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An Assessment of Street Addressing and House numbering

The case of Mekelle-Kedamay weyane sub city

A thesis submitted to Mekelle University, School of Architecture and Urban Planning in partial fulfillment of the requirement for the degree of Masters of Science in Urban Planning and Development.

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DECLARATION

I, Firdawek Meresa, Registration Number/I.D. Number EiT/M /PR160763/11, do hereby declare that this Thesis is my original work and that it has not been submitted partially or in full by any other person for an award of a degree in any other university/institution.

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APPROVAL

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ABSTRACT

This study evaluates the existing state of street addressing and house numbering system in the Central Business District (CBD) in Mekelle City, specifically in the Kedamay Weyane Sub-City, and its significance in enhancing the management, governance, and delivery of services in the district. The study used a mixed-methods research technique that combines both qualitative and quantitative methods, such as surveys, observations, and analysis. The study used interviews, observations, and analysis, while the house numbering system was analyzed using surveys, geo-spatial analysis, and combination analysis. The study has identified several important shortcomings, including lack of standardization, absence of house number labeling, low level of participation, failures in human, physical, and digital representation, that cause limitations to the operation of the urban system, leading to confusion among citizens and visitors, poor delivery of emergency services, postal, and utility services, and lack of coordination in collecting revenues and urban planning. Moreover, it has also identified that Mekelle's CBD has experienced tremendous growth, informal growth, and overlapping street names that contribute to low efficiency in institutional operations and increasing costs in operations for businesses. To improve upon the identified shortcomings, the study recommended the construction of an effective and coherent pattern in house addressing that is well-supported by a comprehensive house number labeling system, enhancing participation for guaranteeing its continuation, enhancing the physical representation for better recognition, and enhancing the digital cartographic system for better geographical and geo-spatial analysis representation for better integration, analysis, and spatial analysis for improved geographical and geo-spatial representation analysis. Moreover, the study also emphasizes strengthening and enhancing the institutional requirements, enhancing collaboration and partnership, and ensuring collaboration for enhancing improved operations, performance, and governance improvements for better operating, governance, and geographical, geo-spatial analysis, and adaptation analysis in Mekelle's Central Business District.

Key terms: *Street address, house number, digital mapping, physical landmarks, informal naming systems, standardized address system, educational campaign.*

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Table of Contents

Contents	Pages
DECLARATION.....	i
APPROVAL.....	ii
ABSTRACT.....	iii
ACKNOWLEDGEMENTS.....	iv
Table of Contents.....	v
List of tables.....	ix
List of Maps.....	ix
List of figures.....	x
List of Acronyms.....	xi
CHAPTER ONE.....	1
1. Background of the Study.....	1
1.1 Statement of the problem.....	2
1.2 Objectives of the study.....	3
1.2.1 General objective.....	3
1.2.2 Specific objectives.....	4
1.3 Research Questions.....	4
1.4. Scope of the Study.....	5
1.5. Significance of the study.....	5
1.6. organization of the paper.....	6
CHAPTER TWO.....	7
2. Literature review.....	7
2.1 Definition of terms.....	7
2.2 REVIEW OF CONCEPTUAL AND THEORETICAL LITRATURE.....	7
2.2.1 History of House Numbering and Street Alphabets.....	8

Source: Addis Ababa tourism bureau (1949)	10
2.2.2 Conceptual Foundations	10
2.2.3 Key Criteria and Dimensions in Measuring Street Addressing and House Numbering	11
2.2.4 Why Street Addresses and House Numbers Matter.....	11
2.2.5 Common Challenges in Practice, especially in CBDs and in Newly Industrializing Countries	15
2.2.6 Case Studies.....	17
2.2.7 Methodologies Utilized for Literary Studies Evaluation	18
2.2.8 Guidelines and Recommendations of the Literature.....	19
2.2.9 Short falls in Existing Literature.....	20
2.2.10 Specific Issues Related to CBD Scenarios	21
2.2.11 Metrics/Indicators for Evaluation in Community-Based Development	22
2.2.12 Implications and Recommendations	23
2.3 EMPIRICAL LITRERATURE REVIEW	24
2.3.1. Methodological Approaches in the Literature	24
2.3.2. Key Empirical Cases & Findings.....	25
2.3.3. Key Findings across Studies: What Works, What Fails in CBD / Dense Urban Core Contexts	27
2.3.4. Lessons / Best Practices Emerging	29
2.3.5. Case Gaps & Areas Under-Researched	30
2.3.6. Implications for Future Assessment Frameworks	31
2.4. Conceptual Framework.....	32
CHAPTER THREE	35
3. Research Methodology	35
3.1 location and Profile of Mek’ele City	35
Source: Adopted from Bureau of Land (2024) and compiled by researcher	36
3.2 Research Design	37
3.3 Research Approach.....	37
3.4 Data source and data collection Methods	37

3.5	Target Population.....	39
3.6	Sampling Method	39
3.7	Sample size	40
3.8	Sample size determination.....	40
3.9	Data collection techniques.....	42
3.10	Method of Data Analysis	42
CHAPTER FOUR		43
4. RESULT AND ANALYSIS.....		43
4.1.	Introduction	43
4.2	Response Rate.....	43
4.3	Respondents Profile.....	44
4.4	Assessment the availability of street addressing and House numbering	46
4.4.1.	Street Inventory.....	46
4.4.2.	Number of Streets, junctions, Blocks and parcels	47
4.4.3.	Existing Addressing system.....	47
4.4.4	Existing house numbering	53
4.4.5.	Street name signage poles and house number plates	53
4.4.6.	Availability of Mapping and database management.....	54
4.5	Awareness of citizens in addressing system	54
4.5.1.	Citizens engagement	54
4.5.2.	Description of home address	56
4.5.3	Knowledge on street addresses	56
4.5.4	Use of street names and house numbers in daily life.....	58

4.6.	The Effectiveness of the Addressing System for efficiency (user-friendly) of street addressing and house numbering	67
4.6.1.	Visibility of addresses (street signs and house numbers)	70
4.6.2.	In effectiveness of color coded number plates	71
4.7.	Challenges encountered in giving out Locational Information and Navigating the Study area	75
4.7.1	Perception on the Implementation of Street Naming and Property Addressing System	76
4.7.2	Lack of Coordination between Stakeholders	77
4.7.3	Technical and Operational Challenges	78
4.7.4	Financial and Resource Constraints	78
4.7.5	Community and Social Challenges	79
4.7.6	Urban Dynamics and Environmental Factors	79
4.7.7	Digital and Technological Problems	80
4.7.8	Street addressing and public safety challenges	80
4.8.	Evaluation of the Potential of the Street Addressing and House Numbering System in the area	81
4.9.	Triangulated the findings with various institutions	83
CHAPTER FIVE		86
5.	Conclusion and Recommendations	86
5.1	Conclusion	86
5.2	Recommendations	91
5.3	Further Research	94
References		95
ANNEX		100

List of tables

Tables	page no
Table 1 Sample representative	41
Table 2: Techniques for data collection from the respondent	42
Table 3: The response rate of the respondents	44
Table 4: respondents profile.....	45
Table 5: Description of Home Addresses	56
Table 6: Respondents Knowledge on named street addresses	57
Table 7: Use of street address by age group.....	59
Table 8: Use of street addresses by educational attainment.....	61
Table 9: Duration of stay in using street addressing:	64
Table 10: Visibility of Street Addresses	71
Table 11: Challenges encountered in locating places	76
Table 12: Perception of residents	77
Table 13: Triangulation of data with different institutions	84

List of Maps

Map 1: Part of Addis Ababa's named and numbered streets	10
Map 2: Mekelle City location map.....	36
Map 3 Map showing Named streets in the sub- city	52
Map 4 Map showing house number in the sub- city	53
Map 5: Widely used land marks in the study area	66

List of figures

Figure : Conceptual Framework.....	34
Figure 1 View of Godena Guna	48
Figure 2: View of Godena Hakfen	49
Figure 3: View of Godena Alula	49
Figure 4: View of Godena Ageazi	50
Figure 5: View of Godena Mizer	50
Figure 6: View of Godena Eyasu Berhe.....	51
Figure 7: View of Godena Selam	51
Figure 8: View of Godena Mussie	52
Fig 9. Unaddressed and narrow streets	68
Fig10. Unmanaged streets in the study area	68
Fig 11. Unaddressed Households in the study area.....	69
Fig 12: Existing house number in the study area	70
Fig 13: Visibility of Street Addresses	71
Figure 14 The ineffectiveness of the coloured numbered plates in the study area	75

List of Acronyms

CBD	Central Business
EEPCO	Ethiopian electric power corporation
FDRE	Federal democratic republic of Ethiopia
ISPRS Int. J. Geo-Inf.	An international, peer-reviewed, open access journal on geo-information
IoT	Internet-of-Things
GIS	Geographic Information System
MDPI	multi-disciplinary digital publishing institute
OSM	Open Street Map
APA	American Planning Association

CHAPTER ONE

1. Background of the Study

According to United Nations, currently more than 75% of countries have poorly maintained addressing system or no street addressing system at all. Around the world, 4billion peoples are unaddressed. In Africa alone, there are 440million people without recorded place to call home. Currently the roads in the world are not mapped, and this number is increasing in developing countries. This problem is more critical in disaster zones; as even aid agencies struggle to agree on names for streets. For example, after the Haiti earthquake, the Open Street Map (OSM) community started processing satellite imagery to track the roads within 48h. (*ISPRS Int. J. Geo-Inf.* **2018**)

Despite the significant role that clear addressing system plays in the efficient management of cities, many cities in developing countries including Ethiopia do not have a coherent system of addressing. On the other hand, many cities in the developing world have recently experienced extremely rapid growth which has created many underserved neighborhoods. (Farvacque-Vitkovic, C., & Kopanyi, M. 2019, *Better Cities, Better World*) Mekelle is no exception since it is one of the cities in the country experiencing rapid urbanization. This in turn has created additional challenge to the already weak management that is depicted by inadequacy in the provision of basic service necessary for the wellbeing of their residents on one hand and difficulties in the collection of taxes from land and related properties which is one of the lucrative financial sources. Various attempts have been made by city administrators in different times to identify housing units by assigning numbers with in their lower administrative units, even though ineffective. Street addressing makes it possible to locate a parcel or building on the ground, thus demand of residents. Inadequate identification systems have created a worrisome predicament for urban services. (ibid)

Street Addressing as it is defined by Catherine F. Vitokovic et el. (2005 World Bank) is an exercise that makes it possible to identify the location of a plot or dwelling on the ground, i.e. to “assign an address” using a system of maps and signs that give the numbers or names of streets and parcels. The street addressing operation enables people to locate a plot of land or a dwelling that is by means of a system of maps and street signs indicating the numbers or names of streets and buildings. This concept may be extended to urban networks and services. In addition to buildings, other types of urban fixtures, such as public standpipes, street lamps, and taxi stands etc. also get addresses. (ibid)

Addressing makes it easier to: a) locate residents and their homes by means of an address system

that can be used by the people themselves and by government officials, concessionaires, and other service providers; b) operate urban services (ambulances, fire trucks, taxis); c) enforce collection for user-pay services, in particular those provided by utility concessionaires [water companies, electrical companies]. (ibid)

Now days, assisted by international organizations, cities and towns of the Least Developed countries have launched a street addressing projects to bring about an efficient urban management system. Following the implementation of federal government system and increased efforts to empower urban centers in playing their envisaged roles in realizing the overarching development policy of the country cities in Ethiopia, Mekelle Being among the forerunners, are taking bold steps to improve their urban management systems.

One of the bold steps taken in the last few years (2010) by the city is the preparation of comprehensive addressing system collaboration with private consultant which is expected to create a favorable condition in identifying all urban assets/ properties related to land facilitate ease of identification and thus open the path to good urban governance and improved urban life. (Mekelle municipality 2010: TOR for implementation street addressing project)

1.1 Statement of the problem

In recent decades, many cities in the developing world have experienced extremely rapid growth. This growth has created many under-serviced neighborhoods Most Ethiopian urban centers are characterized by very poor urban service delivery which attributes specially the lack of proper infrastructure. Inner parts of most big cities are known to be over-crowded with unplanned houses with little or no access roads to receive services when needed. It is also a common practice to people in town to get confused to reach the right location of service points or houses of their choice. This problem becomes worse for new visitors because in any Ethiopian urban centers there is no formal way to locate any place or service point as they do everywhere else. Inadequate identification systems have created a troublesome dilemma for urban services. With no system of street coordinates, it is difficult to find your way around a constantly growing city, to dispatch ambulances, to address firemen, or law enforcement personnel quickly, to send mail and messages to private homes, to help municipal services be provided, to pinpoint breakdowns in water, electricity, and telephone systems, and to set up an

efficient tax collection system and other services. Therefore, street addressing is an important to the function of the city.

According Catherine F-Vitasovic et al. (2005 World Bank) in Many developing countries specially in Africa have the problem in operation and implementation of street addressing and house numbering. Currently, many Ethiopian cities do not use modern styles of street address and house numbering system while use conventional way from the old system of routing address. As any urban centers of the world, the number of population living in mekelle has an increasing trend It results in the formation of many urban problems usually citizens pay the cost of poorly designed addressing systems through inefficient government services and through lost and un clear location establishment, loose of property(land), less provision of infrastructure. The existence of unclear street address infrastructure also makes confusion especially for those visitors, facility providers and needs to spend a lot of time looking around due to the factor of unplanned streets, distance and complexity of the street pattern. Although this needs more investigation to realize; the following can be identified to show the sensitivity of the problem

- The rapid population growth and urbanization rate in the city
- Existence of narrow, unplanned and un named streets make the people confused
- Increase crime
- They are not integrated with GIS
- Lack of provision of infrastructure
- Lack of integration with different institution (i.e. Municipality with tele-communication corporation, EEPSCO, water supply Authority ...etc.)

Therefore, the study aims all the above mentioned issues forced to make clear solution and will improve on street addressing and house numbering system.

1.2 Objectives of the study

1.2.1 General objective

To evaluate the availability and effectiveness of street addressing and house numbering in the in mekelle Kedamay weyane sub city by examining existing conditions, public perceptions, implementation challenges, and potential opportunities for improvement.

1.2.2 Specific objectives

1. To assess the current availability and coverage of street addressing and house numbering in the study area.
2. To examine the effectiveness (user-friendly) of street addressing and house numbering in the study area
3. To examine public perception and awareness regarding the importance of street addressing and house numbering.
4. To identify the main challenges encountered in implementing and maintaining the addressing system.
5. To explore the potential opportunities for improving and expanding street addressing and house numbering in the study area.
6. To propose practical recommendations for strengthening the street addressing and house numbering system.

1.3 Research Questions

The study is expected to answer the following questions

1. What is the current status of street addressing and house numbering practice in the study area?
2. How do residents perceive the importance of street addressing and house numbering and what level of public awareness is made before?
3. How effective is the street addressing and house numbering in terms of accessibility and usage in public service delivery system for :-
 - a) Navigating the study area? /Are people get around the city easily?
 - b) Enhancing urban management? / What is the role of street addressing and house numbering system in Facilitating emergency services like health, fire, police service, and locating urban facilities in the study area?
4. What are the major challenges faced in implementing the street addressing and house numbering system in the study area?
5. What are the possible solutions to improve the effectiveness of street addressing and house numbering in the study area?

1.4. Scope of the Study

The issues that the research is expected to address is mainly the identification of availability of street address and their role in the development of the city, examining the challenges of stakeholders, identification of the effects and opportunities for the problem on the residents and visitors and suggest possible recommendation based on the challenges and effects of the study. Nevertheless, the study is limited due to: -

Geographically, the research pertains specifically to the town's CBD (Kedamay weyane sub city). All the significant streets, residential areas, business establishments, and public services conducting operations are covered in the research of this study. Outsides areas beyond the administrative boundary of kedamay weyane shall not form part of this study.

Thematically, the study examines issues revolving around street and house numbering like:

Assessing the availability, level of implementation, challenge and opportunity in the Existing address names and maps for residents, businesses, and service providers caused by deficient addressing, house numbers and important landmarks, The accuracy and distinctiveness of the street designations and dwelling identifiers, The effect of addressing the management of cities, emergency responses, and economic operations. The research would not include other urban planning matters such as road development, drainage, or traffic control.

Temporal, the study focuses on the contemporary state of street numbering and house numbering within the study area in the previous 30 years. It shall consider recent developments, urban growth in the same time, and changes in street layout and numbering regimes. The study May need update after improvement of Parcels and streets.

1.5. Significance of the study

The evaluation of street addressing and house numbering within the study area is of both theoretical and practical value. In the first place, for the municipal government and urban planners, the research reveals existing gaps in the addressing system and hence assists in enhancing the management of the town/city, service provision, and infrastructure development. It facilitates effective collection of taxes, administration of lands and regulatory enforcement.

Secondly, in the context of emergency services—including fire, police, and medical responders—accurately numbered and labeled streets greatly diminish response times, thereby augmenting public safety and preserving lives. In a similar vein, both businesses and residents obtain the advantages of enhanced accessibility, since deliveries, customers, and visitors can more readily find addresses, which in turn enhances commercial effectiveness and convenience.

Third, for the case of digital services such as navigation applications, post office deliveries, and e-commerce, standardized street addresses are primarily mandatory for precise mapping of locations and provision of online services. The research also identifies areas in which the digital system can breakdown through a lack of complete or incoherent addressing.

Ultimately, this work strengthens the understanding of the challenges involved in managing a growing town, providing a base point for later studies in urban planning, municipal government practices, and sustainable development procedures. Additionally, the work potentially can serve as a basis for policy recommendations attempting to rationalize the system of street addressing beyond the business district and possibly even beyond the town at large and similar urban centers.

In short, the study highlights the value of street addressing and numbering of houses as fundamental aspects of properly organized, accessible, and effective urban spaces, having bearings on the quality of life, economic participation, and administrative efficiency.

1.6. organization of the paper

The paper is organized in to five chapters. The first chapter is an introductory chapter which includes the background of the study, statement of the problem, objectives and research questions of the study, scope, significance and organization of the study. The second chapter deals with the literature review that comprises definition of important terms, conceptual/theoretical literature, empirical literature and conceptual frame work address the literature review on different authors, countries experience which are assisted for the term paper.in the third part the methodology used including the data sources, types which are relevant for the study, software's and hard wares and materials used are stated and the forth part includes result and discussion and finally addressing conclusion and recommendation will be the last part of the study.

CHAPTER TWO

2. Literature review

2.1 Definition of terms

(According to FDRE Ministry of Urban Development and Construction standard the following definition of terms are adopted for this study)

Addressing-Addressing is an exercise that makes it possible to identify the location of a plot or dwelling on the ground, that is, to assign an address using a system of maps and signs that give the numbers or names of streets and buildings.

Addressing map - a map that specifically indicates street names and numbers, house number and the main facilities. This map is accompanied by a street index.

Codification The process of identifying streets by a name or number and assigning a number to doorways.

Geocoding- The process of assigning code to geographic locations or map features.

GIS (Geographic Information System)- An organized system that combines hardware, software, and the geographic data needed to enter, store, update, process, analyze, and display all sorts of georeferenced information.

Property - Piece of land on which a building is built.

Signage maps- a map that shows where address sign should be placed (on posts or on wall, bi or unidirectional sign post).

Street sign plate- A sign that designates a street and is placed at intersections during addressing

2.2 REVIEW OF CONCEPTUAL AND THEORETICAL LITRATURE

Systems of house numbering and street addressing are integral parts of city infrastructure. They are used to uniquely distinguish properties, create spatial references, aid in navigability, optimize service provision, promote logistics, aid in emergency response, and are integral to urban management, taxation, planning, map-making, and even facilitating identity and inclusivity among city inhabitants. In densely populated city centers (CBDs), a clear and consistent addressing and numbering scheme is especially critical because of high building densities, varied land uses, high turnover, complex-built environments, and high service volume(Nottrot et al., 2023).

Assessing existing street addressing and house numbering in a CBD requires consideration of how effective in practice the current strategy is: how systematic, coherent, accessible, legible, usable, maintained, inclusive, and robust the strategy is. A literature review that studies conceptual and empirical work can elucidate what criteria, best practices, common problems, and potential improvements there are, and what research gaps there are.

The study, then elaborate in significant length: (1) historical and theoretical foundations of street address and numbering schemes; (2) key criteria and evaluation dimensions; (3) prevalent problems in practice (especially in developing worlds); (4) case studies; (5) evaluation methods used; (6) gaps in current literature; (7) CBD implication

2.2.1 History of House Numbering and Street Alphabets

Although it is uncertain to say where, when and how addressing streets started, studies of the Romans (La Rome Antique) started naming their streets and public spaces. This was not however for planning and management purposes. Some of the names given were via Latina, via Tiburtina, via Ostensis and via Clivus which are roads named after their physical characteristics or their final destination. (Albin Michel 1971, cited in les Romaine Nomment Leurs Rues)

Europe's early adoption: City house numbering came into being as trade and governance required more orderly systems. When cities grew, so did address requirements. Anton Tantner's paper "Addressing the Houses: The Introduction of House Numbering in Europe" traces Europe's slow institutionalization of house numbering, usually in relation to taxation, urban planning, and city management.

Colonial legacies: Postcolonial city centers often feature systems of addressing that mimic colonial-era schemes or naming practices, usually imported, hybrid, or inconstant, as planned cities versus non planned cities (Villard, 2019).

Emergence of Street Addressing in Africa

Street addressing in Africa is a colonial legacy especially of French and English. According to studies most of the African cities and towns has adopted their street names during the colonial period following the European system.

After independence most of the street names have been changed and were subject to many conflicts for example Nairobi in 1963 has changed most of its road names like St Austin road to James Gichu-ru road Duke Road to Ngala road the name after their patriots, however with

severe resistance. (Wanjiru, Melissa Wangui, Matsubara, Kosuke 2017)

Street addressing in Ethiopia (The case of Addis Ababa) before 1970s (Before Dergue)

Naming of streets started during Menilik II. The streets were named after his loyalists and patriots. This was again strengthened during the Haile Selassie when streets and squares are named after the Royal families, patriots and favorite & renowned foreigners. Some of the streets named during this time were Patriots Road Haile Selassie Road, King George Road, Menilik Square, Queen Elizabeth road Cunningham road Miazia 27 square etc. Historical document /written by the municipality of Addis Ababa in 1949/ explain that the squares were used not only as a symbol of glory or memorial but also referred and used to determine the limits of the roads. For example, Queen Elizabeth road goes from Yekatit 12 square to Menilik II Square etc. (**Addis Ababa Mirror 1949**).

Even if these streets and squares are named, it never served to improve the management of the city. Except for the division of the city in to ten woredas for administrative purposes, no systematic building numbering was in place until the revolution of 1975. (ibid)

During Dergue

After overthrowing the emperor in 1973 the socialist government introduced a new system of urban administration and decentralization system in whereby Kebeles are the smallest units of urban government. Numbering of housing units was introduced for the first time for controlling and rent collection purposes following the Proclamation that Nationalized Land and Extra Houses. Apart from an effort done to prepare the master plan of the city in 1980s and the preparation of Land Information System for the city /under taken with the assistance of the World Bank/ no initiative was observed to exercise street addressing projects. (**Addis Ababa Mirror 1949**).

From 1990s to date

Although the urban management and administration system is decentralized to woreda and kebele levels, at the beginning no effort was done to initiate street addressing system at a city level. Thus identification of parcels and housing units remain the same. In Addis Ababa the use of Nortek Maps supported by GIS was introduced for cadastral purposes. However, naming of streets was prepared not as a part of the cadaster but to reflect historical milestones.

An important event of street naming occurred following the launching of African Union in 2005. During the summit, unnamed street in the city were given names of countries to

strengthen the idea that Addis Ababa is the capital. Numbering of streets in addition to their name was carried out by the Addis Ababa road authority (see Map 2.1.) in collaboration with the city council of Addis Ababa.

But it still is not officially in use. The city’s tourism office is preparing a project to address streets in Collaboration with the municipality.

Map 1: Part of Addis Ababa’s named and numbered streets



Source: Addis Ababa tourism bureau (1949)

2.2.2 Conceptual Foundations

Geo-Domain Coding and Addressing as Spatial Reference Systems: Addresses can be envisioned as parts of geo-domain coding systems that map human-created identifiers (e.g., street name and number) onto spatial locations. The concept forms the basis of much of current work in address matching, parsing, and automation.

Legibility, Orientation, and Urban Form: The address system goes hand in hand with how legible (according to Kevin Lynch) the city is. Ease of orientation, sense of place, and simplicity are added by a good address/numbering scheme.

Governance, Rights, and Inclusion: An address is not technically sufficient: it ties in with rights (e.g. postal, utilities, property rights), inclusion (in cartography, services, civic identity) and legitimacy. In much of the developing world, informal addressing is a source of invisibility in official cartography and service (Nottrot et al., 2023).

2.2.3 Key Criteria and Dimensions in Measuring Street Addressing and House Numbering

Numerous aspects in the literature are employed in evaluating/ addressing performance and quality of house numbering/address systems. They could be clustered in:

Dimension what it refers to Why it matters **Uniqueness / Non-ambiguity** Every address must be unique; no duplications, no repeated street names, no overlapping numbers. Avoid confusion; ensure reliable service delivery & emergency response. **Consistency & Standardization** Consistent use of numbering rules (even/odd, intervals, orientation), consistent street names, use of standard signage, standard formats. Easier mapping, easier navigation; reduces errors by postal, utility, emergency, logistics. **Visibility & Legibility** Physical display of house numbers (signage, plaques), clear placement, durability, size, contrast; readability in daylight/night. So people, couriers, emergency services can actually see them. **Accessibility/Geospatial Accuracy** The address system aligns well with physical reality: entrance detection, correct mapping, and correspondence of field data to GIS. For geocoding, mapping services; important in CBDs with many entrances, mixed uses. **Maintenance & Upkeep** Repainting or restoring of signs, updating changes (building renumbering, new streets). To ensure system remains useful and current. **Ease of Extension & Adaptability** The system can accommodate new streets/buildings without massive renumbering, allows subdivisions, infill. Vital in growing CBDs. **Integration with broader systems** Integration with postal systems, emergency services, mapping/GIS, utility networks. Without this, the address might be formal but not functional. **Legality / Institutional framework** Laws or regulations setting standards, responsibilities, authority for naming & numbering. Ensures accountability, avoids ad hoc or inconsistent practices. **Public Awareness & Use** do residents, businesses, service providers use and understand the system? Do people know their address? If not used or known, even the best system fails in practice. **Cost and Feasibility** Implementation and maintenance cost; ease of enforcement; institutional capacity. Especially as resources may be limited in some town (Davis, and Fonseca, 2007).

2.2.4 Why Street Addresses and House Numbers Matter

A structured system of street addresses and house numbers forms a base for managing cities well. It creates a way to recognize each building, piece of land, and public spot, connecting people and places to important support. Though it might look basic, how a city runs, grows, and helps its people depends a lot on its address system. (Kevin Lynch 1960)

Assistance for City Services

Street addresses make it easier for city governments to plan, control, and give support. When every piece of land has a special address, city offices can find buildings, keep records, and answer people's needs more easily. Trash collection routes can be planned better, which means fewer missed pickups and trips that are not needed. Emergency support like ambulances, police, and fire teams can find accidents fast, saving time and lives. In city control, addresses also aid city governments in watching city growth, controlling how land is used, and checking if local rules or building permits are being followed. Without clear addresses, even simple support becomes confusing and not done well. (Farvacque-Vitkovic, C. 2016)

Better Income Collection

Addresses make a clear link between pieces of land and who owns them, which lets city governments collect income more exactly. Property taxes, business permits, and fees for support depend on knowing where things are happening. With a standard address system, local governments can keep records of pieces of land that can be taxed up to date and find those that are not registered or are being taxed too little. This makes taxes more fair and open. Also, addresses link utility bills like charges for water, power, and trash to the right homes. Because of this, the city's income gets stronger, giving it the money it needs for public spending and better support. (The World Bank, 2005)

Improved Planning and Giving of Infrastructure

Building infrastructure like roads, drains, streetlights, and communication lines depends a lot on correct location data. Street addresses offer a clear place to look when mapping the infrastructure that is already there and planning where to put it in the future. When addresses are linked to where they are on a map, city planners can easily see where support is lacking and put money first into areas that need it most. It also aids utility companies in working together on their infrastructure work; for example, road work, water, and power setup can all follow the same location points, which cuts down on doing the same thing twice and saves money. Basically, an address system changes physical space into data that is structured and easy to control for planning and spending. (Kevin Lynch 1960)

Enhanced service delivery

Addresses make support given faster, more exact, and more open to everyone. Postal and delivery support depends fully on address systems for reliable delivery. Also, businesses like online shopping, ride services, and shipping use addresses to link support to customers without wasting time. For health and social support, correct addresses make it easier to find homes in need, give out help, and plan vaccination or awareness events. In unplanned areas, putting in place an address system aids in adding people to official systems, making them seen in government records and giving them better ways to get support. (McClendon, B. 2018)

Base for Smart City Growth

In smart cities, combining data and making things automatic is key. A working address system gives the location structure that links all city data. Every address can act as a digital ID for physical spaces, linking details about how land is used, who owns it, infrastructure, population, and how support is used. This makes it easier to use Geographic Information Systems (GIS), sensors, and Internet-of-Things (IoT) programs for watching city systems as they are happening. For example, smart trash control, traffic flow, and energy sharing all depend on correct location data. A standard address system makes sure that these digital tools can talk to each other without problems and give solutions based on data for lasting city growth. (Farvacque-Vitkovic, C. 2016)

Digital Integration in Governance

In the modern era, effective governance runs on digital systems. These systems hinge on digital records and online platforms. Address systems are the base for integrating urban data into these digital setups. Verifying each household's address makes it possible to offer digital services, like online registration, e-governance tools, and utility billing. It also backs mobile mapping apps, digital identity tools, and emergency response systems. Street addressing acts as a bridge connecting the physical city to its digital version, fostering transparency, accountability, and streamlined decision-making processes. (McClendon, B. 2018)

Broad Social and Economic Advantages

A dependable address system offers direct benefits to people. It gives residents a formal identity linked to their location. This identity is useful to access banking, participate in voting, and receive postal services, and so on. Businesses see increased credibility, and new firms can

register without hassle. Delivery and transport become more reliable, improving trade and opening job opportunities. In short, addresses introduce organization, accessibility, and economic chance to both formal and informal parts of the city. (Deirdre Mask 2020)

Strengthening Civic Duty

A correct address can give a sense of place to both individuals and communities. When people know their address is recognized, they feel like a part of the city since they show up on the map. This fosters civic duty and inclusion. Residents can get mail, register to vote, open bank accounts, and use public services as confirmed city residents. For local governments, addresses also make it simpler to get residents involved in city planning and improvements. Street addressing connects people to their city both in physical and administrative ways, giving them recognition in their community. (James Howard Kunstler 1993)

Reducing Confusion and Saving Resources

Without understandable street names and house numbers, daily life gets harder. Visitors, delivery workers, and emergency teams waste time asking for directions. A good address system removes this problem by presenting a way to find every location. Transportation becomes easier, cutting travel time and associated costs. Both public and private services work better, spanning from postal services to ride-sharing apps. In commercial zones, this also helps with customer access and boosts the surrounding economy. To put it simply, addresses improve and make navigation much faster. (Catherine Farvacque-Vitkovic et al. 2005)

Boosting Security and Fighting Crime

Street addresses play a role in public safety and law enforcement. When every building and street has a clear identifier, police and emergency responders can quickly respond to emergencies. Accurate addresses help in keeping track of illegal action, properly log incidents, and manage surveillance or patrols. Houses without numbers and streets that are not marked create a window for illegal actions to occur. A solid address system makes people and businesses easier to identify, discouraging unreported or unsolved crimes. (World Bank 2005)

Fair Support for Taxation

For cities, address systems support a fair way to collect taxes. Every property can be properly registered, mapped, and linked to its owner. The city knows who is responsible for tax payments and ensures that everyone is paying their fair share. Without proper addresses, many

properties stay off the radar of the tax system, creating an uneven distribution where some people pay and others do not. A complete address registry fixes this gap, improving revenue collection. This action increases city cash flow and helps to invest in better infrastructure, education, and social programs for everyone who lives in the city. (ibid)

2.2.5 Common Challenges in Practice, especially in CBDs and in Newly Industrializing Countries

Recent literature identifies a number of issues that occur in the evaluation or implementation of street addressing and numbering schemes. The prominent issues are:

Lack or Inadequacy of House Numbering

Most of the buildings might not possess a number, or numbering does not exist at particular façades; in parts numbering does not continue past street name level but without building numbers.

In Accra, Ghana, few of the parcels lacked numerical designations, and street name addressing did not become widespread until initiatives in the early 2000(Dumedah, 2021).

Tanzania: employing landmarks ("giant coconut tree," school, mosque, etc.), instead of official house or street numbers in large parts of the country (Dumedah, 2021).

Irregular numbering, redundancy, and impromptu methodologies

Repeat street names in immediate locations, more than one numbering scheme in same street, inconsistent numbers, odd/truncated numbering (breaking even/odd, increment rules). Double addressing in NIPOST case (Nigeria), old and new numbers, non-standard ordering.

Multi-entrance buildings are at times incorrectly or irregularly numbered. Numbering at times by lot numbers instead of entrance front, or varying locals employing differing convention (Essien, and Jesse, 2024).

Inadequate visibility, unreadable signs, and maintenance

That is while numerical designations might exist, signs of association might be faded, obliterated, vandalized, defaced, or simply not visible along the roadway. In Accra, alphanumeric designations or street names marked on walls often get degraded in repainting or building maintenance exercise (Oteng-Ababio, and Velden, 2020).

Inconsistency in numerical convention

It was noticed that Odd/even side, first point of numbering, distance versus sequential numbering, interval numbering, and block-oriented numbering rules are often poor, obscure, or ineffective.

For instance, there are "serial numbering" (simple numbers that rise along streets) and "distance numbering" (number corresponds to distance along route from initiating point) being employed. The Chinese "block-segmenting" approach aimed at numbering by block segments, presuming 100 numbers per block, in order to be robust as buildings emerge/ disappear (Njoh et al., 2020).

Institutional and legal issues

Inadequate defined institutional accountability. In a few cases, street naming and numbering becomes statutory by law, though enforcement remains absent. In Tanzania, there are statutory measures in place, though enforcement has been erratic and poorly funded.

Public opposition: revising existing addresses or street names could be met with opposition as people resist changing existing street names, especially in commercial interests that are tied in with set locations. Also, some property holders could resort to defacing or obstructing numbering signs.

Accra case: after being assigned, new numbers and street names were defaced or painted over by some owner (Njoh, Chie, and Soh-Agwetang, 2021).

Accelerated urban sprawl, uncontrolled housing, and mixed land use

CBDs often have mixed uses (commercial, residential, informal) and buildings with multiple entrances, floor entrances, etc., complicating numbering.

In rapidly growing parts of the world or poorly planned areas, streets might develop haphazardly without sequential naming and numbering; small alleys, corridors, and internal courtyards could be disregarded(Thomson et al., 2014).

The technological and map issues

Typically, address datasets will have missing data, errors, missing/unmodified street names, incongruent addresses in the mapping as well as GIS systems.

Address matching/parsing automated systems are challenged by non-standard or incomplete addresses, variations in language/abbreviation conventions. The recent systematic review (MDPI) concluded them to be significant limitation (Kılıç, and Gülgen, 2020).

2.2.6 Case Studies

Using case studies from documents helps to illustrate methods used in evaluation and insights that have been gained.

Accra, Ghana

Accra Metropolitan Assembly embarked on street naming and new numbering project, assigning odd numbers to one side, even numbers to the other. Motivations involved enhanced service delivery, revenue (property rates, bills) collection. Making it easy to get mail and courier services.

Concerns that arose included opposition by the public to upgrade, cost of implementation, maintenance and visibility of signs. Furthermore, some zones were problematic because of unplanned development or informal settlement (Farouk, and Owusu, 2012).

Tanzania

Tanzanian national program: 45 billion Tanzanian shilling will be invested in naming and numbering every house and street in councils. The paper also notes that while planned zones typically do naming and numbering, much (especially growing or informal) does not, so people rely on landmarks and ad-hoc direction.

Obstacles such as maintaining the effort, understanding among the masses, standardization, and compatibility with services. Plus, planned versus unplanned differences in terms of ease and cost (Unknown Author (2024). (Abstracts of the 10th Tanzania health summit. BMC Proceedings, 18(S15).

Block-Segmenting Method, China

In "Study on Block Segmenting Method of House Number," authors argue that traditional house numbering of Chinese cities has become chaotic amid urban renewal; they compare "block geocoding" and "street geocoding" strategies. They propose a "block segmenting method" with an assumption that there are 100 numbers per block, connecting numbers to street block segments, in a bid to boost robustness, keep it systematic, and aid in localization.

2.2.7 Methodologies Utilized for Literary Studies Evaluation

When in-place street addressing/numbering schemes are assessed by researchers/planners, there are several means as follows:

Data Input According to Compliance

Spot checks of buildings in a CBD to determine whether houses are numbered, signs in good condition, legibility, readability, correct match to street, presence of duplications. Observations, photo documentation.

Interviews with residents, businesses, delivery services (postal, emergency, couriers) to understand practical challenges (finding addresses, mistakes, delays (Rose-Redwood, and Kadonaga, 2015)).

Institutional / Legal/Policy Review

Checking up on laws, bylaws, street naming, numbering, addressing policies—whether there are good clear standards, whether there are legal requirements, who is responsible, who pays, who enforces.

These case studies frequently also involve consideration of local authority law (e.g. in UK, councils establish clear policy regarding numbering & naming in detail (Rose-Redwood, and Kadonaga, 2015)).

Geospatial/GIS analysis

Aligning addresses to current road/street networks; checking mismatches, gaps, duplications.

Using geocoding or address databases to quantify coverage (what proportion of buildings in CBD have usable address entries), error rates, gaps; distance of entrance to street, etc.

Use of remote sensing/satellite or street view imagery to verify physical presence, entry points, signs. Growing increasingly unusual, but becoming more common (Zandbergen, 2010).

Automated / Computational methods

Address parsing and matching (e.g. papers in MDPI like "Automatic Identification of Addresses") that take into consideration data quality, incomplete data, data cleaning, parsing of address strings. Those in general assess how automated schemes work under dirty address data.

It involves applying potential numbering scheme algorithms (e.g., segmentation by blocks), simulating new assignments of numbers and robustness, readability, and scalability checkin(Kılıç, and Gülgen, 2020).

Involvement of stakeholders and qualitative methods

Interviews, focus groups of local officials, residents, businessmen, postal services, emergency services in order to get needs, perceptions, and limitations.

Surveys of visibility, usability, awareness of personal addresses, and service providers' difficulties.

2.2.8 Guidelines and Recommendations of the Literature

A variety of recommendations arise from academic research and policy documentation. Notably:

Standardized Numbering Rules

Use of even/odd numbering of sides of street.

Choosing a clear base (typically city center or key landmark) from which numbers expand.

Interval numbering (leaving space for future structures/infill) versus consecutive numbering, as suitable in context.

For structures of several internal units (offices, apartments), universal manner of numbering units (suite numbers, floor-number, etc.) (Rose-Redwood, and Kadonaga, 2015).

Explicit Policies for Street Naming

Street names must be distinctive, clear, and not duplicate (particularly in immediate surroundings).

Names that are significant, easy to pronounce, culturally significant; do not keep changing.

Street designations appear prominently in clear signs at fixed, standard location (Light, and Young, 2014).

Physical Signage and Noticeability

Long-lasting signs/plates, large and high-contrast letters, illuminated wherever possible, location visible from street, long-lasting against weather.

Maintenance plans: repainting, replacing damaged, obstructed sign (Hummer, and Maripalli, 2008).

Institutional Arrangements and Responsibilities

Clear authority of law regarding who assigns street names, who numbers of structures, who is accountable for signs, who operates the system.

Inter-agency coordination: postal services, utilities, urban planning, emergency services should be coordinated. Keeping aside money both at initial deployment and at subsequent maintenance.

Incorporation into GIS and Digital Maps

Address databases, linked in data with street network, building footprints, entrances. Utilizing geocoded addresses in facilitating service delivery and response times; that official and commercial map products maintain data current. Easier to plan expansion, locate missing addresses, perform spatial queries (e.g. how many addresses in block, what is accessibility (Nottrot et al., 2023).

Flexibility and Scalability

To design systems so that future development (new streets, infill, and sub-divisions) can be accommodated without extensive work. Employment of block segmenting or block-based numbering to permit expansion.

Public Education, Involvement, and Compliance

Engaging residents/businesses so that they know the purpose, accept them (naming/renumbering). Encouraging display of assigned numbers. Enforcement measures or rewards if numbers/signs are not shown or kept (El-Deen, Aboul saadat, and Nour, 2024).

2.2.9 Short falls in Existing Literature

Despite the existence of numerous studies, significant gaps remain apparent, particularly concerning central business districts in developing towns.

Empirical measures of small/medium town CBDs: The vast majority of papers concern large cities, or at the country level/address parsing level, or IT. There is a need to work more to

document in-depth auditing of small town CBDs (especially Africa, Asia, Latin America) of missing address quantity, error rate, etc.

Cost-benefit assessments: While there are as many who indicate good addressing pays, more work has not been done in balancing costs against benefits (financial, social, service provision benefits) particularly in tight CBD cases.

User (resident/business/customer) views: There is more empirical work about how individuals really do experience solving issues hours lost, frequency of mis-deliveries, breakdown delay, etc.

Adaptation to informal/mixed/vertical built form: CBDs typically consist of high-rise, mixed use, buildings with internal passageways and multiple entrances. Least documented is how best to number such units, entrances, ensure that numbering remains consistent in such terrain.

Long-term maintenance & sustainability: Following street naming & numbering, it is challenging to maintain visibility, signs in good condition, refurbish as streets/buildings develop, & little has been documented regarding long-term sustainability, governance, & institutional accountability.

Digital & participatory innovations: Automated parsing of addresses, geocoding, digital addressing systems are topics of studies. But sparse evidence of how digital tools aid implementation in CBDs—e.g. crowdsourcing, community-based mapping, use of mobile apps.

Emergency services performance measures: Relatively few papers even measure how response time, error rate, or life safety performance is enhanced as a function of addressing/numbering upgrades in CBD (Okoye et al., 2025).

2.2.10 Specific Issues Related to CBD Scenarios

When focusing on a CBD of a city, there are also more specific issues, mentioned in literature or deductible by case studies.

Vertical and high rise: The majority of the multi-story structures, vast number of tenants, internal passageways, etc. Street-facing entrances will not be adequate; internal numbering of units becomes imperative.

Mixed uses: Stores, offices, dwellings, warehouses. Differing entry points, differing visibility needs, differing assumptions regarding address use (clients, deliveries, customers).

Alleys, plazas, internal courtyards: Not necessarily official streets, per se, but taken as access. Not necessarily officially documented/named/numbered, so addresses are confusing.

Heavy traffic and congestion: In CBDs, directional confusion can cost more (in time, money). Also, visibility (signs being blocked, walls being obstructed) could be more of a problem.

Dynamic changes: Renovations, new high-rise building, amalgamation of lots, or subdivision might happen often. The addressing system then has to be dynamic to meet such changes.

Cultural / linguistic complexity: CBDs tend to be more cosmopolitan; linguistic differences, multilingual use or transliteration, varying naming convention make standardization more complicated.

Prestige / historical concerns: There might be historical street names; there might be businessmen and householders' opposition to changes. Commercial street name branding matter (Chan, Vasardani, and Winter, 2014).

2.2.11 Metrics/Indicators for Evaluation in Community-Based Development

As per literature, below are potential measurable signs to establish street addressing / house numbering efficiency in a CBD:

Indicator Possible Metric Coverage Percentage of buildings in CBD zone having official street address & house number. Uniqueness Number (and proportion) of duplicate addresses, conflicting numbers, ambiguous street names. Sign Visibility & Condition Proportion of addresses with visible signage (meets standard size/contrast); frequency of signs obscured or in disrepair. Address Accuracy Degree to which the address matches physical entrance location; how many mis-geocoded addresses; mapping discrepancies. Consistency in rules whether numbering uses standard convention (odd/even), continuous or interval; whether street names unique. Time/effort cost to find addresses Time taken by visitors/emergency/courier to locate addresses; frequency of mis-deliveries; delays. Maintenance frequency & cost How often signs replaced/renewed; budget committed; incidents of non-displayed or defaced numbers. Institutional clarity Existence of policies/regulations; clarity of agency roles; enforcement mechanisms. Public awareness & satisfaction Surveys of users' ability to recall their address; satisfaction with ability to use address; number of complaints. Integration with digital systems

Proportion of addresses in GIS; map services matching official addresses; availability of digital map (Haklay, 2010).

2.2.12 Implications and Recommendations

From case studies, in a CBD evaluation (or to improve addressing/house numbering in a CBD), the following measures/recommendations are typically effective:

Baseline audit: Undertake a full audit of the CBD: map all buildings; whether numbered, unnumbered; condition of signs; whether numbers relate to entry; visibility; mapping against GIS.

Policy and legal framework: Set out explicit rules regarding numbering and naming, such as rules regarding numbers (odd/even, interval) and naming & numbering responsibility, maintenance, standard of signs.

Standardization: Adopt common rules of numbering; standard presentation; street naming protocols; sign standards (size, location, and materials).

Extending design: Incorporate numbering schemes that plan ahead (e.g. block-style schemes, interval gaps) so that you don't have to redo numbering or establish cumbersome exceptions in the future.

Signage quality and maintenance: Invest in durable, visible signs; ensure maintenance schedule; monitoring.

Integration of mapping/GIS and digital tools: Maintain current address databases; use GIS to identify anomalies; make data available to service providers; possibly enlist residents in verification/map checking.

Engaging stakeholders: Get buy-in of property owners, commercial interests, and residents; explain changes; engage them in name selection (when appropriate culturally); offer incentives or accommodations in displaying numerical data; keep intrusions to a minimum.

Monitoring and evaluation: Establish indicators (as above) and keep them under regular review; quantify service provision improvements (e.g., response in emergencies, by post, customer feedback) as changes are made.

Resource allocation: Prepare budgets, human resources both to deploy and sustain in operation; possible phased-in deployment, initially focusing in higher priority areas (busy streets, emergency lanes, and primary streets).

2.3 EMPIRICAL LITRERATURE REVIEW

Street addressing and house numbering in CBDs are critical for many urban functions: emergency response, delivery services, taxation, planning, navigation, property rights, utility provision, and identity of places. Empirical assessments of how existing systems perform especially in dense, complex, often partially informal CBDs offer insight into what works, what fails, and why. Below we review key empirical studies, their methodologies, findings, and implications in various global south and some other settings.

2.3.1. Methodological Approaches in the Literature

In assessing addressing and numbering systems, research typically employs a combination of methods (qualitative + quantitative), including case studies, survey research, and spatial/mapping analysis, along with participatory and observational approaches when applicable. Some prevalent methodological elements include:

Surveys / Questionnaires directed at residents, businesses, delivery services, postal services, and emergency services to gauge awareness, usability, and issues encountered, In-depth interviews / Key informant interviews with municipal planners, utility companies, and postal services, among others, to gain insights into institutional arrangements, practices, and challenges faced, Spatial mapping / GIS analysis: this involves mapping streets and buildings, identifying address/number discrepancies, and examining the inconsistencies between official maps and actual field conditions, Document analysis: reviewing policies, legal frameworks, standards, master plans, and official registers ,Field observations: assessing signage, house number plates, and their visibility and legibility and Comparative / before-after studies: analyzing instances where addressing systems or house numbering have been modified or implemented, to evaluate the impacts.

These methodologies facilitate both the assessment of "what is" (coverage, completeness, consistency) and the exploration of "why" (institutional constraints, social acceptance, cultural influences, and resource limitations).

2.3.2. Key Empirical Cases & Findings

Below are several empirical studies that directly examine street addressing / house numbering, with special attention to CBD or high-activity urban center contexts.

Kampala, Uganda: Standardized House and Plot Numbering

Study: An Assessment of the Implementation of a Standardized House and Plot Numbering System in Kampala (Muhumuza, 2024)

Methods: Mixed methods; sample of 60 respondents; field observations etc.

Findings: Some awareness of the standardized numbering among residents, but knowledge is uneven.

Implementation is partial; many buildings/plots still lack number or have inconsistent numbering.

Challenges include lack of clear responsibility among agencies, inadequate signage, poor or outdated records, limited community involvement.

Implications for CBD-like contexts: In denser areas the gaps are more visible; businesses and service providers often suffer more from address confusion; the problem of internal units (buildings with multiple shops/flats) is acute.

Ghana (Greater Accra): Policy & Delivery / Courier Services

Study: An Assessment of the National Policy on Street Naming in Greater Accra (Kuuku, 2017)

Methods: Mixed methods in three assemblies in Greater Accra; survey + interviews.

Findings: Despite the policy (2012, in partnership with World Bank) to name all streets, many residents are not comfortable with the new names; some street names are considered difficult to pronounce / memorize.

The naming policy had not achieved all its objectives: limited improvement in emergency services or revenue mobilization.

Another study: Street Address System and Delivery Service: The Case of Courier Service Operators in the Accra Metropolitan Area (Ofori-Atta, 2015)

Found that a large part of Accra lacks visible street names or address numbers. In poorer neighborhoods especially, address systems are often absent or weak. Courier/delivery services cope by using landmarks or informal descriptions.

Case: Implementing a Street and Property Identification System: A Case Study of Accra, Ghana (Ecklu, 2011)

Identifies political, administrative, technical, socio-cultural challenges hindering a standard address system. Among these: weak enforcement, lack of up-to-date mapping, resistance or indifference from residents when naming/numbering is imposed without sufficient consultation; technical issues of numbering multi-unit structures etc.

Digital Addressing / Smart-City attempts: Ghana has tried to digitize its address system. A study in The Conversation discusses that the first tags lacked street names and house numbers, leading to confusion. Adoption varies; property owners more likely than renters to use/address the tags; trust, awareness, cost, perceived utility are all factors.

Ethiopia: Addis Ababa & Other Cities

Initiative: Addis Ababa Expands Modern Address System (2025) news report. The city government is installing address plaques, standardizing street names and house numbers, linking with digital/GIS databases. Target: legally recognized buildings and ~30,000 roads over two years.

This is still an implementation project; early findings not yet fully published in empirical research, but it signals key institutional recognition of the problem.

Mekelle City, Ethiopia: While not many studies directly assess house numbering/addressing in CBDs, there are studies of related urban infrastructure / street design which touch upon navigation, legibility, usability.

Effect of Sidewalk Design and Obstructions on Pedestrian Mobility: A Case Study of the Main Streets of Mekelle City (2024)

Focus: sidewalks, obstructions, pedestrian safety, etc. Not directly house numbering but gives insight into street legibility, physical order, and human navigation; main streets are part of CBD or central streets, so challenges of orientation, identifying places are relevant.

Practice and challenge of urban land governance: an empirical study in Tigray includes Mekelle among other towns; while it's more about land governance, identity, participation etc., issues of plot registration, mapping, and spatial order come up.

2.3.3. Key Findings across Studies: What Works, What Fails in CBD / Dense Urban Core Contexts

From these empirical studies, several recurring themes emerge:

Coverage & Completeness

Many CBDs or central areas still have partial coverage: many streets, alleys, side streets either unnamed or unofficial, many buildings lacking visible house numbers.

In Accra, one study reports that “60% or more” of the city have no visible street names or addresses in structures, especially in poorest neighborhoods.

In Kampala, standardized numbering is not yet universal; many plots/buildings are unnumbered or numbering is inconsistent.

Legibility, Consistency, and Usability

Even where streets are named and buildings numbered, legibility is often poor: numbers may be small, not visible, obscured, missing, poorly maintained. Street names sometimes change, are duplicated, spelled inconsistently; numbering may not follow clear conventions (odd/even sides, sequential orientation, and logical start point). In Ghana’s Greater Accra, residents expressed difficulty with certain new street names (hard to pronounce or commit to memory).

Institutional / Administrative Challenges

Multiple agencies with overlapping or unclear responsibility: Planning, postal, municipal works, utility companies. Disjointed coordination undermines implementation. Weak enforcement: even when regulations/policies exist (e.g. naming/numbering ordinances), the implementation lags behind. Insufficient technical capacity: mapping, GIS, updated records often missing; field verification limited.

Social / Cultural / Perceptual Factors

Community acceptance and participation matter: residents more likely to accept naming/numbering when involved. Where names are imposed without participation, resistance

or low usability follows. Perceptions of benefit matter: People are more willing to use / maintain addresses/numbers when they see utility (delivery, emergency, identification, services).

Technological Support & Data Infrastructure

Digital address systems (Ghana) show promise, but challenges in adoption: tags without house numbers, street name, or proper integration reduce usability. Linking address systems to GIS / mapping is critical but often under-developed.

Impact on Services / Economic Activity

Poor addressing causes delays in courier/delivery, undelivered, difficulty in emergency response; affects revenue collection when tax or property registers depend on addresses. In Accra, the courier services study found that lack of address visibility is a major operational cost. In Greater Accra, the naming policy was intended to improve emergency services and revenue mobilization but empirical evidence suggests the expected improvements have not fully materialized.

Challenges Unique to CBD / High-Density Urban Cores

Central Business Districts (CBDs) or high-density city centers experience distinct problems of addressing and navigation that differ by scale and degree from those in other areas of a city. The interconnection of complicated building structures, mixed use, and tall structures creates problems of inconsistent internal unit addresses, unclear floor numbering, and unclear entrance identifiers. Multi-story structures commonly feature shops at the ground level with offices or living space above, making it tougher to figure out addresses. The street grid in CBDs tends to be busy and unpredictable with many minor alleys, lanes, and non-grid roadways, making it challenging to order addresses in a logical fashion or to figure out what qualifies as principal frontage. Narrow alleys may be signless or undocumented. The need for exactness is especially great in these locations, for vehicle delivery services, emergency teams, visitors, and clientele all need accurate address information—any inaccuracy or delay translates into higher costs due to the density and volume of activity. In addition, uses and businesses in CBDs change regularly, with renovation, changes of ownership, and informal developments continuously reshaping the built environment. These modifications prevent reliable and up-to-date addressing systems from becoming established. Visibility and signage are also problems in

crowded conditions wherein signs become obstructed, numbering is small-sized or poorly situated, and structures are close together. In informal shops or temporary structures, sometimes even in formal business districts, even informal shops or temporary structures are situated at the edges and often excluded from official naming and numbering regimes, making matters even more complicated for the task of addressing.

2.3.4. Lessons / Best Practices Emerging

From successful or partly successful cases, what practices help address the challenges? As most of urban development projects street addressing and house numbering projects need a firm local and regional government commitment and continuous community participation. The experience learned from relevant studies are as indicated as summarized below;

Well-organized initiatives for development in urban areas can sometimes rely on community participation, especially in relation to crucial aspects like naming and numbering of streets. Community participation in naming and numbering of streets not only acts as a platform where development in creating a sense of ownership is promoted but is also vital in relation to ensuring that street names are relevant to a given community. Community participation in naming and numbering of streets will ensure that people are able to give those streets relevant and meaningful street names that have a relation to history and important personalities. Community participation is vital in offering assurance that development will happen in a positive way that can lead to a better level of cooperation in relation to provision of services.

Apart from engaging with members of the community, a number of legal and administrative frameworks are needed for a successful execution of street addressing and numbering programs. The development of ordinances that entail a number of specific guidelines in relation to addressing and numbering will ensure that a common guideline has been developed and has been established in a given area. The policies that have been developed will encompass concerns in relation to whom the maintenance of this system is entrusted to. In a scenario where this is not heeded to, a concern in relation to efficiency and adherence will arise. There is a need for a well-organized mapping and GIS system in place to address challenges in urban development projects as well. There is a need to have right and true spatial information in digital format in the form of cadastral and building footprint maps. The spatial information facilitates a holistic view of the region and ensures that all developments and new constructions are in line with the infrastructure that is laid out. The need for regular updating through satellite

pictures and aerial photographs ensures that information is relevant and valid. The need to include visual aids and signs to ensure that people can navigate through a location easily through durable and clear signs like house number signs and street signs is important. There is a need for coordination between stakeholders involved in municipality and post offices to ensure that all aspects are well communicated for a successful collaboration between different sectors.

2.3.5. Case Gaps & Areas Under-Researched

There have been a number of empirical studies conducted in relation to address systems and navigation in Central Business Districts (CBDs), and there has been very valuable information gathered. However, there are a number of key areas that have not yet been adequately filled and require more investigation. The first key area that has not yet been properly filled is in relation to a lack of quantitative information regarding costs and gains. Although information has focused on a number of key gains and anecdotal information about increases in efficiency, one key factor that has not featured is quantitative information regarding exactly how much time is saved in relation to delivery and emergency services. The information gained has focused on a number of areas but has lacked a key field.

Yet another area that warrants more attention is related to longitudinal aspects of address system effectiveness. The scope and reach of contemporary researchers can hardly point to a specific time and statistically underscore how all these changes affect address systems. There is a significant gap in knowledge regarding address improvements and how they are developed in a longitudinal fashion. The question is raised regarding how address systems are maintained as effective and applicable over a period of years. The scope of maintenance in changes related to urban development can affect successful maintenance gains over a period of time.

The complexity related to vertical and unit addressing in a CBD environment is still an area that is waiting to be researched. In a densely populated urban area, mixed developments that are high-rise are common. The complexities related to navigating a large high-rise building are not related to one-to-one unit address numbering. Research and development are required in this area to find a natural and effective unit address numbering system related to this complex situation. The factors related to this area are floor numbering and uniform signs in a building and how all this is related to unit addressing for a seamless entrance into a unit.

To more effectively provide address systems that work well in a CBD, user behavior and cognitive maps are topics that must be understood. There are a number of different methods of

navigating through a city that humans have devised that not only depend upon address points but that can and sometimes do refer to landmarks and personal experience. To more effectively comprehend address information in a CBD and how that information is used intuitively, researchers must examine user behavior regarding address information. Would it not be inconsistent to have a logical address system and a human one when describing location? In other words, how are landmarks and address information used in relation to navigating through a location?

Finally, it's really important to look at whether improving address systems is worth the cost before making any decisions. Things like putting up new signs, updating maps, and using digital navigation can cost a lot of money. So, we need to figure out if these investments make sense from a money point of view. Studies should figure out how much it costs to improve address systems and see if the advantages, like making businesses work better, getting help to emergencies faster, and making it easier for people to visit, are worth it. This kind of cost-benefit study will give people in charge and city planners the info they need to decide what to do first and how to best improve address systems in city centers.

2.3.6. Implications for Future Assessment Frameworks

Given the empirical findings, any assessment of street addressing and house numbering in a CBD area should include the following components:

Inventory / Mapping

Map all streets (major and minor), alleys, side-lanes; map existing street names; map building footprints; map existing house number plates.

Spatially log where gaps are: streets without names, buildings without numbers, signage missing.

Field visibility and legibility checks

Are house numbers visible from street? Are they standardized? Are street name signs present and legible?

Conventions / Consistency

Check whether numbering follows odd/even conventions, sequential order, logical direction; starting point defined; rules for multi-unit buildings.

Institutional & Policy Context Analysis

What regulations/ordinances exist? Who is responsible? Is there enforcement? Is there periodic updating? What capacity (staff, technical, financial) is available?

User / Service-Provider Perceptions

Surveys / interviews of residents, businesses, delivery services, emergency services on problems, usability, perceived improvements, expected benefits.

Technological Data Integration

Presence and quality of GIS / address database; integration with digital maps/navigation services; accuracy of geocoding; mismatch between digital / official maps vs actual on-ground.

Cost & Maintenance

How much has been spent (or what would cost) to install signs/number plates; who pays; what is plan for replacing damaged / missing signs; updating records as development proceeds.

Special Conditions of CBD

Explicit attention to high-density features (multi-story buildings, mixed usage), narrow alleys, frequent change of commercial occupants, developments, possibly informal / semi-formal uses.

Measurement of Impacts

Try to capture outcomes: time/delay reduction, increases in service/utility delivery, reductions in mis-deliveries, ease of navigation, user satisfaction, emergency response metrics etc.

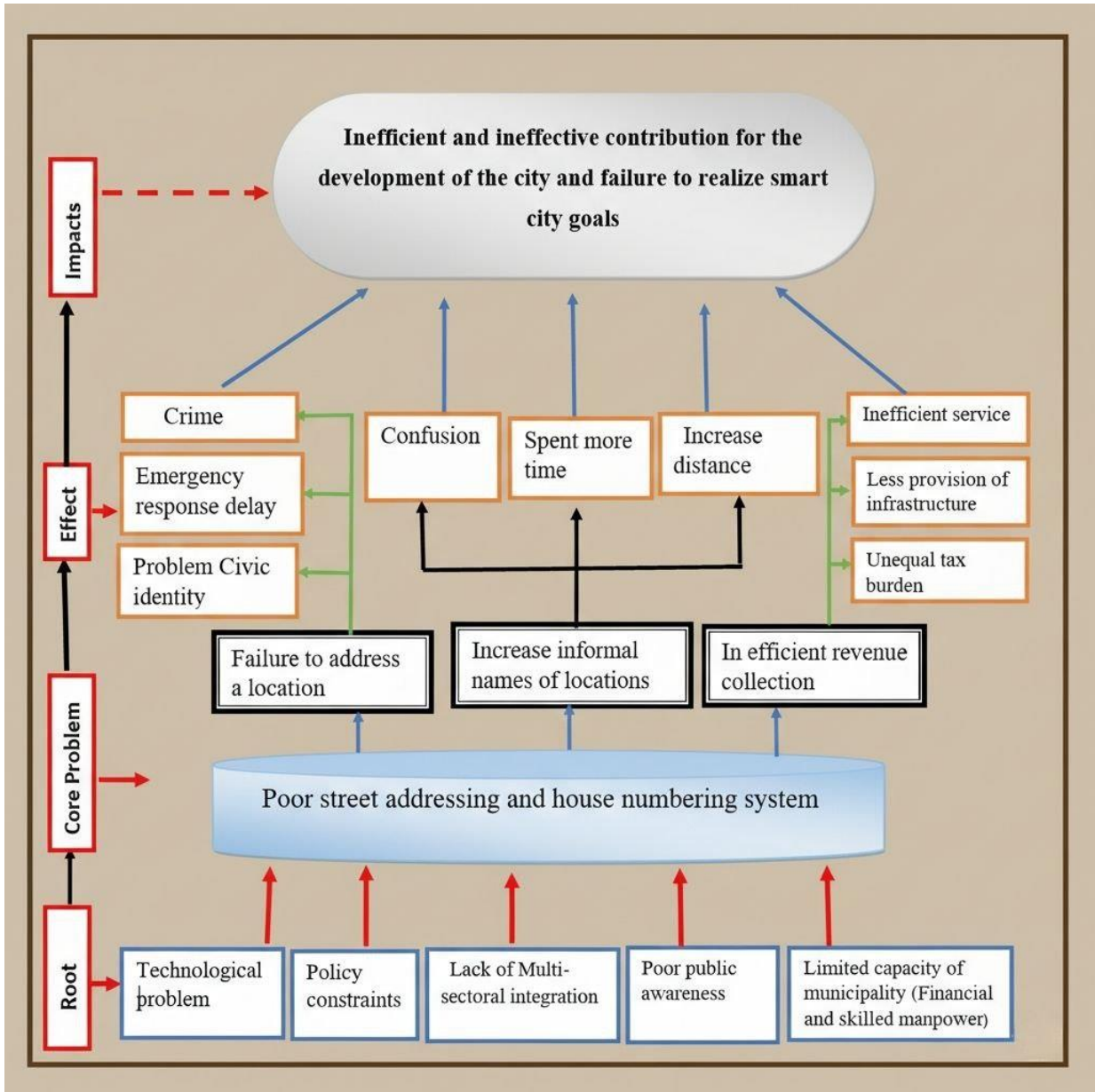
2.4. Conceptual Framework

The existence of efficient and effective street addressing has much significance as tool for planning and managing municipal services and development of a given city. It makes conducive environments for Civic Identity, collecting urban information, supporting municipal services, and solves societal problem. On the contrary poor street addressing results in hardly leverage on poverty reduction and insignificant role in holistic development of a city. The challenges confronting the municipality arise from a combination of technological inadequacies, insufficient inter-sectoral integration, restrictive policy frameworks, low public awareness, and a dearth of financial resources and skilled personnel within the local

government. These factors collectively obstruct the establishment of an effective street addressing and house numbering system, which is vital for efficient urban management. The lack of a comprehensive addressing framework not only complicates navigation but also amplifies issues related to public safety and a cohesive civic identity. The primary issue of inadequate street addressing engenders several adverse effects. Foremost among these is the inability to accurately pinpoint locations, which can lead to increased crime rates, property loss, and a diminished sense of community identity. Furthermore, the emergence of informal names for locations contributes to confusion, extending travel times and increasing the distance necessary to reach specific destinations. This inefficiency frustrates both residents and visitors, complicating emergency response efforts and ultimately jeopardizing lives. Additionally, the difficulties in revenue collection resulting from poor addressing systems inhibit the municipality's capacity to invest in vital infrastructure and services, thereby perpetuating a cycle of neglect and inefficiency. The cumulative impact of these issues hinders the city's overall development, resulting in an urban environment that fails to align with the aspirations of a smart city. The inability to resolve these foundational problems stifles economic growth, restricts access to essential services, and diminishes residents' quality of life. Consequently, the city struggles to attract investment and talent, further entrenching its challenges. To cultivate a thriving urban landscape, it is essential to prioritize the creation of a comprehensive addressing system, enhance public awareness, and fortify the municipality's capacity to implement effective policies and integrate technological solutions.

Therefore, this study will look in to the problem based on the following conceptual framework.

Figure 1: Conceptual Framework



Source: Adopted from World Bank, (2018) and compiled by researcher

CHAPTER THREE

3. Research Methodology

3.1 location and Profile of Mek'ele City

Mek'ele is one of the largest Ethiopian cities, which have high urbanization rate because of pull and push factors. Mek'ele is the capital of Tigray Regional State. It is about 783 km far away from Addis Ababa. The absolute location of the City is 13°32' N and 39°28'E. The altitude of Mekelle varies from 2150 – 2270 m.a.s. (City Profile of Mekelle City, 1872-2006). This elevation categorizes the city under Weinadega type of agro climatic zone.

Mekelle city is situated at the foot Endayesus cliff on the east side. Quiha, on the other hand is situated on a vast plateau land. At a distance of 10 KM, north from the center of the city there is also a steep cliff. The altitude of the Ellala area varies from 1960 m.a.s.l at the foot of the escarpment to 2080 m.a.s.l at the mouth of the basin. Mountains and steep cliffs have surrounded the city (Structural Plan of Mekelle, 2009).

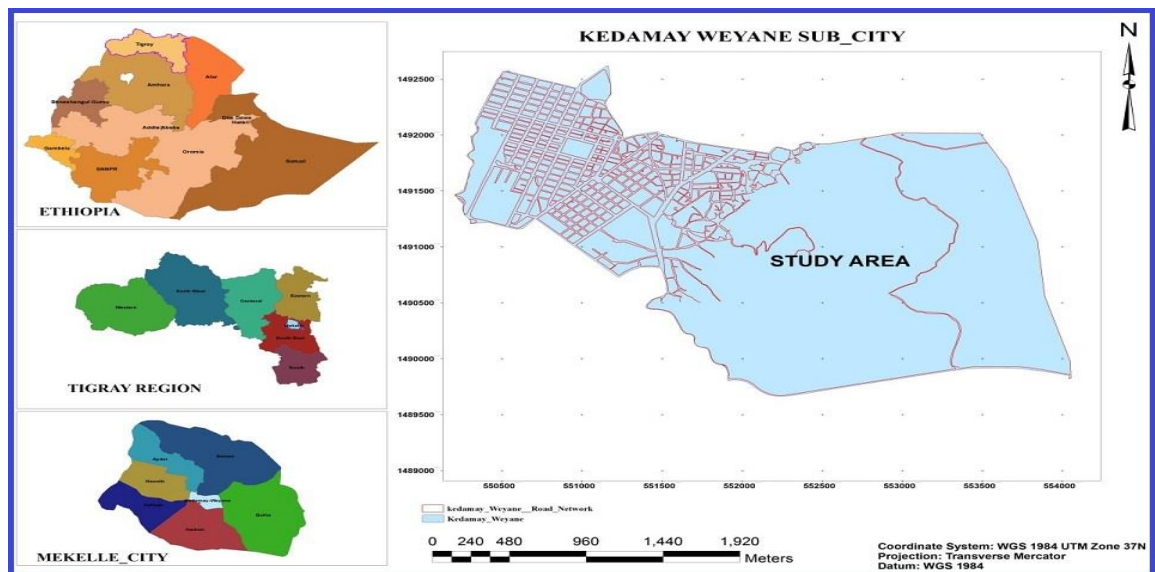
Mekelle experiences mild climatic condition with annual average maximum temperature of 24.1⁰C and annual average minimum temperature of 11.11⁰C. There is monthly variation in temperature June is the hottest month with a monthly mean maximum temperature of 27.1⁰C and monthly mean minimum temperature of 13.03⁰C. December is the coldest month with a mean monthly maximum temperature of 21.9⁰C and monthly mean minimum temperature of 8.51⁰C. The temperature of Mekelle also varies from place to place as a consequence of change in elevation. Neighborhoods around Quiha and Endayesus area are colder than the cities mean temperature.

The prevailing wind direction is the Easterlies wind which blows from east for longer period of the year (September – June) during the dry season. Due to its velocity strengthen the wind blows dust up easily and is a nuisance to residents in larger part of the city (particularly in the Earth roads). On the contrary the westerly wind blows from west during for two months, July and August. The average per annum wind speed of Mekelle is 3m/sec and the maximum wind speed per month recorded is 5 m/sec. (Structural Plan of Mekelle, 2009).

Administrative Boundaries

The existing jurisdiction boundary of the city is defined based on the planning boundary of the recent structure plan and a proclamation passed on July 5/2012. Proclamation no. 223/2004 has divided the city into 7 sub-cities, 33 kebeles and 105 Ketenas. The sub cities namely addihak'i (ዓዲሓቂ), Ayder (ዓይደር), Haddinet(ሓድነት), Hawelti (ሓወልተ),Kedamayweyane (ቀዳማይወያነ), Kuiha (ኩሓ), and Semien (ሰሜን). The focus of this study is in Kedamay weyane sub city (Central Business District) of the city, situated around 13.49° latitude and 39.43° longitude. This district is part of a key sub-city and functions as the city's primary hub for commerce and administration. The CBD is marked by dense construction and heavy traffic. It hosts numerous businesses, offices, and service locations, which draw substantial daily traffic. The high density of people and the somewhat disorganized development in certain areas can cause difficulties in locating exact locations or addresses within the sub-city. This situation presents difficulties for those trying to get around and for service delivery. Visitors, emergency responders, and delivery services frequently face added time and complexity due to the area's layout and congestion. Successfully managing traffic flow and offering location-based assistance is a key challenge in the CBD, needing innovative solutions to address the problems caused by high density and complex urban structure.

Map 2: Mekelle City location map



Source: Adopted from Bureau of Land (2024) and compiled by researcher

3.2 Research Design

The study assessed the current situation, usability, and gaps in street addressing and house numbering within the central business district (CBD) of a town kedamay weyane by combining spatial mapping, field observation, stakeholder interviews, and user surveys: first, it defined the study area and created a baseline map using GPS-enabled walks and existing municipal records to record every street name, sign, and house number; second, it used systematic sampling (e.g., every nth building on each block) to audit numbering accuracy, visibility, and consistency, while recording geo coordinates and photographing examples; third, it conducted short semi structured interviews with municipal planning/utility staff and cadaster agency purposive interviews with 18 professionals to understand governance, maintenance, and local practices; fourth, it ran a brief user-experience survey with 364 respondents drawn from residents in the sub city and site observation 155 streets to capture navigational difficulties and service impacts; it analyzed spatial data in GIS to detect gaps, duplicates, and nonconforming patterns, computed simple descriptive statistics on visibility/legibility, and applied thematic analysis to qualitative data to identify causes and institutional barriers; and deliverables.

3.3 Research Approach

Both quantitative and qualitative methods were used in this study's mixed research approach. The degree of street addressing and house numbering coverage in the town's central business district was assessed using the quantitative component. This entailed calculating the proportion of appropriate coverage by counting the number of streets with and without names, as well as the number of houses with and without numbers. However, the qualitative component was added to record the opinions, experiences, and perceptions of locals, business owners, and government representatives about the drawbacks and effects of the current street addressing system. These insights were obtained through focus groups, interviews, and observations.

3.4 Data source and data collection Methods

Data types and source

To undertake this study, both primary and secondary data are utilized.

Primary sources of data for this study are focused group discussion, survey data, reconnaissance survey and discussion with officials and experts. I use it as a primary source for

the comparative assessment of the existing street addressing accessibility, visibility, comprehensiveness, and accuracy of addressing streets as well as reference points.

The secondary data was obtained from the imageries, line maps, published books, journals, legislations, unpublished reports, and records of the municipality.

Data collection Method

Questionnaires: - The primary instrument for gathering data for this study was a questionnaire. It is appropriate for this study since it makes it possible to quickly gather both quantitative and qualitative data from a large number of people in the study area. There are both open-ended and closed-ended questions.

Interview: - Semi-structured interviews for the current study were conducted with key informants such as municipal officials, providers of utility services, postal officials, and officials of emergency services. These participants were specifically selected purposively as they are directly responsible for planning, execution, or requirement of dealing with systems of addressing in the study area. The interview schedule included questioning about policies and practices concerning naming and number of streets, coverage, difficulties faced, and the possible resolutions. In the conduct of the interview, notes were taken and, with agreement in some cases, voice recording was used to ensure accuracy.

Focus group Discussion: - The focus group participants were selected purposively for responsible administrators to get knowledgeable and attainable individuals with the study case. In the study area, one focus group discussion was conducted. The number of these focus group participants were eight. By preparing a checklist, the discussion was recorded seriously. Participants were also encouraged to share their experiences and draw attention to shared issues like service delivery confusion, difficulties for emergency services or visitors, and the responsibility of local governments for signage maintenance.

Personal Observation: - I conducted Systematic observation along 155 streets in the study area. Using an observational checklist, notes were taken while driving or walking down each street. The physical and social condition of the households, new comers (visitors), streets, taxi and Bajaj drivers, Street name signs at intersections, their legibility, whether house numbers were displayed on buildings, visibility from the street, numbering sequence and consistency, and instances of duplicate or missing numbers were among the topics covered by the checklist. The data collected from observation was recorded. GPS coordinates and photos were also taken to bolster the information that was recorded.

3.5 Target Population

The target populations for the research were those in which the findings are applicable were the number of parcels and streets found in kedamay wayane neighborhoods. The sample frame or the population from which the sample drawn was the owners of the land and streets.

3.6 Sampling Method

The rationale for selecting the sub city was purposively based on the following criteria's:

The selection of this sub-city was not arbitrary; it was a purposeful choice based on particular features. First, consider a location with substantial activity, serving as the central hub for business and trade within the greater city. This was a primary factor in our choice. Second, it has crowded streets, constant traffic, and a generally packed environment, reflecting considerable congestion. This area matches that description. Third, it includes old buildings and streets, with a rich historical past evident in its physical surroundings. This sub-city has that quality. Fourth, accurately describing a specific location within this area is surprisingly challenging, given its complex network of streets and landmarks that resist easy way-finding. These four aspects—dominance, congestion, historical importance, and locational ambiguity—collectively explain why we decided to concentrate on this place.

The initial consideration was the sub-city's role as a key economic engine. Its high concentration of businesses and commercial operations helped it become the focal point for city-wide activities. The high volume of transactions and the presence of important financial institutions made this area a magnet for commerce. This concentration of economic power set the stage for our choice.

The second factor, congestion, stems from this sub-city earning its place in the world, leading to high population density and constant vehicular and pedestrian traffic. The limited space coupled with high demand results in a persistent state of overcrowding, making mobility a constant challenge. The infrastructure struggles to keep pace with the growing population, contributing to the feeling of being packed together.

The sub-city's historical importance is another key aspect. Its streets and buildings tell stories of the past, with architectural styles reflecting different eras and cultural influences. The presence of historical landmarks and preserved sites adds to its character, creating a tangible about the area's historical past. These reminders of the past tied with its current state contribute to its uniqueness.

Finally, the locational ambiguity presented a unique problem. The complex layout of streets, landmarks, and districts makes it challenging to provide clear, concise directions or descriptions of particular places. This ambiguity arises from unplanned expansion, resulting in a maze-like structure that defies simple understanding. The unexpected turns and intersections make it difficult to develop a mental map of the area.

In summary, the decision to focus on this sub-city was guided by a grouping of features that distinguish it from other areas. Its principal role in business, trade, its state of constant congestion, its rich history, and the difficulty in navigating its streets motivated our concentrated attention. These qualities made the sub-city important for closer study and analysis.

Based on the sub city data there are 4009 parcels and 259 streets that make up the study population. A sample of 364 households was chosen by systematic random sampling from a complete house list (every 11th house after a random start) using the Yamane formula ($e=0.05$). From a complete street list, 155 streets list (every 2nd street after a random start) were chosen using simple random sampling. To gather opinions and experiences from municipal employees, citizens, and service providers, key informants were purposefully chosen. Streets and homes that were sampled were the subject of observational audits. Response rates were noted, and non-response was managed using a replacement rule.

3.7 Sample size

The population from which the sample drawn was the owners of the land(households) and streets. In the sub city there are 4009 parcels and 259 streets.

3.8 Sample size determination

The sample frame of the study was being taken 4009 pacels and 259 streets. Because of the homogeneity of the respondent, budget and time constraint and equal chance will be given for all respondents a 95% confidence level was taken.

Based on the central limit theorem

$$n = \frac{N}{1+N(e)^2} \quad \text{Where} \quad n = \text{Number of samples/sample size}$$

$$N = \text{Total population}$$

e = Error tolerance, or 5% is the level of precision or sampling error (0.05)

Therefore, $n = \frac{4009}{1+4009(0.05)^2}$

$n = \frac{4009}{1+4009(0.0025)}$

$n = \frac{4009}{1+10.0225}$

$n = \frac{4009}{11.0225} = 363.71 \cong 364$ parcels (households or residents)

$n = \frac{259}{1+259(0.0025)}$

$n = \frac{259}{1.6745} = 154.67 \cong 155$ streets

$n = \frac{259}{1.6745} = 154.67 \cong 155$ streets

1.6745

Based on their proportion 364 parcels and 155 streets were selected using simple random sampling. In addition, 8 persons for focus group discussion and a group of 17 persons were purposively selected from the cadastral agency, city Mayor or municipal manager, planning unit of the city and local administrators and experts from the municipality have been targeted for interview (Table below)

Table 1 Sample representative

S/N	Description of respondents	Plan	Remark
1	Field survey	364 parcels	Property owners, streets and residents questioner and site visit
		155 streets visit	
2	Police office,	2	Semi structured interview
3.	Infrastructure offices (tele communication, EEPA, Water supply)	3	
4	Fire service and ambulance	2	
5	municipality Manager/vice	1	
6	Local administration/ kedamay weyane sub city	2	
7	Municipality staff	3	
8	Expertise in Cadastre	5	
	Total	532	

Source: Own plan, (2025)

3.9 Data collection techniques

Table 2: Techniques for data collection from the respondent (own plan)

Respondents	Data	Techniques
Residents of the kedamay weyane sub city	-Ages, sex and educational level of respondents -Awareness of the addressing system within the sub city -Challenges encountered in navigating the study area. -Perception on the implementation of the street addressing system.	Field Survey
Officials of the municipality Manager /vice, Local Administration/kedamay weyane sub city, Municipality staff (Planning Department),Cadastre agency	- The implementation strategies used for the addressing system within the study area. - Effectiveness of the implementation strategies towards achieving an efficient and standardized addressing system in the study area and with other sub cities within the city. - Impacts of the address system on urban management.	Semi structured Interview and FGD
Service Providers (Postal Service, Fire Service, Ambulance Service, Police Service, Water supply,	-Strategies used in locating target areas and points of interest. -Challenges encountered in navigating the study area.	Interview

3.10 Method of Data Analysis

The raw data collected from the field will be organized in a manner that facilitates analysis in line with the objective of the study. Finally, the data collected using questionnaires, focus group discussion, interview, and field observations, and from published and unpublished materials was analyzed and presented in various ways. The major activities of this phase were

The research process entailed thorough management and thoughtful analysis of collected information. Data entry happened with precision into SPSS and Excel, which became the basis for producing meaningful visualizations. SPSS enabled the creation of tables, bar diagrams, and charts of varying types, which helped transform the raw data into representation formats. This process, with the use of basic descriptive statistics for initial data interpretation and qualitative reasoning, helped to glean a preliminary impression of the information's trends and patterns. The analysis was further enhanced by the use of GIS software, which integrated maps with street addresses and the photographs of the study area, offering a visual representation of the geographic context and research realities. This spatial dimension considerably enriched the research topic's understanding. All of these elements synthesized into a thorough summarization of the research deliverables. I focused on a recapitulation of the most important points of the analysis and the insights that the visualizations of the data offered.

CHAPTER FOUR

4. RESULT AND ANALYSIS

4.1. Introduction

This chapter focuses on the state of the addressing system within Mekelle particularly kedamay weyane sub city. The main objective is to assess the Availability, challenge and opportunity of street addressing and house numbering in mekelle especially kedamay weyane sub city.

The literature review identified the three basic requirements for designing an address scheme, which serves the foundation of effective implementation of the system: *human, physical environment, and its digital representation.*

4.2 Response Rate

The response rate is an indication of the level at which sampled households, business proprietors, or institutions participate in the delivery of data. A higher response rate improves the research's representativeness, thus allowing findings to reflect the realities of servicing systems in the specified study area appropriately. Street addressing and house numbering concepts include a correlation with the delivery of public services, economic operations, and city safety. However, data acquisition on this subject matter is at times based on the cooperation and availability of respondents to participate in surveys, interviews, or other methodologies. Participation levels in many towns may be negatively affected by challenges of lack of awareness of the study, disbelief in researchers, or time constraints among respondents. These issues indicate the need for closely examining response rates throughout the research activity.

Therefore, in the framework of my work, the analysis of the response rate is of key importance not only for the evaluation of the strength of the data obtained but also for identifying factors promoting or hindering participation. Such findings will serve for the improvement of the methods used in the current study and the frameworks of future studies regarding urban addressing systems.

Table 3: The response rate of the respondents

S/N	Description of respondents	Plan	Accomplish ment	Percent	Remark
1	Field survey	364 parcels	364	100	Property owners/residents and streets (questioner and site visit)
		155 streets visit	155	100	
2	Police office,	2	2	100	Semi structured interview
3.	Infrastructure offices (Telecommunication, EEPA, Water supply)	3	3	100	
4	Fire service and ambulance	2	2	100	
5	municipality Manager/vice	1	1	100	
6	Local Administration/ kedamay weyane sub city	2	2	100	
7	Municipality staff	3	3	100	
8	Expertise in Cadastre	5	5	100	FGD
	Total	532	532	100	

Source: survey data (2025)

4.3 Respondents Profile

The survey took place on One hundred fifty-five (155) streets among them seven of them was Avenues or locally GODENA within the CBD of the area. These are categorized into major and minor roads. The major roads are composed of the principal streets within the CBD with notable land marks as well as high vehicular and pedestrian traffic whiles the minor roads consist of streets and accesses that serves a lesser purpose. The streets were randomly selected from different locations within the study area to ensure a variety of inputs.

In all, 364 respondents made up of 70.61 percent males and 29.39 percent females from all ages participated in the survey with majority (47.53percent) being adult people within the 51 to 65 age cohort.

With regards to the educational attainment, 93.96 percent of the respondents were literate (have been through formal education and can therefore read and write) whilst 6.04 percent had no formal education. The survey established that 29.13 percent of respondents had received basic education (less than high school) whilst 31.87 percent and 32.96 percent had high school diploma and bachelor’s degree or higher respectively. It is important to mention here that the level of education commensurate with the ability of people to read, understand and remember addresses which encompasses the “human requirement” of an efficient addressing scheme. Analysis of the survey results with regards to the educational background of respondents revealed that majority could read and understand addresses and therefore understood the important of the implementation of the street addressing project in the study area. Table 4.3 shows the background information on respondents.

Table 4: respondents profile

Variable	Gender				Total Percentage
	Male	%	Female	%	
Age					
Under 20 years	2	0.55	3	0.82	1.37
21 years - 35 years	58	15.9	29	7.97	23.91
36 years - 50 years	73	20.1	26	7.14	27.19
51 years - 65 years	124	34.1	49	13.46	47.53
Total	257	70.6	107	29.39	100
Educational Attainment					
No Formal Education	6	1.65	16	4.39	6.04
Less than high school	52	14.3	54	14.84	29.13
High school diploma or equivalent	87	23.9	29	7.97	31.87
Bachelor's degree or higher	96	26.4	24	6.59	32.96
Total	241	66.2	123	33.79	100

Source: survey data ((2025)

4.4 Assessment the availability of street addressing and House numbering

4.4.1. Street Inventory

Before attempting on the development of street addressing system, knowing exactly the number and type of street is important. Accordingly, in the study area inventory is carried out. A study conducted on the streets found within the study area reflects a great inequality between the number of streets and the degree of systematic naming conventions. There are 259 streets in the study area, Attempts were made to distinguish between the different types of streets based on internationally/ commonly accepted definitions. Unfortunately there is no such definition particularly as applied to street addressing and house numbering system.but exhibits a very restricted naming method. Among named streets, the common naming standard is the employment of the local term "Godena," which broadly implies a street, road, or passageway. This common naming standard exhibits a tendency towards the use of generic indigenous terminology over employing unique and functional terminologies to communicate varying streets.

This poses problems in clarity and efficient utilization of the addressing system. With several streets bearing only the term Godena without additional descriptors, locals and service delivery organizations find it difficult to tell one street from another. For instance, giving locational details to delivery services, emergency services, or visiting becomes confusing since there is no distinguishing mark to differentiate the streets. This kind of duplicate also diminishes the applicability of the naming setup in urban planning, postal delivery, and navigating software.

The inventory also indicates the lack of standard signage and plate marking. Even where the name Godena is inscribed, visibility is low and the identifiers are in comprehended or go unseen by the people on the streets. This indicates that the earlier attempts to carry out a street addressing scheme never went beyond elementary and token labelling. Furthermore, the lack of variation in the names indicates an absence of community involvement, reference to culture or history in the naming scheme.

In general, the inventory reveals that while the study area's street network is highly dense, the naming practice is still incomplete and inefficient. This confirms the imperativeness of an orderly comprehensive street naming plan.

4.4.2. Number of Streets, junctions, Blocks and parcels

Number of Streets:

There are about 259 streets (measured and counted using arc GIS and site visit). There is no practice that categorizes streets into roads, avenues cul-de-sac etc. In the city as general specifically in the sub city. The already named streets adopted the generic Local name “Godena” which could mean Street or Avenue.

Number of cross sections / junctions:

As mentioned earlier, the dominant settlement pattern of the study area is grid increasing the number of intersection in the sub city. Having large number of intersections has significant financial and managerial implication on street information and sign posting system to be adopted in the city particularly in the sub city.

Number of blocks:

The number of blocks are identified to help divide zones into Equal Street. On top of this, it helps estimate the number of parcels per block. Therefore, the number of defined blocks in the sub city are 448.

Number of parcel/Entry ways:

The end result of the addressing system is to address entry ways /parcels identifying the entry ways is important. Accordingly, the number of parcels in the study area are 4009.

4.4.3. Existing Addressing system

Street Naming Practice

One can boldly say that systematic street addressing has never been practiced in the city. The existing Street Addressing practice in the city is confined to giving names to major roads which was first attempted after the fall of Derge regime around 1992 (with the exception of one). The naming of streets concentrated on the existing asphalt roads. Even this practice was short lived. No scientific system was adopted to name streets, rather, the naming was undertaken to commemorate martyrs, historical figures and important events during the fight to overthrow the previous regime.

A 50 by 60 cm brown marble plaque was used to display the name of the road. Mostly the plaques are posted /mounted/ on the wall of the street at the entrance and exist to the road they are named for at a height of 1.8 to 2 meters. ‘Godana’ (which could mean street or avenue in local language), was used as an affix on the named roads. As discussed earlier the common denominator used for the naming of these streets is the roads being asphalted at that time. The location of the named roads and their names is as described below

Godana Guna: The road which stretches from the present Supreme Court 0.64 km to the junction next to Mekelle Health Center (traffic lights) is officially known as Godana Guna. This road is 25 mts wide and is named after a mountain in the Amhara region to commemorate the martyrs of a momentous combat with the Dergu regime held at the mountain. This street was 2 lanes each running on opposite directions separated by 0.5 mts wide tree lined island. But now it is constructed as one lane asphalt road and the marble is not available.



Figure 1 View of Godana Guna source: survey data (2025)

Godana Hakfen: This name is given to memorialize an important event that occurred at a locality called Hakfen at the early stage of the fight to over through the dergu regime. This name is given to the road that starches from Hawzen square 0.33kms to the junction at Romanat square. This street is 20 mts. wide and is lined by palm trees, shops and boutiques along its length making it a very busy and important commercial corridor in the city.



Figure 2: View of Godena Hakfen source: survey data (2025)

Godana Alula: This 20 mts. wide road stretches 0.69kms from the traffic light at Romanat square to commercial bank of Ethiopia (main branch) is named after this Hero and Historic figure Ras Alula. This road is also an important and thriving road in the city with its shops and boutiques along the length of the road.



Figure 3: View of Godena Alula source: survey data (2025)

Godana Age'azi: the road 20mts wide asphalt road that stretches from Romanat square 0.53 kms.to the office of Police Commissioners is known by this name. This road is also named after a hero and martyr (initiators of TPLF) whose pseudonym is Age'azi. This road is also an important street which currently is undergoing active transformation.



Figure 4: View of Godena Ageazi source: survey data (2025)

Godena Mizer: It is 20 metres wide asphalt road, connects the old municipality (or Commercial Bank, Age’azi branch) to the ring road around old bus station. The road is named after a female martyr Mizer. As is true to the other roads this road is also under transformation.



Figure 5: View of Godena Mizer source: survey data (2025)

Godena Eyassu Berhe: The road is a 25-meter-wide, two-lane asphalt road named in honor of former martyrs, including TPLF musician Eyasu Berhe, who has passed away. It begins at the gate of the Mekelle University Arid campus, runs past the Enda Selassie Church, and ends at the Milano Hotel roundabout.



Figure 6: View of Godena Eyasu Berhe(2025)

Godena Selam: this name is given to the road that stretches 0.57 kms from Romanat square (Housing Agency) to Zeselassie square. This street is 15 mts wide with two way traffic separated by a narrow tree lined island. Shops on both sides frame this street making it one of the active streets in the city



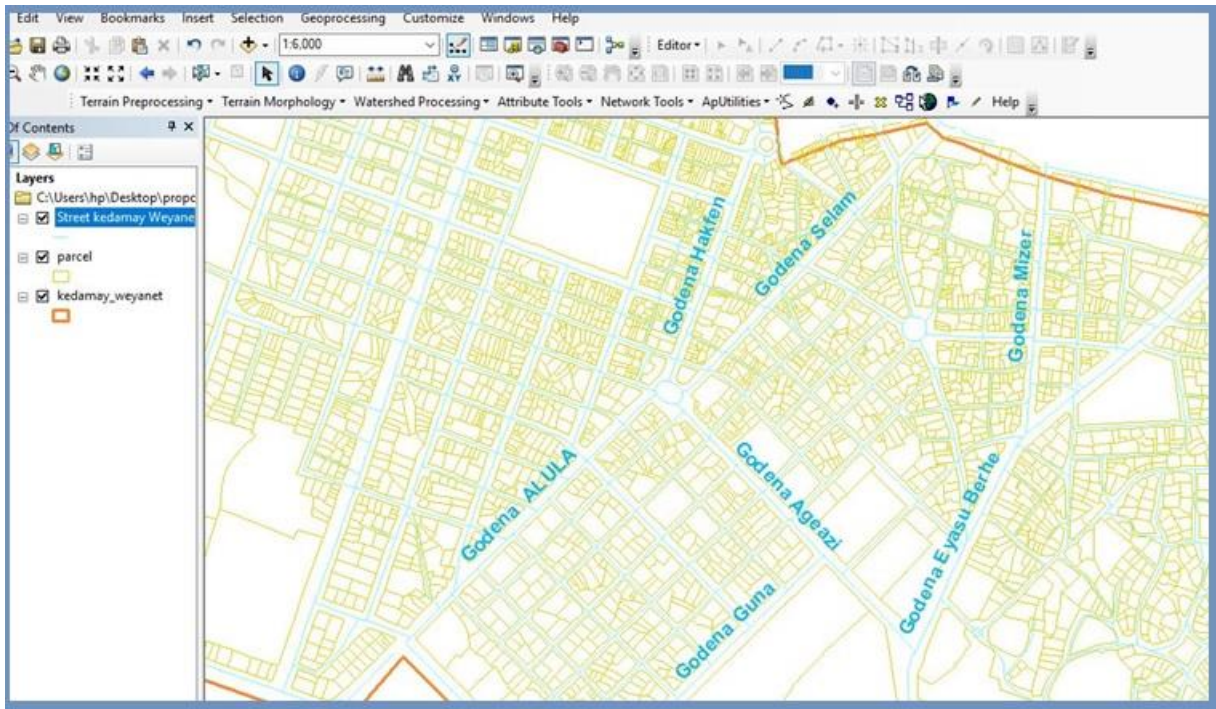
Figure 7: View of Godena Selam source: survey data (2025)

Godena Mussie: This road is also named after a Hero and martyr (also initiator of TPLF). The road stretches from Tigray Development Association (TDA) or Zeselassie Square 1.23 kms to Mesfin Engineering. Road also serves as main road to connect north sub city to the CBD area of the city.



Figure 8: View of Godena Mussie source: survey data (2025)

Existing street names in the study area



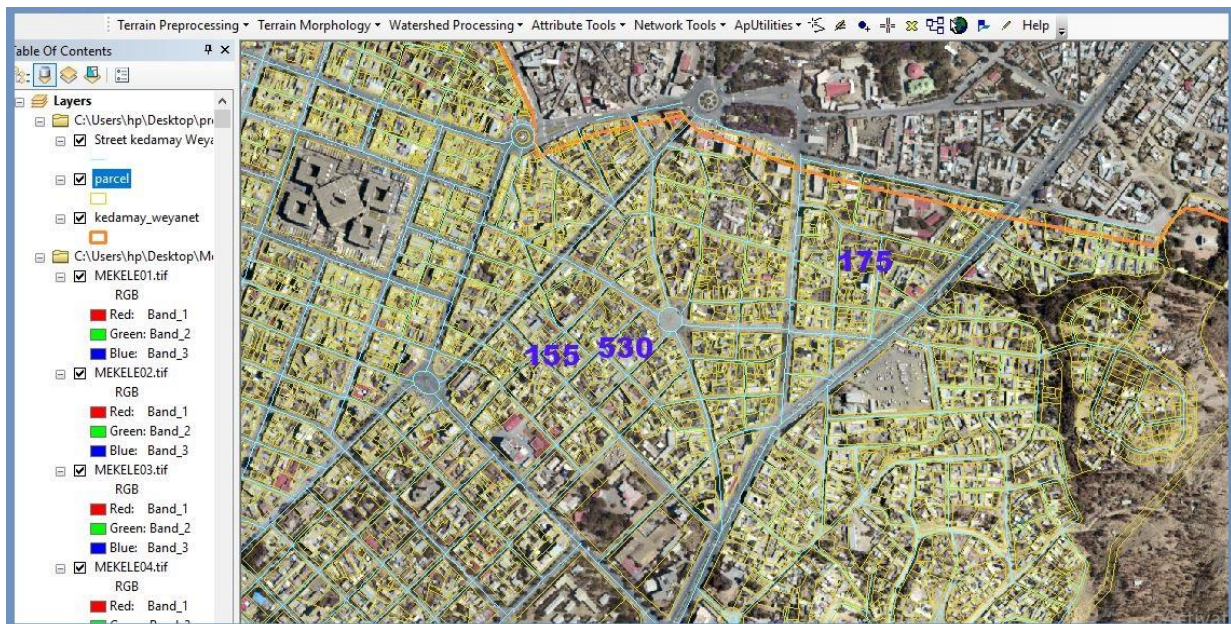
Map 3 Map showing Named streets in the sub- city source: survey data (2025)

4.4.4 Existing house numbering

Inventory of house number

The final stage of the addressing process is to assign addresses to particular residences, businesses, and other property. The general rule to assign the address of a house is use metric system which refers to a street aligned with the center of the front of a building or lot (in a line perpendicular to the centerline of the road) and measure the distance along the street from the reference street. GIS is used to calculate the distance to the center of the plot or building to be addressed from the reference street. This is a very simple process after involving the digitization and verification of each individual parcels from digital aerial photographs.

Rules must be established for assigning numbers with consistency, but human judgment will be necessary at various stages of the procedure. Though in the study area there was only three plots were having a house number given during the emperor period When no existing rule applies workably to a particular situation, residents simulate their current number is still workable.



Map 4 Map showing house number in the sub- city source: survey data (2025)

4.4.5. Street name signage poles and house number plates

Taking into consideration the '*physical environment*' of an addressing scheme, the installation of street name signage poles and house number plates are important components that enhance

the visibility of an address. My interview with city officials and field survey revealed that, a total number of 4009 properties and 259 accesses (streets and major paths) within the study area have been identified. Out of this, those 259 streets are accesses and 3 properties have their old house number signage installed all the three are located within the keblle 14. In effect, most of the street signage's within the study area lack visible signs of street names.

4.4.6. Availability of Mapping and database management

Taking into consideration, the *digital representation* of an addressing scheme, it was revealed by city authorities that the any phase of the addressing system is expected to be carried out on the GIS platform. This encompasses mapping and database management processes as well as integration with land administration systems (Land Use Planning and Management Information Systems). The mapping processes used entail first of all, the acquisition of imageries. This is then followed by a ground truthing exercise to identify all accesses (streets and major paths), existing street names and update of maps as well as execution of initial numbering of properties. The next step encompasses digitizing data obtained from the ground truthing exercise and the preparation of an address map.

From the interviews, it was made known by city authorities that, there have been some efforts made towards the implementation of an integrated approach to address database management which entails linking the attribute or street names orientated data to the address. However, due to challenges including funding and the lack of technical know-how, and guiding standard the execution of the exercise within the study area is failed. Major activities concerning mapping and database management in the study area is still not done.

4.5 Awareness of citizens in addressing system

4.5.1. Citizens engagement

To promote the use of an address system, it is imperative to consider the '*human requirements*' which underscore the ability of residents of a particular urban area to read, understand and remember addresses. As argued by Farvacque-Vitkovic (2005) and Coetzee et al. (2011), a street address system should reflect the local culture as well as support the social and civic identity of people living at the address. The inclusion of residents throughout all the stages of the implementation exercise is crucial towards not only promoting the use of the addressing system by residents but also creating a sense of community ownership of the address system.

The street addressing operational guidelines underscore the need for citizen engagement and outlines the approach and processes that could be used including launching regular educational campaigns to sensitize and engage the public throughout all stages of the implementation exercise. (Federal Democratic Republic of Ethiopia Ministry of Urban Development and Construction- የኢትዮጵያ ከተሞች የአድራሻ ሥርዓት ስታንዳርድ ማሻሻያ ስታንዳርድ ቁጥር 12/2011). However, my interviews with the institutions revealed that, although a number of community outreach programs have been carried out to sensitize stakeholders such as chiefs and opinion leaders on the purpose of the addressing system and especially on the mode of assigning street names, little attention has been given to the inclusion of the residents of the study area in the implementation process. Generally, the approach used in the implementation exercise has been top-down. For instance, one official with the planning department remarked that:

“For Mekelle Street addressing, we (Street Addressing Team) have done a number of community engagements but I think there is still more to be done. For example, I remember we (Street Addressing Team) encountered some opposition from some residents when we embarked on data collection at kebele 14 (the Central Business Area) because they (residents) were not aware of what was going on”.

In effect, this undermines the purpose and use of the addressing system. All the service providers interviewed asserted that, although they were aware of the kedamay weyane (study area) Street naming and Property Addressing, they do not use the addressing system in their day-to-day activities. About 95 percent of these institutions highlighted the lack of involvement in the implementation exercise, unavailability of a GIS database, as well as the lack of visible street name signage poles and house numbers as the main causes of this phenomenon. For instance, one fire officer asserted that:

“We (Fire Service personnel) are aware that the streets have been named and some street numbered, but we are not familiar with these addresses”.

Another officer with the Water supply also remarked that:

“We (sub city Water supply staff) are aware that a street naming and property addressing system has been implemented within the area, but we do not use the addresses. We got to know about it when we wanted to integrate our system with the new street addresses, but we realized there was no GIS database available”.

Moreover, all the commercial drivers (taxi drivers) interviewed under the two major institutions involved in transportation in the CBD indicated that they do not use addresses in navigating the destination area all they use local name” Ketema”. For instance, one taxi driver remarked that “we (drivers) use landmarks and most often depend on the direction given to us by passengers and this sometimes becomes daunting when the passenger is a visitor”.

4.5.2. Description of home address

The survey revealed that, none of them use the plot/block no and street address number, majority (49.73percent) of respondents were able to provide their home addresses which mainly comprised of land marks when unprompted. An example of some of the addresses given include Harmaz shope, Aregawi hagos building ,Milano hotel ,Merkeb hotel,geza gerlase etc where the address can be located within the study area. The rest (36.26 percent) could not provide their addresses or had no idea either because their homes do not have an address or were not familiar with the addresses and (14.01 percent) asking peoples for assistance in locating specific area.

Table 5: Description of Home Addresses (Source: Field Survey, june2020.)

Address Category	Number	Percentage
Plot/Block numbers	0	0
Street address number	0	0
No idea of addresses	132	36.26
Use Land mark	181	49.73
Ask people for assistance	51	14.01
Total	364	100

Source: Field Survey, (2025)

4.5.3 Knowledge on street addresses

Among the study participants, out of the total 364, three hundred and thirty respondents about 63.2% have reported not knowing the names of the mentioned streets or what purpose the plates placed on them serve. This indicates a serious knowledge gap among the residents about the existing street naming system. The plates were put to serve the functions of acting as clear

reference points for navigation, assisting the delivery of public services, supporting emergency response mechanisms, and sustaining overall urban management. The results from the study indicate that these benefits may not be fully realized since most of the residents are unaware of the names or the function of the street plates. A smaller segment of respondents evidenced a certain level of awareness, meaning that the intended goals of accessibility and organized identification are thus far from being realized.

It brings out the argument that the flaw is not in the absence of infrastructure since the plates have been put in place, but it stems from unawareness and lack of participation. Although representatives of the local authorities have tried to reveal and mark these streets, residents are just not informed, thus limiting the infrastructure's functionality. The gulf between implementation and public knowledge leads to practical challenges revolving around assisting visitors, ineffective service delivery, and a general inability for residents to utilize formal addresses in their daily walks of life. This, in fact, clearly suggests that without effective sensitization and education campaigns, technical measures themselves are bound to yield little success. This gap must be bridged through strategies such as awareness programs, encouraging people to come on board, and constant follow-up to ensure that residents are not only aware of the street names but also appreciate their importance. Table 6 shows knowledge of respondents on street names.

Table 6: Respondents Knowledge on named street addresses

Survey Location	Knowledge on Street Names				
	Yes	Percentage	No	Percentage	Total Percentage
Godena hakfen	31	8.51	10	2.75	11.26
Godena Guna	16	4.4	18	4.95	9.35
Godena Selam	24	6.59	46	12.64	19.23
Godena Ageazi	16	4.4	14	3.85	8.24
Godena Mizer	14	3.85	88	24.18	28.03
Godena Guna	12	3.29	28	7.69	10.98
Godena Eyasu	21	5.77	26	7.14	12.91
Total	134	36.8	230	63.2	100

Source: own survey (2025)

4.5.4 Use of street names and house numbers in daily life

4.5.4.1. Use of street address by age group

Considering the use of street names and house numbers as a tool for navigating the urban area and giving out locational information such as filling important documents, majority of respondents (88.74 percent) claimed that they do not use their addresses in giving out locational information as well as navigating the urban area.

With regards to age distribution and address usage, the survey established that out of the 11.26 percent of respondents who indicated a reliance on addresses in giving out locational information, majority (36.81 percent) were composed of old people (51 years and above). The Pearson chi-square for the association between age and address usage indicated a p-value (6.171) that is greater than the chosen significance level (0.05), meaning that there is no association between age level of respondents and use of the addresses. This therefore implies that irrespective of age level, majority of residents are still not attuned with the street addressing system.

Analysis of the current study made clear that the correlation between the age of the respondents and the usage of street addressing and house numbering systems was not significant ($p > 0.05$). This shows that the factor of age has little effect in determining whether or not the residents are utilizing or are familiar with the street addressing system in the area. This has been observed to be true in other studies as well, whereby the usage of the street addressing scheme has been observed to depend more on other aspects like awareness and accessibility rather than factors like age (Global Campaign for the Agrarian, 2022; WHO, n.d.). For example, studies related to urban planning have revealed that visible numbering schemes and concerted city enforcement can promote the usage of the addressing system among people of all age groups (Planning Advisory Service, n.d.).

Other studies also validate the premise that the disparities in the usage of addresses are determined by external factors as opposed to biological age. Research studies conducted in the usability of house numbering systems reveal that the clarity and organization of house numbering systems influence individuals' behavior significantly more than their age alone (ResearchGate, 2016). Similar studies involving the usage of technology and services reveal that the factors determining adoption and usage are age-related factors like education, experience, and perceptions of usefulness rather than age per se (Mitzner et al., 2018; Stamate

et al., 2024). This offers strong support for the non-significant relationship found in the current study between addressing systems' accessibility and age.

Table 7: Use of street address by age group

Age		Use of Street Addresses		Total	%
		No	Yes		
Under 20 years	Count	2	0	2	0.55
	Expected Count	1.78	0.22		
	Residual	0.16	-0.47		
21 years - 35 years	Count	86	34	120	32.97
	Expected Count	106.48	13.52		
	Residual	-1.98	5.57		
36 years - 50 years	Count	103	5	108	29.67
	Expected Count	95.84	12.16		
	Residual	0.73	-2.02		
51 years - 65 years	Count	132	2	134	36.81
	Expected Count	118.9	15.1		
	Residual	1.2	-3.37		
Total	Count	323	41	364	100
	Expected Count	323	41	364	
Percentage		88.74	11.26		100

(Source: Field Survey, 2025)

Chi-square result for Use of street addresses by age (respondents answer “yes”)

Results

Chi-Square (χ^2) Value = 46.8238

Chi-Square Calculator – Results			
Categories	Observed O_j	Expected E_j	Chi-Square Component $(O_j - E_j)^2 / E_j$
Category 1	0	0.22	0.22
Category 2	34	13.52	31.023
Category 3	5	12.16	4.2159
Category 4	2	15.1	11.3649
Total:	41	41	46.8238

P-Value from Chi-Square Calculator

Use this tool to calculate the p-value for a given chi-square value and degrees of freedom.

Chi-square Value:

Degrees of Freedom:

P-value Type:

P-value: 6.171303e-9

Chi-square result for Use of street addresses by age (respondents answer “No”)

Results

Chi-Square (χ^2) Value = 5.9445

Chi-Square Calculator – Results			
Categories	Observed O_j	Expected E_j	Chi-Square Component $(O_j - E_j)^2 / E_j$
Category 1	2	1.78	0.0272
Category 2	86	106.48	3.9391
Category 3	103	95.84	0.5349
Category 4	132	118.9	1.4433
Total:	323	323	5.9445

P-Value from Chi-Square Calculator

Use this tool to calculate the p-value for a given chi-square value and degrees of freedom.

Chi-square Value:

Degrees of Freedom:

P-value Type:

P-value: 0.688343

4.5.4.2. Use of street address by education attainment

Furthermore, analysis of the survey results revealed that a sizeable proportion of respondents (6.04 percent) who had no formal education claimed they do not use addresses. A considerable number (2.19 percent) who used the addresses were people with high school diploma whilst 5.22 percent and 3.29 percent had bachelor’s degree or higher and basic education respectively as shown in table 4.6.

On the other hand, a greater proportion from the total (89.29) they didn’t use addressing system 6.04 were no formal education (83.25 percent) of respondents who were literate asserted that they do not rely on addresses in giving out locational information as well as navigating the urban area. The Pearson chi-square for the association between educational attainment and address usage indicated a p-value (0.22848) that is greater than the chosen significance level (0.05), meaning that there is no association between educational attainment of respondents and use of the addresses. This therefore implies that irrespective of educational background, majority of residents are still not attuned with the street addressing system.

The fact that there is no statistically significant relationship between educational achievement and the adoption of street addressing/house numbering ($p > 0.05$) aligns with earlier studies conducted on formal addressing systems in informal settlements. This has been found to encompass more than the mere demographic factors of individuals related to the availability of a city implementation plan, street mapping, tenure security, and visible connections to services as being pivotal in the adoption of addressing systems (Farvacque-Vitkovic, 2003). In fact, the manuals highlight the fact that more educated individuals can still shun house numbering if the city implementation plan fails to come together or the house numbering program does not offer any immediate rewards (Farvacque-Vitkovic, 2003).

Moreover, the application-oriented white papers add that the relevance of the address system can only be realized when the addresses are used in service delivery. Formal education does not alone guarantee the implementation of numbering or addressing if the connections mentioned above are not made (Universal Postal Union, 2011). In the studies conducted on the informal settlements, the main obstacles identified more often than not relate to lack of awareness, informal tenure of the land, lack of numbering, road accessibility, or lack of registry rather than educational levels (Sliuzas, 2004).

The non-significant p-value found in the study reflects a general trend: the fact that education can play some role under some circumstances notwithstanding, the factor of education is neither sufficient nor required as a predictor of the usage of addresses under circumstances when the requirements of structure and service links are not in place. Here, the implication of the finding in the study would seem to suggest that the finding makes a further case for the importance of improving the infrastructure of the addressing system rather than investing in improving educational levels.

Table 8: Use of street addresses by educational attainment

Educational Attainment	Components of contingence	Use of Street Addresses				Total	
		Yes	%	No	%	Count	percentage
No Formal Education	Count	0	0	22	6.04	22	6.04
	Expected Count	2.36		19.64			
	Residual						

Less than high school	Count	8	2.19	98	26.93	106	29.12
	Expected Count	11.36		94.64			
	Residual						
High school diploma or equivalent	Count	19	5.22	97	26.65	116	31.87
	Expected Count	12.43		103.57			
	Residual						
Bachelor's degree or higher	Count	12	3.29	108	29.68	120	32.97
	Expected Count	12.95		107.14			
	Residual						
Total	Count	39	10.71	325	89.29	364	100

Source: Field Survey, (2025)

Chi-square Calculator result for educational attainment (respondents answer “yes”)

Results

Chi-Square (χ^2) Value = 32.3889

Chi-Square Calculator – Results			
Categories	Observed O_i	Expected E_i	Chi-Square Component $(O_i - E_i)^2 / E_i$
Category 1	5	10	2.5
Category 2	40	20	20
Category 3	25	45	8.8889
Category 4	30	25	1
Total:	100	100	32.3889

P-Value from Chi-Square Calculator

Use this tool to calculate the p-value for a given chi-square value and degrees of freedom.

Chi-square Value:

Degrees of Freedom:

P-value Type:

P-value: 0.228483

Activate M
Go to Settings

Chi-square Calculator result for educational attainment (respondents answer “No”)

Results

Chi-Square (χ^2) Value = 0.8259

Chi-Square Calculator – Results			
Categories	Observed O_j	Expected E_j	Chi-Square Component $(O_j - E_j)^2 / E_j$
Category 1	22	19.64	0.2836
Category 2	98	94.65	0.1186
Category 3	97	103.57	0.4168
Category 4	108	107.14	0.0069
Total:	325	325	0.8259

P-Value from Chi-Square Calculator

Use this tool to calculate the p-value for a given chi-square value and degrees of freedom.

Chi-square Value:

Degrees of Freedom:

P-value Type:

P-value: 0.024648

4.5.4.3. Duration of stay in using street addressing

Use of the street addressing system by the respondents from the study area is not always determined by the duration of their stay. The chi-square test was applied in order to test the association between use of street addressing and duration of stay. The chi-square value obtained from the analysis was 10.3265 while the p-value was 0.933505. The test at the .05 level of significance indicates that there is no statistically significant relationship between the two variables. Put otherwise, the duration of the stay of the residents does not seem to make any difference concerning the use of the street addressing system. The extremely high p-value that is way above the .05 threshold provides strong evidence towards the view that use of the addressing system by the inhabitants is independent of their duration of stay.

Even longtime users tend to use customary landmarks, directions, or personal neighborhood information rather than official addresses. This reveals that although prolonged stay tends to bring a feeling of inclination towards the area, such does not necessarily enhance usage of house numbers as well as street names. The trend thus indicates that exposure, advocacy, and efficiency of the system tend to bear more influence on awareness as well as usage of the addressing system rather than the duration of stay.

The result of this study shows that there is no significant relationship between the stay duration and the application of street addressing and house numbering schemes in the study area. This was consistent with other studies conducted in different cities.

For example, in the study on the urban address systems in Nigeria, Aduwo et al. in 2016 demonstrated that residency in the environment does not in itself equate to efficient usage of the address systems, where most people in the region depend on landmarks for direction rather than addresses. Also, in the study by Ndukwe and Eze in 2018 in Enugu, it was revealed that most people who were resident in the neighborhood for ages relied on personal acquaintances rather than addresses in giving directions in the neighborhood.

Also, Hagen (2017), in conducting his study on addressing systems in urban Tanzania, observed that exposure to digital and city services associated with formal addresses was a more significant factor in adoption than demographic ones such as age and length of residence.

Therefore, by triangulating these studies, it is very clear that the usage of street addressing schemes finds stronger correlations with awareness campaigns and institutional consistency rather than the length of stay in the place by the residents. Length of stay might help in creating familiarity with the place, but it would not help in the utilization of address indicators without functional and accessible addressing schemes in place. The below table shows the duration of stay in the study area.

Table 9: Duration of stay in using street addressing:

Duration of living in the place	Components of contingence	Use of Street Addresses				Total	
		Yes	%	No	%		
0-5 years	Count	12	3.3	4	1.098	16	4.39
	Expected Count	1.714		16.96			
	Residual						
6-15 years	Count	9	2.47	81	22.25	90	24.7
	Expected Count	9.643		80.357			
	Residual						
16-30	Count	8	2.2	94	25.82	102	28
	Expected Count	10.93		91.07			
	Residual						
Above 30 years	Count	10	2.75	146	40.1	156	42.9
	Expected Count	16.71		139.29			
	Residual						
Total	Count	39	10.7	325	89.29	364	100
	Expected Count						

Source: Field Survey, (2025)

Chi-square result for Use of street addresses by duration of stay (respondents answer “yes”)

Results

Chi-Square (χ^2) Value = 65.2524

Chi-Square Calculator – Results			
Categories	Observed O_i	Expected E_i	Chi-Square Component $(O_i - E_i)^2 / E_i$
Category 1	12	1.714	61.728
Category 2	9	9.643	0.0429
Category 3	8	10.928	0.7845
Category 4	10	16.714	2.697
Total:	39	38.999	65.2524

P-Value from Chi-Square Calculator

Use this tool to calculate the p-value for a given chi-square value and degrees of freedom.

Chi-square Value:

Degrees of Freedom:

P-value Type:

P-value: 9.934465e-13

Chi-square result for Use of street addresses by duration of stay (respondents answer “No”)

Results

Chi-Square (χ^2) Value = 10.3265

Chi-Square Calculator – Results			
Categories	Observed O_i	Expected E_i	Chi-Square Component $(O_i - E_i)^2 / E_i$
Category 1	4	16.96	9.9034
Category 2	81	80.357	0.0051
Category 3	94	91.07	0.0943
Category 4	146	139.285	0.3237
Total:	325	327.672	10.3265

P-Value from Chi-Square Calculator

Use this tool to calculate the p-value for a given chi-square value and degrees of freedom.

Chi-square Value:

Degrees of Freedom:

P-value Type:

P-value: 0.933505

4.5.4.4. Use of landmarks and dependence on local knowledge

As described by Lynch (1960), landmarks are points of references considered to be external to the observer which may vary widely in scale. There is the tendency for residents who are more familiar with a city to rely on systems of landmarks as a guide in navigating the built area. Since the use of landmarks involves the singling out of one element from a host of possibilities, the key physical characteristic is its singularity, an aspect that is unique or memorable in context (Lynch, 1960). In that, a landmark should be more easily identifiable and unique to a particular location. Similar to what pertains in most urban areas in developing countries, many residents within the study area depend on the use of descriptive addresses which encompasses the use of landmarks. It is observed from the survey that, a greater number of respondents (49.73) who do not use addresses asserted they use landmarks in giving out locational information. Many of these landmarks consist of temporary structures such as kiosks, taxi stations or frequent activities that dominate a particular area. For example, some of the notable descriptions of locations provided by some respondents included “behind the yordanos blue”, “near the red cross”, “Hawelti taxi station” ,“opposite to my cafe” and many more.



Map 5: Widely used land marks in the study area Source: Field Survey, (2025)

4.6. The Effectiveness of the Addressing System for efficiency (user-friendly) of street addressing and house numbering

An effective addressing system refers to one that is backed by a comprehensive database on the built environment whereby information gathered can be associated with an address to make it easily locatable. In measuring the effectiveness of the system for urban management, some of the parameters used include the impacts of the existence of a standardized addressing system on urban information systems and data exchange amongst institutions, delivery of urban services such as water, electricity, and courier services. Others include prompt response to emergency situations such as fire outbreaks, crime and accident scenes.

Traditionally, people have used addresses to direct themselves to buildings and their occupants. However, the advent of computers has opened up a whole new range of possibilities including routing and vehicle navigation, spatial demographic analysis, utility planning, and many others. The result has been a renewed interest in and demand for a standardized addressing system that facilitates interoperability while taking into consideration the local cultural characteristics.

In order to maximize the full potential of the addressing system towards effective livability, there is the need to integrate the various addressing platforms with the street addressing system as this provides an opportunity to create a map of the city; conduct a systematic survey that collects targeted information about the city and its population; as well as set up an address database on the built environment; whereby information gathered can be associated with an address to make it easily locatable (Farvacque Vitkovic, 2005; Coetzee et al., 2008; Coetzee et al., 2011; Njoh, 2009; Dharmavaram & Farvacque Vitkovic, 2017).

Due to the absence of an efficient addressing system within the area, various institutions have developed their own system of identification to aid in their operations. My interview with various service providers revealed that, all of them first and foremost use landmarks to facilitate their mode of identification of target areas and destinations. For instance, Menen hotel, yordanos blue etc for purposes of identifying their customers, all of them they do not use of GPS coordinates and coding System of the localities and properties within the area. They give successive numbers to addressing their customers.



Fig 9. Unaddressed and narrow streets (Source: Field survey, (2025))

Furthermore, my interview with the police service and institutions such as the fire and ambulance services revealed that, the delivery of emergency services such as attendance to crime and accident scenes, as well as fire outbreaks within the study area is often hampered due to increase in response time as a result of the lack of a functional addressing system. For instance, according to a fire officer:

“Due to the lack of efficient addressing system, we find it difficult in locating the right place an incident occurs on time. Sometimes, we get missing and this affects our response time”



Fig10. Unmanaged streets in the study area (Source: Field survey, 2025)

In addition to reaching vulnerable areas rapidly, emergency services need to be able to identify the people involved in a crisis. Information detailing house numbers and residents is crucial in this regard; without such data, calculating the people affected becomes difficult, especially in the informal settlements.

In summary, the findings of the study indicate that the address system within the study area has had maximum impact on the management of the urban area with regards to facilitating data interoperability among institutions, delivery of urban services such as water, electricity and courier services, as well as prompt response to emergency services such as fire outbreaks, crime and accident scenes. Due to the lack of efficient and standardized addressing system, many service providers such as water supply, Electricity as well as many courier service agencies continue to use their own addressing systems to identify properties to facilitate their operations, thus leading to a multiplicity of addressing systems. Most of these institutions also rely on the use of landmarks which impede service delivery especially in the unplanned settlements.



Fig 11. Unaddressed Households in the study area (Source: Field survey, 2025)

4.6.1. Visibility of addresses (street signs and house numbers)

The movement of people and goods from one geographical location to another within the study area is a daily affair. In well planned urban centers all over the world, this is achieved with ease and forms part of the basic enablers for the functioning of the city. This ease of movement is also partly complemented by the availability of appropriate street signs and property numbers at every part of the city. This is also connected to the “*physical environment*” requirement in the design of an efficient addressing scheme which refers to the actual location of an address and its visibility to people (Barr, 2007; Lind, 2007; Coetzee et al, 2011; Ditsela, 2017). The study revealed that although minority (21.29 percent) of street numbers had visible signs of street names in their places but residents were not familiar with the addresses, only 0.82 percent indicated that there were visible signs of house numbers in their places of residence which were located in old hidmo buildings (with house number 175,530 and 156) fitted during Dergu Regime within the study area. 99.18 percent of parcels indicated there were no visible signs of house numbers in their places of residence. The below image shows the house number in the area.



Fig 12: Existing house number in the study area (Source: Field survey, (2025))

Table 10: Visibility of Street Addresses (Source: Field Survey 2024)

Visible signs of street			Total	signs of house numbers		Total
	Yes	No		Yes	No	
Number	33	122	155	3	361	364
Percentage	21.29	78.71	100	0.82	99.18	100

Source: filed survey, (2025)



Fig 13: Visibility of Street Addresses source: survey data (2025)

4.6.2. In effectiveness of color coded number plates

While moving through the study area, there emerges an interesting finding: tiny plates of metal on walls and on doors, in two strong colors, namely green and blue. At first sight, these plates appear ordered with an eye-catching aesthetic appeal. Green stands here for even numbers while blue represents odd ones. This principle is simple and neat. It is an approach which has the ability to assist with direction, should it work as intended.

However, the paradox becomes evident in this situation. These plates, regardless of their intentional design, fail to fulfill their purpose for the intended audience. Inquire with a local resident about the significance of the colors, and it is probable that you will encounter confusion, reluctance, or even amusement. For the majority, these plates represent little beyond mere background noise. They are physically present, yet mentally absent. They are visually perceived but not comprehended.

It is like having a map with the things inscribed on it set in an unfamiliar language. The information is apparent, understandable to planners and engineers but indecipherable to the community who are to benefit from it.

When a Beneficial Concept Remains Unutilized

The idea of using colors as a tool of distinguishing numerical values is in itself flawed. In fact, it has the potential to be very ingenious. Imagine a case where a delivery driver is lost in an unknown neighborhood. Instead of working with tiny numerical figures, they might use color prompts: green as the left, blue as the right. Alternatively, picture a mother giving navigational directions to a visiting relative: "Look out for the green plate placed on the second house; there will be no mistaking it." This method is simple, effective, and elegant.

In order for a system to operate efficiently, there are two paramount components necessary: communication and clarity. Without them, innovative ideas might never reach their full potential. In the case here, the groundwork was established, funds were designated, and the work was done; but there was a failure to ask questions about whether or not people understood the reasoning behind the actions they were instructed to take. It's like building a beautiful new bridge across a river but having the ways onto it on either bank overgrown with weeds. While the bridge is there, it is still practically unavailable to the general public.

The Cost beyond Money

The scheme took an enormous amount of time, money, manpower, material. The authorities must have considered it a high-tech solution, something to put the town on the same level with other well-developed cities. But what's the use of a system which lies idle?

This situation represents not merely a financial setback; it also signifies a deterioration of trust. Whenever a resident observes those plates and experiences no sense of affiliation, the chasm between urban planners and the community expands. The plates transform into mute symbols of a project that prioritized aesthetics over functionality. Once individuals lose confidence in these systems, it becomes increasingly challenging to persuade them in subsequent efforts. If a new addressing initiative is introduced in the future, will individuals readily accept it? Or will they dismiss it, believing, "This will be yet another failure, akin to the colored plates?"

This is reminiscent of the teacher who takes months planning lessons but never verifies what the students comprehend. As the months pass, students tune out because the learning does not exactly resonate with them.

The Human Factor of Navigation

Consider the everyday challenges that arise from this situation. An individual attempting to locate a friend's residence may inadvertently pass by the appropriate dwelling multiple times, as the address plate lacks significance for them. A taxi operator might repeatedly contact a fare for guidance, thereby inefficiently utilizing both time and fuel resources. Retailers anticipating deliveries may experience annoyance when delivery trucks struggle to locate their premises with ease.

These are not minor disruptions. They permeate everyday existence, resulting in the squandering of time and the introduction of unwarranted anxiety. A Street addressing system is designed to facilitate daily activities, transforming ambiguity into comprehensibility. However, when this system malfunctions, the confusion is exacerbated. Individuals revert to ambiguous points of reference: "turn at the large tree," "look for the yellow gate," "it's adjacent to the store with the red sign." While these may be beneficial in the immediate term, they prove to be inconsistent and ineffective over an extended period.

This is like having a smartphone with the latest software but having a broken screen and dysfunctional touch capabilities. There is existing technical capacity but flawed operational capability.

Lessons in Communication

The lessons derived from the shortcomings of this plate system emphasize the significance and potential pitfalls of effective communication. A message that remains uncommunicated holds no value whatsoever. Consider a scenario in which, prior to the installation of the plates, community gatherings, informational posters, radio broadcasts, or even direct outreach efforts had occurred. Individuals could have been informed: "Green indicates even numbers, blue signifies odd numbers. Here is how you can engage with it." With this basic understanding, the initiative might have successfully embedded itself within the community's consciousness.

On the contrary, the plates were installed inconspicuously, as if the work was finished with the actual physical operation of affixing them to the walls. But in reality, the critical work begins after installation: enabling people's understanding, use, and incorporation of the system as their property. Without this final phase, the whole enterprise becomes an empty shell.

The Emotional Disconnect

The issue becomes especially significant when reference is made to the emotional distance between people and their allotted plates. In many societies, identifiers like house numbers and street names carry deep personal significance. They are but a necessary component of the way people position themselves in the larger social framework. A street name is capable of evoking pride, memory, and belongingness. Likewise, a house number might summarize a family's history: "This is the house where my children were born, the place we've borne with us all these years."

These plates, in such study location, bear no such significance. These plates are soulless symbols. Pride is exchanged with confusion. Sense of belonging is traded with feelings of imposition. This emotional disconnection makes people do more than just neglect the plates they forget them.

It is like planting a tree without nourishing it. The tree might survive for a short while, but without care, it shall never bear fruit.

What's Next: From Symbols to Solutions

If there's a single lesson from all of this, it's that effective systems should also be practical and human-oriented. The colored plates may have appeared to look high tech, but they were never people-friendly. Real effectiveness occurs when a system uses the community's talk in straightforward, noticeable, and memorable ways.

Consider the implications had equivalent resources been allocated towards a more straightforward system, comprising larger plates displaying both numerical and color-coded information, accompanied by public awareness initiatives instructing individuals on their utilization, and consistent follow-up to guarantee both visibility and upkeep. The present-day streets would exhibit a markedly different ambiance. Inhabitants would be able to indicate with assurance: “Indeed, I reside at the green 24.” Guests would experience seamless navigation, resulting in a more structured rhythm within the city.

But here, the basic lesson is: a system without understanding is ultimately ineffective. An information-display sign lacking information is simply an application of color to a surface. The colorful panels in the study area go beyond being just disposal items; they are symbols of missed potential, conveying the realization that transparency, awareness, and connectivity are as critical as design and economic investment. Figure below shows the ineffectiveness of the colored numbered plates in the study area.



**Figure 14 shows the ineffectiveness of the coloured numbered plates in the study area
Source field survey, (2025)**

4.7. Challenges encountered in giving out Locational Information and Navigating the Study area

From the analysis, it is evident that the situation of very limited visible street name and house number signs has led many to find ways and means to navigate through the city. Standard referencing has given way to subjective means of directions, often created out of years of interaction within the city. These means of giving out locational information and navigating The study area is associated with a number of challenges which has serious implications for effective urban management. Majority of respondents (364 out of 364) enumerated some of the challenges encountered in giving out locational information which often results in unnecessary delays and confusion in locating addresses especially under emergency situations such as during fire outbreaks, and prompt response to crime and accidents scenes. For instance, one respondent asserted that,

“Most of the time, it takes a long time for the ambulance service to reach us in times of emergency due to the lack of residential addresses”.

Out of this number (81 out of 364) of respondents, 22.25 percent underscored the Lack of interpretation of the numbers street names and house numbers whilst 50.55 percent enumerated the problems associated with temporary nature of landmarks used. Also, a sizeable proportion (23.9 percent) highlighted the numerous challenges encountered as a result of Lack of visible signs of street names and house numbers, and also 3.3 percent enumerated as a result of reliance on local knowledge of the urban area which mainly

bordered on seeking assistance from people. For instance, one respondent recounted that “when I ask people for directions to a particular location, they give me wrong directions, so I think we (residents) should be sensitized on the addressing system”. Although, many residents are used to descriptive addresses and feel comfortable when narrated to on how to get to a particular location, there is a contradiction that even though some people know how to get to a certain location, giving directions to others can be a challenge as people interpret descriptive directions according to their orientation or local knowledge.

Table 11: Challenges encountered in locating places

no	Challenges encountered in locating places	Count	Percent (%)
1	Lack of interpretation of the numbers and signs	81	22.25
2	Temporary nature of land marks used	184	50.55
3	Wrong directions from people	12	3.3
4	Lack of visible signs of street names and house numbers	87	23.9
	Total	364	100

Source: field survey, (2025)

4.7.1 Perception on the Implementation of Street Naming and Property Addressing System

Regarding the general perception of respondents concerning the implementation of the street addressing exercise, 73.9 percent rated the project done before as not important with the major reason being that, the system facilitates navigation within the city and also, crucial in this contemporary times due to the rapid urbanization the study area is experiencing but no one can interpret the numbers rather it was overwhelm the governmental and the public budget. On the other hand, 6.59 percent viewed the implementation exercise (not the street numbers but the names given by the name of the martyrs) as very important the reason for their perception was they remember the death of the hero martyrs of TPLF.

Thus, although most respondents are not familiar with the addresses done before, but the majority of them consider the street address system as an important tool that has the potential to propel socio-economic development.

Table 12: Perception of residents

Perception of residents					
	Very important	important	Not important	In different	total
count	24	48	269	23	364
percent	6.59	13.19	73.9	6.32	100

Source: field survey,(2025)

4.7.2 Lack of Coordination between Stakeholders

A significant institutional challenge is the lack of alignment between the primary entities involved the municipality, land administration office, water supply authority, and Telecommunications Company. Each of the institutions designed and operated using their own independent reference system or base map. The water supply institution, for instance, divides the city into pressure zones, while the telecom sector uses an address map of the city that is completely unrelated to the municipal map. The absence of any form of collaboration between the institutions is one of the reasons an integrated and standardized system for addressing the city has yet to be developed.

Weak Institutional Ownership

In the addressing project, although there were a series of planned activities that involved the integration for the addressing system, the ownership and responsibility to the municipality departments was never legally formalized. On top of that, insufficient personnel, the absence of a dedicated monitoring unit, and scarce budget provision caused the system to decay. There were no processes that involved the addressing system integrated by the municipality, which left the system to stagnate.

Inadequate Policy and Legal Framework

The city has no robust, enforceable policy, or system of by-laws that provides for the maintenance of the city's addresses, or the alteration of the numbering of addresses in circulation.

Without legal requirements, property owners and businesses had no obligation to keep or display numbers. There were also no fines or rewards to encourage this. Consequently, due to lack of attention and reconstruction activities, the system dispensed itself entirely.

4.7.3 Technical and Operational Challenges

Poor Base Map Quality and Inaccurate Data

At the time of implementation, the base map and spatial data were not regularly updated. As a result, there were discrepancies between the field situation and the map. In the years that followed, the addressing system remained static while the base map became physically outdated due to new buildings, road changes, and other redevelopment initiatives in the CBD. Consequently, irrelevant and outdated numbers confused people.

Lack of Standardization and Clear Guidelines

There was no standard national or international model for the numbering and naming system. Mixed arbitrary names and no categorization of road types were done, but given all the names, “street” while others had arbitrary numbering schemes set by the consultant. The lack of clear guidelines on the order of numbering, street naming, and signage placement rendered the system difficult to interpret. The lack of alignment in later development projects with the initial design compounded the inconsistency.

Maintenance and Updating Problems

Addressing systems need a high level of ongoing maintenance, especially in urban centers where there is frequent demolition and reconstruction. (Njoh, Chie, and Soh-Agwetang, 2021) No team was tasked with updating new buildings, fixing mistakes, or replacing signs that were damaged. When buildings changed hands or were renovated, old signage was taken down and never replaced. The lack of digital records combined with the lack of physical upkeep accelerated the breakdown of the system.

4.7.4 Financial and Resource Constraints

Restricted Municipal Budget

The municipality is permanently strapped for cash which severely limits its capacity to implement any long-term initiatives. The addressing initiative relied heavily on external funding and on consultants. During and after the first phase of the project, no funds were allocated for follow-up the activities of replacing signboards, surveying, or training staff.

Materials and Logistics

Durable materials such as signboards, mounting poles, paint, and blank data storage devices are required to implement any addressing system. The original signboards were flimsy and non-weatherproof and, therefore, deteriorated. Faded plates became unreadable and were left as is to deteriorate. The costs of logistics related to field verification and community sensitization were ignored, leaving the program uncompleted.

4.7.5 Community and Social Challenges

Low Public Awareness and Engagement

From the planning to the implementation phases, community participation was minimal. Residents were neither properly briefed on the objectives for, nor the benefits of, street addressing, and thus, saw house numbering as pointless or temporary. Owners of old, deteriorating signs were under the impression that replacing such signs was the government's obligation. Low levels of awareness resulted in the unsuspecting public not employing or requesting address-based services. As a result, delivery services, local shops, and institutions continued using landmarks and informal directions, rendering the formal system in practice as unnecessary.

Resistance to Change

In some instances, property owners have been hesitant to permit signboards to be attached to their walls for fear of damage or visual aesthetics. Others doubted the need for numbering as they relied on personal networks or direct routes to their destination. The lack of visible short-term benefits further, which discouraged compliance, led to the downfall of the initiative.

4.7.6 Urban Dynamics and Environmental Factors

The Study area is grappling with some serious challenges when it comes to setting up and keeping a reliable street addressing and house numbering system, all thanks to the rapid changes happening in urban life. This area is bustling with activity, marked by heavy traffic and constant evolution, where you'll often find informal structures like plastic shades, kiosks, and temporary stalls taking over sidewalks and street edges. These unauthorized setups throw a wrench in the planned street layout, block building frontages, and frequently hide or even replace visible address signs. The unregulated nature of these structures, which can be easily

moved or changed, makes it tough for authorities to assign and maintain consistent address numbers. On top of that, narrow access roads and irregular building patterns further limit visibility and accessibility for the teams tasked with numbering. This whole situation is made worse by environmental issues like waste buildup, flooding during heavy rains, and poor upkeep of public spaces, all of which lead to the deterioration of address signs and muddle the clarity of street names. The mix of informal urban development, ineffective environmental management, and a lack of enforcement of city regulations has really taken a toll on the reliability and permanence of the addressing system in the CBD. Consequently, finding your way around and identifying locations in this lively area has become increasingly tricky, underscoring the urgent need for a well-rounded approach to urban planning and regulation enforcement.

4.7.7 Digital and Technological Problems

No Digital Address Database

The first system used paper and didn't connect to GIS or city info systems. This meant address information was hard to find, change, or share between departments. Today's address systems use digital tools that link location info with property, tax, and utility records. Because the old system lacked this digital base, it couldn't be updated or kept running.

Limited Tech Skill

City staff as well as the sub city staff didn't have GIS, database management for showing the already established names and numbers, or location analysis training. Because there weren't enough skilled people, data updates and system upkeep didn't happen often. This skill shortage also made it harder for the city to work with other services like telecom or water companies.

4.7.8 Street addressing and public safety challenges

The survey results reveal that poorly prepared street addressing and a lack of house numbers directly affect the effectiveness and promptness of emergency response activities. Out of 364 respondents, 46 (12.6%) reported that they had experienced emergencies like fires, electrical accidents, or crimes committed by gang members. In all of those cases, respondents reported that their experiences were marked not only by the initial surprise of the accident itself but also by a good deal of frustration as a result of delayed access to aid. Respondents explained that

when they called the police department, fire department, or ambulance services, the reactions were frequently slow to come usually only following incidents that caused a lot of damage.

This time loss constituted mainly of difficulties experienced by rescue teams in identifying affected house locations. When no house numbers were visible or no familiar street labels were given, victims were obliged to rely on vague descriptions like "the house behind the market" or "next to that big tree near the road bend." While such terms may be familiar to residents of that place, to emergency teams working against time and pressure, such indications can be vague and unhelpful. For example, in a recorded fire incident, neighbours tried to guide the fire brigade through landmark descriptions; however, the fire truck drove through that section of the location for nearly twenty minutes before it found the house. By that time, much of the house had already been destroyed.

This exemplifies how small lapses in reaction time can turn a manageable situation into a large catastrophe. In criminal situations, respondents reported that police officers often arrived later than the criminals have escaped from the crime scene. Similarly, in electrical accidents, the inability to quickly de-energize and administer immediate medical attention made families vulnerable to further dangers. These events reaffirm the fact that a confusing addressing system creates not only daily nuisances but also compromises the core of community protection. A working addressing system is like a compass that will guide emergency responders straight to the right location. Without it, those in distress and service suppliers are quite literally "searching in the dark." This research's results drive home that if cities continue without proper street designations and house numbers, lives as well as property will continue to be put at risk. As such, addressing systems improvement is not so much a matter of bureaucratic formality, but rather an absolute life-saving priority.

4.8. Evaluation of the Potential of the Street Addressing and House Numbering System in the area

The Study area (Kedamay weyane) is the CBD area of the town exhibits a wide array of opportunities for both the establishment and revitalization of an effective street addressing and house numbering system, despite the existing shortcomings that currently plague it. This particular area, the kedamay weyane, is arranged in an almost grid-like pattern, which happens to be one of the most favorable and advantageous urban layouts for the successful implementation of a comprehensive addressing system. The grid blocks that characterize this

layout allow for the easy and logical sequencing of house numbers and facilitate the straightforward allocation of street names, which in turn reduces complexity not only for the residents who live there but also for the various service providers who operate within the area. This inherent urban structure that the CBD possesses provides a strong and stable foundation upon which a modernized and more efficient addressing system could be effectively rebuilt and restructured.

One of the great opportunities that can be leveraged lies in the fact that a street addressing initiative was initiated within the study area about 15 years ago. Although true that such an initiative lacked the support that could have maintained its weakness, and consequently its results have gone by the wayside over time, it does mean that there already exists a body of work of sorts in terms of planning efforts, community education, and existing administrative data. Although the reality that only 3 parcels of land from a potential of 364 continue to have the old house numbers assigned during dergue regime from that earlier effort the numbers are written in the owners ID as active house number. This only highlights the best that could be done by that earlier effort, the very existence of that earlier effort does mean that there exists institutional memory that could be reappraised and perhaps revitalized. That there is an opportunity for local authorities to examine and glean valuable lessons from the failure of the earlier effort; ascertain the very reasons why such an effort failed e.g., problems with poor street signage that made such signage hard to read; ambiguity inherent in the numbering system; poor public participation processes is that such accumulated wisdom could be used by such authorities to craft a stronger and more resilient system of addressing going forward.

The opportunity presented here also significantly extends to the potential adaptability of the community as a whole. Although the current residents may not be fully aware of or actively utilize the existing plates that are intended for navigation purposes, their support on informal methods to determine their locations indicates a strong and practical need for a reliable and effective addressing system. Once a clear, comprehensive, and user-friendly system is introduced and made accessible to everyone in the community, it is highly likely that the residents will quickly embrace and adopt it, as it would greatly simplify the process of navigation, provide robust support for local businesses, and enhance the efficiency of delivery and emergency services. The lack of a functional system in place today results in a significant gap in service and utility that a new initiative could promptly address, leading to visible benefits for all members of the community.

Economically, the sub city will greatly benefit from a modernized addressing system. Being the center of commerce and government, the area draws businesses, service industries, and visitors who need good directions leading to designated areas. Clearly maintained street names and house numbering will enhance customer access, spur business investment, and enhance the CBD image as a sophisticated, organized city center. Public services like mail delivery, ambulance, billing, and tax collection will also become more effective after parcels become sequentially numbered and visible.

The grid structure also offers an intense opportunity of integrating modern digital mapping technologies within its framework. The whole of the city can be incorporated easily within Geographic Information Systems (GIS), which are essential tools for diverse uses such as phone navigation programs and databases that play an essential role in emergency response operations. Such a system's implementation will yield long-term dividends that will outlast the immediate user base of the city's residents; rather, its effects will drop down across users such as institutions, investors, and visitors. The opportunity that arises because of the structure therefore goes beyond the installation of actual plates and signage; rather, it also involves the crucial exercise of integrating the CBD with larger smart city programs and e-governance initiatives that are being conceived in city planning today. Overall, although the existing condition of street numbering and house numbering of the CBD is poor, there are good opportunities for upgrades. The grid block pattern, the inheritance of an earlier attempt at addressing, the economic contribution of the CBD, as well as the increased need for effective means of navigation and service provision present good opportunities for rebuilding the system. With renewed energy, public sensitization, and harmonization with the latest technologies, the CBD can make its system of numbering an instrument of efficiency, accessibility, and urban development.

4.9. Triangulated the findings with various institutions

Triangulation was utilized to guarantee the validity and thoroughness of the study findings. Data were collected from residents, direct field observations, and various institutional sources. These included records and maps from the municipality, telecommunication service providers, and the water supply office. Each of these kept its own address or spatial data. I was able to check the accuracy of the information, find places where the data didn't match up, and look at how the lack of integration between sectors affects the performance of the street addressing and

house numbering system in the study area by comparing and combining these different datasets. The detail is described below.

Table 13: Triangulation of data with different institutions

Institutions	Existing Situation	Identified challenge System
Water Supply	The distribution system includes interconnected reservoirs and pipes laid out along side roads. Mekelle town including Aynalym are administered in one system where as Quiha has a different one Distribution is carried out based on their own addressing system. They have divided the town in to 4 zones (called presser zones) which does not follow the existing or previous administrative divisions of the town. To identify their customers, they use customer identification number (CIN).	The difficulties observe as a consequence of lack of commonly adopted addressing system is frequent breakdown of pipes, get valve etc. (distribution network).Communicating with other utility providers and non-technical person to identify the location of an important feature of the system is another challenge identified.

Institutions	Existing Situation	Identified challenge System
Electric Power	The Mekelle substation serves the town proper and surrounding settlements. As is the case for the water supply system, electric supply they use their own addressing system. Accordingly, the town is divided in to 3 centers and each customer has book and account number. Sequential numbers are given based on the density of settlement, the denser the settlement the more chronological the numbering. Land marks like buildings, churches/Mosques etc. are frequently used to describe location when reporting power interruption, maintenance and demand for new connection.	Because construction pace and request for new connection are not synchronized assigning account number to customers is challenging, redundant and un chronological The existing system is recognized by technical personnel only.

Telecommunication	The Mekelle branch of the Ethiopian Telecommunication corporation provides various services. Presuming that addressing is important to land based line services the study specially focuses on that. Land line telecommunication services has its own system adopted globally i.e. Exchange-Main Distribution Frame (MDF)-Cable Cabinet (CC) - Terminal Box (TB)-customers. This system is understood by technical personnel	The biggest challenge faced during service delivery is lack of citywide addressing system. The town not having well defined addressing system which is exacerbated by frequent change of administrative boundary and name within the city has made identifying customers difficult.
Postal services	The Ethiopian Postal Service agency gives service mainly based on box system. It is only through EMS that they provide door to door service.	No address system to provide better customer friendly (door to door) Service.
Fire Brigade	The institute has three cars but only one is functional. Currently the system used by the office is land mark like known establishments, houses and the like. Though the current system is not reliable most of the employees know their way around in the different neighborhoods	No addressing system to clearly identify clients.

Source: field survey, (2025)

CHAPTER FIVE

5. Conclusion and Recommendations

5.1 Conclusion

In this study, assessment the implementation, performance level, perception of residents and challenges associated with the street addressing and house numbering process in Mekelle's Kedamay Weyane Sub-City were evaluated. The primary objective was to identify why the addressing system program has failed to serve its purpose and the level of human, physical, and digital representation involved in it.

The study employed qualitative and quantitative methods to seek information from households, local authority members, and relevant service providers such as telecommunication companies and water supply organizations. The data illustrates that there is institutional fragmentation, inadequate physical presence, technological connectivity, and absence of community engagement. When considered together with data from related studies in other settings, it becomes apparent that there is validity in concluding that the situation in Kedamay Weyane illustrates the trend of responding to systemic failure in most developing cities.

Human, Physical, and Digital Representation Failures

The study has shown that each of the three aspects of the addressing scheme: human, physical, and digital, is underperforming. There is little institutional coordination, data management is not integrated, and most physical components, such as signposts and house numbers, are either missing or destroyed.

This is consistent with what has been experienced in other cities. The study on the national addressing system in Saudi Arabia showed that only 25.8% of the respondents were able to recall their addresses, while less than 16% relied on the system for routing. The low usability was attributed to the absence of institutional coordination, communication with the inhabitants, and consistency in the physical aspects of the addresses (Al-Sobhi & Alawad, 2024, ISPRS International Journal of Geo-Information). There is also agreement that most cities in Turkey are characterized by outdated address maps, untrained personnel, and inadequate GIS capabilities, resulting in duplications and confusions in addresses (Güngör & Yomralıoğlu, 2020).

In Kedamay Weyane, the same problems are experienced. The telecommunication company, the water company, and the concerned local authority keep different maps of addresses, which are not shared or integrated in any way. There is no working GIS database, nor any unit to keep the data regularly updated. The absence of name signs and house numbers has impaired orientation and access to services in physical terms. The connection between results and the general literature confirms the assumption that it is imperative to have an efficient institutional base and data management to implement an efficient addressing system.

Lack of Coherent and Structured Addressing Scheme

The major flaw in an organized and rational address system is observable in the study area. Only three out of 364 houses surveyed were marked with their original addresses, with new houses unnumbered and the old signs fading or torn down in some areas.

Such problems can be seen in Ghana's capital city, where the lack of complete and official addresses makes it difficult for the couriers to perform their duties properly. In Accra, it was discovered that the city was prone to improper and inadequate growth in terms of addresses, resulting in problems related to misdirection in postal and delivery services (Amoako, 2021). Such problems can also be experienced in Nigeria, where improper street arrangements and kiosks hinder signs and numbering (Adeniyi et al., 2020).

The American Planning Association similarly states that if there is no standardized number range and if there are no mechanisms to implement it, even the best-meaning addressing strategies fail eventually (Wallace, 2019). The case in Kedamay Weyane is not different, in the sense that it fits the global trend where addressing schemes fail if there is no connection to implementing standards, and if there is unstructured growth.

Absence of Public Engagement and Ownership

Another key aspect revealed in the study is the absence of community participation in the matter of addressing. The residents of Kedamay Weyane tend to think of address-related issues as concerns of the governance rather than the responsibility of the community in general. Few residents know their house number and the name of the street where they reside.

This is consistent with literature that supports the view that community engagement is crucial in ensuring the success or failure of address-related interventions. In Saudi Arabia, Al-Sobhi and Alawad in 2024 demonstrated that most residents fail to commit the address to memory

because it was systemic in nature and not community-led. In Ghana, Amoako in 2021 supported the claim that even though governmental addresses were allocated, most residents in the communities failed to commit them to memory because they used local nicknames in addition to landmarks even after the installation of systemic addresses by the APA. The APA (Wallace in 2019) supports the claim that addresses should be community-led to ensure that there is data accuracy but most fundamentally to instill community pride in addresses.

Thus, the case of Mekelle confirms that any address design work is not sufficient on its own without communication and participation in order to ensure that the public not only values address-related infrastructures but is able to maintain them. Community participation can be recognized, in other words, as the key human factor in addressing.

Weak Digital Representation and Technological Gaps

The technological component of the address system in Kedamay Weyane is almost negligible. There is no integrated GIS data base or digital address management system in place. All sectors record data independently, without any means of integrating them or associating the digital data with physical signs.

Such an imbalance can be attributed to the fact that other studies demonstrate that growing cities continue to view address management in a way that is “manual and paper documented” rather than treat it as an “evolving online process” in general. The paper “Peculiarities of Modern Street Addressing System toward Implementation of the Smart City Conception” emphasizes the need to involve “digital data bases” in addition to sign posts to improve data usage in general in modern city settings (Wroclawski, 2023). Another project in Ethiopia involves integrating physical addresses with “mobile and GPS” platforms in Addis Ababa (AllAfrica, 2025).

The absence of such integration in Mekelle shows there is a big gap in the digital divide between cities. Your study thus not only shows there can be problems associated with management in the city, but it can also lag behind in technology in terms of smart city preparedness. In modern cities, technology has become the key in the management of property, security, and taxes.

Influence of Informality and Urban Dynamics

Another factor that has contributed to the weakening of the address system in Kedamay Weyane is informality. The rising number of illegal settlements, kiosks, and extensions along the roads has interfered with the original grid system and ensured that numbering is not done in an organized manner. Some of the signposts are either covered or taken away, and new routes are opened beyond the planned routes.

This situation is not specific to Mekelle. Research conducted in Accra, Addis Ababa, and Johannesburg has indicated the same challenges associated with addresses in these cities. Research conducted in Accra indicated that it is difficult to assign addresses in Accra without an intervention to improve settlements in the city to allow for easy assignment of addresses (Amoako, 2021). Research in South African townships indicated that house addresses bear no significance if houses were erected without approved layouts and roads (Mokoena, 2022).

The Ethiopian Urban Infrastructure Review further supports conclusions that unplanned expansion and the absence of mechanisms to effect change are key inhibitors of modern infrastructure provision, such as that related to address matters.

When these results are triangulated, it becomes clear that the problems experienced in Kedamay Weyane are related to general issues in urban management. Street addressing needs to be considered in terms of general control over land use and general management of physical infrastructures to eliminate any growth in the unplanned areas.

Comparison and Triangulation Summary

In various settings, there are recurring themes:

Findings on this study (Kedamay Weyane) Similar Findings in Literature Human/Institutional Weakness Fragmented institutions; no coordination among sectors. Saudi Arabia (Al-Sobhi & Alawad, 2024) poor coordination and usability; Turkey (Güngör & Yomralıoğlu, 2020) lack of coordination and data sharing. Physical Representation Missing or unclear house numbers and street signs. Ghana (Amoako, 2021) incomplete numbering; Nigeria (Adeniyi et al., 2020) unregulated kiosks blocking signage. Digital Representation No GIS integration; no shared database. Smart city literature (Wroclawski, 2023) – importance of digital linkage; Addis Ababa project digital addressing. Public Engagement Residents uninformed and unmotivated to maintain signage. APA (Wallace, 2019); Saudi and Ghana studies low awareness and civic

ownership. Informality & Urban Dynamics Informal kiosks and unplanned structures disrupt layout. Accra and Johannesburg studies informality undermines address continuity.

The consistency between the findings and the world experiences makes the study very valid and puts it within the rising literature on urban governance studies relating to the failure addressed by weak institutional coordination and urban informality.

Broad Implications

The triangulated evidence indicates there are three integrated aspects necessary in well-functioning address systems: governance, participation, and technology. If any of these aspects is weak, it would work to reduce the others' effectiveness. The fact that the three in Kedamay Weyane are weak explains why the address system failed.

The premise is that address handling should be viewed not only through the lens of a technological challenge but in the context of governance reform. It needs to involve institutional collaboration, budgetary commitment, organizational support, and public education and awareness. Secondly, address handling forms the backbone of smart city technology and management because it is difficult to efficiently deliver associated services in the absence of accurate and consistent address information.

The results of the study also emphasize the significance of context with respect to the implementation of the model in different cities across the world and learn lessons from them to suit the needs of that city. For Mekelle, it involves establishing local standards, equipping in-house human resources with digital literacy, and regularizing the so-called informal areas to make them addressable.

The conclusion reached in this study is that there has been failure in the addressing system in the Kedamay Weyane Sub-City primarily because of the failure of the three essential elements: human, physical, and digital representation, which have collapsed in the process.

When one considers cases with comparable characteristics in other growing metropolitan centers, it becomes clear that it is not one but multiple challenges that define the findings on tackling failure. The data gathered in Saudi Arabia, Ghana, Turkey, and South Africa verifies that where there is no single solution with ongoing maintenance and community engagement, tackling failure rapidly becomes less functional.

For Mekelle, the solution to the address crisis is to rebuild an integrated addressing authority, to implement uniform processes, to involve communities in giving addresses and assigning numbers, and to apply technology in mapping and data management. Proper address management not only provides ease of access and identity to locations but can further assist in taxation and smart city construction.

In conclusion, the study makes a local and global contribution in highlighting how the problems of Kedamay Weyane are representative of the difficulties experienced in the management of growing cities, and in underlining that tackling the situation is not only a matter of technical competence—but rather it provides the backbone of modern city management.

5.2 Recommendations

The street naming and residential number survey of the study area has identified major weaknesses for clarity, standardization, community involvement, and physical and electronic representation. From the above results, a series of concise recommendations are proposed. Each of the proposals is supported with a reason to characterize its purpose, suitability, and potential impact on fostering sustainable urban development.

Construct a Clear and Coherent Pattern of Addresses

Establish and enforce a consistent street addressing standard using standard nomenclature, continuous numerals, and strict adherence to city planning principles. This standard must be legally enshrined as a municipality's official policy and complemented with technical standards.

Rationale

The survey uncovered universal confusion from a lack of consistency. In the absence of rules, street names intersect, numbers are not in sequence, and signs do not assist residents or tourists. A systems approach to standardization ensures consistency, so people can travel around a city easily. Overseas research indicates standardized addressing minimizes emergency response times, improves service delivery and brings cities within world navigation systems. For a CBD to rapidly urbanize, clarity of this sort is necessary to prevent multiplying inefficiencies.

Establish Comprehensive House Numbering

The municipality must assign unique numerical numbers to all institutional, commercial, and residential buildings, backed up with sturdy and highly visible plaques. It is essential that it be inexpensive, mandatory under law, and integrated with property registers.

Rationale

The lack of systematic house numbering emerged as a significant shortcoming identified in the analysis. A residence that lacks a numerical designation poses challenges for location identification, thereby hindering the effectiveness of emergency services, postal delivery, utility provision, and social engagements. Internationally, the practice of assigning house numbers is regarded as fundamental to civic identity; it facilitates individual recognition, supports business operations, and enhances the functionality of government entities. The establishment of house numbers contributes to both spatial organization and social equity, ensuring that even marginalized communities achieve visibility and access to essential services.

Improve Community Involvement and Ownership

Residents must be Involve as community members in conceptualizing, implementing, and evaluating intervention measures through participatory workshops, forums, and awareness-raising activities. Build a sense of local guardianship by ensuring naming and numbering systems are consistent with cultural identity and include community input.

Rationale

The study showed that earlier efforts failed to engage residents, so there was less awareness and ownership. In cases when communities are not consulted, systems become unused or are quickly abandoned. Academic writings on urban governance highlight the fact that inclusive planning not just increases acceptability but also encourages pride and ownership among community people. Incorporating cultural values in street naming and directly involving citizens, the addressing becomes not a technicality but a social contract embraced by people.

Improve the Physical Representation of Addressing

The regional bureau of land should implement standard signage for streets and house number plates, readable, long lasting, and easily interpretable. Set forth standard procedures for maintenance and inspections to have physical elements perform well in the long term.

Rationale

Physical representation was found to be weak or absent, undermining the entire system. If signs are not clear, even a well-designed framework fails in practice. Visibility is especially important for non-local users such as visitors, delivery services, and emergency responders. Evidence from urban design research shows that high-quality signage contributes to urban aesthetics, accessibility, and trust in public systems. Regular maintenance ensures sustainability, preventing waste of resources on short-lived interventions.

Build Digital Cartography and Address Systems

The municipality and the local administration of kedamay weyane should establish and keep a GIS-based database of all streets and properties, with an integration of global digital map platforms including Google Maps and Open Street Map. Support the creation of local applications for portable technology for the purpose of facilitating user-friendly navigation for both institutions and citizens.

Rationale

The study found a significant failure in digital representation, which disconnects the city from modern navigation systems. In the digital era, an addressing system is not complete without integration into online maps and applications. This digital infrastructure enables e-commerce, improves logistics, and makes emergency services more efficient. Moreover, digital inclusion supports socio-economic growth by connecting the city with regional and global networks. Without such integration, the city risks being invisible in the digital economy.

Fortify Institutional and Legal Systems

The regional government should establish a special street addressing and house numbering department in municipalities, supported by legal and policy frameworks. Impose compulsory use of official addresses on all official transactions, registrations, and modalities of service delivery. Establish training schemes for municipality officials to combine both technical expertise and administrative efficacy.

Rationale

Institutional weakness is a recurring barrier in urban management. Without a dedicated body and legal backing, addressing systems are often implemented in fragments and abandoned over

time. Establishing an official unit ensures accountability, coordination, and continuity. Legal enforcement ensures compliance, making the system functional rather than symbolic. Training staff creates technical expertise, preventing future failures and guaranteeing long-term sustainability. Globally, successful addressing systems are always anchored in strong institutional frameworks.

Support for Multi-Sectoral

City administration should incorporate Street addressing within holistic systems of urban administration, generating interconnections with emergency actions, postal systems, and administration of utilities, taxing systems, voting systems, and plans for development. Generate partnerships with private businesses, including delivery and communications sectors, to mutually share technical expertise and financial accountabilities.

Rationale

The study showed a fragmented implementation with few inter sectoral linkages. However, addressing is not just a stand-alone service but a groundwork of virtually all of urban life. In linking addressing across a range of sectors, a municipality gets the best return on investment, reduces duplication of effort, and builds incentive for compliance. For example, the linking of addresses to revenue collection fortifies municipal revenue, and connecting it to emergency services saves lives. Public-private partnerships also reduce the financial burden on the public sector and quicken technological innovation.

5.3 Further Research

Due to the essential role a functional addressing system plays in urban development and management especially in this era of rapid urbanization and globalization, it is anticipated that further studies be carried out to determine the implications of a standardized and GIS- based addressing system on socio-economic development with a particular focus on the provision of basic services, poverty mapping, and vulnerability assessment in the informal settlements as well as in the new under construction areas like Mizer 70qare.

Furthermore, due to the fact that the street addressing project within the Mekelle- Mekelle city is still ongoing, it is expected that subsequent studies should be carried out to ascertain residents' perception and user experience of the address system. This would help establish residents' familiarity with the system and perception regarding their changing environment and how this new urban information system influence the identification of people and places.

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ANNEX

Section A

I. HOUSEHOLD QUESTIONNAIRE

Objective of the questioner: is to prepare a research for academic purpose in the Mekelle university school of architecture and urban planning on a topic entitled assessment of street addressing and house numbering. (The case of mekelle- kedamay weyane sub city). The information collected through this questionnaire will be handled and kept with security and confidentially. Therefore, you are kindly request to give your opinion.

A. General information

1. Sex of respondent a) Male b) Female
2. Educational status a) Illiterate b) 1-8 c) 9-12 d) college diploma and above
3. The age of the respondent?
 - i. 18-25 Years ()
 - ii. 25-35 Years ()
 - iii. 35-45 Years ()
 - iv. >45 Years ()

II. Questions: about addressing the street and house numbering issues

Underlying factors leading to the persistence of the problem of Street addressing and house numbering

4. Indicate duration of stay lived in kedamay weyane in the space provided
 - a) 0-5 b) 6-15 c) 16-30 d) >30 e) No permanent place but in and out
5. Have you got any accident before (fire/hung _____)

A) yes (if your answer is yes answer Q-6)

b) no

6. How do you locate your location for emergency?

a) By street number

b) Using house number

c) Local names

d) Other please specify-----

7. Have you house number? A) Yes b) no

What was the house number before and now? -----

8. Have you participated in a meeting regarding to street addressing and house numbering? a) Yes b) No

9. If you did not participate why? _____

10. If yes how do you evaluate the nature of participation?

a) Very satisfied b) Satisfied c) Neutral d) Dissatisfied e) Very dissatisfied

11. What are the impacts for persistence of the problem of street addressing if strong measures are not taken by the government to curb the situation?

SECTION B Problems and challenges facing the Government in addressing the problem of Street

12. Do you think that the government is adequately addressing the problem?

i. Yes ()

ii. No ()

13. Do you know the official name of the street where you live?

i. Yes ()

ii. No ()

14. Is it true that ineffective policy, legislation ,poor planning, lack of political will, lack of coordination and weak enforcement of laws can be considered as problems and challenges facing the government to address the problem of Street addressing?

i. Yes ()

ii. No ()

15. What are the main problems and challenges facing the government in addressing the persisting problem of Street addressing and house numbering?

.....
.....

Alternative Strategies to Curb the Problem of Street addressing

15. Effective planning, formulation of specific Street addressing and house numbering Policy and legislation, effective enforcement of laws and proper coordination are the alternative measures towards addressing the problem of crime and emergency?

i. Yes () ii. No ()

Thank you for taking the time to complete this questionnaire

Section C

FOCUS GROUP: DISCUSSION GUIDE

Purpose

- To examine the overall principles, addressing challenges, pros and cons of existing street address system and its implementation so that the information to be an input for further assessment and improve the accessibility.

Procedures

- If you participate in this study, you will be in a group of approximately eight participants. “A facilitator will guide the discussion by asking questions, while two note-takers will capture the ideas and points raised by the group.” If you volunteer to participate in this focus group, you will be asked some questions relating to your experience in street addressing, implementations, and integration with cadaster schemes and other infrastructure organizations. Your participation is voluntary. You may withdraw from this study at any time without penalty.

Benefits and Risks

- Your participation may benefit you to by helping those researchers who participate in street and cadaster geospatial infrastructures and provide a fruitful knowledge and skill and lastly improves the problems faced now. No risk greater than those experienced in ordinary conversation is anticipated.

Confidentiality

- Anonymous data from this study will be analyzed by the researcher and the results of this study may be reported and presented to the department of urban planning and architecture at the University of Mekelle Institute of technology. However, your identity will not be disclosed. None of the participants will be identified or connected to the results. Everything shared in this study will remain completely confidential.

Consent by signing this consent form, you are indicating that you fully understand the above information and agree to participate in this focus group.

Participant's signature: _____

Printed name: _____

Date: _____

If you have any questions or concerns about this study, please contact me using the following address. Thank you!!

Name Firdawek Meresa

Email-raeyfirdawek@gmail.com

Phone no +251914754230

1. What is your professional background?

- Surveying
- Land Administration
- Civil engineering
- GIS / Geo-informatics
- Land Information system
- Remote sensing and photogrammetry
- other: _____

2. Question (15 minutes)

Prompt: what do you know about the Principle and techniques that the existing street addressing system was established and implemented?

Probe_1: What are the challenges faced as per our city context?

Probe_2: What do you think about the complexity of referencing specific place from the vast principal point and baseline? Specially at kedamay weyane sub city.

3. Question (17 minutes)

Prompt: What are the attitude of you and other staff towards the concepts in the implementation of a street address? (What did people think/say/do?)

Probe_1: What drove the positive/negative reaction? If negative, how could it be rectified?

Probe_2: what do you think that the existing street address is accessible by society and even the foreigner?

4. Question (12 minutes)

Prompt: What do you know about the challenges faced during and after the implementation of the street address project before?

Probe_1: what do you think that is the existing street address being accessible with society and integral with other geospatial data infrastructure like cadaster?

Probe_2: What do you think are the pros and cons of implementing street address geospatial infrastructure?

5. Question (10 minutes)

Prompt: What do you think that the possibilities of a street address to be accurately navigable with online and offline devices and applications?

Probe_1: what international and national experiences do you prefer?

6. Question (12 minutes)

Prompt_1: According to you, how can we improve to provide better accessibility and integrality of street address with other geospatial infrastructure like cadaster?

Probe_1: Which parameters and fields are to be considered for the better user friendly street address?

Concluding question (5 minutes)

Conclusion (4 minutes)

