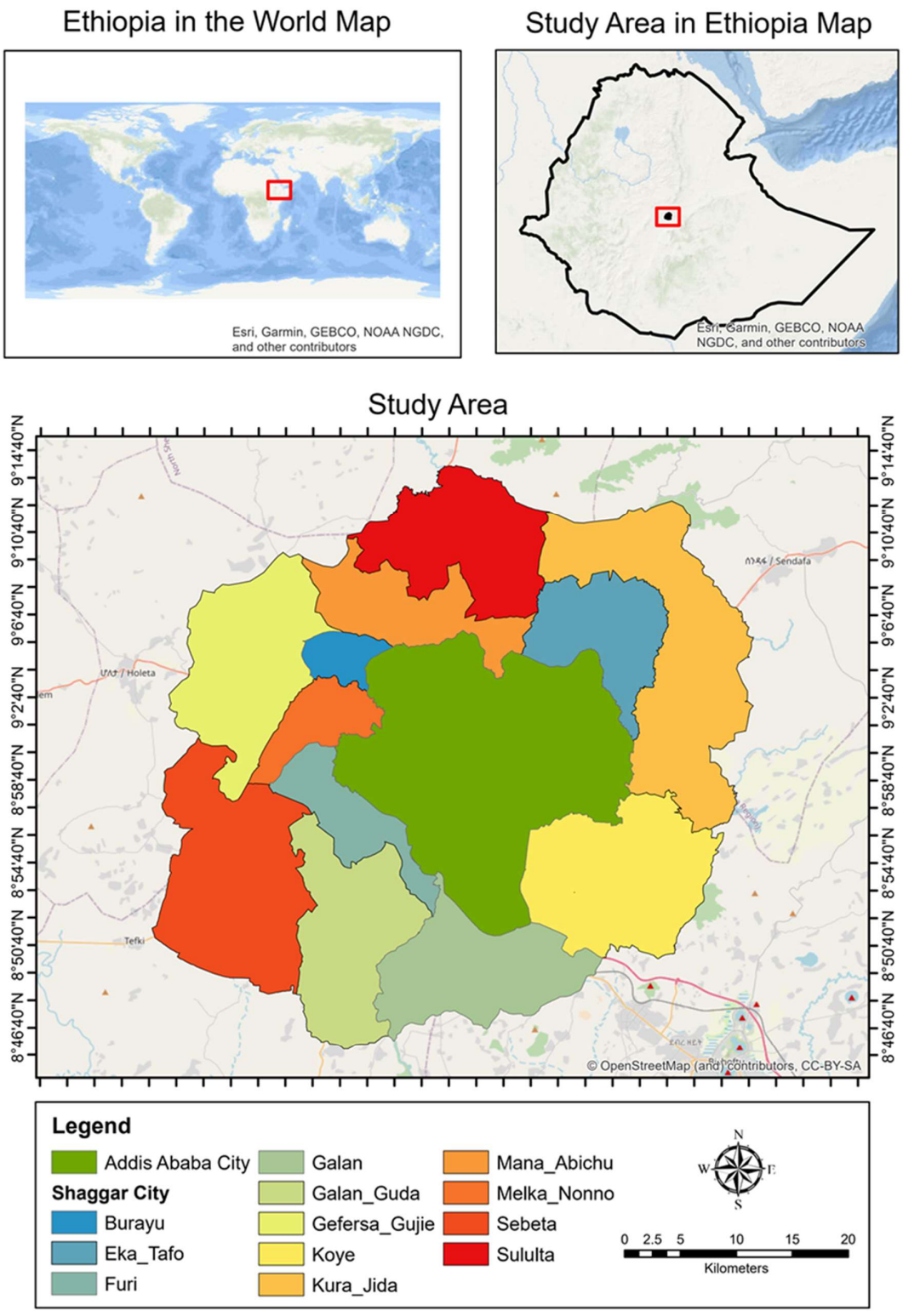

Fig. 1: Location map of the study area .

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2.2. Research Methodology

We conducted the investigation using a descriptive methodology. In order to acquire a thorough understanding of the practice of integrated infrastructure planning in the study area, the investigation implemented a mixed-methods approach that integrated both qualitative and quantitative research methodologies [28,29]. We analyzed the practice of integrated urban infrastructure in the studied areas using descriptive and explanatory research designs. We developed the study design as a comprehensive framework to direct the research activities while taking into account the objectives. The nature of the research, the identified problems, and the available data are the primary determinants of the types of data and tools used to capture relevant information. The research aimed to answer the following four fundamental questions.

I. What is the current state of infrastructure and planning practices in Addis Ababa and Sheger, and where are the critical points of interdependence?
II. How can integrated infrastructure planning contribute to resource efficiency and service improvement in both cities?
III. What are the main challenges to implementing integrated infrastructure planning, especially regarding governance and policy coherence?
IV. How can Addis Ababa and Sheger practically adopt a framework for coordinated infrastructure planning, and what best practices could be adapted from other regions?

2.3. Data Types and sources

We used questionnaires, key informant interviews (KII), focus group discussions (FGDs), and document analysis as data sources to collect both primary and secondary data in the study areas. We collected primary data through surveys KII and FGDs. We extracted secondary data from research findings, books, review articles, published and unpublished reports, and field observation.

2.4. Sampling techniques and determining sample size

We selected convenient sampling techniques for surveys, KII and FGDs based on their availability and accessibility, especially when targeting specific groups or populations. We selected experts from five sectors the cities based on their experience and educational level. This helps to provide sufficient information about the integrated infrastructure planning in the study areas shown in figure 1 and 2

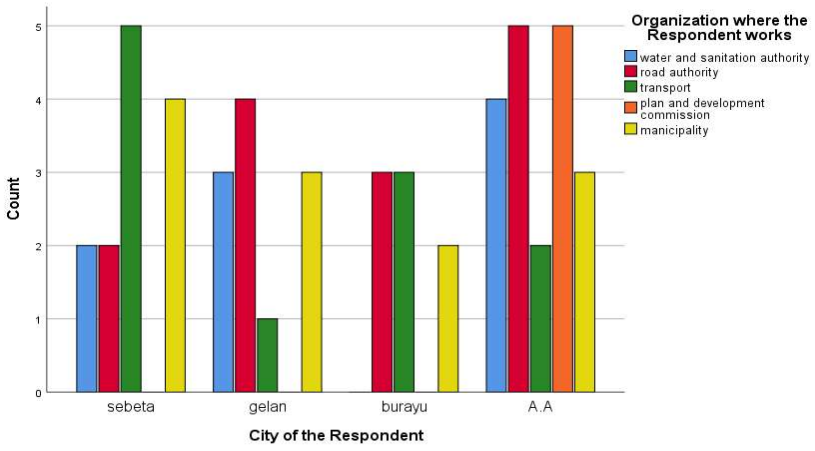

Figure 2. - City of the Respondent .

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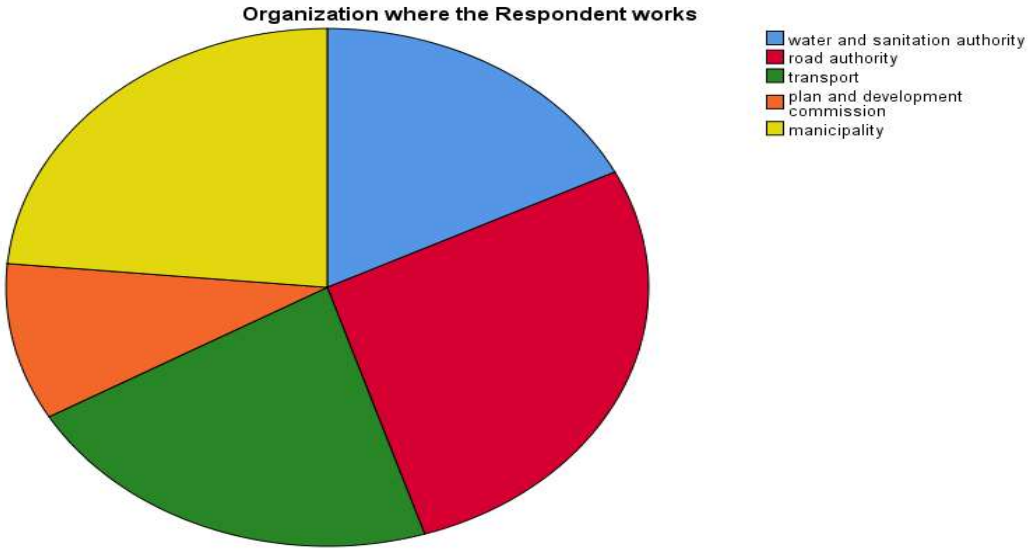

Figure 3:- Organization of the Respondent .

According to [30] the number of participants in the FGD session was 40. For fair representation, 10 participants participated in each case study area.

2.5. Data Collection Methods

We gathered both qualitative and quantitative data for the present research through a survey, structured and semi-structured interviews, and focus group discussions ([31]; [32]. Therefore, we conducted interviews with officials, professionals, community representatives, and relevant stakeholders. Furthermore, as [33,34] employed during his data collection, we extensively used participant observations to capture typologies of development on the ground and modalities of the infrastructure through photographs, note-taking, and typo morphological mapping. Furthermore, during the data collection process, we conducted extensive participant observations to document the infrastructure modalities and development typologies present on the ground. Based on this, the researcher employed the following data collection methods in our study. We provided both closed-ended and open-ended questionnaires to the respondents. We employed the questionnaire to gather insights from the sector expertise of various infrastructure providers.

2.6 Data Analyses

We edited, coded, classified, and encoded all the gathered data into a computer for analysis using Microsoft Excel, AutoCAD, ArcGIS, and Statistical Package for Social Science (SPSS) Version 22 software. We analyzed and presented the qualitative data in a non-numerical form. We first transcribed these into text, and then categorized them based on the frequency of ideas. We used each coded response category as a variable in SPSS for subsequent statistical analyses.

2.7. Data Presentation

Presentations of the analyzed data include tables, graphs, charts, and percentages. Additionally, we have integrated GIS and CAD figures along with field surveys.

3. Results and discussions

3.1. Sewerage system

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For a variety of reasons, a sizable majority of respondents (85.7%) in the study areas indicated that there was no integrated sewerage system between the two cities under study, as revealed in Table 1 below.

Table 1: The absence of integrated sewerage system.

S/N	Issues	Frequency	percentage
1	Lack of agreement between the cities	7	24
2	Disagreements on boundaries	4	13.2
3	Lack of a compensation mechanism	6	20
4	Lack of a legal framework	12	42.9
	Total	29	100

Source(s): Expertise survey, 2023.

The findings suggest that the lack of an integrated sewerage system between cities has serious implications for public health, environmental sustainability, and regional development. Key obstacles such as administrative disagreements, boundary disputes, absence of compensation mechanisms, and lack of a legal framework hinder collaborative infrastructure projects [35,36]. This can lead to inefficient waste management, increased pollution, and strained inter-city relations, highlighting the need for cohesive policies and legal framework to support sustainable urban development

The issue of lack of sewerage integration between urban centers, as reported by the respondents, aligns with findings from various studies across both developing and developed countries[37,38]. Similar issues emerged in a Lagos, Nigeria, study, where municipalities struggled to integrate sewerage disposal due to a lack of cohesive planning frameworks and institutional cooperation [39,40]. This aligns with the respondents who noted the absence of an integrated sewerage disposal site, pointing to complex barriers that make inter-city coordination challenging. Findings from Southeast Asian cities [41,42] echo the structural and political challenges in developing such systems, including the absence of agreement among cities. For instance, historical disputes or unclear jurisdictional delineations in Latin America often lead to boundary-related conflicts in many metropolitan areas [43,44]. Additionally, inadequate compensation mechanisms can impede waste management initiatives, as affected communities and municipalities often demand assurances of equitable resource allocation and compensation [45]. From all, the absence of a legal framework is crucial for successful inter-city infrastructure projects, as it provides guidelines, standards, and enforceable measures for collaboration. In Kenya, legal ambiguities in environmental and sanitation policies have led to stalled waste management initiatives between cities [46,47]. The absence of a legal structure may exacerbate existing disputes and complicate resource allocation, further delaying essential infrastructure development.

According to the study, (30.9%) stated that there is a common sewerage disposal area, while (69.1%) stated that there is no such common disposal site. The result suggests that the majority (69.1%) perceives an absence of a shared disposal site, indicating potential challenges in waste management and environmental health due to fragmented disposal practices. This lack of a unified system can lead to increased pollution, inefficient resource use, and possible health risks for surrounding communities[48,49]. Establishing a common disposal site could improve coordination and promote sustainable waste management across the cities involved.

The majority of respondents indicated the absence/inadequate of a common disposal site, which is consistent with other rapidly urbanizing regions where waste management infrastructure often lags behind population growth, like in Dhaka, Bangladesh [50]. The minority reported the existence of a common disposal site, potentially due to isolated efforts by certain neighborhoods or sectors, consistent with similar patterns observed in Jakarta, Indonesia [51,52]. The lack of inter municipal coordination and planning may also contribute to confusion and inefficiency in waste management, which is consistent with studies in metropolitan areas like Mumbai, India [53–55].

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3.2. Drainage system

When asked whether the cities have common storm water master plan, 17.4 percent of respondents indicated that cities have a common drainage master plan. While 82.6 percent of respondents stated that cities do not have a common storm water master plan. The lack of a common drainage master plan, as indicated by respondents, implies significant risks for the cities, including increased vulnerability to flooding, water pollution, and infrastructure damage[56,57]. This absence of coordinated planning could result in costly repairs, environmental degradation, and health risks for residents. Developing a shared drainage management strategy is crucial for enhancing urban resilience and mitigating these risks, especially as climate change intensifies extreme weather events.

The lack of a common drainage master plan in urban areas, as reported by respondents, is a significant gap in urban water management. Studies from other rapidly urbanizing areas, like Nairobi, Kenya, have reported similar findings, highlighting how the lack of an integrated drainage management system between neighboring jurisdictions has exacerbated flood risks, damaged infrastructure, and contributed to water contamination [58,59]. The small percentage of respondents acknowledging a shared drainage plan suggests isolated agreements or fragmented efforts. In urban regions like Johannesburg, South Africa, partial or fragmented drainage management initiatives within city sections often create inconsistencies, failing to address broader drainage issues and placing isolated neighborhoods at higher risk during heavy rainfall [60,61]. A coordinated approach to drainage management across cities can reduce flood risk, protect ecosystems, and improve urban resilience. Adopting a shared drainage master plan could offer environmental and economic benefits, reducing the need for costly repairs and providing better protection for residents[62,63]. It also, underlies issues in inter-city governance, as seen in case studies from metropolitan areas in Asia. For example, in the Pearl River Delta region in China, studies have shown that competing priorities and inadequate policy alignment between neighboring cities often hinder the development of regional water management plans [64,65]. Similarly, research in Latin America demonstrates that a coordinated approach to drainage management across cities can reduce flood risk, protect ecosystems, and improve urban resilience [66,67].

Regarding strategies for flood protection in lower reaches, 16% of respondents reported the existence of strategies to protect people in lower reaches from floods. And 81.3% of respondents stated that there were no strategies in place to protect people in lower reaches from floods. The lack of flood protection strategies for lower-lying areas, as reported by 81.3% of respondents, suggests the high vulnerability of these communities to flood risks [68–70]. This absence of protective measures increases the likelihood of severe damage to homes, infrastructure, and public health in these flood-prone areas.

. The study illustrates a critical vulnerability in urban flood management in lower-lying areas, which are increasingly susceptible to flooding due to their proximity to waterways and their location. This absence of strategic intervention, which is also evident in other rapidly urbanizing regions, such as Dhaka, Bangladesh [71], places low-lying areas at a high risk of flooding due to inadequate protective infrastructure and inadequate urban planning. In urban areas like Manila, Philippines, the small percentage of respondents who acknowledge the existence of flood protection strategies may suggest that these strategies are isolated initiatives or pilot programs that are specific to specific communities rather than a comprehensive municipal plan [72,73]. This fragmented approach can result in disparate levels of protection, which places the most vulnerable communities at a higher risk. Fragmented policies, resource limitations, and a lack of intergovernmental cooperation frequently impede the development of comprehensive flood protection measures in urban resilience literature, particularly in Lagos, Nigeria [74,75]). [76,77] conducted comparative studies in New Orleans, USA, demonstrating that the implementation of sturdy flood protection systems, such as levees and storm surge barriers, significantly reduces the risk of catastrophic damage in vulnerable areas. Additionally, the absence of flood protection strategies for the lower reaches may impact the urban ecosystem [78,79].

The overwhelming majority of respondents (78.3%) indicated that their organization intends to establish shared institutions with other cities in the future. However, a smaller proportion of

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respondents (17.4%) indicated that they do not or intend to prioritize such coordinating efforts at this time. The strong interest in establishing shared institutions suggests a significant desire for collaboration and coordinated governance among cities, which could enhance resource sharing and improve service delivery[80,81].

The finding of respondents express an intention to establish shared institutions with other cities signals a robust interest in collaborative governance as a means to address shared challenges. For instance, studies in the context of metropolitan governance in North America demonstrate that shared institutions can lead to improved service delivery, increased efficiency, and better alignment of regional development goals [82]. However, the of respondents who do not prioritize establishing shared institutions highlight a significant minority perspective that warrants attention. This contrasts with the majority's enthusiasm and suggests potential barriers or concerns regarding collaborative efforts [83,84]. For example, in metropolitan areas like Los Angeles, attempts to create regional governance structures have faced challenges due to entrenched local interests and skepticism about the benefits of cooperation [85,86].

Furthermore, the desire for shared institutions may not always translate into effective collaboration without addressing the underlying governance structures and processes. As noted in the literature, establishing shared institutions requires careful negotiation of governance frameworks that delineate responsibilities, authority, and accountability among participating entities [87,88]. The presence of a sizable minority who are not prioritizing coordination efforts suggests that there may be unresolved questions or concerns about how such shared institutions would function in practice. Moreover, this division in perspectives may also reflect varying levels of readiness or capacity among organizations to engage in collaborative governance. For instance, a study of inter municipal cooperation in Europe indicated that local governments with limited administrative capacity were less likely to engage in collaborative initiatives, opting instead to focus on internal improvements [89,90].

Regarding the existence of rules, frameworks, or other legal circumstances that support institutional integration among stakeholders, the survey's results showed that (47.8%) of respondents said "yes." (51.2%) of respondents, on the other hand, indicated that they did not have such laws or rules in place. The survey results reveal a significant gap in legal and regulatory structures necessary for effective collaboration among stakeholders, respondents acknowledging the existence of supportive rules or frameworks for institutional integration. The majority who indicate the absence of such support suggest challenges in fostering inter-organizational cooperation, potentially hindering efforts to address shared urban issues. This underscored the need for the development and implementation of clear legal frameworks that facilitate collaboration, enhance governance, and promote resource sharing among stakeholders to improve overall institutional integration.

In line with other research on urban governance [91], survey respondents indicate a significant lack of the legal framework required for effective integrated infrastructure. In many urban settings, the absence of such frameworks can lead to fragmented efforts, undermining the potential benefits of integrated governance. For instance, studies on regional governance in the United States have demonstrated that clear legal guidelines can facilitate partnerships between municipalities, resulting in more coordinated responses to complex urban challenges [92,93]. The fact that a slight majority of respondents indicated that there are no supportive laws or rules in place suggests a significant obstacle to the institutional integration that many urban areas seek. This finding is consistent with research from metropolitan regions like Los Angeles, California; for instance, a lack of inter-jurisdictional agreements has led to inefficiencies in addressing regional issues like transportation and challenges in achieving integrated governance and environmental management [94,95].

Lack of legal frameworks in urban regions like Nairobi, Kenya, exacerbates governance capacity and institutional trust issues, leading to mistrust and reluctance to cooperate [96,97]. The study areas may exhibit a lack of trust among stakeholders, exacerbated by unclear legal frameworks, which may hinder the establishment of shared institutions for integrated governance [98,99]. The Greater Toronto Area in Canada has successfully implemented inter-city cooperation due to the presence of supportive legal frameworks among municipalities [100]. The cities under study stand to gain from

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the development of these frameworks, as they can foster collaboration and improve governance outcomes.

Regarding whether cities have collaborative projects through shared finance, (53.8%) of respondents said "yes," while (65.3%) said "no." Focus group discussions and interviews verified that cities do, in fact, currently have collaborative projects underway. The survey results underscored a discrepancy between perceptions and actuality in the context of intercity collaboration. Despite the existence of ongoing projects, a substantial number of stakeholders may not fully understand or participate in these initiatives. The implication is that it is imperative to improve the communication and visibility of these collaborative endeavors in order to encourage a broader base of support and participation. Furthermore, addressing the concerns of who perceive a lack of collaboration could enhance trust and investment in shared financial initiatives among cities.

The survey findings highlight the complexity of fostering inter-city cooperation, as effective collaboration often hinges not only on the presence of projects but also on stakeholders' awareness and engagement with these initiatives [101–103]. In the context of the study cities, the perceived lack of collaboration could hinder the potential benefits of shared financial projects, indicating a need for improved outreach and education about existing initiatives. The discrepancy between the survey results and the verified existence of collaborative projects underscored the challenges inherent in promoting inter-organizational cooperation. For instance, studies in metropolitan regions like São Paulo, Brazil, demonstrate that even when collaborative projects are in place, local stakeholders may remain unaware due to insufficient communication strategies from governing bodies [104,105]. This suggests that, for the cities under study, enhancing communication strategies and providing clear information about collaborative initiatives is critical to bridging the gap between perception and reality. To address this issue, it is essential for city leaders to engage a broader range of stakeholders in discussions about ongoing projects, thereby fostering a sense of ownership and increasing awareness of shared financial initiatives.

Furthermore, the majority of respondents indicated "no collaboration," which may indicate structural or governance issues hindering the success of shared finance initiatives and requiring strong governance structures and mutual benefit commitments, as noted by [106]. Successful collaborative finance projects in regions such as the European Union rely on the establishment of clear agreements, mutual trust, and equitable resource sharing among diverse stakeholders [107,108]. For the cities under study, addressing governance challenges and ensuring equitable frameworks for collaboration will be crucial for increasing both the visibility and effectiveness of shared financial initiatives.

In response to a question concerning a project's funding source, participants gave the following breakdown: (19.2%) identified municipal funds, (30.8%) stated special savings, and (34.6%) confirmed government loans. The funding breakdown, identifying government loans as the primary source, indicates a reliance on external financial support for projects, which may impact sustainability and long-term planning. The significant portion suggests some proactive financial management at the local level, while the smaller percentage relying on municipal funds may reflect constraints in local budgets or priorities. These findings imply a need for diversified funding strategies to reduce dependency on government loans, enhance local fiscal capacity, and ensure the sustainability of projects.

Participants identified government loans as the primary funding source, highlighting a significant reliance on external financial support for project implementation. This is consistent with trends observed in urban infrastructure financing to bridge funding gaps, particularly in developing regions [109–111]. For example, research on urban development in South Africa shows that excessive reliance on loans can lead to unsustainable debt levels, impacting future budgetary flexibility [112,113]. In contrast, the respondents citing special savings as a funding source suggest some degree of proactive financial management among local stakeholders. Studies show that municipalities that establish dedicated savings funds for infrastructure projects can achieve greater financial stability and flexibility in funding decisions [114]. However, the management practices employed and the

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adequate support from broader fiscal policies will determine the effectiveness of these savings mechanisms.

A minor percentage (3.8%) of respondents answered affirmatively to the question of whether the topography of the cities impedes the integration infrastructure, while the majority (77.7%) answered negatively. The small percentage of respondents suggests that local entities do not perceive geographical factors as a significant barrier to collaboration. In contrast, the majority indicates that topography does not impede integration; rather, other factors, such as governance structures or community engagement, may play a more critical role in facilitating or hindering integration.

The survey results suggest that geographical features are not seen as significant barriers to integration of infrastructure. This perspective aligns with literature that highlights the adaptability of urban systems to geographic constraints through innovative land-use planning, creative engineering solutions and infrastructure development [9]. The respondents' overwhelming majority believe that topography does not impede integration indicates a recognition of the potential for strategic planning to mitigate geographical obstacles, thereby fostering inter-city collaboration.

3.3 Solid waste management

The survey revealed that a mere (24%) reported the existence of a common solid waste disposal site in the study area, while a substantial majority (76%) reported the absence of such a facility. The survey results reveal that the lack of a centralized disposal facility may lead to increased environmental degradation and public health concerns, as improper waste disposal practices could become prevalent in the absence of a designated site [115,116]. The findings imply a pressing need for local authorities to prioritize the establishment of a common solid waste disposal facility to enhance waste management efforts, promote sustainability, and protect community health. Additionally, the issue of stakeholder engagement and awareness in the planning and implementation of waste management solutions suggests that improving communication and collaboration among community members and local governments is essential for effective waste management strategies.

The survey results reveal a significant gap in the perception of solid waste disposal sites in a region, with respondents recognizing the existence of a common site and asserting its absence. This disparity suggests that many people may be unaware of existing facilities or that they may not be effectively serving the community's needs. Inadequate waste disposal facilities can have serious implications for public health and environmental sustainability, contributing to pollution, vector-borne diseases, and negative health outcomes[117,118]. The lack of a common disposal site suggests an urgent need for local authorities to develop effective waste management strategies that prioritize community health and environmental protection. The text emphasizes the significance of infrastructure investment and planning in addressing solid waste management issues, emphasizing the need for effective waste management strategies and stakeholder engagement[119,120].

Table2: The reason for the lack of a common solid waste disposal area.

S/N	Issues	Frequency	percentage
1	Lack of an integrated plan	17	34
2	Lack of agreement	1	2
3	Lack of Compensation mechanism	8	16
4	administrative problems	24	48
	Total	50	100

Source(s): Expertise survey, 2023.

As indicated in Table 2, these results mean that fixing inefficient administrative processes, creating an integrated waste management plan, and setting up ways for people to get paid will be needed to make it easier to build a common solid waste disposal area and improve waste management in the region as a whole.

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Administrative problems pose a significant challenge in governance and management structures, contributing to the lack of a common solid waste disposal area. These issues, such as poor coordination, unclear responsibilities, and inadequate regulatory frameworks, often hinder effective waste management[121,122]. Additionally, the lack of an integrated plan, a gap in strategic planning, can impede collaborative waste management efforts. Compensation mechanisms, which ensure equitable resource distribution and incentivize participation from various stakeholders, can enhance collaboration and facilitate the development of a common solid waste disposal area[123,124]. The survey findings highlight the need for improved governance, strategic planning, equitable resource distribution, and stakeholder engagement in waste management initiatives.

When asked about the existence of integrated solid waste management plan, only 18% of respondents answered yes, while a substantial majority of 82% answered no. These findings highlighted a lack of coordinated and future-oriented planning for solid waste management infrastructure. Administrative challenges can hinder effective decision-making, resource allocation, and coordination among municipal authorities, leading to gaps in infrastructure planning and implementation.

The survey results highlight a critical gap in integrated strategic planning for waste management; comprehensive waste management plans are essential for effective and sustainable waste disposal practices[120,125]. Without a formalized plan, cities may struggle with waste collection, recycling, and disposal, leading to increased environmental pollution and public health risks. The absence of integrated solid waste management plan can significantly impede the effectiveness of waste management initiatives, as it requires an integrated approach that includes planning, financing, implementation, and monitoring[126,127]. The findings also highlight the importance of developing a participatory approach in the formulation of integrated solid waste management plans, involving residents, businesses, and community organizations[128,129].

The alternative questions about who should assume responsibility for joint cooperation received, representation from the mayor's committee (30%), a newly established institute (13%), and no institute (57%). The survey results highlight that without a clear coordinating body, there is a risk of disorganization and missed opportunities for effective collaboration, necessitating urgent attention from local authorities to facilitate cooperation in waste management efforts.

The survey results reveal the lack of designated leadership can lead to fragmented efforts and inefficiencies, inhibiting effective collaboration and the implementation of comprehensive waste management strategies. The lack of a designated institute may contribute to ineffective waste management practices and failure to address urban waste challenges[130,131]. The respondents' suggestion of a newly established institute as a coordinator presents an opportunity for innovation in waste management governance, but it requires clear mandates and sufficient resources.

When asked if cities need new solid waste disposal sites, the survey results show that a majority (98%) of respondents agreed. Conversely, a small minority (2%) expressed that there is no need for additional waste disposal facilities. The survey results indicate that cities require new solid waste disposal sites, underscored the necessity of acknowledging the deficiencies in current waste management infrastructure, and recommend that local authorities prioritize the development of additional waste disposal sites to address the increasing waste management challenges. This highlighted fears about the potential for environmental degradation, public health dangers, and the inefficiencies of current facilities.

The survey results show that respondents believe cities need new solid waste disposal sites, highlighting the need for improved waste management infrastructure. This is in line with urban environmental studies, which show that inadequacies in waste disposal capacity can lead to environmental degradation, public health risks, and operational challenges[132,133]. The need for new sites indicates a critical awareness of the unsustainable nature of current waste management practices. The overwhelming support for new waste disposal sites may also reflect a desire for modern and sustainable waste management practices, such as recycling, composting, and waste-to-energy technologies[134,135]. It also suggests that local authorities should engage in comprehensive planning and community involvement in waste management decision-making processes.

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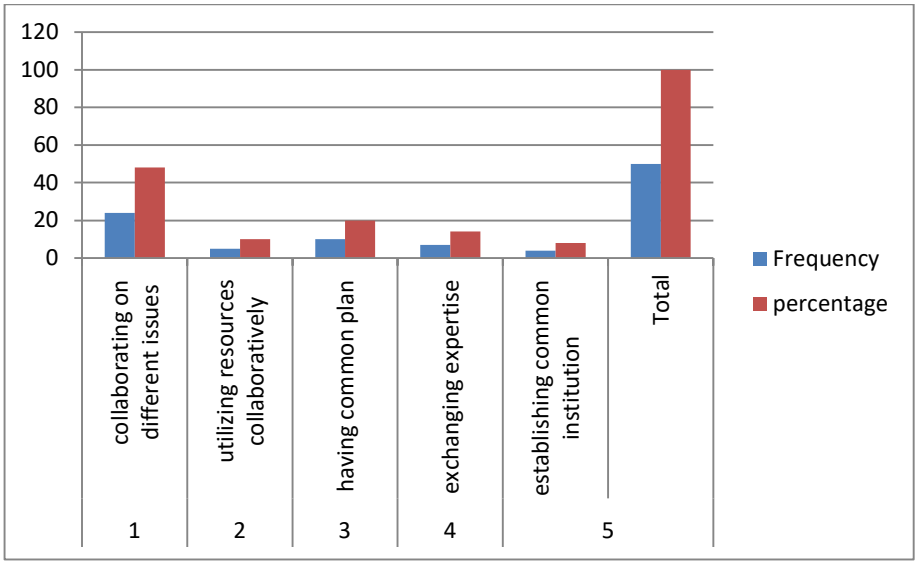

Fig 4: Methods of collaboration between the citie.s

The implicational findings of Figure 4 suggest that cooperation between cities primarily focuses on collaborative efforts and joint planning, as these accounts for a significant portion of the responses (48% and 20%, respectively). This indicates that cities see the value in aligning goals and strategies to address shared challenges and opportunities. Additionally, the aspects of using resources together, exchanging experts, and establishing shared institutions highlight a broader understanding that effective cooperation requires resource sharing, knowledge exchange, and potentially formalized partnerships. These insights suggest that policymakers should prioritize the development of collaborative frameworks and planning mechanisms to ensure successful intercity cooperation.

The survey responses reveal a diverse approach to inter-city cooperation that aligns with research suggesting collaboration across cities is essential for addressing common urban challenges, such as waste management, infrastructure, and environmental issues [136]. The preference for informal collaboration suggests that respondents may view flexibility as critical in building effective partnerships. Resource-sharing is a strategy that urban governance literature supports as a means of achieving cost savings and efficiency gains[137,138]. Respondents support joint planning, acknowledging the advantages of coordinated urban development[139]; respondents support [140]. A formalized approach to collaboration is supported by those who advocate for the establishment of a shared institution. These preferences align with literature emphasizing the benefits of flexible, informal arrangements in fostering effective partnerships while also highlighting the potential of structured approaches in certain contexts[119,141].

3.4 Transport and road network system

The results of the survey show that 34.6% of participants said "yes," indicating that there are sufficient parking lots, bus terminals, and other forms of transportation to link the two cities. On the other hand, 65.4% of respondents said "no," indicating deficiencies in the infrastructure of transportation connecting the cities. The survey results of respondents indicated insufficient transportation infrastructure (parking lots, bus terminals, etc.) connecting the two cities, implying significant logistical and accessibility challenges for intercity movement. This deficiency likely hampers efficient commuting, economic activity, and urban integration between cities[142,143]. The lack of adequate infrastructure can lead to increased congestion, longer travel times, and limited options for residents and businesses relying on inter-city connections[144,145].

The survey results reveal a significant lack of transportation infrastructure between two cities, highlighting the need for systemic improvements. The majority of respondents believe that adequate transportation facilities are crucial for urban integration and regional economic growth. Inadequate

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infrastructure can lead to increased congestion, reduced accessibility, and impeded economic flows, contributing to urban inefficiency[144,146]. The lack of connectivity can restrict labor mobility and limit access to essential services, exacerbate socioeconomic disparities, and contribute to environmental degradation. The survey also highlights the importance of sustainable urban planning, which emphasizes the role of efficient public transport systems in reducing traffic congestion, emissions, and resource consumption[147–149].

The results showed that 26.9% of people rated the state and condition of the transportation infrastructure as good, 53% as medium, and 49.2% as terrible. The varied survey responses imply significant concerns about infrastructure quality and performance. The medium opinions suggest that while some areas or aspects of the infrastructure may meet basic standards, a substantial portion is perceived as subpar. This range of perspectives highlights the need for targeted improvements to enhance the reliability, safety, and accessibility of transportation infrastructure.

The survey results reveal significant disparities in perceived quality of transportation infrastructure in growing cities. The majority rated the infrastructure as "medium," suggesting that the transportation network is functional but may lack critical features of high-quality infrastructure, such as reliability, accessibility, and efficiency. This rating implies that while residents can navigate the current infrastructure, improvements are necessary to elevate its effectiveness, especially as cities expand and demand increases. The high percentage rating the infrastructure as terrible highlights a serious concern, pointing to fundamental deficiencies such as inadequate capacity, poor maintenance, or lack of integration in the transport network[150,151]. This disparity suggests that infrastructure quality may be inconsistent across different locations within the cities, with some areas enjoying better conditions than others. The mixed ratings of infrastructure quality are consistent with common challenges faced by rapidly urbanizing regions, where transportation systems often struggle to keep pace with population growth and demand[152,153].

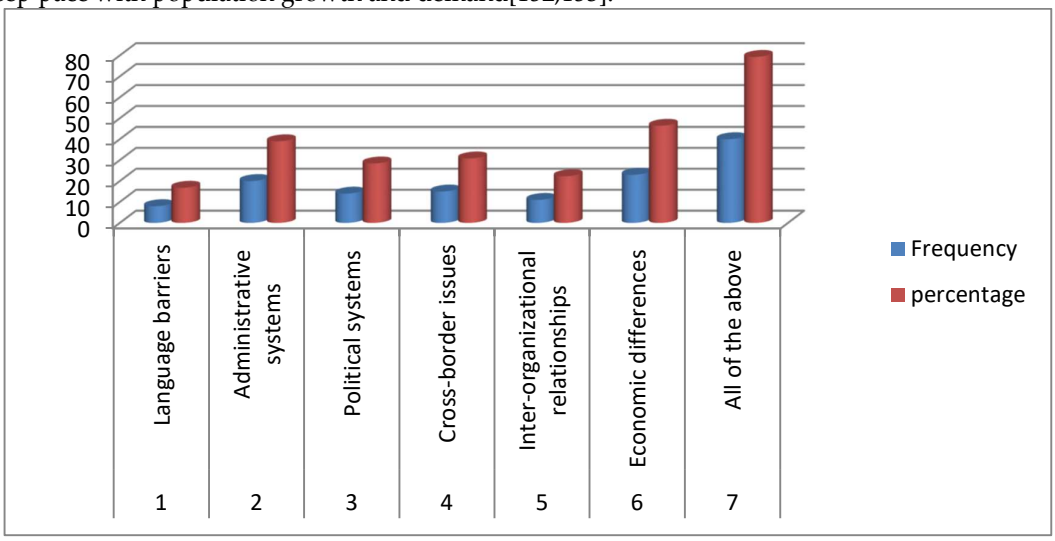

Figure 5. Factors influence integration.

As the findings indicate in Figure 5, participants in focus groups and interviews reiterated similar arguments and added other elements influencing integration. Respondents acknowledge a complex array of factors that hinder integration efforts. Economic disparities, administrative systems, and cross-border issues particularly underscored the multi-layered challenges to integration. This implies that successful integration requires a holistic approach, addressing economic inequalities, harmonizing administrative and political systems, and fostering inter-organizational collaboration[154]. Without a coordinated strategy that tackles these interwoven factors, integration efforts may be limited, with fragmented progress across different areas.

The survey results reveal a complex landscape of factors influencing integration efforts, with respondents identifying all these as barriers[154,155]. Economic differences were the most commonly

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cited factor, highlighting economic inequality as a significant barrier to collaborative efforts across regions. The study also identified administrative systems and political systems as obstacles, underscoring institutional and governance-related barriers. The study identified cross-border issues as a significant barrier, necessitating logistical coordination and legal frameworks to account for shared resources and responsibilities. Organizational relations and inter-organizational relationships were significant, reflecting the importance of trust, communication, and collaboration among organizations. Despite being a minor factor, language barriers can still impede integration, especially when diverse linguistic groups are involved. The survey results emphasize the need for an integrated, multi-level strategy that addresses economic disparities, harmonizes administrative and political systems, and fosters strong inter-organizational relationships. Tailored solutions that incorporate both structural reforms (such as aligning regulatory frameworks) and relational strategies (such as building trust among organizations) are likely necessary to overcome these complex barriers and realize successful integration.

Table 3: Effects of population growth on integrated infrastructure planning.

S/N	Issues	Frequency	percentage
1	increased demand for infrastructure	25	50
2	the need for collaborative management	24	48
3	necessity of open finance	29.2	58.4
4	all these impacts were possible	41.6	83.1
	Total		

Source(s): Expertise survey, 2023.

Table 3's survey result highlights that Population growth significantly influences infrastructure planning; increasing demand and necessitating open financing and collaborative management, according to the survey. 83.1% of respondents acknowledge the combined impact of these factors, suggesting that infrastructure planning needs adjustments to facilitate sustainable growth. This means cities need integrated approaches that include resource sharing, transparent financial strategies, and coordinated efforts to meet increasing demands. Ignoring any of these factors could result in strained resources and inadequate infrastructure to support population expansion effectively.

Respondents indicated increased demand for infrastructure, indicating that urban population surges often outpace adequate development[153,156]. This can strain existing systems, necessitating a reevaluation of infrastructure planning strategies. 48% of respondents noted the need for collaborative management, highlighting the importance of integrated approaches in addressing complexities introduced by population growth[157]. 58.4% of respondents emphasized [158]. 83.1% of respondents acknowledged the interconnectedness of demand, collaboration, and financing, highlighting the need for a comprehensive strategy that considers social, economic, and environmental factors[159,160]. These findings underscored the critical need for coordinated efforts and innovative funding mechanisms to ensure sustainable infrastructure development for urban areas.

Table 3: The reasons for the absence of integrated infrastructure planning.

S/N	Issues	Frequency	percentage
1	Hesitancy among stakeholders	5	10
2	Lack of support from policymakers	11	21.2
3	Lack of leadership	16	31.2
4	Lack of attention	18	36.1
	Total	50	100

Source(s): Expertise survey, 2023.

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Table 3's results indicate that the most significant obstacles to integrated infrastructure planning are a lack of attention and leadership. This suggests that effective planning requires both strong, visionary leadership and priority-setting. The absence of support from policymakers and stakeholder hesitancy further underscores the necessity for increased political commitment and confidence among all parties involved. This implies that policymakers and planners must take proactive measures to secure policy support and engage stakeholders, thereby mitigating hesitation and promoting integrated infrastructure planning. Additionally, they will need to increase their focus and leadership.

The survey results reveal several barriers to integrated infrastructure planning, including stakeholder hesitancy, lack of support from policymakers, a lack of leadership, and lack of attention. Stakeholder hesitancy can stem from fears of losing control over decision-making, resource allocation concerns, or apprehensions about the efficacy of collective efforts. Policymakers play a crucial role in facilitating or obstructing collaborative efforts, and advocacy for policy reforms that promote integrated planning and allocate resources can help overcome these challenges[161]. A clear strategic vision is also essential, as without a unified focus; stakeholders may become disengaged, leading to fragmented initiatives. Increasing awareness of the long-term benefits of integrated planning can address the institutional bias towards siloed planning efforts reflected in the lack of attention to integrated planning[162,163].

Within the infrastructure-provider sectors, we observe the following patterns of coordination: There are three different levels of coordination: strong (26.9%), weak (57.7%), and unknown (11.5%). This indicates that people generally perceive infrastructure suppliers to be poorly coordinated. This can lead to inefficiencies and challenges in managing intricate, interdependent services. A dominant approach with weak coordination leads to a fragmented approach, where providers operate in silos. This fragmentation can lead to higher costs, duplicated efforts, and slow response times during crises, underscoring the need for standardized practices and improved communication.

Research on coordination in the infrastructure-provider sector reveals challenges and tendencies towards weak coordination. [164,165]. This lack of cohesion can hinder service reliability and reduce operational costs. Addressing these issues could help improve data transparency and develop more rigorous assessment tools. Public administration literature, which emphasizes the difficulties in cross-sector coordination due to competing objectives and limited incentives for alignment, aligns with the perception of poorly coordinated infrastructure suppliers.

4. Conclusion and recommendations

4. 1 Conclusion

Lack of an integrated sewerage system between cities is a global issue, involving issues such as disagreement, boundary disputes, inadequate compensation, and lack of a legal framework. This highlights the need for cohesive policies and cooperative governance to improve urban living conditions and environmental health. The survey results also reveal a significant gap in coordinated drainage management, highlighting the need for cities to prioritize collaborative efforts in developing and implementing shared drainage management strategies. The lack of flood protection for vulnerable populations in lower reaches also highlights the need for urgent development and implementation of flood protection strategies. The majority of respondents express a positive outlook toward collaboration among cities and sub-cities, but significant minorities do not prioritize these efforts. The survey results also highlight a significant challenge in institutional integration among stakeholders, emphasizing the need for clear legal structures that promote collaboration and enhance inter-agency coordination. The survey also reveals a critical gap in the perception of solid waste disposal facilities, with a majority indicating the absence of a common site. The findings call for local authorities to prioritize the development of effective waste management strategies, improve stakeholder engagement, and invest in necessary infrastructure.

The survey results reveal significant challenges in strategic planning and stakeholder engagement in urban areas, with only a few respondents recognizing the existence of a solid waste

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management plan. The lack of a specific institute for coordinating joint cooperation in solid waste management suggests the need for local authorities to establish formal governance structures for effective waste management. The respondents assert the necessity for new solid waste disposal sites, underscoring a deficiency in waste management infrastructure. The majority of respondents favor collaboration on various issues, with smaller groups advocating for resource sharing, joint planning, knowledge exchange, and institutional establishment. Transportation infrastructure gaps hinder economic and social integration, and the majority view existing facilities as adequate. The survey results emphasize the need for an integrated, multi-level strategy that addresses economic disparities, harmonizes administrative and political systems, and fosters strong inter-organizational relationships. Tailored solutions, incorporating structural reforms and relational strategies, are likely necessary to overcome complex barriers and achieve successful outcomes. The survey findings resonate with existing literature on integrated infrastructure planning in the context of population growth.

4.2. Recommendations

We propose the following recommendations to improve the integrated infrastructure planning practices between Addis Ababa and Sheger metropolitan cities, based on the study's findings and conclusions.

- ✓ The concerned body, particularly the cities administration should establish a legal framework for cooperation
- ✓ The cities administration planning institutes should develop integrated infrastructure plan for well-coordinated infrastructure management
- ✓ The cities Road Authority should expand flood protection and stormwater management
- ✓ The Federal Government and the cities administration should create institutional support for ongoing collaboration
- ✓ The cities administration should encourage public and political support for integration
- ✓ The cities administration and concerned body should improve transportation connectivity and infrastructure quality.
- ✓ The Federal Government and the cities administration should address economic, political, and administrative barriers to integration.
- ✓ The cities administration and concerned body should enhance infrastructure coordination levels

Declarations

The authors declare no conflict of interests

Author contribution statement

GeremewWorku:- Comprehended and designed the experiments; executed the experiments; analyzed and interpreted the data; contributed components, materials, analysis tools or data; and wrote the paper.

DagnachewAdugna:- comprehended and designed the experiments; executed the experiments; analyzed and interpreted the data; contributed components, materials, analysis tools or data; and wrote the paper.

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Data availability statement

No additional data except in the paper is attached as supplementary material.

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Additional information

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Supplementary content related to this article has been published online at [URL]. Acknowledgements

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