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Achieving sustainable mobility through public transport: An analysis of the public transport ecosystem and digital policy interventions to increase its usage in Bengaluru.

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॥ यस्तु संचरते देशान् यस्तु सेवेत पण्डितान् ।तस्य विस्तारिता बुद्धिस्तैलबिन्दुरिवाम्भसि ॥

(Yastu Sancharate Deshaan Yastu Seveth Panditaan

Tasya Vistarit Buddhistail bindurivaambhasi

The Sanskrit shloka from India says emphatically that " The intelligence of a person who travels in different countries and associates himself with scholars, expands, just as a drop of oil expands in water." Nothing can better explain my journey as being a student of the Masters of Public sector Innovation and eGovernance (PIONEER). It has been a journey of learning, expanding knowledge, meeting scholars and a journey of adventures. As the case in every journey, this journey was also a roller coaster ride having its fair shares of ups and downs. I would like to remember everybody who were related and a part of the journey and who stood as a strong support in various capacities during the last two years of this endeavour.

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Abstract

Sustainable mobility has been a research topic for generations and it is also considered as a crucial aspect in achieving sustainable development goals. Sustainable mobility is a paradigm in itself and enables us to see transport and related policies in a more nuanced way. Public transportation has been always considered as a primary way to achieve sustainable mobility for its social, environmental and economic benefits. This research tries to look at how sustainable mobility can be achieved by increasing the ridership of public transport taking the case of the Indian city of Bengaluru. A variety of literature is available on sustainable mobility initiatives in developed countries, however similar research in developing countries and especially India exposes a gap in the research literature. This study tries to see the concept of achieving sustainable mobility from the theoretical lenses of Collaborative governance and intends to identify the stakeholders and study their mutual integration or non-integration. This research also focussed on the digital initiatives by these stakeholders and their impact on ridership. The research studies the impact of factors like age, gender and occupation on the ridership of public transport. The stakeholders of the public transportation ecosystem of Bengaluru were classified four fold. The methodology of mixed method approach was adopted and a quantitative survey of 130 people in Bengaluru and eight qualitative interviews were conducted to get viewpoints of both authorities and citizens. Further the data obtained was subjected to box plot representation, correlation analysis and exploratory factor analysis as quantitative methods and a thematic analysis was conducted to obtain seven. Combining all the results this study proposes a theory of collaborative governance to achieve the transition multiplex. Multiplex societies have a large number of networks and relations and factors acting simultaneously and it needs a multiplex approach to achieve a transition in such ecosystems. The study also gives concrete recommendations on how sustainable mobility transition can be achieved in Bengaluru by increasing the public transport ridership. This research assumes significance in the sense that it can be a way forward to achieve collaboration and cut down the vicious cycle of competition which often impedes integration in developing countries and multivariate cities like Bengaluru.

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Abbreviations

BMTC	Bengaluru Metropolitan Transport Corporation
BMRCL	Bengaluru Metro Rail Corporation Limited
DULT	Directorate of Land Transport
BBMP	Bruhat Bengaluru Mahanagara Palike
BMLTA	Bengaluru Metropolitan Land Transport Authority
BDA	Bengaluru Development Authority
IISc	Indian Institute of Science
BPAC	Bangalore Action Political Committee
PCA	Principal Component Analysis
EFA	Exploratory Factor Analysis

1 Introduction

Perhaps the most significant thing ever that contributed to the success and survival of the human species, has been their ability to evolve and start moving from one place to another for livelihood and sustenance. Inventions like wheel to modern mobility modes have followed due course. Man's contribution towards finding faster and more efficient ways of mobility has been a constant endeavour (Hoyle, 1973; Ambra et al., 2019; Cohen & Jones, 2020). This is where the concept of 'Mobility' assumes significance and with the threat of climate change and Global warming looming large, sustainability has to be an important part of it. 'Sustainable mobility' is defined by the United Nations Secretary General's high level advisory group as " the provision of services and infrastructure for the mobility of people and goods — advancing economic and social development to benefit today's and future generations — in a manner that is safe, affordable, accessible, efficient, and resilient, while minimising carbon and other emissions and environmental impacts" (United Nations High level Advisory Group, 2016).

The Sustainable Development Goal's (SDG's) (UNFCCC, 2015) directly relates to Green mobility which forms one of the most important components of Sustainable mobility (Tammaru et al., 2023). Many important cities globally are striving to bring about a transition of individual auto mobility to that of a more greener mobility practice like public transportation, walking or cycling (Newman & Kenworthy, 2006; 2014). As alarming as it may sound; according to the Global Mobility Report (2022) only 10 % of the people currently live in cities which have an acceptable air quality as per the World Health Organisation (WHO) standards. Noise pollution, lack of universal access and safety are other concerns and need to be addressed by the broad concept of sustainable mobility (Global Mobility Report, 2022).

Sustainable mobility can be realised through various measures; promoting the use of public transport, reallocating space, innovation in efficiencies of the transport sector and better land use policies (Banister, 2008). The concept of sustainable mobility also makes use of two broad intervention measures namely active mobility, promoting green mobility and encouraging the use of public transport (Newman & Kenworthy, 2006; Global Mobility Report, 2022). Though the transition towards a low carbon future and green mobility is very necessary and also motivates the nations and their governments to bring in policies towards it, the very transition

towards it can be complex. The broad nature and complexity of the term sustainability and sustainable mobility contributes greatly towards it (Baker, 2007).

The complexity would further increase if we consider the cases of developing countries and specially a country with the largest population like India. The research aim here is to look as to how sustainable mobility can be achieved through increasing the use of public transportation specifically with respect to Bengaluru; the capital of the state of Karnataka in the southern part of India.

1.1 Problem definition and the case of Bengaluru

Transport and mobility is an important aspect to unlock the nuances of societal interactions in the city (Mathews, 2015). The patterns associated with that and the modal share of transport and the demand for such services assumes even more significance in a developing country like India. The vehicle fleet and the associated impacts have a great impact on the economy, demand for energy and resources (Bansal et al., 2018; Krishna, 2024). The cities were mainly designed with the colonial viewpoint which then transformed to rapid expansions after Independence and thus resulted in an urban sprawl that was difficult to contain (Gopakumar, 2020). This has resulted in large auto dependence (Nesamani, 2010) which has a direct consequence in terms of vehicular emissions.

India has alarming levels of CO2 emissions and is one of the countries which has a leading number of deaths due to air pollution (Nesamani, 2010). Multiple health issues and risks coupled with unplanned development and over dependence on private vehicles has been the most intriguing problems for India and various studies like Bansal et al (2018), Mathews (2015), Krishna (2024) and others have directly associated the problem of vehicle ownership with increased economic prowess, buying power of the people and also the rise in per capita GDP. There needs to be thought put in and a comprehensive planning to develop policies which make the modal shift in people to transit into more of public transportation and reduce the overly large auto or vehicular dependence. In view of this context and background this research specifically chose the case of ‘Bengaluru’ which is a growing and leading city in India to study the impact of sustainable mobility, ways to achieve that through the increase in ridership of public transport.

Bengaluru presents a unique and interesting ground to do this research in the sense that it is famously called as the 'Silicon Valley' of India (Mathews, 2015, Guttikunda et al, 2019) and is very multifaceted in nature. It is a large city with multiple ethnicities, income levels and is also the fastest growing city in India (Census, 2011). With an approximate population of 14 Million (World Population Review, 2024) the problems discussed above become even more important in the context of Bengaluru. Given its large Information Technology (IT) industry base which drives and leads technological change; it is also quite enlightening for studying it from the perspective of socio technological transformations and the technopolitics of mobility (Gopakumar, 2020). The vehicular growth has been tremendous in Bengaluru with more four wheelers being purchased and is predominantly a car driven transition (Venkatraman, 2014). As per the Ministry of Road Transport and Highways (MoRTH, 2019) Bengaluru has the third highest number of motor vehicles registered at 8.1 million , just trailing behind the national capital Delhi and Faridabad at 11.4 million and 8.6 million respectively. The result of such expansion manifests in the form of carbon emissions, vehicular pollution, poor quality of air and health issues and also the observed reduction in the modal share of public transport usage in Bengaluru.

Various data on the modal share of transport that is existent in bengaluru are available, the recent one is the research by the TUMI management in June 2022; where, 42% of the transport was by public transport and 36 % by the private transport, 10 % by non motorised transport (walk and bicycle) and 12 % by intermediate public transport. Though there have been variations in modal share according to different estimates, one common observation that emanates is the considerable reduction in the share of public transport and reliance either on the private vehicles or on non motorised transports. It is in this regard that the need to incentivise public transport and make it more lucrative can contribute to green mobility and sustainable mobility in a considerable way.

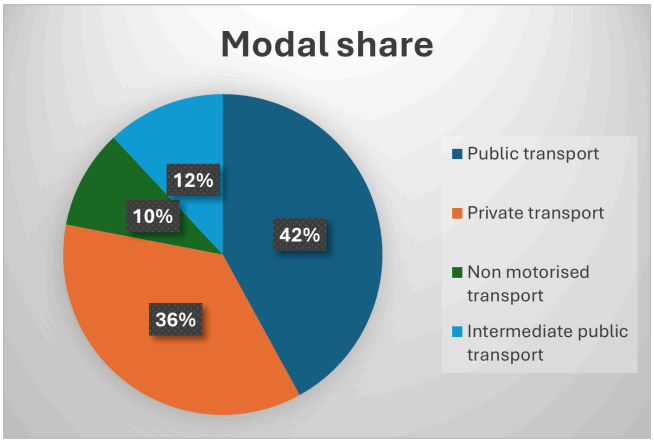


Fig No.1. Modal share of transport in Bengaluru (Source: TUMI Management (2022))

The air quality of Bengaluru has declined considerably (Abhilash et al., 2018), given the fact that the particulate matter PM 2.5 and PM 10 and other pollutants like Nitrous Oxides, CO2 and CO have risen significantly and vehicular emission was the greatest source combined with dust from road and resuspended particles (Guttikunda et al., 2019). The traffic situation is often highlighted and its congestion is often intertwined with any discussion about the city of Bengaluru. The annual Tom Tom traffic index features Bengaluru globally at the sixth rank estimating about 28 minutes and 10 seconds average travel time required to commute 10 Km. It pegs the traffic congestion at about 63 % and has estimated about 132 hours of time lost per year at rush hours (Tomtom Traffic Index, 2023). The contribution of these chaotic traffic situations on the economy and the associated productivity loss due to it were researched by Vijaylakshmi & Raj (2020) and they concluded in the year 2018 alone it led to a loss of about 11.7 billion Indian rupees. This multidimensional problem calls for a specific problem solving oriented policy and promoting the use of public transportation can be the most effective way given that it offers equitable access to all economic classes and has positive effects both on environment and traffic congestions.

Another important feature of public transportations organisation in Bengaluru is that it has multiple agencies which are responsible for city planning to infrastructure planning to that of transport corporations and land agencies which determine the land use patterns (Mathews, 2015). There is no one single agency that acts as an apex body for coordinating and taking binding decisions which is also a reason for the transportation and other land use patterns in Bengaluru (Mathews, 2015). This important aspect of bringing in a collaborative way of functioning rather than a competitive mode is what this research aims to explore to increase the use of public transport in Bengaluru which would address one large area towards achieving sustainable mobility. Hence, Bengaluru serves as an interesting case study for the research and in the next section we will discuss the actual research questions this research seeks to answer and the core areas that will be discussed about.

1.2 Research Questions

This research seeks to concentrate on the way to achieve sustainable mobility in the Indian city of Bengaluru by assessing the ways to increase the public transport ridership and looks at mainly three different aspects of the problem. These three different aspects will be captured in the research sub questions.

Thus this research seeks to answer the following research question: ***How can sustainable mobility be achieved through the increased use of public transport in Bengaluru ?***

The research question is divided into three sub questions to cover different aspects of the main question.

1. ***What are the various factors and problems that affect ridership of public transport in Bengaluru?***
2. ***Who are the different network actors that are part of the public transport ecosystem of Bengaluru and the role of their mutual integration or non-integration towards increasing the use of public transport and how have the digital policy initiatives adopted by them impacted public transport usage in Bengaluru?***
3. ***What could be the way forward to encourage public transport ridership for achieving sustainable mobility in Bengaluru?***

1.3 Research Scope

1.3.1 Scope of sustainable mobility

Ever since the concept of sustainable mobility emerged from the EU Green paper on the impact of Transport on Environment in 1992 (EUCOM, 1992), the concept has evolved and expanded (Holden et al., 2019). The concept of sustainable mobility is an overarching concept which according to (Banister, 2008) includes social dimensions, peoples accessibility, need to reduce or substitute travel, envisioning the design of cities, seeing road planning as a space to integration of people and space among the important ones. Sustainable mobility has been linked to sustainable development and its goals (Holden et al., 2019; Høyer, 1999) though not similar concepts. Green mobility is also an integrated part of sustainable mobility which depends on

having modes of transport which are less carbon emitting and also active mobility which has direct health benefits (Echeverría et al., 2022). The frameworks and indicators to measure sustainable mobility have been mentioned by (Gudmundsson, 2003) as environmental integration of policies, sustainable sector management, eco efficiency and so on.

Therefore with such a broad and overarching concept that includes almost everything related to sustainability and transport, which authors like (Banister, 2008) also calls a 'sustainable mobility paradigm' the research has to define what is the sustainable mobility aspect that we are considering here for the purpose of our future discussions. This research focuses on the concept of sustainable mobility from three different perspectives. These perspectives are also chosen keeping in the nature of the city of Bengaluru which we have chosen to study as the focus point. As already elaborated vehicular emissions have a great deteriorating effect in Bengaluru. We also observe that there needs to be an integrated planning and execution of transport policies given the fact that multiple agencies are at work and tasked differently. Therefore we here for the purposes limited to our research see sustainable mobility as those practices that reduce the vehicular emissions and carbon footprint and also reduce the use of fossil fuels and conventional resources like petrol and diesel. It consists of practices which makes the efficiency of people movement better i.e. to carry more people at the same time hence utilising the space in the best possible manner and thirdly also from the perspective of an integrated transport provision mechanism. Therefore the concept of sustainable mobility will be limited here to increasing public transportation use which ultimately promotes green mobility and also helps in achieving the goals as mentioned in three perspectives that were discussed.

1.3.2 Scope of public transport

Public transport is understood in terms of all means of transport that is public, available to all general public for hire (Preston, 2009) and includes a variety of modes like buses, trains, trams , domestic air services and also sea services. Both passenger and freight are considered public transport as long as it is available for the use of the general public. Having such a broad definition of public transport, it is pertinent here to define what is public transport in the context of this research.

Bengaluru has many modes of services like Buses both operated by the Bengaluru Metropolitan Transport Corporation (BMTC) and other private players, it has metro rails operated by the Bengaluru Metro Rail Corporation Limited (BMRCL), it has also a variety of Intermediate Public Transport (IPT) like the traditional Auto Rickshaws, the taxis and cab aggregators that are run by Ola and Uber (CSTEP, 2018). There have even been e-bike services launched by aggregators like Rapido, which was discontinued by the government for policy issues (Economic Times, 2024). Hence for this purpose keeping in mind our research questions and also the three perspectives discussed above, the public transportation scope would be limited to the buses operated by the BMTC, the metro rail operated by the BMRCL and also the Autorickshaws that serve as the intermediary connections and popular mode of transport in India and also in Bengaluru specifically. The Autorickshaws in Bengaluru have also completely transformed into either electrically driven or running on Compressed Natural Gas (CNG) which is a less polluting and cleaner source of fuel due to the government's decision to promote e-Rickshaws and CNG fitted ones (Deccan Herald, 2018). Auto Rickshaws are also a quintessential feature of the urban and semi urban transport in India and provides the public transportation to millions (Harding et al., 2016, Rao et al., nd).

The nature of private operated buses are not organised and are usually ad hoc in nature and the cab aggregators and private taxis will be excluded from the perspective of this research as the main goal here is to reduce the number of cars plying on the road and transition to a major public transportation mode.

Fig No.2. Bus, Metro and Auto Rickshaw-Modes of transport in Bengaluru

This makes it imperative that cabs operated by aggregators or individually still fall under the category of cars and neither contribute to the reduction of emissions or transporting large numbers of people. Therefore excluding these modes of transport, the research in its quest to find means and ways of increasing public transportation ridership means to examine the ridership and promote ridership in these three modes as mentioned above.

2 Literature Review

2.1 Sustainable mobility research

Sustainable mobility emerged in 1992 (EUCOM, 1992). Since then it has developed into its own research field. Studies and research in the field of sustainable mobility have greatly contributed to the literature and are also ongoing. The epistemology of sustainable mobility and its study serve as a guiding light for this research. A comprehensive overview by (Holden et al., 2019) acknowledges the rich literature in the field of sustainable mobility and they say that it can be clustered into four distinct generations of research. Plethora of studies in the fields of ecology, psychology, behavioural change , technology oriented change and planning research etc have contributed to the field of research in sustainable mobility (Holden et al., 2019) and the current status of sustainable mobility research has significantly evolved and stands differently from what it was conceive three decades ago (Holden et al., 2019) . The research has also become broad and holistic (Holden et al., 2019) and according to the authors today there has been a much better understanding of the impact of car dependence and also on how to reduce them (Holden et al., 2019) . One important change (Holden et al., 2019) observes that the stage of research has now moved from just focussing on the health of the environment to that of health of people and also involving more people to achieve sustainable mobility. It was in the same context that this research proceeded and hence the main objective was about curbing emissions and participative processes which are both people centric.

In the subsequent research (Holden et al., 2020) in their paper ‘The Grand narratives of sustainable mobility: A conceptual review’ set forth the main narratives that the concept of sustainable mobility has brought in. Holden et al., 2020, acknowledge that achieving sustainable mobility is a ‘Wicked’ problem (Churchman, 1967) highlighting the complexities associated with the means and ways of implementing them. Nine different narratives of sustainable mobility are identified by (Holden et al., 2020) which also becomes very relevant in this case of the research as it identifies what are the aims to be achieved and the stakeholders who are supposed to be doing it who are identified as homobureaucratis, homocivitus and homoeconomicus (Holden et al., 2020). This gives rise

to the nine narratives which elaborate on the different conceived objectives and main ideas behind sustainable mobility. The following table from (Holden et al., 2020) summarises these narratives.

Table 1. Narratives of sustainable mobility (Source: Holden et al., 2020)

	Agency (Who?)			
		Leave it to the experts (*homo bureaucratis*)	**Leave it to the people (*homocivitus***	**Leave it to the firms (*homo economicus*)**
Strategy (What?)	**Efficiency (improve)**	1. The green government	2. The green purchaser	3. The clean vehicles
	Alteration (shift)	4. The public transport provider	5. The responsible traveller	6. The shared mobility schemes
	Reduction (avoid)	7. The compact city	8. The essential life	9. The travelling electrons

This thesis mainly revolves around the fourth narrative of the public transport provider but also encompasses the narratives of the green government, responsible traveller, clean vehicles and also the compact city (Holden et al., 2020). They further then cluster and propose three grand narratives which are Electromobility, Collective transport 2.0 and low mobility societies (Holden et al., 2020). Collective transport is the main focus of the research with the collaboration and integration/ non-integration that is studied in case of Bengaluru's public transportation network actors. Electromobility will also be touched upon in terms of the electric buses being introduced by BMTC and the main source of energy to run the metros operated by the BMRCL and also with respect to the e-Auto Rickshaws.

The most elaborate and significant contribution to the field of literature in sustainable mobility and the greatest amount of citations in the field has to be attributed to (Banister, 2008) who proposed the very alternative of the 'sustainable mobility paradigm'. He advocates that the paradigm of sustainable mobility should enable to investigate cities and to unravel the relationship between transport and the land use pattern (Banister, 2008). The agglomerated nature of cities and what he calls as 'Polycentric cities' and the ways in

which sustainable mobility practices can be brought in needs an innovative approach coupled with clarity of thought (Banister, 2008). The author's perhaps most important contribution is to distinguish the conventional approach to transport planning with that of the paradigm of sustainable mobility. The table No.2 would provide the overview of differences as identified by (Banister, 2008). Most important aspects that are discussed by (Banister, 2008) are the transport perspective whether transport is a demand derived activity or a value added activity and the subsequent changes that the perspective has undergone. This assumes importance in this context of the research that transport and mobility in a city as complex as Bengaluru, could mainly happen as a demand derived activity, but the role of sustainable mobility by improving the existing system can drive it towards a more value based activity.

The concepts that (Banister, 2008) elaborates in his paradigm of sustainable mobility like the need to reduce travel and effect a modal change in the mobility patterns and also the importance of reducing distances through right planning (Banister, 2008) is very relevant from the point of view of this research to understand the constraints and problems that discourage people from using public transport. The identification of the strong relationship between Transport and ICT (Banister, 2008) is of direct relevance to our research questions in studying the digital initiatives and their effect on increasing ridership. Also given the technocratic nature of Bengaluru this assumes further significance. One aspect that has been observed from long and which also forms the core of the problem statement of this research is that in spite of the best public transportation systems, there would always exist reasons to use the car (Banister, 2008). Therefore there needs to be very comprehensive and innovative policy designs and planning to discourage people dependent on personal mobility and encourage them to take up public transport. The need to see the streets and the surrounding aspects of mobility given the nature of interconnections in the ecosystem of public transport and their work in silos can be analysed and understood from the lenses of (Banister, 2008) sustainable mobility paradigm.

Table 2. Alternative approach of sustainable mobility (Source:Adapted from Marshall, 2001 by Banister, 2008)

The conventional approach—transport planning and engineering	**An alternative approach—sustainable mobility**
Physical dimensions	Social dimensions
Mobility	Accessibility
Traffic focus, particularly on the car	People focus, either in (or on) a vehicle or on foot
Large in scale	Local in scale
Street as a road	Street as a space
Motorised transport	All modes of transport often in a hierarchy with pedestrian and cyclist at the top and car users at the bottom
Forecasting traffic	Visioning on cities
Modelling approaches	Scenario development and modelling
Economic evaluation	Multicriteria analysis to take account of environmental and social concerns
Travel as a derived demand	Travel as a valued activity as well as a derived demand
Demand based	Management based
Speeding up traffic	Slowing movement down
Travel time minimisation	Reasonable travel times and travel time reliability
Segregation of people and traffic	Integration of people and traffic

We have till now discussed the main paradigm, the understanding and narratives of sustainable mobility. However, research has also explored the ways in which sustainable mobility can be measured. Gillis et al., 2015 developed a set of indicators namely Global environment(g), Economic success (e), Quality of life (q) and added mobility performance (m) as the fourth dimension and indicator. These indicators though cannot measure exactly the level of sustainable mobility in a city or country but definitely serve as indicators for the effectiveness and the amount of sustainable mobility present in a particular city or country. Quality of life is directly dependent on the ease of access to the modes of transport and

includes different factors discussed earlier like traffic congestion, air quality and the planning of the city. In this regard (Chakraborty et al., 2021) have also spoken on the various implementable strategies to achieve sustainable mobility and have mainly discussed Environmental aspects, Socio-Technical aspects and Technical aspects. The technical aspects here in our research could be the use of ICT and various digitalisation initiatives, switching to more greener modes like Metro and e-buses and rickshaws would have a direct impact on the emissions which is our main problem area contributing to environmental aspects. Seeing it from the perspective of society to induce a behaviour change to increase the ridership of public transport is very important given the focus of our research questions and here we can make use of the socio technical aspects as discussed by (Chakraborty et al., 2021).

Addressing this need of different approaches to bring in sustainable mobility and nudge a behaviour change an important work by (Vergragt & Brown, 2007) advocates the need for societal learning and the need to move away from technological solutions. Behaviour change is the most important factor that has to be addressed to bring out any transition towards sustainable mobility (Vergragt & Brown, 2007; Higam et al., 2013). Theories like bounded rationality have tried earlier to predict and assess people's behaviour towards public transport which have not been very successful (Vergragt & Brown, 2007) and hence transition management according to them requires more nuanced and novel approaches like Socio-technical testing, backcasting etc (Vergragt & Brown, 2007) . This research also tries to look at the constraints and bottlenecks to greater adoption of public transport in Bengaluru and the peoples perspective in these issues. The behavioural and societal perspective plays a great role in any sustainable initiatives becoming successful and sustainable mobility is not any different. Further lets take a look at the concept of transition management which has evolved into a field in itself which focuses mainly on the ways and means to bring about sustainable transitions.

2.2 Sustainable transition and transition management

Sustainable mobility is one of the branches and aspects of the larger field of sustainable development and achieving sustainability. A new field of ‘Sustainable transition’ has also

evolved simultaneously which deals with all sorts of sustainable issues in various sectors like energy, water, environment etc (Markard et al., 2012). This field emerged because of the increased attention on the question of how the green transition can be achieved and how to promote more green transition in a sustainable manner (Markard et al., 2012). To define what sustainable transition is; it is basically the study of socio-technical systems and the network of actors and institutions who are part of it and the study of their interactions and inter relatedness to achieve effective sustainability transition (Geels, 2004; Markard, 2011; Weber, 2003; Markard et al., 2012). So it can be understood that all societal, technological, institutional and organisational changes constitute what can be called a 'sustainable transition'.

The essential factors for sustainable transition are the active involvement of users in the vision building process (Weber, 2003) . These concepts and understanding of them assumes importance from the perspective of the research given that increasing the ridership of public transport as against cars and individual personal mobility automobiles need to incorporate these concepts of transition management effectively. The complexity and the societal aspect of the problem is already present in any transition scenario, but it would get more pertinent in the case of India and Bengaluru given the complex nature of the society, population and the fact that India is still considered as a developing country.

Sustainability transition goals have also been discussed by authors in the various articles and papers and according to (Parris & Kates, 2003) one of the main goals of sustainability transition is to curb the emission of atmospheric pollutants and another driving force of sustainability transition is stabilisation of the concentration of greenhouse gases. This would need the willingness of governments and civil society to act as a powerful instrument of transition (Parris & Kates, 2003). This research also considers the problems of emission and hence the concept assumes importance here. One of the major impediments for a smooth and effective sustainable transition is policy resistance (de Gooyert et al., 2016). Multiple agencies like that in Bengaluru with different goals would invariably lead to these effects of policy resistance and would contribute to the same.

In the light of discussion about sustainability transitions, another very important concept that has emerged with a vast amount of literature is the concept of 'Transition Management' (Loorbach et al., 2015; Rotmans et al., 2003). It deals with the transition of complex socio-technical systems towards sustainability (Loorbach et al., 2015). Complex transitions often need dedicated ways and strategies to implement it and hence the concept of transition management has been studied. The concept of transition management first evolved and has largely been implemented in the Netherlands, United Kingdom and Belgium (Rotmans et al., 2003). Long term thinking , steering, flexible objectives, timing of interventions, creation of space for alternative regimes and focus on different actor perspectives are the ways and means to achieve according to (Loorbach et al., 2015). They also advocate a need for informal methods and an experimentalist governance approach. Rotman et al, 2003 in its critical and reflection about the concept of transition management acknowledges that it has been promising and applied over in the Netherlands but also discusses the various criticisms that exist. One major criticism according to Rotman et al, 2003 is about the question whether deliberate systematic interventions are possible for achieving sustainable transition and transition management? It has been accepted that it is possible but it needs a pluralistic network of actors who would communicate and interact well with each other to overcome this problem (Rotman et al., 2003; Kemp et al.,, 2007).

This problem has not been something new and the contribution and collaboration of actors are very necessary to achieve any mission and the goal of sustainable transition is no different either. Single interventions in such complex socio-technical problems are not effective (Berger et al., 2014). Specifically considered in the case of sustainable mobility, mobility patterns are varied in nature and the dominance of cars is also a big problem (Berger et al., 2014) and hence transition management with respect to achieving sustainable mobility would require complex and differentiated strategies (Berger et al., 2014). This understanding of the nature of problem and the literature about the complexity and nature of interventions for a successful transition management in mobility is important as we have already understood the nature of complex problem that we are trying to address and successful transition from cars to public transport is un arguably a complex problem that would need varied and differentiated ways of solutions to achieve the same.

Lastly, it would be also important to introduce a rather new concept but very relevant from the perspective of research which is ‘De Transition’ (Taillandier et al., 2023). Introducing their concept in the work of ‘Back to the Future:Transition into Low car cities’ they have studied the region of Clermont-Ferrand, France. They studied the concept of making the region less dependent on cars and defined de transition as reversing the urban transition towards accessible low car cities (Taillandier et al., 2023). This would also be the final aim of this research and the goal behind increasing the ridership of public transportation albeit it would be on a general term of less vehicle dependence be it a car or a two wheeler in the case of Bengaluru. The authors here differentiate between the concepts of car free cities and sustainable mobility cities (Taillandier et al., 2023. The concept that research would use is the sustainable mobility city as the goal is to not go completely car free and it is also as discussed earlier being a kind of status associated with rising incomes it would be hard to do so in India and Bengaluru. Their concept of achieving de transition is through the design of such infrastructure that would constrain the use of cars and in turn support active mobility like walking or cycling and also sustainable mobility options like that of increased use of public transport (Taillandier et al., 2023). Achieving the de transition would also be a part of achieving sustainable mobility, but the focus of this research would be limited to public transportation.

2.3 Prior research on public transportation systems

Different research topics about the public transportation or public transit system is widely available as literature. Starting from describing the different kinds of public transit (Vuchic, 2002) to the relation between sustainability and adoption of public transport (Miller et al., 2016; Sinha, 2003; Canzler, 2016) there have been available discourses exploring the different aspects in the field of public transportation research. The economic impact of the adoption of public transport and its relation to the macroeconomic problems like poverty and unemployment has been studied by Sanchez (2008). Finally this section would look at the concepts of integration of public transportation systems (Solecka & Zak, 2014) and also the digitalisation aspect of public transport and its contribution to the digital economy and relation with automobile use (Canzler, 2016). These studies would give valuable inputs

about the aspects of public transportation that are relevant from the perspective of this research and the overview of the epistemological view of sustainability and mobility in relation to the use of public transport.

Vuchic (2002), defines public transport as something that is accessible to everyone which means to even people who do not possess a car. He has classified the categories of public transport namely into Row A, Row B and Row C where Row A are categories which have exclusively designed lanes and associated infrastructure (Vuchic, 2002). The Metro that we consider in Bengaluru falls into this category and description. The Row C category are the ones which use common lanes and spaces for commuting like the other users and the Bus and Auto Rickshaw categories can be understood in this context. Vuchic, 2002, also makes classifications of public transport in terms of Rapid transit, street transit and semi rapid, depending on the commute time and purposes. The bus transport is the mainly used and it has a wide customer base (Vuchic, 2002) and hence he emphasises on the need to make bus travel and bus transport facilities more attractive to the public in cities. Some of the measures that he has noted in his literature to make buses more attractive are the preferential signals, alternating stop location, exclusive busways, and also exclusive and separate bus lanes for use (Vuchic, 2002). These options serve as probable solutions even in Bengaluru which would be used in interviews with experts as part of the methodology. Further he goes on to discuss the way transport planning is to be done which is mainly based on two points namely character of the city and the aim to provide mobility to all (Vuchic, 2002). Further consideration of the future demand and its projection also determines what kind of modes to be developed in the transport planning for a city (Vuchic, 2002).

Vuchic (2002), also talks about the developing countries and the need for public transportation being even more important as the inequalities in economic capabilities of people would naturally means more number of people without cars and it should be the main purpose of providing universal access to mobility by the development of an extensive network of public transportation. The author has stressed on the capacity development

keeping in mind the population density of the city and also that it will be more effective in cities with a population of more than 10 million (Vuchic, 2002).

Miller et al (2016) also believes that public transportation acts as a key component for the development of sustainable cities. The benefits of public transportation can be seen and assessed by three factors which are Environment, economy and social dimensions. They have conducted an extensive literature review of Indicators and metrics for sustainability and the different concepts associated with them (Miller et al, 2016). Environment and the sustainability of it through the use of e buses and cleaner modes coupled with curbing emission from the vehicles and then also at the same time contributing to a cleaner economy is the goal. Sanchez (2008) has also conducted research on the linkage between public transportation and the macroeconomic parameters like unemployment and poverty. A linkage and correlation with low mobility and poverty was established (Sanchez, 2008) which specifically validates the importance of design in public transportation systems as it can be a lifeline to the section of population. The modes of transport being an Auto Rickshaw or Bus or Metro is vital in cities like Bengaluru and a developing country like India where they serve as lifelines for the people highöly dependent on them, specially the economically weaker sections.

The importance of integration of all modes of transport and other factors to effectively design a functional and beneficial public transportation has been emphasised by many authors (Solecka & Zak, 2014) and literature on it is widely available. Integration and the network of the public transport ecosystem in Bengaluru is the main research focus area and hence considering this aspect and delving deeper into the concepts deserves merit. Integration in public transportation can include reconfiguration, introduction of new lines, integrating infrastructure, having an integrated passenger information system and also shared multimodal ticketing system (Solecka & Zak, 2014). The paper describes how the integration can be then simulated on a macroscale and the various integration that can turn out be efficient and result oriented. This research concentrates on the integration of actors and also multimodal transport integration. Talking about integration Sinha (2003) opines that just factors like improving the service quality and marketing efforts might not increase

ridership substantially but it has to be supported by other factors like land use patterns and city planning. These aspects are also only achievable with integration.

Sinha (2003) also re-emphasises the fact that was put forward by Vuchic (2002), that the question and ability of public transportation to bring urban sustainability depends on the population density. Therefore metropolitan planning, design and neo-traditional approaches are required for a sustainable design of public transportation (Sinha, 2003). One more important research question and research area this thesis focuses on is the aspect of digital initiatives and the role of those kinds of policies to increase the ridership of public transport in Bengaluru. Sinha, 2003 discusses the role of ICT and digitalisation and how they can play a larger role in improving service quality. He has opined that the main role of such technologies is to reduce the resistance of people and measurable improvements in the number of people using it (Sinha, 2003).

Canzler (2016) also speaks about the digital options that would allow better and safe mobility without the need for private vehicles. The digital economy and the digital world are personalising the needs of customers and it is not different for automobiles and their manufacturers too (Canzler, 2016). He has claimed that the digitalisation initiatives would bring about a fundamental shift in the mobility sector (Canzler, 2016). There are also large changes that can occur in the dynamics of the mobility sector that digitalisation brings in (Canzler, 2016). The digitalisation initiatives have to be studied in this light as to what could be the contribution of such initiatives in increasing the ridership of public transport and how it can be achieved in Bengaluru and the various public transport providing organisations. However the basic thread that would be required to achieve all the above discussed points would be an integrated system which functions on the collaborative governance model and the different stakeholders actually work towards a goal in unison with coordination and collaboration and hence we would further look at the theoretical framework of collaborative governance and would try to analyse and assess the situation of public transport in Bengaluru with these conceptual lenses.

2.4 Theory of collaborative governance

The theoretical framework of 'Collaborative governance' would be used for the understanding of intricacies between different stakeholders and how it can be used to achieve the desired results of an increased use in public transportation in the city of Bengaluru. Collaborative governance is mainly popularised by (Ansell & Gash, 2008) and it can be defined as " A governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets" (Ansell & Gash, 2008, p544). The idea of the arrangement is to bring both the public as well as private stakeholders in a common forum and involve them not just merely at the consultation level but also to achieve a consensus oriented decision and policy making (Ansell & Gash, 2008). The failure of policies and managerialism approach towards it and to counter the group pluralism which downstreams the implementation (Ansell & Gash, 2008) the concept of collaborative governance emerged.

Ansell & Gash (2008), in their definition mainly identify five aspects that should be a part of any arrangement to be collaborative governance in nature namely, that it is initiated by the public agencies, it includes non state actors, there has to be consensus engagement, organised structure and meetings and finally the focus should be on collaboration for public management. Public agencies in this context could be different kinds of entities namely Bureaucrats, courts or legislatures (Ansell & Gash, 2008). There has to be an environment that promotes two way communication and creates an atmosphere that enables all the stakeholders to express their views and exchange opinions (Ansell & Gash, 2008). The authors also specifically differentiate between the policy network and that of collaborative governance which they base on the formal or informal networks that it consists of. Collaborative governance is more formal in nature. The responsibility of the decisions and outcome also lies with the stakeholders and the main focus here is on public issues and policies (Ansell & Gash, 2008).

The below figure represents the model of collaborative governance as conceived by Ansell & Gash (2008). It represents the different influences , the process of collaborative governance and the different factors that are associated with it.

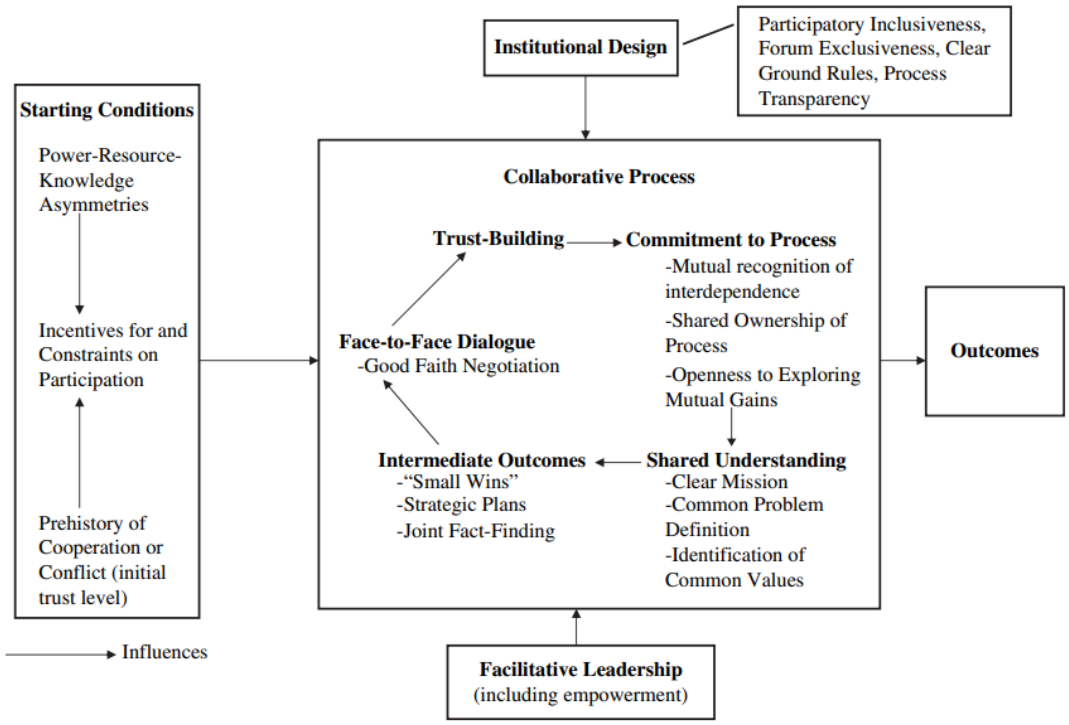


Figure 3: A model of Collaborative governance. (Source: (Ansell & Gash, 2008, p 550))

Other scholars have also taken and expounded upon the structure of collaborative governance. The very concept emerged because of a renewed focus on the aspects between democracy, public administration and management (McIvor, 2020). Emerson et al., 2012 have defined collaborative governance as "the processes and structures of public policy decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/or the public, private and civic spheres in order to carry out a public purpose that could not otherwise be accomplished." (Emerson et al., 2012, p 2). They consider it to be more broadly defined than that defined by Ansell & Gash (2008) and having applicability across classes and structures.

Emerson et al (2012), have introduced the concept of a Collaborative Governance Regime (CGR) and believe that cross boundary collaboration is the predominant mode to make decisions. Collaborative governance would act as a framework for obtaining solutions and

addressing policy issues which are a consequence of wicked problems (Emerson et al., 2012). They introduce the concept of 'Principled Engagement' (Emerson et al., 2012) which describes how the stakeholders interact, are approached and how they bring about the change. Shared motivation and shared actions (Emerson et al., 2012) form the most important facets and criteria for achieving collaborative governance.

Trust among the stakeholders plays a vital role in the collaboration and is also a crucial aspect (Getha-Taylor et al., 2019; Ansell & Gash, 2008). The lessons that can be learnt from the conflict resolution literature can be applied at interpersonal, inter organisational and systemic levels (Getha-Taylor et al., 2019) to achieve better collaboration. In essence the factors like trust, commitment, understanding, communication and outcomes mark successful collaborative efforts (Johnston et al., 2011).

There has been reference in literature to another concept called Network governance (Wang & Ran, 2023) and they have also tried to compare the same with collaborative governance. It is important to understand the exact concept we would be focusing on in this research and hence we delve into these concepts. Governance, be it either collaborative or network oriented, always involves interdependence of stakeholders and hence networks (Wang & Ran, 2023). Both these governance concepts are used to tackle complex problems and associated task complexities (Wang & Ran, 2023). According to the authors, there are similarities, differences and points of entanglement of links between the two concepts. Leadership, resource dependence, trust, power and network performance are the major similarities (Wang & Ran, 2023) however network governance lays more emphasis on aspects like network dynamics, formation and network management (Wang & Ran, 2023). Both the cases the consideration of interorganisational conflicts play an important role in the outcome and the way collaborative governance has to be carried out (Wang & Ran, 2023).

The concept of collaborative governance has been chosen for this study specifically due to the large number of agencies and stakeholders who influence the outcomes in the public transportation sector of Bengaluru. The basic assumption is that there is an environment of

competition among the various modes of transport for the ridership and often the policies of one entity impacts the other either in a positive way or negative way. Thus the integration of these stakeholders and the way they interact can be studied from the conceptual lenses of whether they are collaborative, are the decisions being taken with consensus and what are the ways this can contribute to the increase of ridership and motivate more citizens to use public transportation in Bengaluru. The element of public participation and involving people and making the entire policy formulation structure participatory will also have to be studied along with that. There is no doubt that a great number of efforts in different dimensions have gone to increase and make public transportation more service oriented and convenient, yet the ridership is still not on the expected lines and hence a reinvigorated approach is required and it is to be a collaborative approach. The data collection methods which we would further discuss would also stress on the points of collaboration and participative decision making and would try to understand the problems and answer the research question with this theoretical framework.

2.5 Prior mobility studies in Indian context

A literature review of different mobility studies conducted in India and specifically in the context of sustainable mobility and public transportation was conducted as it would give an overall picture of the public transportation scenario and also the state of affairs in different Indian cities. Firstly, the main determinants of urban mobility in India was studied by (Ahmad & de Oliveira, 2016). They acknowledge that there are limited studies in this regard for developing economies and bring out an interesting observation that larger cities prefer public transportation more and the densification of a city drives greater ridership of public transport (Ahmad & de Oliveira, 2016). Personal income has an effect on the mobility patterns and the lack of proper public transportation facilities exacerbate the problems further (Ahmad & de Oliveira, 2016). Thus the need for improvement and expansion in public transportation is more important in a country like India (Ahmad & de Oliveira, 2016). An important suggestion that they advocate is the issuance of predetermined public transportation passes to the employees by the employer rather than the current norm of private travelling allowances that are being provided to promote the use of public transportation (Ahmad & de Oliveira, 2016).

Jain & Tiwari, 2017, conducted an assessment of what could be considered as the indicators of sustainable mobility in India and have identified broadly four indicators namely Social, Environmental, Activity and Economy and further other 31 factors which can indicate the sustainable mobility progress in Indian cities (Jain & Tiwari, 2017). This is very important in the context of studying sustainable mobility for the purpose of this research as it provides a set of determinate measures to record the sustainable mobility of a city or region.

As mentioned earlier with the limited literature available about the mobility patterns in developing countries, it is imperative to look at the transport and mobility policies of other developing nations and evaluate the policies in India in that light so that valuable lessons can be learnt (Mohapatra et al., 2023). The case studies and policies of countries like Jordan, Rwanda and Jamaica have been illustrated and the need to learn, adapt and formulate a long term vision for India is important in this context (Mohapatra et al., 2023).

One of the main works with regard to the public transportation scenario highlighting the state of affairs in India is done by (Pucher et al.,2004) who have identified problems like chronic corruption, inefficiency, undependable service and overcrowding as the most pressing problems that plague the Indian public transportation scenario and attribute a large role for this to the rapid urban sprawl the Indian cities are experiencing in an unplanned way (Pucher et al.,2004). The research also highlights large variation among the users of public transport in different cities of India with Kolkata being the highest users and Lucknow being the lowest and Bengaluru citizens, at the time of research just using a little more than 30 % public transportation as the mode of commute. They have also acknowledged the importance of Auto Rickshaws in the urban transport scenario of India and it is also an important constituent of this research.Privatization of public transportation services, capital funding by the governments to ensure financial viability and planned improvement (Pucher et al.,2004) are the measures that they suggest for attracting the population to make use of public transportation more.

The history and watershed moments which started the planning and popularising efforts towards public transportation and the recognition of it to be the solution to the vows of

public transportation are documented by (Agarwal & Zimmerman, 2008). They have identified the increased importance to public transportation and the policies of National Urban Transport Policy (NUTP) in 2006 and the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) which aimed at making public transportation financially viable and boost investment (Agarwal & Zimmerman, 2008) as the most important policy decisions that started India's public transportation revival and popularisation journey. Shift to multimodal and a comprehensive approach for transport planning (Agarwal & Zimmerman, 2008) with capacity building are the suggested solutions.

Informal modes of public transport which include the likes of Auto Rickshaws and cycle pulled rickshaws and a variety of other modes have been studied by (Kumar et al., 2016) as they form a crucial part in the mobility networks of Indian cities. The lack of adequate formal transport networks (Kumar et al., 2016) and the lack of sufficient information on them hinders rational policy making concerning these modes (Kumar et al., 2016). There is also a negative perception that has been built due to the safety issues, congestion and other factors which have resulted in a failure to acknowledge the contribution of these informal transport modes (Kumar et al., 2016). High flexibility and adaptation to local conditions have made them a prominent transport mode and specifically Auto Rickshaw that is a part of the scope of public transport for this research has been found out to predominantly occupy the arterial and sub arterial road networks in India (Kumar et al., 2016). Thus there is an important need to acknowledge their contribution and involve them in policy formulations towards public transport.

Talking about the various Indian cities there has been research and literature available and one of the interesting works that throws light on the relation between gender and mobility in the city of Pune has been conducted by (Baudens et al., 2023). They have researched about the effect of digital transformation on the mobility of women in desk jobs in Pune. The research analysed women preferences of mobility options as per safety, time and reliability. It also sheds light on why some of the participants did not opt for a regular commute using public transport. This gives valuable insights on the connection of socio economic backgrounds to that of public transport usage as people with price considerations

went for public transport mode often (Baudens et al, 2023). Harsha et al.,2020 have conducted a specific research on Bengaluru which is also the city setting for this research and the insights they have published give great insights for this study. BMTC being the largest bus network and provider in India (Harsha et al.,2020) needs to be upgraded and analysing the data collected some of the policy recommendations they give for increasing the ridership of BMTC in Bengaluru are the reduction in frequency of fare revision, provision of Bus Rapid Transit (BRT) lanes and an important aspect of restructuring the fares for short to medium trip in these buses (Harsha et al.,2020).

All of the above literature points towards some of the common problems faced generally in developing countries and specifically India which include the noise, pollution and lack of capacity of public transport. The policies have not done sufficiently well to improve them though it has to be also considered that these policies take time and are often long term projects. The study of these literatures gives us an understanding of the context in which public transportation is based in India and also the crucial linkages of it to the concept of sustainable mobility. The lessons from other cities and research also yield valuable insights in the background to study Bengaluru. Sufficient literature still does not exist in this field for developing countries and specially for a city like Bengaluru with a varied composition of people and with a rapid urban sprawl that it entails. Though there have been a variety of recommendations for the identified problems in public transportation, very little literature exists about the need for collaboration and a collaborative governance approach for solving the problems and increasing the ridership of public transport. This is an area which this particular research tries to bridge.

3 Context and stakeholder classification

Stakeholders is an important term that has been used in management practices and the management field (Mitchell et al., 1997; Benn et al., 2016). Stakeholders can be persons, groups, neighbourhoods, organisations, institutions, societies and even national environments (Mitchell et al., 1997). It is based on what actually counts or who has the stake (Mitchell et al., 1997). The primary criteria would be as to who can affect the environment and objectives of the organisation (Benn et al., 2016) and as to how the organisation is dependent on the stakeholders or vice versa (Benn et al., 2016). We need to see in this context when we consider a whole city and its public transportation ecosystem here and not just any individual firm or organisation. The different stakeholders who are present in Bengaluru actively involved in framing and implementation of policies regarding public transport are enumerated in the table given below.

Table 3. Different stakeholders of public transport ecosystem Bengaluru (Source: Fieldwork)

Stakeholder	**Function**	**Nature**
Transport ministry, Government of Karnataka	To manage all the transport policies and the ministry responsible for all road and rail transport.	Public
Bruhat Bengaluru Mahanagara Palike (BBMP)	Urban local body incharge of administration and providing basic facilities for Bengaluru	Public
Bengaluru Development Authority (BDA)	Authority responsible for maintaining land resources and development and planning of Bengaluru city	Public
Directorate of Urban Land Transport (DULT)	Coordinating agency which plans and executes programmes with respect to land transport and land use	Public
Bengaluru Metropolitan Transport Corporation (BMTC)	Responsible for managing the buses and provide public transport for Bengaluru area as defined	Public owned corporation
Bengaluru Metro Rail Corporation Limited (BMRCL)	Responsible for constructing and managing the metro lines and adding new ones and all related	Public owned corporation

	infrastructure	
Auto Rickshaw Unions	Groups established under labour laws and representing interests of the Auto Rickshaw drivers.	Private
Traffic Police department	Maintain and ensure appropriate following of the traffic laws and maintain law and order with respect to road traffic and maintain road safety.,	Public
Civil society organisations	Representing citizens and their concerns and distributed organisations who work for social causes	Private
Research institutions and groups	Institutes and academia who research on issues related to transport and provide inputs	Public or Private
Private app developers	Private entities who either with collaboration or independently develop new technical solutions for transport problems	Private
Non Governmental Organisations (NGO's)	Organisations engaged in transport and environment protection fields who are actively trying to contribute towards problem solving and creating awareness in these areas.	Private
Media	Various print and electronic medias who disseminate information about the related policies and also hold the government accountable	Public and Private
Citizens	People living in Bengaluru who constitute the main customers and end users of public transportation	Private individuals

Several schemes were studied regarding the different ways stakeholders can be categorised for the convenience of understanding their inter relationships and how they play a role in public transportation in Bengaluru. Masso & Kasapoglu, 2020, in their work made use of a triple agency model to classify the digital landscapes produced by data algorithms into

three different entities: the agency of experts, agency of data subjects and agency of algorithms. Other studies like the one identifying sustainable tourism practices for Baltic regions by Kiryluk et al (2021) have classified the stakeholders as the strategic agents, operating agents and participating stakeholders. Mitchell et al., 1997, has used three factors namely power, urgency and legitimacy. However not all the stakeholders necessarily need to wield power and urgency, hence (Wagner Mainardes et al., 2012) had developed a stakeholder classification in which they define the categories as active stakeholder, passive stakeholder, collective stakeholder and a non stakeholder and also establish the strength of relationships between them. Other classifications widely mentioned in literature and as part of stakeholder theory are the primary and secondary stakeholders (Savage et al., 1991), the active and the passive stakeholders (Mahoney, 1994), wide and narrow stakeholders (Freeman & Reed, 1983) etc. Other research works specific to public transportation research have viewed broadly stakeholders as the commuters and citizens who use public transport (Too & Earl, 2010; Manetti et al., 2017).

Keeping the various parameters and classifications of stakeholders, this research would be classifying the stakeholders in a four fold way basically depending on the function that they carry out in the ecosystem of public transport in Bengaluru. This approach was deemed suitable because the question of network actors in the ecosystem and their mutual collaboration can be best studied if viewed from the perspective of their core functions that they are assigned. The ability of them to function in a specific way and their role in increasing the ridership directly depends on their functionality. Hence this research has adopted a fourfold schema of dividing and classifying the stakeholders as the public transport providers, the city administration, the facilitators and the citizens who are the end consumers as the large and important category.

The public transport providers are the agencies and institutions who provide the core function of providing means of this transport like the buses and metro's. The city administration are the public bodies who are responsible for infrastructure management, management of the city and the main ministry responsible. The facilitators form a group of stakeholders who out of their social responsibilities or profit motives or research motives are contributing in a way to the uptake of public transportation or who are facilitating the

larger use of public transportation in Bengaluru, thus it would involve the academia, the private application developers the civil societies and the NGO's.. The last but not the least and the most important category of stakeholders will be the citizens who are the ultimate beneficiaries and the target group who will be responsible and would cause the actual increase in ridership that this research aims at. The table summarises the classification of stakeholders of the public transportation ecosystem in Bengaluru.

Table 4. Classification of stakeholders in public transport ecosystem, Bengaluru (Source: Original work)

Categories	**Public transport providers**	**Administration or City administration**	**Facilitators**	**Citizens**
Stakeholders	BMTC BMRCL Auto Rickshaw Unions (ARU's)	Transport ministry BBMP BDA Traffic Police	DULT NGO's Academia (Indian Institute of Science, Bengaluru and others) Civil society organisations	Citizens (Includes commuters of these services all together)

4 Methodology

4.1 Mixed method approach

Mixed method approach employs both the qualöitative and quantitative methods of research simultaneously in a single research (Rossman & Wilson, 1985; Creswell, 1999; Malina et al., 2011; Bulsara, 2015). This kind of study would enable us to interpret data qualitatively as well as represent the phenomena through numbers and statistics (Creswell, 1999). The unified perspective (Leech et al., 2010) that forms the research foundation would then enable us to approach and understand and analyse data from different perspectives. The evolution of a mixed method approach developed first from the field of psychology (Migiro & Magangi, 2011) and has now come to be used extensively in the field of social science (Morse, 2016). This research employed a quantitative survey of 130 participants in the city of Bengaluru as the quantitative method and at the same time also conducted eight interviews with the experts to find answers to the formulated research questions. The research also made use of the document analysis method for studying the Bengaluru Metropolitan Land Transport Authority (BMLTA) Act, 2023.

There have been researches concerning public transport and transport policies which have employed the mixed method approach like the researches of Tiznado- Aitken et al (2020), Green et al (2014), Waara & Risser (2013), Al-Rashid et al (2022)..... and so on. The quantitative study can through statistics understand the underlying factors and corroborate the findings from the qualitative data (Kelle, 2006). Thus this methodology intends to capture the viewpoints both from the provider side as well as the user side

4.2 Data collection methods

The step of data collection gathers the required information required to answer the research questions and forms a very important step through which information is obtained and further analysed to get the results (Mazhar et al., 2021). Data collection methods depend on the methodology and analytical framework of the researcher (Paradis et al., 2016). This research involved a field work of about three months in India for the process of data

collection. Interviews as part of the qualitative method were held with the experts after carefully selecting them and then a survey was designed and conducted in Bengaluru which got 130 responses. The data collection aspects would be elaborated further.

4.2.1 Qualitative method-Interviews

Qualitative data collection is basically collection of non numeric data and often seeks to get an insight and perspective of the subject on the topic being researched on (Carter & Henderson, 2005). Semi structured interview is a qualitative method of interview is a popular method which has a set of questions in an order but also allows deviations and flexibility (Smith & Bowers-Brown, 2010). The style is usually that of a conversation (Smith & Bowers-Brown, 2010) and allows the researcher to gain in depth insights on the problem at hand.

4.2.1.1. Method and procedure

This research adopted a mode of semi structured interviews focussing on a set of topics which were the focus area of the research questions like the ridership of public transport, collaboration among actors and stakeholders and the aspect of digitalisation. A total of twelve interviewees were primarily shortlisted for interviews, however two of the officials were unable to attend due to the General Elections that started in India in the month of March-April-May 2024. Two other interviews were later decided to be dropped as it would most probably give the same viewpoints and insights as already that were obtained. Finally eight interviews were conducted out of which seven interviews were semi structured interviews and one was a written response to the interview as preferred by the interviewee. There was enough flexibility offered to the participants to add their own viewpoints and any other information or their own experience which they felt relevant and could be fruitful for the research. The offline interviews (Four of the eight) with the consent of the participants were recorded and then transcribed manually. The online interviews (four of the eight) were conducted using Microsoft Teams and the option of recording and transcribing was used to obtain the transcripts. One interview was held in the language of Kannada which is the local language of the region due to the interviewees unfamiliarity

with English. This interview was then translated into English manually and then was used for the purpose of analysis. The questions were mainly in the nature of how, what and why as also recommended by Smith & Bowers-Brown (2010). The below table gives the details about the eight interviews that were conducted.

Table 5. List and description of Interviewees for data collection(Source: Fieldwork)

Interviewee	**Type/Mode**	**Description**
1. Managing Director, BMTC	Semi structured/Offline	The head of the bus corporation which is a main stakeholder, senior government official in Karnataka govt.
2. Ex Managing Director, BMRCL	Semi structured/Offline	The ex head of the BMRCL and the incharge then, who has vast experience in metro operations and a senior official of Karnataka govt.
3. Director, IT, BMTC	Semi structured/Offline	Official who heads all the IT initiatives of BMTC and a senior official in Karnataka govt.
4. DULT	Written/ Offline	The main coordinating agency which is responsible for promoting sustainable mobility and coordinates the research on it.
5. Mr. Satyajit Arikutram	Semi structured/Online	An expert in the field of transport in Bengaluru and the person who was connected closely with the development of the Namma Yatri Auto Rickshaw app.
6. Chairperson, Bengaluru Political action committee (BPAC)	Semi structured/Online	The chairperson of leading civil society BPAC and also a pioneer in herself in mobility related developments and citizen involvement
7. Prof. Dr. Abdul Pinjari	Semi structured/Online	Professor at the Indian Institute of Science (IISc) and heads CISTUP research unit which researches on public transportation.
8. Auto Rickshaw Drivers Union (ARDU)	Semi structured/Offline	The union of Auto rickshaw drivers who acts as a representative body and protects their interests. Represents the viewpoint of the Auto Rickshaw community.

4.2.1.2. Selection and profile of Interviewees

The primary criteria of selection of interviewees was based on the equal representation that all stakeholders must get to give their opinions. The senior officials of the Karnataka government were contacted which included the Managing Directors of BMTC and the BMRCL which were the main public transport providers of bus transport and Metro respectively. The digitalisation aspect had to be captured with respect to BMTC and a specialised official who exclusively headed the IT department of BMTC was chosen for that. The interviewees were able to reflect upon the current state of their transport corporations and assess the benefits of sustainable mobility, the problems and constraints they faced and also expand about their current initiatives. Valuable recommendations were also received from them.

The academia was represented by Prof. Abdul Pinjari who was a senior researcher and has been involved with the public transportation and sustainable mobility field in Bengaluru. DULT formed an important organisation which was responsible for coordinating between all the agencies and was actively involved in promoting active mobility and sustainable mobility and the set of questions were provided to them which were answered in the form of a written response. The other important mode of transport was that of Auto Rickshaws and the organisations that formally represented them were numerous with many associations being present. The largest and the most popular association was picked for interview and data collection. Though not all the views expressed can be assumed to be collectively representing the Auto Rickshaws, it was the best way to collect data about their involvement and insights.

The citizen and civil society was selected which was involved in various initiatives specifically in the field of sustainable mobility namely through an initiative B-MOBILE and also the society was actively involved in voicing for the legislation of a BMLTA Act and was involved in the stage of drafting and reviewing of the legislation as well. On the advice of the same BPAC organisation, the transport export Mr. Satyajit Arikutram was also contacted for an interview. He has been actively involved in the transport sector and framing of various policies in the field in Karnataka. The expert was also an advisor and is part of and keenly knows the journey of development of Namma Yatri Application for the

Auto Rickshaws. Hence his views on the problems of public transportation in Bengaluru affecting the ridership and also views on collaboration and the recently legislated BMTC Act and his recommendations were very resource rich for this research.

The effort was also to contact the head of the BBMP and the Traffic Police department who represented important stakeholders of the public transportation ecosystem in Bengaluru. However the timing of the research coincided with that of the Indian parliamentary elections and it was not possible to get the appointment and time for the interview of these officials even though they had consented earlier. The primary factors that were used to shortlist and choose the interview partners were the current role of them with respect to public transport in Bengaluru, their experience and prior works, and the expertise that they had with respect to the subject. This would provide in depth insights and qualitative data which could then be analysed to arrive at answers for our formulated research questions.

4.2.2 Quantitative method-Survey

Quantitative study tries to measure the relation of attributes in numerical quantities (Bowling & Ebrahim, 2005). A survey as an instrument can be used and it seeks to collect the information of interest from a select sample of the population (Bowling & Ebrahim, 2005). There can be both strengths and weaknesses of different survey instruments (Nardi, 2018). The design of a survey depends on the design of the questionnaire and how it seeks to measure the respondent answers (Nardi, 2018). This quantitative method was chosen to get responses from the citizens' side and to assess their preferences and insights on barriers and other issues. This provided the qualitative inputs with numerical data to forge and arrive at better conclusions.

4.2.2.1 Design of the Survey

The first step of the survey design was to design the questionnaire for which the help of google forms were selected. The questionnaire was designed and then distributed among a few participants (n=5) and feedback for the questions and any difficulty or errors that were experienced during the response was obtained. This allowed us to refine the survey and

appropriately mark the mandatory and the non mandatory questions. Simple random sampling was used where a random number (n=130) were selected out of the total population of Bengaluru (N). Here the person is not replaced and hence obtains equal probability and weightage for their responses (Bowling & Ebrahim, 2005).

The survey was shared through the online means to all the possible participants so as to ensure a wider reach and the digital divide was also considered to be an important factor and the respondents who were not digitally comfortable to use the links also had to be considered. Hence the physical printed forms of the survey were also carried to different localities situated at the North, South, East and West part of Bengaluru at random locations and were requested to be filled to capture a diverse sample space. Market labourers, vendors, lower level staff working at restaurants and even some students from college campuses were asked to fill in the hard copy of the survey questionnaire. Later the results and responses were marked and uploaded on to the google forms manually to obtain a holistic response and survey result in the end from google forms.

Since the survey was designed to be quantitative, a five point Likert scale was used. Psychometric studies and their quantification has been evolving (Joshi et al., 2015). It is a set of items or questions that are provided to the participant to record their sense of agreeableness or disagreement to the question (Joshi et al., 2015). There are various types of Likert scale available namely the four point, five point and the seven point likert scales. There is a view that a seven point scale offers more varieties than a five point scale and hence can capture the respondents thinking better (Joshi et al., 2015), however there are also opinions that it becomes too complex and hence an appropriate selection should be made keeping the context in mind (Joshi et al., 2015). Therefore a five point Likert scale was used to design this survey. The range was from Completely agree (5), Rather agree (4), Neither agree or disagree (3), Rather disagree (2) and Completely disagree (1). The frequency of travel of various modes of public transport in consideration was also based on a five point Likert scale with the measures as Always (5), Often (4), Sometimes (3), Rarely (2) and Never (1). The appropriate quantification as per the responses were then used to analyse the survey response.

4.2.2.2 Participants and their profile

The participant profile was random but it was ensured that it would have a uniform mix of participants from different genders, age profile, professions and also economic backgrounds. This was done with the objective that a sample space should best reflect the kind of population that it seeks to survey (Bonar et al., 2011); given the nature of Bengaluru as a cosmopolitan city, best efforts were made to obtain responses from different participant profiles. The under represented participants were pursued to participate and the different sections were reached in the fieldwork.

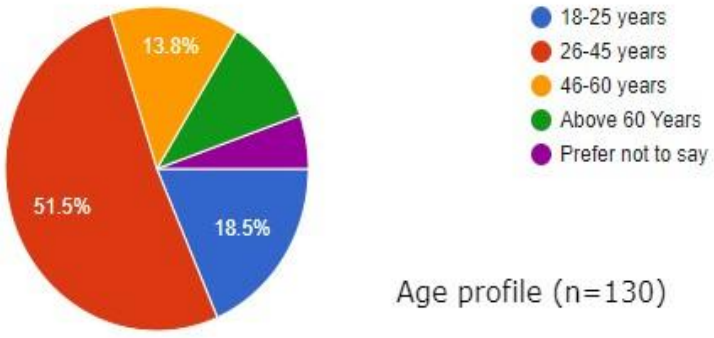


Fig No. 4 – Participant profile (Age) of the Survey conducted(Source: Fieldwork)

The table below gives the exact profile distribution of the respondents in a descriptive manner. The choice was also given to the participants to not give any personal information if they wished to do so. The age profile was quite varied and adults (Over 18 years of age) were considered, with senior citizens falling in the category of above 60 years. The gender and professional variations were also diverse. Though the gender of participants were not exactly equal, it still included and represented all genders.

Table No. 6. Profile of the respondents in the survey (Source: Fieldwork)

Personal attributes	Categories	Number of respondents
AGE	18-25 years	24
	26–45 years	67
	46-60 years	18
	Above 60 years	14
	Prefer not to say	7

GENDER	Male	75
	Female	52
	Others	1
	Prefer not to say	2
PROFESSION	Private employee	60
	Student	18
	Self employed	16
	Others	15
	Government employee	14
	House manager	7
PRIVATE VEHICLE OWNERSHIP	Yes	106
	No	24

4.3 Data analysis methods

The data obtained by both the interviews and the quantitative survey was analysed in a number of steps. The data from interviews were sorted and transcribed and the methodology of Grounded theory (Glaser & Strauss, 1967, 1970, 1971, 1974, 1975; Strauss & Corbin, 1994) and Thematic analysis (Braun & Clarke, 2006) was applied for the qualitative data obtained by interviews. The quantitative survey data was analysed using descriptive statistics with the help of Box plots (McGill et al., 1978) and the methodology of Exploratory Factor Analysis (EFA) (Fabrigar & Wegener, 2011) was also used on certain data sets to obtain meaningful interpretations. The next section would in detail explain the data analysis methods and process that was used for the research.

4.3.1 Thematic Analysis

Thematic analysis as a methodology was demarcated and popularised by Braun & Clarke (2006). It is a qualitative analysis methodology where the data is coded and then analysed

for forming a thematic map and hence finally arriving with themes. The process in a nutshell is to identify, analyse and report themes from the data (Braun & Clarke, 2006). The main advantage that thematic analysis as a methodology provides is the flexibility it offers (Braun & Clarke, 2006). Theme is a patterned response and something that captures important aspects in a collected data (Braun & Clarke, 2006). Themes need not be present throughout the data, but on the contrary certain themes can be present in certain data sets but can also be completely absent from certain data sets (Braun & Clarke, 2006).

Along with the methodology of thematic analysis some elements of the grounded theory approach (Glaser & Strauss, 1967) were used. It relies on the concepts grounded in the empirical data and accordingly the theory can be hypothesised later from the set of relations that are found between them (Strauss & Corbin, 1994; Holton, 2008). The major difference here is that the grounded theory is theoretically bounded but thematic analysis offers a way out for the researcher if implicit theoretical commitments are not wanted by the researcher (Braun & Clarke, 2006). Using thematic analysis with elements of grounded theory, patterns of interaction are revealed among the actors which can then be codified into theories and results (Jørgensen, 2001).

Braun & Clarke (2006), have listed out six main steps to conduct thematic analysis. They are the steps of familiarising with the data set by transcribing if necessary, initial coding of the data, researching themes, reviewing the themes. Defining and naming the themes and then finally producing the report. Accordingly the interviews were coded and then the themes were recognised. Some of the themes were recurrent in most of the data sets and some were specific to one particular interview and then further analysis had to be done to identify the themes. Once the themes were obtained, by merging the smaller sub themes, they were again reviewed and contrasted with the whole data set to check whether they make sense and finally seven themes were finalised. These themes were further then used for a theory building with the grounded theory methodology. Hence both the methods were used in combination to conduct the qualitative analysis part of the research.

The main pitfalls a researcher needs to keep in mind while following the methodology as enumerated by Braun & Clarke (2006) were also kept in mind. The themes just do not emerge and often the questionnaire used for the analysis in itself should not become the source for the themes (Braun & Clarke, 2006), hence there has to be actually an analysis and the data should be seen from the perspective of what the interviewee wants to express and the themes should reflect the same (Braun & Clarke, 2006). Hence sufficient attention was given to these aspects when conducting the thematic analysis of the data. The method was chosen because of the flexibility it offers and as it is suitable for any framework and also suitable for researchers new to qualitative research (Hayfieldet al., 2017).

4.3.2 Quantitative data analysis

The first step towards quantitative data analysis was to transform the responses into a quantified data which was represented in numerical values. Each response to the survey was to be represented with a code which is a numerical value (Treiman, 2014). Hence on the basis of the five point Likert scale every response was then transformed into a numerical value in the initial data transformation process. The responses were recorded in an excel format and appropriate values from ‘1 to 5’ were assigned accordingly. There were two categories of variables namely a nominal variable and a metric variable (Bryman & Cramer, 1992; Treiman, 2014). The variables like Age, Gender and Profession were nominal variables and the responses related to frequency of use, importance of digital initiatives, constraints and the need for collaborative and participative planning process after being converted to numerical values formed the metric variables.

Reliability of the data and internal consistency of the data obtained is crucial for conducting valid analysis on the obtained data set (Tavakol & Dennick, 2011). Among the various methods available for estimating the reliability, the standard measure of Cronbach’s alpha (Cronbach, 1951) was chosen and was calculated to assess the reliability and internal consistency tests. The online statistics calculator of ‘Data tab’(https://datatab.net/) was used to do the calculations and obtain Cronbach's alpha value. The measure of Cronbach’s alpha is expressed as a number between 0 to 1 and it measures the extent of the variables being

related and being able to measure a same concept or construct (Brown, 2002; Tavakol & Dennick, 2011). There are a range of interpretations but the most accepted and standard measure of consistency of the Cronbach's alpha values is which is greater than 0.65 and up to 0.95 (Nunally & Bernstein, 1994; Bland & Altman, 1997; DeVellis & Thorpe, 2021). All the different Cronbach's alpha values obtained for different data sets used for the quantitative analysis were found to be in the range and greater than 0.70. However the frequency data showed the value of 0.65 which was due to only three variables and reliability tests other than cronbach alpha justified its use. There were also values obtained up to 0.95 indicating a high level of consistency which can also indicate that the data is all uniform and pointing to the same thing, however given the sample size of 130 and the common responses was determined to be the reason behind this. The obtained Cronbach's alpha values are represented in the further sections with respect to the datasets used for analysis.

4.3.2.1 Descriptive statistics

Large sets of data need to be summarised and the tools like averages, percentages and graphs are used to analyse and summarise such data is known to be called as descriptive statistics (Holcomb, 2016). The nominal variables like Age, Gender and Profession were used for comparison with the obtained data on the frequency of use of the three modes of public transportation namely Bus, Metro and Auto Rickshaw. With the range of responses being converted on a scale from 1 to 5 with the always response coded at 5 and the never response at 1,

it gave a range of values which could signify the frequency of use of public transportation by the 130 respondents. With three different modes of transportation, a single measure was to be calculated which gave a overall measure of use of public transport and hence the concept of averages was made use and a 'Index value' of frequency of use per respondent was calculated

(Table No. 7. Cronbach's Alpha (Source: Survey))

Responses (Frequency of use)	Numerical Values
Always	5
Often	4
Sometimes	3
Occasionally	2
Never	1
Index Value	Average(3 responses)

Cronbach's Alpha	Number of Items
0,65	3

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
BUS Use Frequency	0,4	0,66
Metro use Frequency	0,57	0,41
Auto Use Frequency	0,44	0,59

which is the average of the three indicated frequencies rounded of to two decimal points.

These values were then represented in the form of Box Plots, and this was the chosen method because box plots represent numerically rich data of a large sample space in an effective way (Nuzzo, 2016) . It also represents statistical measures like median and interquartile range and helps to identify outliers without any prior assumption about the population (Nuzzo, 2016).

Similarly to assess the frequency of use of public transport by respondents who owned a private vehicle (n=106) the same measures were used but with different vehicle categories. The intention was to observe the impact of vehicles and the category of vehicles on the frequency of use of public transport. The vehicle ownership response was also categorised into five different categories as illustrated in Table No. 8 and box plots were drawn for the same.

Table No.8. Vehicle ownership categories (n=106)

Ownership category of private vehicles	Responses
CAT 1	Two wheeler (One only)
CAT 2	Two wheeler(More than one)
CAT 3	Four wheeler(One only)
CAT 4	Four wheeler (More than one)
CAT 5	Both two and four wheeler

4.3.2.2 Correlation analysis

Correlation is the measure of statistics which measures how strongly one variable relates to another or in other words the association between each other (Asuero et al., 2006). There are numerous methods available to calculate such a coefficient but the most popular one has been the Pearson correlation coefficient or the product- moment correlation developed by Pearson in 1896 (Asuero et al., 2006). The frequency responses of the users for the three different modes under consideration namely the Bus, Metro and the Auto Rickshaws were quantified and then Pearson's correlation test was run on them. The results would give an idea as to how these travel patterns are associated with each other and the degree of linear relation between the two variables and as to whether the relation is strong, weak or no relation between the different sets of factors.

According to Gotgay & Thatte (2017), mention the different principles to be kept in mind when conducting correlation analysis and the major principles are to be aware if the data is linear and that it should not be collected from the same individual as it can give a false relation. Similarly according to them sufficient sample space must be considered for obtaining fruitful results. The correlation was conducted using the software Data tab and it was done by drawing the scatter plot and then obtaining the correlation matrix and then using the data, a correlation heat map was drawn to analyse whether any relation exists within the use of different modes to get an idea about integration or association and whether travel by one mode would affect the probability of ridership by the other mode. This analysis was important from the perspective of answering the question about the mutual integration or non-integration of the transport modes and the way it can affect the ridership as a whole.

4.3.2.3 Exploratory Factor analysis

Exploratory factor analysis (EFA), is a multivariate statistical method (Watkins, 2018), which is used to group a large number of variables and determine factors. The large set of observations that is encountered usually in Social sciences research is difficult to analyse and hence there is a requirement of a methodology that can be used to represent these observations parsimoniously (Fabrigar & Wegener, 2011). Correlation is a measure that can be used to measure the association but with a large number of variables the correlation matrix becomes too large and hence this methodology needs to be adopted (Fabrigar & Wegener, 2011). Factor analysis provides a way to determine the distinct number of constructs needed to account for correlation (Fabrigar & Wegener, 2011). This method is also commonly used in Psychological and educational studies (Williams et al., 2010), and hence was deemed suitable to study the responses that were obtained from the survey regarding the constraints and digitalisation efforts that the respondents felt were the most important factors for them making a choice on using public transport or that mode in specific.

There are two ways or methods of conducting factor analysis, which are the Exploratory Factor Analysis (EFA) and the Confirmatory Factor Analysis (CFA). Exploratory Factor

Analysis is used when the researcher is looking to find the factors and generate a new theory; on the other hand Confirmatory Factor Analysis tries to confirm the existing hypotheses and prove whether the factors support it or not (Williams et al., 2010). This research had the motive of finding out and exploring the factors and hence went for the EFA methodology. The result was expected to reveal as to what are the different factors or groups of digitalisation efforts or constraints that commonly affected the citizen and ridership behaviour. The responses regarding the need for collaboration was also subjected to the methodology, but due to the similarity of the responses and overwhelming yes response, it was later kept out of the methodology.

The same reliability measure of the Cronbach's Alpha was used for the data about constraints, digitalisation and collaboration responses to assess the reliability of the data set before proceeding for the EFA methodology. The table below gives the Cronbach Alpha measures which were recorded using Data Tab and it was 0.73 for collaboration related responses, 0.93 for the constraint related responses and 0.95 for the digitalisation related initiatives. The values of 0.93 and 0.95 can be regarded as extremely high and also interpreted as meaning a high degree of uniform responses; however the digitalisation and

Table No. 9. Cronbach's Alpha (Collaboration, Constraints and Digitalisation initiatives)

Response category	Cronbach's Alpha	Number of Items
Collaboration	**0.73**	**3**
Constraints all	**0.93**	**26**
Digitalisation initiatives	**0.95**	**26**

constraints also were of the same nature like congestion, cleanliness, cost and so on and hence the high value was accepted and the EFA was conducted using the methodology of Principal Component Analysis (PCA).

Williams et al (2010) have given a detailed stepwise procedure to be followed. The methodology used the statistics calculator from the Data tab to compute large data and accordingly, first the suitability of the data was assessed keeping in mind the number of

variables and sample size that was considered. Secondly the correlation table was computed and the Eigenvalues which are greater than one were considered (Williams et al., 2010) using the scree plot which is a standard way the number of factors are determined. Later the communalities were computed and a suitable way the component matrix is to be rotated was decided. This methodology used the ‘Varimax’ rotation technique to arrive at the rotated component matrix and then accordingly it was analysed as to what factors the values loaded into. The value loading was not uniform and accordingly the factors which did not have sufficient value loading were excluded and the factors thus obtained after categorisation based on the variables were named to get an idea about the underlying principal reasons and factors that make a particular variable dominant or negligible.

5 Results

This section would elaborate on the results obtained as a result of the above mentioned data analysis methods. The first part would discuss the results of the quantitative analysis part and the final outcome as to how it can be interpreted later followed by the qualitative analysis results in the form of obtained themes.

5.1 Individual attributes and their impact on ridership

The box plots of the mean index value of the frequency of use of public transport with age, gender and profession revealed the pattern of ridership and the ways which these individual attributes affected the ridership. This would give inputs about the target group and category of people who are less likely to use the public transport modes and hence devise ways to increase their public transport usage. The box plot basically represents data and gives out the minimum, maximum and median of the data and is a tool to visualise the data. The data in the box constitutes 50% of all data and the dots if any represent the outliers.

5.1.1. Age and frequency of use of public transport

The age categories of the survey respondents were divided into categories of 18-25, 26-45, 46-60 and above 60 years respectively. The box plot for the age vs frequency of use of was obtained as shown in the figure. As it can be seen that the overall general visualisation indicated that the frequency of use is slightly higher for the 18-25 years group, than others.

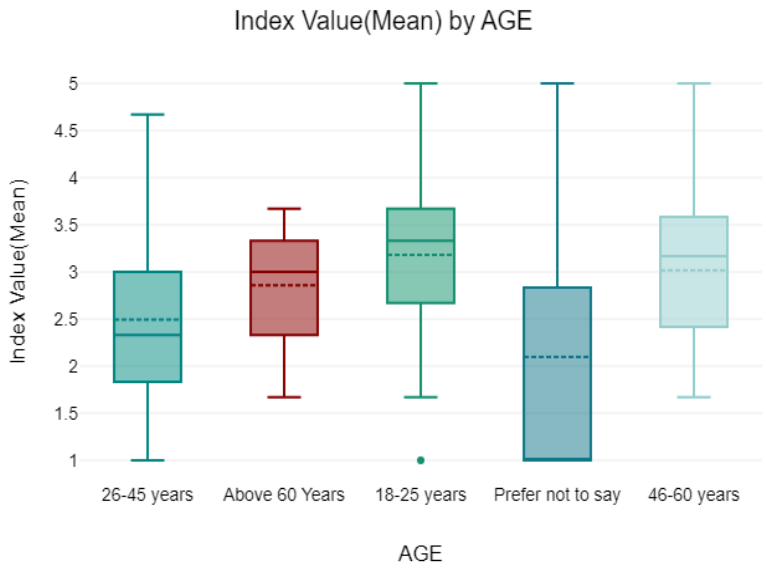


Figure No. 5- Box plot Age vs Frequency of use of transport

There is one outlier in the category who never indicated the use of public transport, but this larger use can be attributed to the students who occupy the most space in this age group. The interviews also clearly corroborate this fact and can be seen from the response that " *We have a software solution called TUMOC by oracle and it is to give daily passes and monthly passes. It is a very easy thing where the four numbers are captured using Aadhaar and also the students pass, students are the highest contributor to ridership"* (Interview: Director IT, BMTC). The most diverse ridership and a large spread is observed in the 26-40 years age group which predominantly consists of the working population and the use of public transport for work is indicated in the responses. The category of prefer not to say can be considered as an outlier here and the range extends from never to always. The median is also the highest for the 18-25 year category and then followed by the 46-60 year old category and then the 26-40 year old category.

The senior citizens who are aged above 60 years showed a balanced response with the minimum value being 1.67 to the maximum value being 3.67; it's interesting to observe among the limited participants in this age category nobody had extreme responses of always using the public transport and never using the public transport. Given the retirement age in India being at 60 years , the above 60 year population are all retired personnel who do use the public transport given their decreasing ability to drive and safety concerns, but it is equally evident that it is only on a need basis that they use public transport. The most promising categories here would be the student and young 18-25 year old category then followed by the working populations of 26-40 and 46-60 who can be targeted for an effective increase in ridership. The concept of monthly passes and student passes was mentioned in the interviews and one such innovative recommendation was to at least start the collaboration and integration efforts by the introduction of a joint pass or joint ticket combining bus and metro. *" So exactly as a starter? No…… BMTC and BMRCL if they can come up with a joint daily pass. That would be great"* (Interview: Transport policy expert). The importance of collaboration to attract these age groups is also highlighted here that they can have an effective and an established way of reaching their offices or educational institutions, if they had a joint ticket at reasonable prices. However this also throws up a challenge of the public transport that needs to be punctual and timely in order

to attract ridership as students and the working population would have to be on time for their respective assignments.

The bright part of this observation is also that the younger generation are willing to use public transport and it is also a usual case that 18-25 year old respondents often do not have a private vehicle exclusively for use and hence shows that the effective curbing of need to use automobiles voluntarily or involuntarily would directly result in the dependence of public transport given the imminent need to travel daily.

5.1.2. Gender and frequency of use of public transport

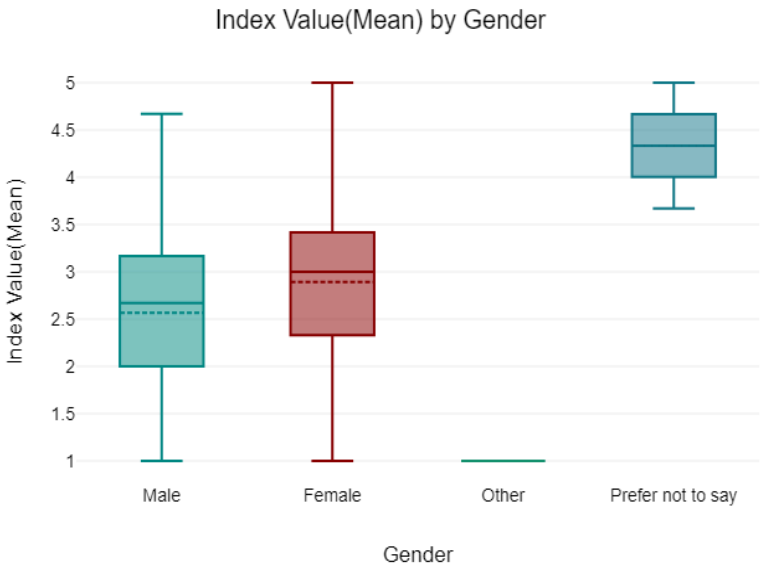


Figure No. 6. Box plot Gender vs Frequency of use

The data distribution from the box plot where the gender of the users was plotted against the average index value brings out interesting observations in the sense that the women have a higher frequency of use of public transport as compared to men. There was also two cases where one was an other or third gender who never used public transportation for reasons unknown. The respondents who did not prefer to reveal the gender had a high frequency of use of public transport. Both these cases do not yield any valuable insights and hence considering the larger cases of men and women, the spread, mean and median of the frequency of travel of men is lesser than females. The results are on similar lines with what was described by Baudens et al (2023) and that social conditions influence the mode of transport that is chosen (Hananel & Berechman, 2016). A large section of the women who were respondents in the survey were working women and also some who were from a lower economic background. This could explain the choice of

public transport which is more pocket friendly. It is also a usual case in India where the number of women who use private vehicles or drive themselves are less compared to that of men as reflected by the meagre 6.8 % of valid driving licences in India belonging to females (Statista, 2020). This again corroborates the fact that the dependence and ridership of public transport in the absence of private vehicle availability or limited choices in this regard. One further addition in terms of development is that the new 'Shakti' scheme from the government of Karnataka has made it free for all women travelling by buses operated by BMTC in the city (The New Indian Express, 2023) and this could have contributed for more ridership to the already existing female ridership statistics. The fare and economics along with social criteria determine the ridership patterns of public transport.

One more important reflection from this finding is also the importance that should be accorded to women safety issues by the public transportation authorities. CCTV's have been installed in all the buses according to the Managing Director, BMTC and this has resulted in a better safety environment. " *We also have a panic button for women safety and we also have live location auditing and we also have digital measures of CCTV and that will actually show how accidents have happened and what its fault is."* (Interview, Director, IT, BMTC). The digitalisation measures in ensuring women safety have to become an integral part of all the public transport systems given the fact that the majority of their ridership consists of women. As per the Interview with the Managing Director of BMTC, he stated that *"Also criminal activities like theft, activities like women harassment, any misbehaviour from passengers or our crew, any sort of problems can be fixed with these digital interventions."* (Interview, MD, BMTC). BMTC has also started a new concept of pink buses which are exclusively managed by female staff including the driver and the conductor and only female passengers are allowed to ride on these buses.The metro too has a separate female compartment exclusively reserved for them to ensure better comfort and safety for them.

The Auto Rickshaw do not yet fully have CCTV kind of coverage and also the female managed Autos are very rarely found in the city, which could be a concern for the females to take Auto Rickshaw more frequently. The survey participants if only females are

considered out of 52 respondents, 8 were always using Auto, 10 were using it often, 14 used it only sometimes, 14 used it occasionally and 6 never used it. This also strengthens the same observation that there can be considerable scope to attract more female ridership of Auto Rickshaw and this is one area where they can invest and work on to make it more convenient and attractive for the female passengers.

5.1.3. Occupation and frequency of use of public transport

The box plot representation of the frequency of use of public transport with the occupation of respondents reveals varied insights. The students who used public transport were the highest re emphasising the benefits of student passes and their primary dependence on public transport for commuting. The second highest were the private employees which has been consistent with the results obtained in the age vs frequency of plot as well. The government employees usage was less frequent than the private employees given the fact that many government offices in India do provide some or the other means of commute to offices and the employees without the access would be the prominent users of public transport. Two interesting observations that can be made with this analysis are one about the self employed and the other about the house managers. House managers given the social context of India are female participants who do not go in for any kind of professional work but rather manage the household and the affairs of the home. It again can be understood in the social context that they would only use public transport on a need basis and to often commute short distances. Thus the spread and the median of this category of respondents has been less. There also have been outliers represented by the dots in the house manager categories

Fig No. 7. Box plot Occupation vs Frequency of use

indicating not a uniform assessment can be made about the category and various factors dictate their use.

The self employed on the other hand has a wide range of data spread and the maximum and minimum being the extreme cases of always using public transport and never using public transport, however this can also be analysed in terms of the nature of work they are undertaking on their own and what kind of transport or mobility it demands thus indicating a strong dependence of public transport usage with the kind of economic activity and occupation one is into. The interquartile range of the category of respondents who did not wish to specify the occupation is the highest indicating that the respondents were from diverse occupations and the range is also extending from the maximum to that of the minimum of possible values. Large potential exists in terms of planning public transport according to the occupation, and having the employers compensating the employees in terms of public transportation passes and allowances rather than in monetary terms.

5.1.4. Vehicle ownership and frequency of use

The vehicle categories were divided as represented in table number 8 and were plotted against the mean frequency index value as well as individually against bus use, metro use and Auto Rickshaw use to understand the effect that the private vehicle ownership had on the different choices of public transport. The analysis also helped to differentiate any specific pattern that could be associated with specific vehicle categories. The vehicle categories also served roughly as an economic indicator. The economic capacities influence the ownership decision of automobiles in India (Verma et al., 2016) and hence this response tried to capture that data which can be used to correlate with the public transportation use behaviour. It can be assumed that category 5 having both two wheeler and four wheeler represents the upper economic class with the only two wheeler class representing the other end of the spectrum.There were 106 participants who indicated that they or their family owned a private vehicle and 24 did not possess any. The below figures and box plots reveal the characteristics of travel of respondents differentiated by their vehicle ownership patterns.

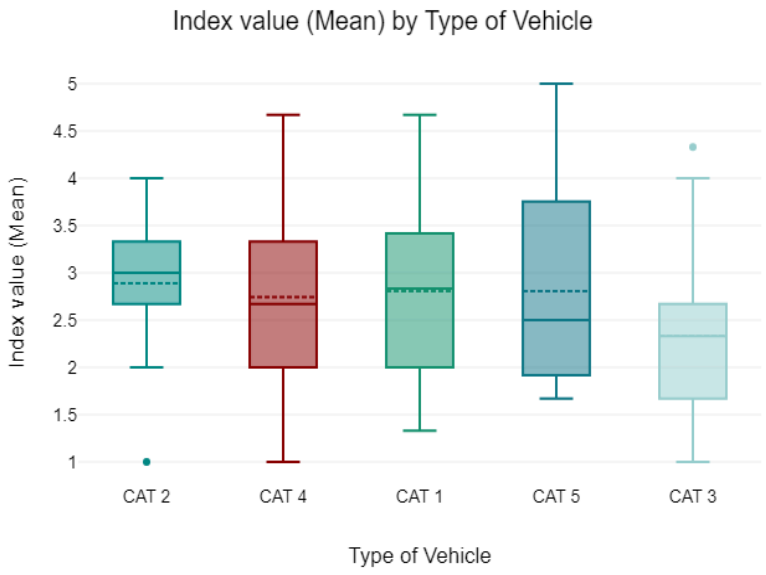


Figure No. 8. Box plot vehicle category vs Frequency

The results here are surprising in the sense that there are no large or considerable variations among the category 1 and category 5 in terms of usage of public transport, with in fact the spread of respondents in the higher side in category 5. The mean of travel frequency was equal between category 1 and category 5. The category 2 which had an outlier as well as the minimum spread belongs to the category of having more than one two wheeler and the lowest frequency was for the category 3 which was respondents having one four wheeler only. This can be on a general level interpreted as the access to the vehicle matters and not exactly the kind of vehicle ownership or the economic capabilities when the use of public transportation is considered. It can also be that people do not prefer to use their cars for short distances in the traffic congestion and hence the category 5 respondents can use two wheelers for short commute distances or Auto Rickshaws. The respondents were given a choice to indicate the vehicle ownership of their response which consisted of them individually and the family and hence it can also be assumed that females and students who indicated the ownership of vehicles may not necessarily be the users of those vehicles and have to depend on public transport. Further research and a much larger sample space will be able to throw more light on it. To gain a more deeper understanding on this pattern, the individual mode of transport frequencies when compared against the vehicle categories also gave interesting insights.

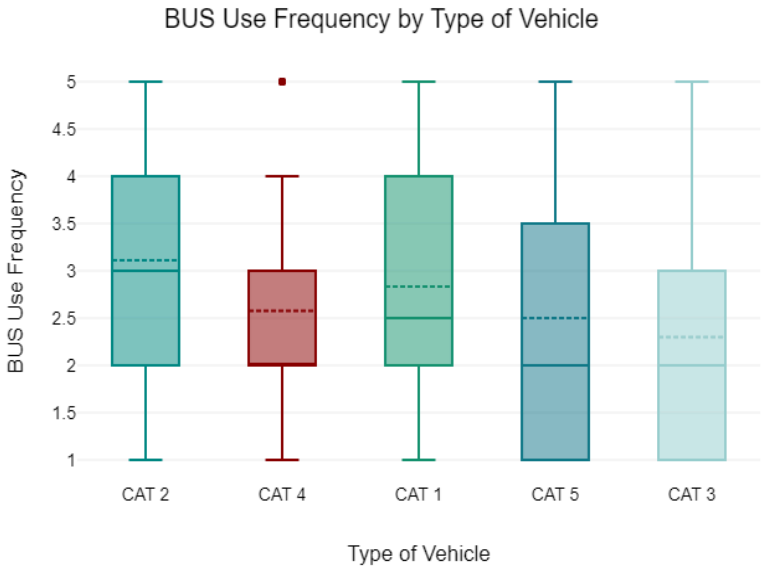
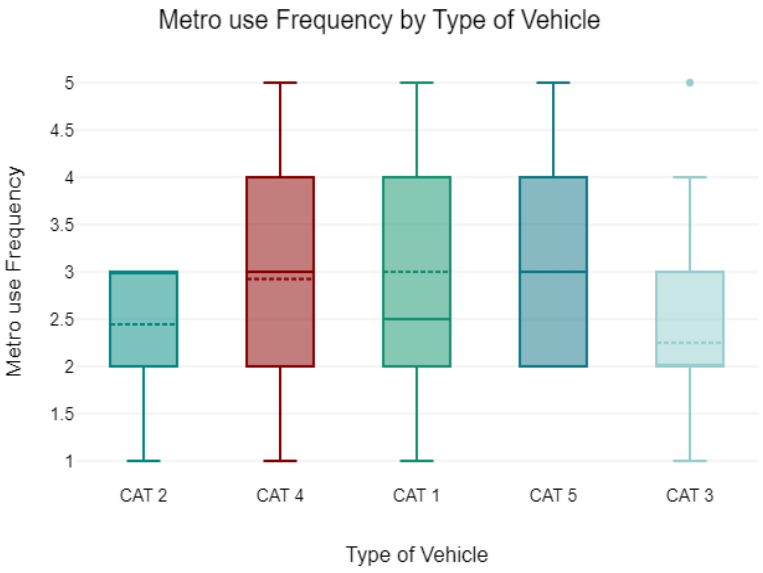


Figure No. 9. Box plot of Vehicle category vs Bus use frequency

The bus use frequency with respect to the vehicle category shows very homogenous results with all categories except category 4, having a spread of maximum 5 and minimum 1. There is an outlier in category 4 who always opted to use buses but apart from it, the spread and the frequency of use is evenly spread.

The highest mean among all the categories is the category number 2 who owned more than one two wheeler but no four wheelers. This can be due to the fact of a larger family size and the inevitable need of using them when more than two persons of the family had to travel together. The auto use frequency is also similar to this among category 2 which again signifies the reliance on auto's for three people travel. The mean of the category 1 and category 5 shows a difference that the bus was more frequently used by the respondents who only possessed two wheelers and not four wheelers. The category 1 and 2 have very similar riding patterns. Category 4 respondents who possessed more than two four wheelers have relatively less use of buses and the spread of the respondents are also very limited compared to the other which on the outset might signify the flexibility that they were offered and that their travel was usually long distance and hence buses could be only used for nearby well connected areas.

The metro use frequency on the other hand is diverse in the sense that category 1, 5 and 4 compare very similarly with their means and medians ranging very close, however category 2 and 3 respondents have indicated a very constrained use with no responses in the always category except for an outlier. Category 2 and 3 are respondents owning more than one two wheelers and the ones owning only one four wheeler. Parking facilities in the metro are varied and are not integrated yet fully as even confirmed by an interview.



The BPAC civil society responded by commenting that *"The infrastructure. How will the citizen get off the metro? Cross the road.Get on to the footpath. What are the parking facilities?"* (Interview BPAC).

Figure No. 10. Box plot of vehicle category vs Metro use frequency

Thus even if the citizens would want to use the metro by getting their vehicles to the station it might not be yet fully developed. Similarly the citizens would also rather prefer to travel by their two wheelers if there are short distances rather than the metro as it is usually for farther destinations. The Auto Rickshaw use frequency by different vehicle owners show a similar kind of use except for category 5 where the minimum value was 2.

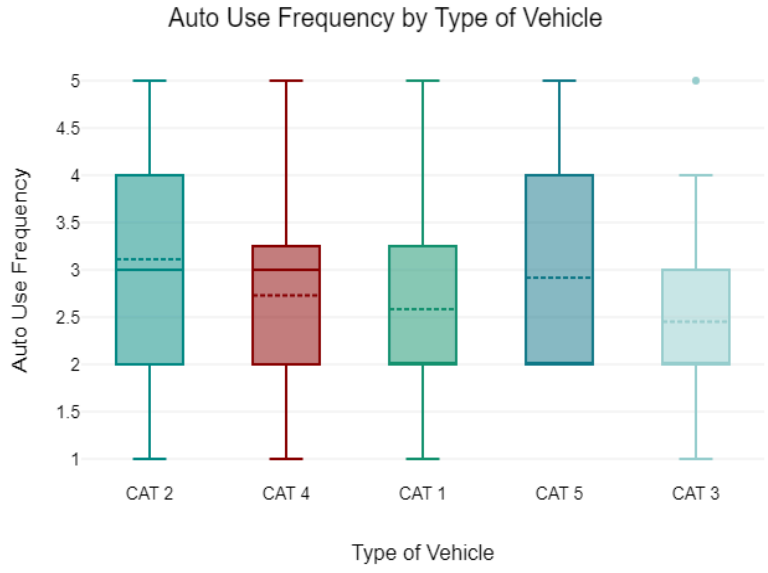


Figure No.11. Box plot of vehicle category vs Auto Rickshaw use frequency

This indicates that all of them used Auto Rickshaw on an occasional to everyday basis. A large number of respondents as indicated by the larger interquartile ranges of category 2 and 5 used Auto Rickshaws. The Auto Rickshaw has a very niche use in Bengaluru and it is mostly used on a need to need basis as it is an intermediate transport mechanism. The interview with the Auto Rickshaw union describes the utility of Autos as " *Autos are the lifeline of the transport in Bengaluru city and we are the main providers be it in the form of school commute or emergency services or short distance services. Autos have been a very traditional and an age-old transport medium in India"* (Interview, Auto Rickshaw Union).

The other reason for large use of Auto Rickshaw by everybody irrespective of the vehicle ownership pattern is it being used for emergencies, its availability throughout the clock and also as a primary means of reaching nearby metro or bus stations. *" Our support has now become limited to the feeder services and we are usually commuting between the homes and offices to the Metro station. However we also have various traditional areas which are still predominantly covered by Autos"* (Interview, Auto Rickshaw Union). The immediate on a need basis and large availability, provided with swift short distance travel makes it an attractive option. Another important observation that can be made is that the category 5 respondents coming with greater financial abilities would also not mind taking Auto Rickshaws for short distance commutes and wouldnt depend on buses , more so when they have been made free for females. However the other categories are showing a decrease in Auto Rickshaw usage trends and trying to travel by bus to save money as also noted in the interview with the Auto Rickshaw union-*"They also have a government scheme now that makes it free for the women travelling in all BMTC buses and our main customer base were women and housewives. Hence there has been a hit there, especially among the lower and middle income groups"* (Interview, Auto Rickshaw Union).

Finally assessing all the above travel and pattern behaviour in a bid to uncover the factors that affect the ridership of public transport in Bengaluru, it can be summarised that the factors of gender and occupation play an important role and the prime users are office going people and students. The Auto Rickshaws are largely used by all at varying times for short distance and emergency travel. The ownership of vehicles though has an effect but it

is not a great factor as to what kind of or number of vehicles they have except when the number of family members outgrow the capacity of the vehicles they own. Otherwise it is the access and flexibility and comfort that the vehicle offers for which it will be preferred over public transport. The main factor that has to kept in mind is that this survey was also limited to just 130 people who represent a very miniscule fraction to represent the entire choices of the Bengaluru population and without the data on the location, destination and whether the majority is long distance or short distance travels, specific patterns cannot be uncovered but a larger picture can be obtained from the above results.

5.2 Correlation between different modes usage

Pearson's correlation was calculated for all the frequency responses by respondents and a correlation matrix and a correlation heatmap was obtained.

Table No. 10. Correlation matrix for frequency of use of public transport in Bengaluru.

CORRELATION MATRIX			
	BUS Use Frequency	Metro use Frequency	Auto Use Frequency
BUS Use Frequency	1	0,43	0,26
Metro use Frequency	0,43	1	0,49
Auto Use Frequency	0,26	0,49	1

The correlation values that were obtained suggests that correlation exists but is very low positive correlation. The thumb rule for correlation interpretation (Hinkle et al., 2003) says that correlation value of 0.3 to 0.5 signifies a low positive correlation and the values between 0 to 0.3 signify a very low level or negligible albeit a positive correlation. All the values were obtained positively signifying that even though low there exists correlation of user behaviour in public transportation usage.

Considering the first pair of variables namely the Bus use frequency and Metro use frequency, it can be seen that the value of correlation coefficient obtained is 0.43. This signifies that there is a low positive correlation meaning that users of metro tend to use

buses and vice versa. This is a direct significance of the partial integration between the bus transport system and the metro transport system. There are feeder buses that are started, which cater to the metro station and hence there is a positive correlation. The feeder bus service and its importance was also mentioned in the participant interview where it was said that *" We are already providing 160 metro feeder services in collaboration with BMRCL"* (Interview, MD, BMTC). The correlation only comes with proper collaboration and integration. Collaboration forms a very important and inevitable aspect in terms of achieving multimodal transport. The correlation factor will improve with more feeder buses and greater collaboration and integration efforts of BMTC and BMRCL. The correlation when considered with Auto Rickshaws is 0.26 which signifies a positive but a very low or negligible correlation. This can be attributed to the competition mode of operation of the buses and Auto Rickshaws. Both see each other as mutually taking up their rider share and since there is no active collaboration or integration between these two distinct entities, the correlation stays very low.

The competition between buses and the Auto Rickshaws were expressed explicitly by both the organisations. The MD, BMTC opined that *"I cannot support Auto rickshaw, and make people make use of auto rickshaw more. My mandate is to increase the use of public transportation of the bus as it is a sustainable means, more greener and making them avoid the more private and smaller vehicles. If people use my public transport the same one litre of petrol will carry about 120 people in one go which needs at least 30-40 auto rickshaws."* Similarly the state government scheme of 'Shakti' which is operational now and allows for free of cost travel to women has also hampered the Auto Rickshaw business as per the Auto union response. This has resulted in low earnings and livelihood concerns for the Auto Rickshaw drivers *"For us Autos are a means of livelihood and hence our earnings form our first priority. Many Auto drivers have purchased Autos on bank loans and need to pay the instalment and also run the family, which becomes very difficult with a reduced customer base."* (Interview, Auto Rickshaw Union).

The next set of variables of Metro ridership and Auto Rickshaw ridership is the highest correlation that was obtained which was 0.49. This is still indicating a low correlation but

the correlation is higher than that between the metro and the bus services. The Auto Rickshaw after losing out on the main customer base has turned towards providing the feeder services to the nearby metro stations and they have also tried to make up for the less number of feeder buses operated by the BMTC. The interviews also bring out this fact of the feeder services of Auto Rickshaw for metro services. *" Well with the introduction of Metro and also with the coming of Ola and Uber cabs, it has been the more preferred mode of transport especially with the middle class and above and they usually prefer to travel in a comfortable way. Our support has now become limited to the feeder services and we are usually commuting between the homes and offices to the Metro station"* (Interview, Auto Rickshaw Union).

This aspect gives us with multiple observations that the Auto Rickshaws and the buses are in a competitive mode often eating into one another's share; however Metro still seems to be the more popular option due to the convenience like Air conditioning etc which are not available among all buses or Auto Rickshaws. The primary ridership of Auto Rickshaws is for the first mile and last mile connectivity and this is where the space for Auto Rickshaws can be the most appropriate in the public transportation landscape of Bengaluru. The nature of collaboration between the BMTC and BMRCL regarding the feeder buses are official and formal, in the sense that both have agreed to integrate with each other in this regard. However, the collaboration between the Auto Rickshaws and the metro is more spontaneous and naturally arising out of the market opportunities on one side and the need and convenience of the passengers on the other. Therefore the important part here to be acknowledged is the collaboration and when done formally and institutionally it has potential to become more effective.

The final observation is that the minimal amount of existing integration increases the correlation and effects on increasing ridership on one another. With more integration and collaboration and specific roles assigned to individual carriers the correlation values will increase further and result in greater ridership among all the public transport modes. Non-integration and competition clearly hinder the correlation and therefore the larger

benefit lies in collaboration and integration as far as increasing ridership and achieving sustainable mobility is concerned.

5.3 Factor analysis and the factor identification

The constraints and digitalisation measures on which the responses were collected were subjected to Principal Component Analysis (PCA) and the correlation, component matrix and the rotated component matrix were obtained (Tables in Appendix). The factor loadings were considered. The factor loading was considered based on the highest values of loading and were grouped. The scree plot gave the Eigen values above 1 in both the cases and based on that the number of factors were selected to be six initially. Some of the factors did not show any sort of loading in the rotated component matrix and hence had to be discarded. Finally the constraints were grouped into four factors based on the loading and the digitalisation measures were grouped into five factors.

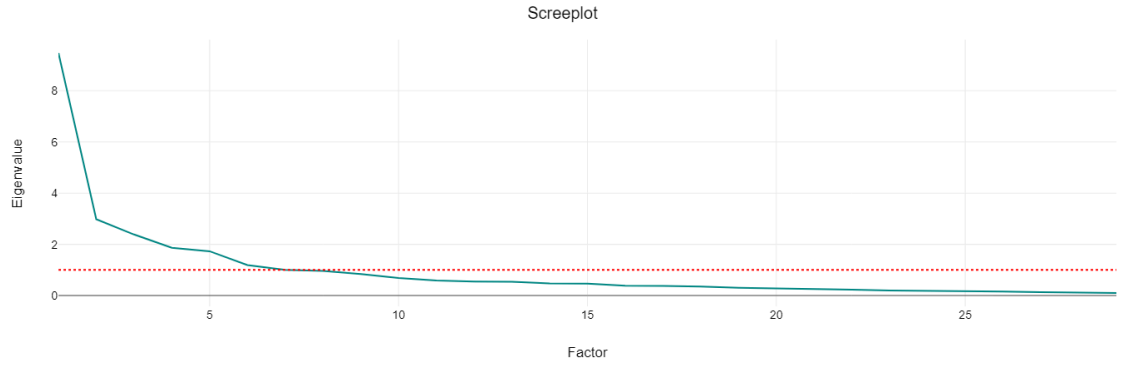


Figure No. 12. Scree plot for PCA of constraints (Bus, metro and Auto Rickshaw)

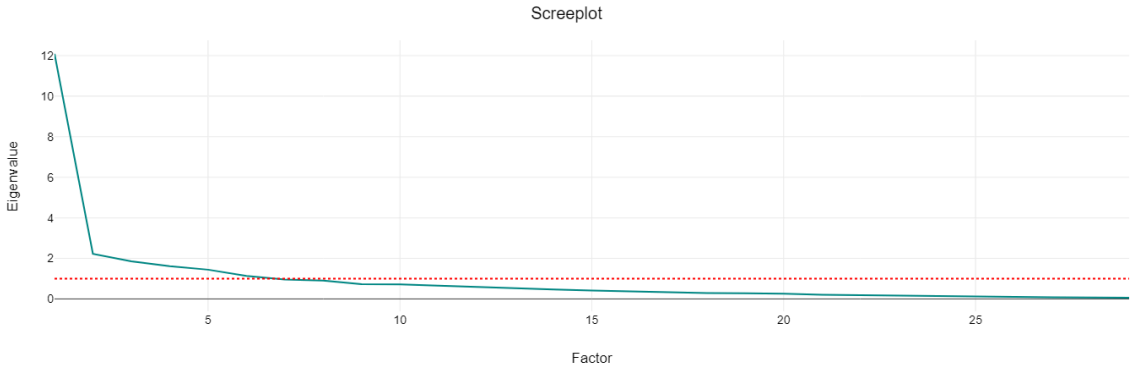


Figure No. 13. Scree plot for PCA of digitalisation initiatives (Bus, metro and Auto Rickshaw)

The next step was to name the factors accordingly based on the factor loading by the individual variables. The below table shows the factors segregated and the analysis follows thereafter.

Table No. 11. Factor loading and grouping-Constraints (Source: PCA of survey data)

Factor 1	Factor 2	Factor 3	Factor 4
Congestion in Bus Irregular schedule Longer travel time bus No end to end connectivity Insufficient buses Lack of digital payments Cleanliness	Status reduction-Bus Status reduction-Metro Status reduction Auto Congestion Metro Congestion Auto Traffic congestion Auto Metro-Ticket cost Longer travel time Auto	No end to end travel Metro Less frequency Metro No connectivity to my place Far from office/home-Metro	Rash driving-Auto Charging higher rates Auto Refusing to hire Auto Trustworthiness Auto Pollution concern Auto Cannot travel more than 3 Women safety Auto

The common observation is that the factors underlying or binding similar constraints appeared to be specifically divided based on the mode of transport. factor 1 contains most of the constraints that are specifically related to buses and factor-4 specifically related to Autos. The general observation is that the people see these constraints as one and associated with the mode of transport. They show relations and mutual relevance and hence the decision to opt for a particular mode of transport is a holistic one with consideration of all these factors.

Let's consider every factor individually; factor 1 can be named as ‘Core bus constraints’ which talks about the lack of proper schedules and time variations that are present. The longer travel time and the ability to not know in advance what time they will be reaching is certainly a dissuading factor for the use of buses in large numbers. Cleanliness and lack of digital payments are very important for the convenience aspect of travel by buses. Insufficient number of buses has been highlighted time and again even in the interviews that were conducted.

"According to the comprehensive mobility plan of the city, I should have 12000 fleet of 12000 buses, but currently I am only having 6200 and additionally 1200 electric buses on a lease basis. Whatever I am adding, every year scrapping is also happening. I should therefore go beyond my scrapping number, without which there is no net increase." (Interview, MD, BMTC).

Similarly the Director, IT also highlighted this aspect; *" As of now our fleet strength is around 6000 and we will induct more."* (Interview, Director IT, BMTC)
Thus the lack of capacity and not having sufficient strength of the fleet for extended operations definitely forms one of the core constraints of the bus transportation system in Bengaluru.

Factor 2 gives interesting insights on the social aspects concerned with riding the public transport system and also the main aspect of convenience. The reduction in status or perceived reduction in status due to the use of public transport all loaded into one factor, which shows that it still remains an important constraint with respect to public transportation use. The higher status associated with the cars and the feeling that travelling by a public transport is affecting societal status is an important constraint and the factor loading shows that it is not just related to any specific mode but applicable to all the three modes evenly. The congestion and lack of comfort and convenience is a common factor and given the population density in Bengaluru and a country like India. Thus this factor has been identified as 'Socio cum convenience constraints'.

The factor 3 relates exclusively to Metro and the group of constraints bunching together to form this factor highlights the lack of reach of Metro everywhere in the city and hence though people are keen to use it, they get dissuaded from it. The lack of first mile and last mile connectivity which is an inevitable one and the metro stations being far off from the homes or places of work along with complete no connectivity to certain areas and parts are the major constraints. As seen and observed in the last part the correlation between Metro and Auto Rickshaw is higher, as this constraint acts in favour of Auto Rickshaw making them important carriers of people to metro stations. As recorded from the interview with

MD, BMRCL, *" only limitation of the metro is that it cannot go to every nook and corner of the city."* (Interview, MD,BMRCL). The interview also speaks about the fact that the Metro projects are expanding but they are long term and capital intensive projects hence it would take considerable time that accessibility to Metro becomes a easy endeavour.

"See metro is one thing like, especially in Bangalore we have only 80 Km operational and roughly about 100 Km work is ongoing and in next 2-3 years 180 Km will be ready and our plan is 317 Km and completion of master plan of 370 Km we will not be able to satisfy the demand. " (Interview, MD, BMRCL).
Similarly, " *Whenever the metro starts, it cannot suddenly come into the city. Metro is a very costly affair. One Km of elevated corridor with the coaches and all infrastructure comes up to about Rs 450 crores. It is a very capital intensive infrastructure"* (Interview, MD, BMRCL). These are some of the inevitable constraints that have to be acknowledged till the Metro network develops completely and is able to serve every part of the city. This factor is hence named as the 'Metro accessibility constraint'.

Finally, the last factor 4 is completely related to the aspects that people consider important when making a choice to ride the Auto Rickshaw. The important observation here is that it all relates to personal safety and road safety aspects. The factors were loaded here negatively, meaning it means the inverse construct and the variables were bunched together taking the absolute value. The factor can be named as 'Passenger safety and well being' aspects and all the negative loadings indicate a contrary perception and these dissuade people from choosing Auto Rickshaws. Refusing to be hired in emergencies and also charging more than mandated rates are definitely constraints but also the aspect of reckless driving and such bad experiences have formed a kind of notion that makes taking an Auto Rickshaw riskier. The Auto Rickshaw union body also accepts these shortcomings and they reasoned it from their perspective as follows, *" The problem is also about the changes and comfort and with the hot weather coming in , a lot of people prefer Air conditioning and so on. There are also complaints that we receive about the digital metering being not used and also negotiation of prices, but it is also kind of understandable that it is done as the fares have not been revised and running Auto on these existing metered prices is really not*

profitable. The problem of also not agreeing to go to a required location is again interconnected with profitability, as certain places we need to come back empty and it doesn't turn out profitable." (Interview, Auto Rickshaw Union).

Similar factor analysis procedure for digitalisation had the following variables loading into five different factors as represented in the table below.

Table No. 12. Factor loading and grouping-Digitalisation initiatives (Source: PCA of survey data)

Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Metro Application Metro website Metro CCTV Metro digital payment Smart card metro Instructions inside metro Automatic entry exit gates Digital luggage scanners	Namma BMTC Application BMTC website Digital driver info boards (Auto)	Location tracking bus Live route map bus Display board in bus stops	CCTV in bus Digital stop display inside bus Digital payment bus Wifi bus Wifi metro	Namma Yatri app Auto Ola uber apps booking Auto Digital metres Auto Digital payment method Auto Share and ride track Auto

The factors which were loaded showed similar characteristics. The first factor contained exclusive initiatives that were already operational in Metro. These initiatives are also quite well known because of the existence of them for a long time. The metro application to the digital luggage scanners which provides convenience and safety to the passengers are well integrated and perceived by the people as an important aspect of the metro and that influenced their choice for the same. This factor was named 'Functional digital initiatives in Metro'.

The second factor consisted of two initiatives of BMTC and one initiative from the Auto Rickshaw. The Namma BMTC application is intended to provide information on the buses

and their schedules. The BMTC website gives information about the bus routes, the contact persons and the information on fares and procedures to obtain monthly or daily passes. The digital driver information display board was mandated in Auto Rickshaws by the traffic police department to ensure women safety and also providing riders and citizens information about the antecedents and details of the driver. The information is also stored in a central hub with unique numbers associated with each driver which enables the police to track any driver in case of any mishap. These initiatives all are informative by nature and make the riders gain information or become aware. Thus these initiatives were bunched and this factor was named ‘Informative digital initiatives’.

The third factor had the loadings of the variables related to buses. The variables were related to location tracking, live route map and digital information boards in the bus stops. The time schedules and punctuality has been a constraint that was extensively mentioned even in the interviews as well. Knowing the exact location of a bus and the time that it is expected to reach the stop or a particular location is important for students and office goers and to keep up appointments. This shows the importance of such initiatives to make the bus a popular option among riders if implemented well and accuracy is maintained. This factor was named ‘Time tracking and punctuality digital initiatives’.

The factor number 5 consisted of initiatives like the CCTV in buses, digital stoppage displays and digital payment systems that are being introduced. The wifi facility though not currently operational also featured in it, but one of the probable digital initiatives of wifi in metro also loaded into the factor. This was the only initiative from the Metro which loaded into another factor. If keenly observed all these digital initiatives are initiatives that offer convenience and safety to the passengers. These are also intended to be used by the passengers who are already inside the bus or the coach of the metro. Hence this factor was named as ‘Passenger convenience and safety digital initiatives’.

The last factor and the sixth factor consisted of all the digital initiatives which were recently introduced in Auto Rickshaws, which were completely manual and had no technological support earlier. The Namma Yatri application which was designed on the

model of the Software as a Service (SaaS) model (Interview, Transport expert) enabled the citizens to call for an Auto Rickshaw via an application similar to Ola and Uber from the convenience of the home. The fare was predetermined and all the details of the driver was provided and also the time in which they would be picked up. The Ola and Uber applications also provided the same service but this being self developed by the Auto Rickshaw stakeholders with a technology provider support was more profitable for them (Interview, Transport Expert). Hence this variable, also loaded alongside the initiatives of Uber and Ola applications. The other initiatives are all provided by the same applications which provide the facility of digital or card payments, ride tracking, digital metering and time schedule monitoring. This factor was named as 'Application mediated digital initiatives'.

The overview of different factors that were obtained as a result of Exploratory Factor Analysis (EFA) has been summarised below in table number 12 for an overview of the results.

Table No.13. Different factors identified (Source: EFA using PCA on survey data)

Constraints related factors	**Digitalisation initiatives related factors**
1. Core bus constraints **2. Socio cum convenience constraints** **3. Metro accessibility constraints** **4. Passenger safety and wellbeing**	**1. Functional digital initiatives in Metro** **2. Informative digital initiatives** **3. Time tracking and punctuality digital initiatives** **4. Passenger convenience and safety digital initiatives** **5. Application mediated digital initiatives**

The results from all the quantitative data analysis has been described above; Keeping these above results and observations the thematic analysis also yielded themes which were obtained by the codes obtained from the interviews. The next section would bring out these results from the qualitative analysis. The results will then be holistic when viewed both

from the quantitative as well as the qualitative aspects. Some of the results which are common and indicating the same direction would be important in the case of this research. Further it can also be seen from the themes which results are being reinforced or how they can be interpreted in the light of qualitative analysis.

5.4 Thematic analysis results

All the interviews after coding and subsequent iterations resulted in 366 codes which were then grouped into sub themes and then after obtaining 14 sub themes they were finally merged into themes. The final result was the seven themes which completely captured the qualitative data.

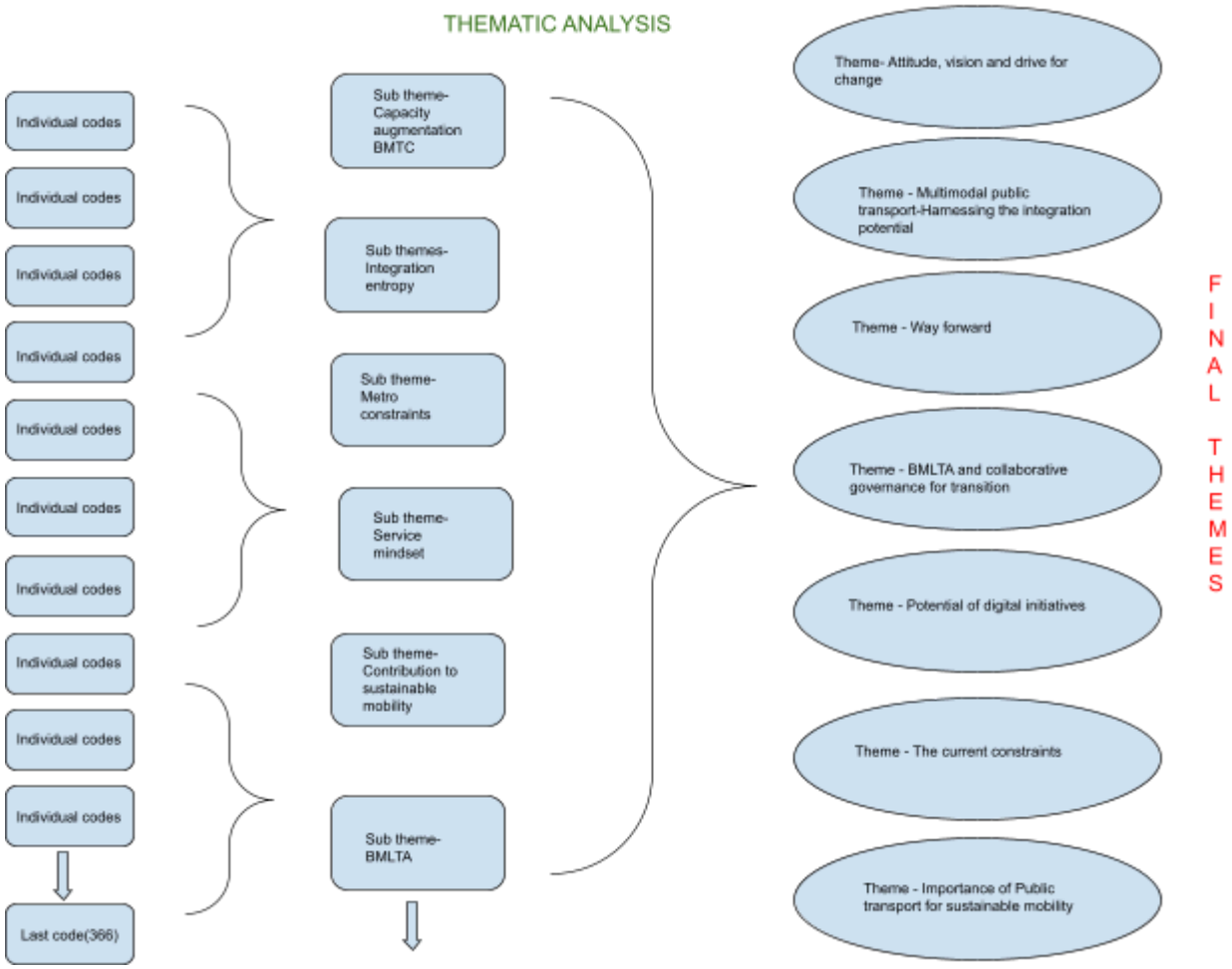


Figure No. 14. Representation of coding, thematic analysis and final themes (Source: Interviews)

Theme. 1. The importance of public transport for sustainable mobility

The first theme which forms the basis of this research is the importance of public transport for achieving sustainable mobility in the city of Bengaluru. The public transportation network of Bengaluru is large and many livelihoods depend on it. *" Uh, a lot of people rely on these transit systems in Bangalore. Many people use it for their livelihood from the springtime point of travelling to work or Education, for meeting people, recreation and so on."* (Interview, Researcher, IISc). There is a high socio economic benefit (*"There is a high socio economic benefit as far as the metro is concerned. Our ridership is increasing like anything, when I joined the ridership was around 3,50,000 and when I left the metro the ridership was around 7 lakh odd"* (Interview, MD, BMRCL)) in the sense that most of the public transport mechanics are environmentally friendly including Auto Rickshaws.("*So by circumstances now today auto is the most environmentally friendly mode because all of them run either on the LPG or yeah or electric, nobody"* (Interview, Transport Expert)).

The ridership of the metro is picking up and is expected to increase further with introduction of new lines and routes. The comfort of travelling in Metro has also its advantages and people like to travel more in them provided first and last mile connectivity along with other associated infrastructure is well established in and around metro stations. As per the interview, "*Well with the introduction of Metro and also with the coming of Ola and Uber cabs, it has been the more preferred mode of transport especially with the middle class and above and they usually prefer to travel in a comfortable way"* (Interview, Auto Rickshaw Union). The value added in terms of health, reducing traffic congestion and also encouraging the less use of automobiles can also be achieved by the buses *"Buses will certainly gain because more travellers will come to buses. Umm I and in in the process the society will also gain because society will now have more cost effective travel options in the form of these collaborative modes and also they'll contribute to some extent reduction in congestion."* (Interview, Researcher, IISc). The buses will also reduce the dependence on automobiles in the sense that it can transport 60 people at a time compared to 5 people in

a car utilising the same road space (*"It will reduce the manufacturing growth but will be good for the carbon footprint and traffic scenario in Bengaluru"* (Interview, MD, BMTC)).

Thus it can be concluded that the growth in public transport networks is a much needed aspect of any large city with a great urban sprawl and Bengaluru is no different. Our consideration of achieving sustainable mobility in Bengaluru through public transport is also justified by the affirmations of that fact in the interviews.

Theme 2. Attitude, vision and drive for change:

The next theme that was identified from the coded excerpts was the importance of what the interview participants felt in terms of mindset, attitude of the authorities and the government at large. No change or transition can take place without the will to bring about it and a clear vision that is backed by the top leadership. Bengaluru according to the interview responses still had a lot of red-tapism in terms of the bureaucracy, be it the BBMP, BMTC or the BMRCL and also the transport ministry at large. Multiple departments who lacked a clear vision as to how the public transportation has to be organised in the ever growing city and a clear lack of planning were the main reasons for the diminishing ridership of public transport and a well coordinated sustainable transport plan for the city. *"That's all it is, so it's only you can't rely on serendipity and luck for governance, isn't it? Has to be deeper."* (Interview, Transport Expert). The level of performance and intentions changed with the change in government and also the bureaucrats who headed organisations like DULT and transport ministry. Governance needed to be shifted from a mere implementation and ticking the box mindset to that of truly wanting to put in place a system that is efficient and functional. The profit oriented motives of the corporations like BMTC were also questioned and it was opined that the profit motive and mere lets get it done approach has to be replaced by the service oriented mentality. *"When you were there for service, your metric of success is service, not profit and loss, as a corporation now both."* (Interview, Transport Expert). The profit mindset has been also highlighted when the state of loss that BMTC is going through was expounded by

its officials. *"Yeah, that is because they are. They are measured on the wrong metrics, be it a ring itself, on profits if it starts entering itself only on profits."* (Interview, BPAC).

The bureaucracy has to be infused with young blood and they have to interact and understand the issue at hand and in a very nuanced way.. *"I mean, this is how things just keep going round and round. Yeah, without you nobody is being monitored by uh, you know, the level of service you're providing to a customer, to a citizen, the citizen finally is the citizens. Problem is not getting solved and unless we monitor the performance of all these people, not by the infrastructure they created, but by the level of service which was provided and the quality of service that was provided, that is how you have to start monitoring all these agencies as service providers. How effective are they? So see if he does not start monitoring them as service providers, but you keep monitoring them as infrastructure providers."* (Interview, BPAC).

The service level has not been up to the mark and the multiple agencies that are present make it harder for the civil society or any other stakeholder to engage them for an effective response. Every agency blames it on another and hence the problems remain unsolved. No clear division of responsibilities was found and the accountability of the authorities also suffered due to the same problem and it was a difficult task for the citizens or their representatives to approach the right authority for their grievance redressal. *"So one of the issues we faced with the BBMP is that there are multiple divisions under them. So coordinating and getting uh it to be for a common man to be able to understand where should they raise their issue, who would exactly solve them as itself a huge task."* (Interview, BPAC)

An example of how the bureaucracy went about trying to tender fresh proposals for purchasing new buses was made, the civil society representative highlighted that there was a clear lack of purpose and direction. It was said that, *" They raised fresh tenders. They put out fresh stuff. They give award, they said this. On contract will not work. We want our own buses. They gave out some orders after 4-5 years of wrangling. Some orders were given to uh Sakamoto's, etc Now those orders have been cancelled"* (Interview, BPAC).

The tenders were first called and later they were put off and even though this process was started quite a long time ago, BMTC is still struggling with a reduced capacity in terms of its fleet.

The issue is not just limited to this but the interview participants have highlighted apathy in most of the processes including digitalisation initiatives. The bus tracking application of Namma BMTC app has been termed as non accurate and such incidents are common as there is a presence of a laid back attitude and no proper coordination and vision from the authorities and the existing public sector in Bengaluru. The following excerpt crisply puts the entire problem in a nutshell, *" They are mixed up with all their ideologies. You, you want to provide for the mass do by all means provide everything you should, but that is not going to remove the traffic from the road."* (Interview, BPAC).

Thus to summarise the first theme the main aspect of changing the attitude and the mindset is required, especially with respect to the government and public authorities initially start the journey towards transition to a sustainable mobility system with public transport being the main and integral part of it.

Theme. 3- Multimodal transport system-Harnessing the potential of integration

This theme helps us to answer the role of mutual integration among the public transport providers and the modes. The correlation analysis has already made it clear that integration would result in greater use of public transport. A large city like Bengaluru has to have a multimodal transport system and in larger cities across the world, it is now increasingly accepted that reliance on one particular mode of transport won't be feasible and hence multimodal transport which offers seamless connectivity is the way forward. " *No single mode of transport is sustainable on its own. So whichever city you have to go for a combination and that's why we talk about multimode connectivity. Unless we have a multimode connectivity your transport in the city cannot be a sustainable mode"* (Interview, MD, BMRCL). Hence a multimodal transit system which is well planned and well integrated is the need of the hour in Bengaluru. However as per the interviews this

multimodal transport is not fully functional in Bengaluru and there is no seamless connectivity which would bring in convenience for the people and hence make taking the public transport more attractive. *"Public transit. See, almost all public transit are multimodal by nature, right? Buses or trains can't go door to door as cities spread out."* (Interview, Researcher, IISc). The inevitability of having a multimodal transport also should be recognised by the fact that Metro and buses cannot cater to the first and last mile connectivity. They have to cover the major areas and then have to be in turn connected with other modes of transport like the Auto Rickshaws, the cabs and other means.

Currently what is present in Bengaluru is a very premature kind of multimodal system without proper integration. The multimodal transport is not seamless. There is no single mechanism or application or joint tickets and measures to bring in true multimodal transport to a reality. *"DULT is also very important in the Master plan of the city also. How, what, where etc all the study has to be done by DULT. All these activities have to be done by DULT and it is very important."* (Interview, MD, BMRCL). There is a comprehensive mobility plan but there are no enforcement mechanisms for ensuring the same and it has just remained on paper. The woes of not having seamless integration and even accessibility to change from one mode of transport to another has been highlighted by the civil society representative as follows: *" After I got off from the station. I had two small grandchildren with me. I said let me take them by Metro and I took them to kadugodi park to get to the park next to the metro. For me. OK. Uh, seamless booking of tickets? Seamless tracking information?"* (Interview, BPAC). The seamless connectivity will also be encouraged by clubbing the tickets or having a common mobility card. As put by the researcher of IISc, *"Yeah, that also can make it more seamless for travellers, right? If the traveller doesn't have to buy multiple tickets or travel and multiple modes of travel for a journey, if they can buy 1 ticket and then use it at the interoperability, for example, that's where the presentation helps a lot."* (Interview, Researcher, IISc). This aspect of Bengaluru where there is chaos and lack of proper integration is termed as integration entropy of Bnegaluru signifying the randomness in its design.

The integration does not only mean the seamless shift from a mode to another but also an important part of land use integration and infrastructure integration. Bengaluru currently is

laden with construction and various new projects including under construction Metro lines are coming up. Thus the integration does not exist in terms of proper planning of layouts, office workspaces and also the new projects. There has been great difficulty for pedestrians to commute without an accessible footpath and changing from an Auto Rickshaw to a metro involves crossing the road putting the people at risk of road accidents. *" Because land use and transport are very closely linked, if you miss that link, you'll be having situation like road is somewhere, development is somewhere and that's why"* (Interview, Transport Expert). The infrastructure responsibility is that of BBMP the city planning and administration organisation and they also need to be involved in integration along with the Bengaluru Development Authority (BDA). Infrastructure forms the weakest link of integration in Bengaluru and hence the first stage towards moving into a well planned sustainable public transport network is the integration of all stakeholders and the physical, multimodal, infrastructural and digital integration and the right formulation and execution of the comprehensive mobility plan.

Theme. 4- The current constraints

Apart from the constraints discussed in the earlier part as results from the quantitative analysis and from the citizen perspective, this research tried to uncover further constraints and what the authorities and transport providers face first hand. The main problem is about the capacity and fiscal constraints that these transport providers face. The lack of a proper fleet strength of BMTC or the livelihood concerns of the Auto Rickshaw drivers all boil down to the important aspect of money. The major problem is with the growing population in Bengaluru the transport system needs to augment its capacity continuously. As put by the BMTC chief, *"Growing population and robust growth of the city like Bengaluru which is the IT Capital of the country, we have to find more routes. Currently I am only having 6200 and additionally 1200 electric buses on a lease basis. Whatever I am adding, every year scrapping is also happening. I should therefore go beyond my scrapping number, without which there is no net increase."* (Interview, MD, BMTC) this problem looms large. The others also opined the same with, *"Umm there is a need to expand these systems substantially."* (Interview, Researcher, IISc).

Thus the public transport providers and all transit systems depend on the capital incentivisation and financial grants from the government. Without these grants sustaining the entire system would become very difficult. The main fiscal constraints were expressed as *"Most transit systems across the world cannot financially sustain themselves, umm, and also serve the society from the standpoint of providing connectivity to various parts of the society in various segments of the society and various parts of the city."* (Interview, Researcher, IISc). There is a severe crunch in BMTC and was expressed, *"Any public transport organisation, government capital grant and assistance is mandated. Without which we cannot sustain it. Our wage revision has not happened in the last 8 years and we cannot burden people with more fares so the fare revision cannot take place, and the government is subsidising me and giving me grants and with the government assistance we are still running and I am under loss"* (Interview, MD, BMTC). It was added that the government is trying its best to provide these fiscal resources and run the corporations but this acts as a big constraint and often drives the organisations towards profitability goals rather than service goals. This may include running less number of buses and hence less frequent options or not being able to provide superior services as most of the Indian population are cost conscious when it comes to making choices.

The profitability brings in competition among the different modes and hence collaboration sufferers. *"So we, we diagnosed the problem clearly. There's a see today we have got a public transport in the form of BMTC and BMRCL who do not collaborate with each other and BMTC suffering from underinvestment. BMRCL doesn't have any clarity because sometimes it is a construction company at, sometimes it's an operating company."* (Interview, Transport Expert). Competition brings grudges and disharmony between the stakeholders. *"The institutions are basically doing it grudgingly, from the last activity and the loss after away."* (Interview, Transport Expert). In this light, an important constraint that was uncovered was the 'Vicious cycle of competition'. Firstly, the need for these fiscal resources and loss of profitability drives these transport providers to go for increasing their profits which increases the competition among them; this competition then counteracts the collaboration aspect and hence then reduces the ridership which again leads to loss of

profitability for all and the cycle continues as a result of which the transport providers are all in losses and at the same time the public transport ridership and service quality drops. It therefore becomes very pertinent to break this vicious cycle through a well thought out collaborative approach and achieve higher public transport ridership and better fiscal health.

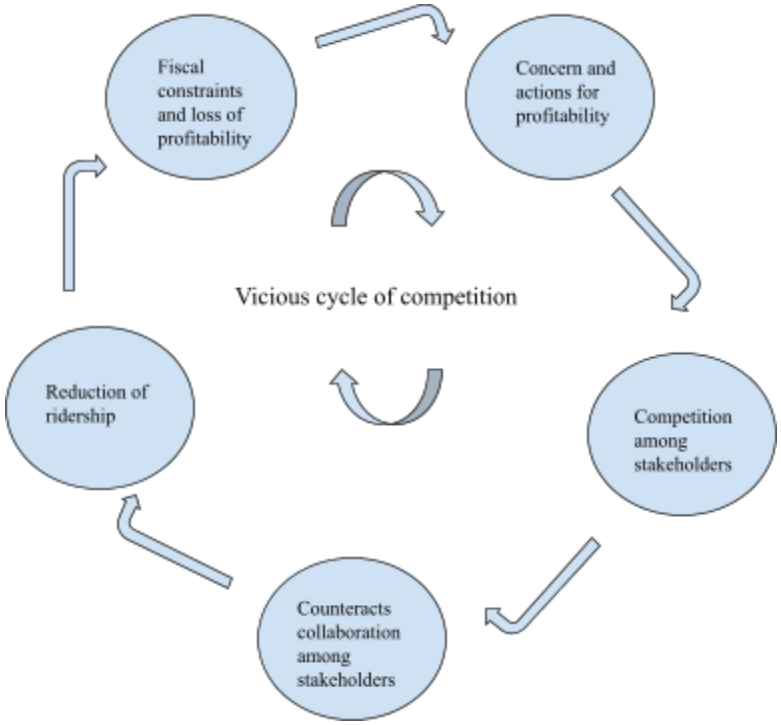


Figure No. 15. Vicious cycle of competition (Source: Analysis of qualitative data)

Theme. 5- BMLTA and collaborative governance for transition

The Bengaluru Metropolitan Land Transport Authority (BMLTA) which has been legally established through the BMLTA Act, 2023 was the institution all of the network actors were keen on being implemented. As discussed earlier for a suitable integration, to integrate land use pattern and transport policies or to formulate and ensure the implementation of the Comprehensive mobility plan, to aid researches and onboard all the stakeholders, academia, technology providers, public authorities and the citizens finally the BMLTA has a pivotal role to play. Collaboration is an accepted fact and the only way to move forward to realise the vision of a fully connected, seamless, well planned sustainable public transport network

in Bengaluru. *"Collaboration is a no brainer"* (Interview, Transport Expert). This theme is also the largest theme which was obtained which had many sub themes under it and had 77 individual codes as part of it.

The need for a single agency arises from the fact that *" Multiplicity of institutions, departments, and independent legislations that they are bound to follow are currently causing overlap in responsibilities and functions, which impede the process of planning and implementation of major transportation schemes aimed at streamlining and improving urban mobility."* (Interview, DULT). The stakeholders also voiced the same opinion for the need of an authority like BMLTA. *"So if we have an authority like BMLTA then we can represent our concerns and also rationalise number of Autos plying on a route and also decide with mutual collaboration as to what can be the target modal share and what can be the way forward we can all collaborate to finally make it very convenient for the customer"* (Interview Auto Rickshaw Union).

Participatory approach and taking the view of citizens and all the associated stakeholders in a formalised and institutional setting would enable for the success in planning and implementation of the projects.*"Participatory approach that includes as many stakeholders as possible to encourage consensus and cooperation at all stages of a project development is very important for the success of a project These consultations have helped in improving DULT's reach and connect with the citizens"* (Interview, DULT). Though the legislation for the BMLTA has been passed, the main lacunae is that it has not yet been established until now. The rules are still being formulated and no members or office bearers are yet appointed. ""The Bengaluru Metropolitan Land Transport Authority (BMLTA) has thus been formulated through the Bengaluru Metropolitan Land Transport Authority Act, 2022. *The state government notified the Bengaluru Metropolitan Land Transport Authority (BMLTA) after receiving the assent of the Governor on January 11, 2023. Currently the rules and regulations for setting up of the authority are underway."* (Interview DULT). Therefore the immediate priority should be to get it implemented and have the authority present there on the ground without which all the efforts would be in vain and the status quo would continue.

"Everything was very carefully crafted when it gave space for individual authorities, but made it incumbent on them that they should. Then we have embarked on an institutional reform process of BMLTA. Let's do that quickly. Empower it so that we get conversations going amongst all the transport providers so that collaboration is no longer just in the pipeline but a reality on the ground." (Interview, Transport Expert). However, one important aspect that has to be kept in mind here is that not all stakeholders would be willing to get onboarded and participate in the new authority without any benefit to them. Profitability especially for private stakeholders like Auto Rickshaw, technology providers, academia and experts would need to be convinced and remunerated in a decent measure to ensure their smooth onboarding. As put by one of the participants in the interview *" It's important to recognize that our priorities are for profit. They can't collaborate if they don't make profits."* (Interview, Researcher, IISc).

Establishment and having a strong institutional framework, making the authority autonomous and ensuring sufficient funding and decision making powers would truly realise the potential of collaborative governance for transport related planning in Bengaluru.

Theme. 6- Potential of digital initiatives

The sixth theme answers the digitalisation initiatives aspect of our research question. All the interview participants were of the opinion that digitalisation is the way ahead and with the high penetrating internet technology and many more new technologies that are being invented, harnessing the potential of digitalisation is very important to make public transportation an attractive option. Various initiatives have been already implemented, some which are at a nascent stage and some which have taken its roots and are gaining popularity among the people. The different respondents expressed their views as given in these excerpts.

"The crowd is reduced, my manpower is also saved. Before if we had 4 people at the counter now we just need 2 people. It saves money also. Now we have launched multiple QR codes, for example if 5 people are going they can buy a single QR code valid for 5

transactions. This is with respect to ticketing, then multimodal integration we are using digital technology and in parking we are using the digital model which will show the empty spaces and also payment can be made." (Interview, MD, BMRCL).

"See digitalisation is something that is very important and everything has to move on that and as far as BMRCL is considered we have moved at the right time. Like in the beginning we brought the concept of smart card, smart card was the beginning of the digital payment mode, now we have come with the common mobility card, we also started whatsapp chatbot, for booking of the ticket. We were the first to introduce a QR code system, and if you are leaving your house you can book the ticket on the app itself using any applications and multiple agencies have associated with our platform." (Interview, MD, BMRCL)

"Information also goes to ITS server, due to this data accumulation our revenue audit has become more robust. Now we are trying to integrate all these things, the data about ticketing, routes and locations. We are also including it in the MyBMTC app and we are also integrating the scrapping policy into and the data regarding it as well." (Interview, Director IT, BMTC)

"As said earlier people tend to have a larger confidence with digital applications and we have seen they prefer it more. All are having smartphones nowadays and it is convenient for them. We have also seen that the other features like live tracking and location services help a lot. We had a great problem dealing with change and cash earlier and thanks to UPI, now we have applications where the customer pays directly to us through digital means and this money instantly gets deposited into our accounts. So, yes, digitalisation is definitely the way ahead." (Interview, Auto Rickshaw Union).

The digitalisation ranges from organisation management initiatives to information initiatives to that which ensures tracking and safety for passengers. One important aspect that was discussed was also that there should be an open data sharing policy by all the transport providers and departments which would enable individual innovators to utilise that data and create new applications which can increase the convenience of the passengers and hence contribute in better digitalisation and their popularity in the public transportation

scenario. Currently no such data sharing policy exists and BMLTA once established can have a separate unit looking into it. To summarise the digital initiatives have shown great potential and have been accepted by the people and the effect is positive. Bettering the initiatives, ensuring their accuracy and making more people friendly applications would truly boost the public transport ridership by bringing in convenience, security and accessibility.

Theme. 6- Way forward

Several recommendations were given by the interview participants with regard to how ridership of public transport can be achieved and how sustainable mobility can be achieved in Bengaluru, apart from the mandatory ones like having seamless integration, an enforcing body like BMLTA with collaborative governance framework and of course the digital interventions and making them better. Innovations and innovativeness should be the key to find solutions for a complex problem like this given the multivariate setting of Bengaluru.

Some of the solutions that were innovative were, having the private sector alongside the public transport providers who can offer services like the feeder buses or charter buses that ferry people to workplaces or schools. The facilities like advance reservations and convenience would definitely attract the citizens. The planned introduction of joint tickets and day tickets which would enable the public to use any mode of transport for that particular valid day and make seamless connections are the way ahead. The common mobility card is in the pipeline and it is being introduced but that would also need prior integration of modes and the requisite infrastructure to turn it into reality.

The provision of tiered level of services with the basic buses, the air conditioned and modern buses with different pricing is seen as a way which can attract all classes of citizens. The public would not be interested in shifting away from the convenience and flexibility offered by their private automobiles if equal flexibility and convenience is offered by the public transport. Right schedules and punctual services coupled with convenient measures would compel the citizens. Having dedicated bus lanes or even public

transport lanes that would be only earmarked for buses, Auto Rickshaws and cabs would ensure a faster travel option and the congestion due to private automobiles delaying the transit might also compel the citizens to explore the faster public transportation medium.

Another very important but radical recommendation that was uniformly voiced by all the participants are penal measures to curb the use of private cars and automobiles. Taxes that are imposed on congested roads, extra charges for using roads at peak hours and even carbon taxes and environmental taxes would make the use of automobiles more expensive and if public transportation can offer different level of services at different rates and also be efficient and punctual would then bring about the real transition from the automobile led movement towards a more sustainable public transportation mode. Sufficient awareness creation followed by the right attitude and vision as explained earlier will actually manifest in terms of real changes on grounds. Further recommendations and the way forward to achieve sustainable mobility will be covered in the discussion chapter and broad recommendations will be given for the same.

6 Discussion :

6.1 Theory of collaborative governance to achieve transition multiplex

The important contribution of this research is the proposing of a theory to achieve the sustainable mobility transitions in developing countries and especially in cities like Bengaluru. Using the themes that were obtained and the quantitative result analysis, the elements of grounded theory were combined with them as the methodology to arrive at this theory grounded in the data collected. This theory gives the possible actions and factors that have to be kept in mind to achieve a sustainable mobility transition.

Multiplex simply put in terms of the Oxford dictionary means " Involving or consisting of many elements in a complex relationship"; it could also mean simultaneous existence of multiple elements like in a multiplex theatre with several screens or multiple signals being transmitted through the same media in case of multiplex transmission. The concept of multiplex here means the existence of multiple agencies, actors and also multiple constraints and multiple associations which all have to be given a due regard when proposing a solution or way to implement a solution in these kinds of conditions. Bengaluru or for that matter most of the developing countries in the east have such unique societies and such unique kinds of interactions and networks. The actors and constituents in a multiplex relationship often have struggles to transition into new roles without disrupting the hierarchy in other domains or the existing structures (Li & Piezunka, 2020). Compliance with one disrupting the compliance with others and conflict of roles are a common characteristic of multiplex relationships , which are found even in management literature (Valcour, 2002). Thus for a city like Bengaluru with such multiplex actors and scenarios all unfolding simultaneously next to each other, this theory explains a possible way out or rather a best approach to deal with this scenario and ensure a successful transition.

The important constituents of such a transition have to be the government which provides a vision, a collaborative agency which through the collaborative governance (Ansell & Gash,

2008) mechanisms drives the transition which is BMLTA in this case, the bureaucracy which has to implement it on the ground and the final beneficiaries the people or citizens. The transition has to occur in a bidirectional way and simultaneously from the top level as well as the bottom level to drive the transition in its core. Collaborative governance acts as the driving force and the skeletal structure of such a transition. This theory advocates that since the problem is a multiplex, the solutions and the transition should also be multiplexed in nature tackling different aspects at the same time, but a single vision should bind these individual actions into one transition.

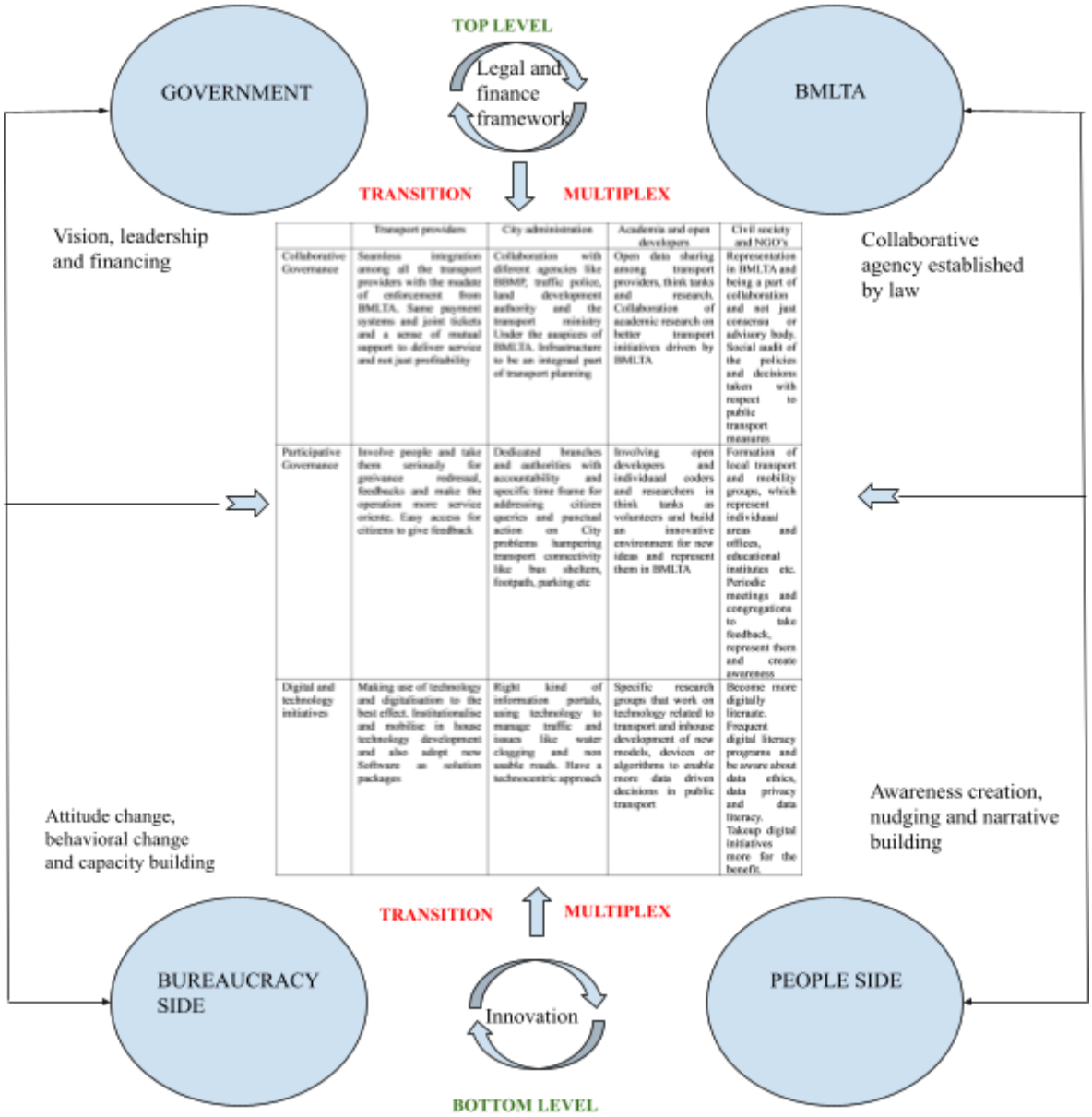


Figure No. 16. Proposed Theory of collaborative governance to achieve transition multiplex

The theory proposes that the government should establish this collaborative agency with a proper legislative framework and should ensure sufficient fiscal resources to take actionable decisions. The agency would consist of all the stakeholders and the mode of functioning would also be multiplexed in nature. Similar to a multiplex movie hall where different mo9vies are played together, similar sub processes like the framing of a comprehensive mobility plan, research into new digital innovations and actionable framework for participative processes are ensured. The bureaucracy would be responsible to implement the decisions taken in this regard and it should be mandatory upon all the stakeholders to adhere to this. An accountability framework coiled with penal provisions for non adherence to the decisions are an integral part of the framework. Smooth onboarding of the stakeholders are only ensured when everybody realises a benefit out of such collaboration.

Single interventions can never be fruitful (Berger et al., 2014) in such complex scenarios as already explained in the literature review. Hence, similar to a multiplex movie hall, the other facilities like refreshment, convenience facilities and digital initiatives for booking will be ensured side by side so that riding through a public transport becomes compelling and at the same time pleasurable. Frequent congregations on the citizens' side in a periodic manner can be ensured by the authorities for feedback and grievance redressal and at the same time the civil society should also engage with citizens regularly to be able to voice their concerns at the apex to make it more democratic in nature. The drive towards a transition multiplex is also not possible with building of sufficient infrastructure on the lines of modern cities and BBMP as the nodal agency to be responsible for understanding the concerns of transport authorities on one hand and the citizens on the other should be responsible for creation of secondary facilitating infrastructure like bus shelters, toilets and parking facilities at large metro hubs. The traffic police would also have a crucial role in implementing the decisions of the BMLTA by ensuring that dedicated lanes, if designed, are available exclusively for public transport.

Finally sustainable mobility as discussed with reference to the paradigm of Banister (2008) should involve seeing streets more as a space and should even involve slowing the traffic at

certain areas if necessary and a component of active mobility has to be present alongside well established public transport to achieve true sustainable mobility. Innovation and digitalisation are the key factors to enable this transition.

This theory by no means would claim to solve all the problems related to public transport in all developing countries as there always needs to be context oriented decisions. However, the overall framework would be suitable with modifications to be applicable in general to drive a society towards using more of public transport and realise the green development goals and make the cities more smart and sustainable. The role of academia has to be an active one without which new technologies and new insights would never come into the front. Private researchers, established research groups and BMLTA funded research should be an ongoing process to bring the best and also conduct the efficacy analysis of the existing structures or any new decisions made. The collaborative governance approach as said earlier should be a bedrock to cut across the vicious cycle of competition and bring in profitability along with sustainability and development. Here there is also a need to mention the modifications in the collaborative governance framework as suggested by Ansell & Gash (2008) to make the structure more suitable to be applicable for this theory and the same will be elaborated in the next section.

6.2 Nature of collaborative governance to achieve the transition multiplex

The collaborative framework proposed by Ansell & Gash (2008) holds good for a large part of the purpose of transition here (Figure No. 4). The minor modifications and additions to this framework to make it more suitable for the context of public transportation use in Bengaluru or even in general for mobility related policies would be the addition of the concept of benefit and profitability as another starting condition which would influence this process. This is different just from the incentives that one would get out of collaboration in the sense that it should be the main and only reason to collaborate without which other incentives would not mean anything to the stakeholders, specially the private stakeholders. Hence alongside the other factors namely power asymmetries, history of conflict and

cooperation this should be an important factor. The other important factor that becomes relevant is to have a legal basis like the BMLTA Act, 2023 here, which has the due approval of the legislature as a starting condition as it would make the entire process very accountable.

On further looking at the collaborative process itself, this theory also lays importance on trust building, shared ownership of process and good faith (Ansell & Gash, 2008). However what is also important here is the level of commitment to the process. The level of commitment to the process and the collective decisions taken should be a driving factor without which the collaborative process would not result in any substantial change. One another aspect that Ansell & Gash (2008) discuss in their framework is the role of facilitative leadership. This is also mentioned here as one of the main factors for driving the transition but what should be alongside a leadership is also a constant source of funding and the autonomy that has to be granted to the process or organisation without which it won't sustain for long. This becomes more important in developing countries with a resource crunch. The resources are often distributed for macroeconomic problems like poverty, hunger and security. The understanding that sustainability is also equally important and that sufficient resources should be made available to achieve transitions in this area is an important factor to be noted of.

Finally, small wins along with a long term vision is necessary here as the policies related to transport and mobility are usually long term in nature. Pilot projects and constant fact finding should go hand in hand with a fixed long term vision to not lose track of the main objectives. The outcomes being enforced in a right manner should be a responsibility of law enforcement agencies and that would ensure all the fiscal and human resources invested in the deliberation process was not wasted.

6.3 Recommendations and way forward

This section would try to wrap up and bind all the recommendations that were obtained as part of this research to suggest a general framework so that the sustainable mobility related transition can be achieved. The recommendations are in the nature of general

recommendations holistically and also certain sector specific recommendations in the context of Bengaluru.

The multiplex problem would invariably require multiplex solutions as highlighted above. The recommendations for achieving and implementing the solutions are as follows:

1. To have a common collaborative agency like BMLTA with powers where the decisions are bound on all stakeholders. Utilising aspects of network governance and network dynamics (Wang & Ran, 2023) alongside collaboration governance is the way ahead.
2. Smooth onboarding of all stakeholders and practice of conflict resolution measures (Getha-Taylor et al., 2019) both in theory and practice are a necessary precondition for this endeavour. Specially the private stakeholders like Auto Rickshaws, academia, software providers etc need to be accomplished before the collaborative exercise begins.
3. Integrated transport is the only way (Solecka & Zak, 2014) and the same is voiced here as an outcome of this research as well. Multimodal transport with seamless connectivity and to engage all the transport providers with different nature of operations has to be made with the use of constructive engagement (Emerson et al., 2012). The integration process should be flexible and steered right by the BMLTA and the interventions should be timed well and planned well in advance as also opined by Loorbach et al (2015).
4. Sufficient services should be ensured with a clear demarcation of vision for the individual modes. Metro can be at the top level providing connectivity to and from the major areas followed by the buses which provide individual connectivity to minor areas and also act as the feeder buses from these minor areas to the major metro hubs. The Auto Rickshaws should adopt the feeder and the role of providers of first mile and last mile connectivity. Active mobility and Auto Rickshaws should be the preferred mode of commute to the nearest bus station or the metro hub.
5. Penal measures on the use of automobiles and vehicles would ensure they are not used in a careless and unwanted way. Vehicles should be used only when there is a

dire need and the public should be dissuaded from using them using higher road taxes, penalties, congestion tax and also at the same time providing equally flexible and convenient services by adopting a tiered level service. The private sector can also be roped into work for this and given a specific role in the comprehensive mobility plan.

6. In the end as rightly said by Geels (2004), Markard et al (2012) the transition is basically dealing with socio technical systems. The technology and societal factors influence and also drive transition in these contexts. Thus understanding the very nature of having regular public meetings, digital literacy sessions and promoting digital technologies will have a long lasting effect and would also benefit the society in this datafied world. This research also re emphasises the importance of the civil society as acknowledged by Parris & Kates (2003), and they have to take the initiative and drive the change
7. Other added recommendations could be to keenly observe the developed countries and the way the public transport has been organised there. Trying to emulate the best practices in terms of service quality, fares or new innovations would make a world of change in the current system of how public transport is organised in Bengaluru. Vision building (Weber, 2003) is important in this context and sticking to a long term plan.

The sector specific and transport provider specific recommendations for the BMTC buses are to have a right journey planner and ensure proper schedules and punctuality in services. Dedicated bus lanes would help this cause. Capacity augmentation and procurement of new buses preferably electric has to be undertaken as an immediate measure to cater the ever growing public demand. BMLTA should be implemented first and subsequent capacity and procurement related decisions can follow. Metro on the other hand should have a faster approach at building new lines and also should have an internal division clearly demarcating its responsibilities as a transport company and as a construction company. The Auto Rickshaws have already moved into the CNG mode and are using cleaner fuel, however their transition into electric rickshaws are very important in the context of environmental sustainability. As an innovative measure to ensure their profitability and

smooth onboarding, Auto Rickshaws that agree to be a part of feeder services can also be paid through the common mobility card and free charging hubs can be created for them thus saving them from the burden of fuel prices and insulating them from the same. The provision of free electricity would also motivate more and more Auto Rickshaws to join the network and the fuel charges can be compensated in the overall ticket pricing for the entire journey.

These recommendations though are beneficial and effective, they are by no means comprehensive. The process of transition should be a continuous one and should evolve with time. The sustainable mobility transition with a complete move away from vehicles is also very aspirational and also to an extent impossible as cited by various authors discussed in the literature review; however incremental steps and small wins would keep the wheel of sustainability spinning and these recommendations ensure that.

6.4 Contribution of the research

This research started out with an aim of answering the main research aim as to ‘ How to achieve sustainable mobility in Bengaluru through public transport?’. Research sub questions were formulated which tried to understand the factors and barriers that affect the public transportation ridership and the role of the mutual integration or non integration of the network actors who formed the part of the public transportation ecosystem of Bengaluru. The research also aimed at recommending suitable measures to achieve the same and as a way forward.

This research contribution to practicality has been the various factors that it uncovered that affect the public transportation ridershipü. The findings can guide the current public transportation agencies on their potential riders and how they can improve their ridership. The correlation and factor analysis also have provided a baseline for the need of integration among all the modes and how it can be achieved to improve the convenience of the citizens. The research has tried to collect viewpoints from different stakeholders including transport corporations, academia, Auto Rickshaw unions and also citizens. The

observations and the results will be contributing to an overall improvement of the public transportation scenario in Bengaluru.

This research tries to bridge the gap of studies with respect to collaborative governance and how it can be used to drive sustainability transitions in developing countries. There was a gap in literature with respect to the collaborative efforts in public transportation specially in India and the other developing countries. This research proposes the theory of collaborative governance for achieving transition multiplex , to explain the way transition can be achieved in such environments which have a large population, multiple actors and agencies and more importantly a limitation on fiscal resources. The research also tries to contribute to the theoretical framework it used which was the Theory of collaborative governance by Ansell & Gash (2008) and proposes some additions and modifications to their framework to make it more suitable to the city of Bengaluru and a growing multivariate city in a developing country like India.

The contributions in terms of numerical results further reinforced by qualitative data would serve to reduce the gap in literature and to provide practical solutions to the issue of achieving sustainable mobility in Bengaluru which has been deemed a complex task.

6.5 Limitations

This research also has its own limitations which would be discussed in this part. The first and foremost limitation was the need for field work for data collection and the fieldwork involved travelling to India and collecting the survey responses and the interviews. The sample size of the survey is limited to only 130 respondents which when compared to the population of the case study of Bengaluru is quite small. Hence the research findings represent a very miniscule of the population and further research with a much greater sample size needs to be conducted to arrive at other results and then validate these findings

The interviews also represent only certain stakeholders and the research would have been more holistic if the responses and viewpoints were obtained from BBMP, BDA, the traffic

police department and also the government representatives from the transport ministry. The research initially planned to interview all these respondents along with the minister in the Karnataka government responsible for the Bengaluru city development and its affairs. However, the general elections to the parliament were announced in India at the same time coinciding with the field work which made getting interviews and meeting all these authorities very difficult as they were all on different electoral duties. The research would have been replete with more information, data and viewpoints had all the interviews been possible.

The context and the city of Bengaluru is quite large to comprehensively cover every nuanced aspect in a single research. The time availability for completing this research and writing the thesis was also smaller given the size of the case. Thus this research has made its best effort in reaching out to all the important stakeholders and also trying to combine with a quantitative survey. Efforts were made to make the sample space as varied as possible. The large amount of data that the research was able to collect is also its strength as well as its weakness. The data can be analysed using even more methods and especially the quantitative analysis can be done with more methods. However the time frame of the research did not allow for such extensive data analysis and hence can serve as one more limitation.

Lastly, several public officials were interviewed to get an opinion on the current state of public transportation and the associated problems in Bengaluru. The responses can contain an inherent bias with the intention to project their organisation and efforts in a good light and also to be not very critical of the government. Thus it has to be viewed in that light and the bias should be factored in for any conclusive results.

6.6 Scope for further research

Various studies on public transportation related fields were earlier discussed. The further scope of research in future can be on the lines specifically focussing on the global south and developing countries and how they can be improvised. Sanchez (2008) has discussed the

impact of public transportation use on macroeconomic problems like poverty, similar research can be done on the role of collaborative governance and how integrated modes of transport can uplift the economic benefits and standard of living of people.

Further quantitative studies trying to decode the public behaviour with respect to commuting in developing countries and also the impact of allowing free of cost rides like the scheme currently in progress in Karnataka can be studied both from a behavioural aspect as well as an economic aspect. The open data sharing concept emerged with respect to public transport and the role of ICT has always been prominent (Sinha, 2003). With an emerging economy with deep internet penetration and smartphones; the effect of such data sharing and the bright potential it has on new innovations coming to the forefront will be an interesting topic. The data privacy and data security concerns are however not to be undermined and hence such a research should be accompanied by further data security and privacy related research.

Various digitalisation initiatives are coming to the forefront which are also used for integration, like the common mobility card. Biometric based or Aadhaar card linkage of the transport card and using it as a means of commute can be studied and it can also be studied whether such an integration will have any effect on the ridership and also whether it would improve collaboration.

Last but not the least the further research has to concentrate on ways and means to improve the financial health of public transport corporations in India and come with new recommendations for ensuring a sound financial health.

7 Conclusion

This research set out with an aim of finding out ways in which sustainable mobility can be achieved in the Indian city of Bengaluru. Researching the factors that affect the ridership behaviour, the impact of integration, the efficacy and importance of digital initiatives on improving the ridership were all studied. The research made use of a mixed approach methodology, combining a quantitative survey which was conducted with 130 people and then eight interviews with the stakeholders who were part of the public transportation ecosystem of Bengaluru. The scope of the public transport was limited to buses operated by BMTC, the Metro operated by the BMRCL and the intermediate public transport namely the Auto Rickshaws. Quantitative analysis using box plots, correlation analysis and exploratory factor analysis gave details about the general patterns of ridership and the attributes that affected it. The integration factor and importance was studied by the correlation analysis and the exploratory factor analysis shed light on what are the group of initiatives and constraints that can be analysed and addressed together. The thematic analysis on the qualitative data resulted in seven themes which were then combined with all the results and a ‘Theory of collaborative governance to achieve transition multiplex’ was proposed on how to approach complex transition goals in cities situated in developing countries.

Developing countries come with a different kind of context and governance structures. They have to be taken into consideration for forming policies. Tenets of the Non Western Public Administration paradigm has to be applied to understand the nuances of the case which is quite different from the public administration paradigms which are essentially western or Anglo American (Drechsler, 2015). Therefore the collaborative governance theory when applied in a different context needs to be modified and be it transportation or any other policies need to have their own field for themselves. Banister (2008) differentiated between demand derived travel and value derived travel. In today's world where travel and mobility just does not arise out of demand but also is a leisure activity and can generate value in itself, it becomes more so important to study the ways and means to achieve sustainable mobility. In this regard the results from Bengaluru serve as a hope as well as a warning on what has to be done and what has to be avoided.

The major question that one has to ask at the end is whether the transition towards a car less or automobile free or rather clean automobile is possible. Several researchers have advocated that it is very difficult and almost impossible. This research also opines that it is a very difficult task and gets more difficult in large cities in developing countries like India, but with the right vision, method and processes the increments can be made. The research has contributed in showing a direction, however one has to note that such a transition is a long drawn battle. It would not be possible for an immediate overhaul of things, especially when it is being applied to cities which are already existing and come with their own nature and flavour. The same dilemma of whether to promote manufacturing and economy or to curb the use of vehicles and also the associated resistance that will be faced when penal measures are imposed to curb the automobile use , both from the people and the automobile manufacturers have to be accounted for. Ultimately ridership and the choice of mode is a choice and such a choice can not be mandated.

All these factors make transition in multiplex a complex scenario. However the hope that digitalisation and technology offers, the hope that dedicated citizens and democracy offers can be relied upon to set the wheel spinning. Generational studies on sustainable mobility have contributed to the field and yet we are at the crossroads of choosing what is flexible and convenient against what is sustainable. In Spite of understanding the benefits of community action and collaborative action the state of affairs look more fractured today with factors like red tapism, political rivalries being cog webs in the wheel of progress. Innovativeness and the will along with sufficient awareness are the factors that can help us fight this wicked problem.

Having a sustainable city which is at the same time smart and easy to commute for daily needs is probably the most important aspect of having a good and healthy life. This research is not in an utopian world that believes that sustainable mobility can be achieved by diligently following all the steps that have been listed. Achieving sustainable mobility is even more difficult than achieving sustainable development (Holden et al., 2019). Thus making small progress and utilising varied approaches like targeting specific groups of customers, having a well established network of public transport and the digitalisation

measures well incorporated can lead to a progress. The research has come with its own limitations but it believes that the theory for achieving transition in a multiplex society can give its contribution even though the time frame would be a longer one. On the other hand Bengaluru is also showing a good rate of progress given that it is the only state to have an authority like DULT and also the first state which has passed a legislation to establish BMLTA kind of authority. The progress and the vigour should not be lost and the efforts should be collaborative and consistent in nature.

This research hopes that further research and developments related to Bengaluru and more such cities would bring in more sustainable initiatives in mobility and improve the way in which we travel alongside benefiting the health and the environment. It is best to conclude that sustainable mobility is not just a need anymore but a necessity, and we would make the world better, greener and healthier in the times to come.

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Appendix

A Theory of collaborative governance for transition multiplex

	Transport providers	City administration	Academia and open developers	Civil society and NGO's
Collaborative Governance	Seamless integration among all the transport providers with the madate of enforcement from BMLTA. Same payment systems and joint tickets and a sense of mutual support to deliver service and not just profitability	Collaboration with diferent agencies like BBMP, traffic police, land development authority and the transport ministry Under the auspices of BMLTA. Infrastructure to be an integraal part of transport planning	Open data sharing among transport providers, think tanks and research. Collaboration of academic research on better transport initiatives driven by BMLTA	Representation in BMLTA and being a part of collaboration and not just consensu or advisory body. Social audit of the policies and decisions taken with respect to public transport measures
Participative Governance	Involve people and take them seriously for greivance redressal, feedbacks and make the operation more service oriente. Easy access for citizens to give feedback	Dedicated branches and authorities with accountability and specific time frame for addressing citizen queries and punctual action on City problems hampering transport connectivity like bus shelters, footpath, parking etc	Involving open developers and individuaal coders and researchers in think tanks as volunteers and build an innovative environment for new ideas and represent them in BMLTA	Formation of local transport and mobility groups, which represent individuaal areas and offices, educational institutes etc. Periodic meetings and congregations to take feedback, represent them and create awareness
Digital and technology initiatives	Making use of technology and digitalisation to the best effect. Institutionalise and mobilise in house technology development and also adopt new Software as solution packages	Right kind of information portals, using technology to manage traffic and issues like water clogging and non usable roads. Have a technocentric approach	Specific research groups that work on technology related to transport and inhouse development of new models, devices or algorithms to enable more data driven decisions in public transport	Become more digitally literaate. Frequent digital literacy programs and be aware about data ethics, data privacy and data literacy. Takeup digital initiatives more for the benefit.

B Sample Interview Questionnaire

Interview with Directorate of Urban Land transport (DULT)

1. What is the mandate and the role of your organisation in effectively managing and coordinating between different land transport entities?
2. How important do you think is the collaborative aspect of governance in order to effectively achieve sustainable and green mobility in Bengaluru?
3. Can you please elaborate your views on the collaboration between institutions and also the collaboration with civil society, citizen organisations to enable participative planning?
4. There has been advocacy of a United Metropolitan Transport Authority bill for the purpose of creating a unified planning structure to achieve sustainable mobility, what is your opinion on that?
5. What are the various digitalisation initiatives that DULT is planning to introduce for technology oriented transport planning?
6. How do you envision the future role of DULT as a main collaborating agency to create an effective and sustainable transport infrastructure in Bengaluru?
7. Can you elaborate on the different projects and researches undertaken by DULT? What are the initiatives in the pipeline?
8. How effective do you think the digitalisation process is to motivate people to use more public transport?
9. Why do you think there is an increase in usage of private vehicles over and above public transport? Would a penalising approach or traffic based surcharge approach solve the issue in your opinion?
10. Any other thoughts on reducing carbon footprint due to vehicles and achieving sustainable mobility?

Thank you for your cooperation

Declaration of Authorship

I hereby declare that, to the best of my knowledge and belief, this Master Thesis titled "Achieving sustainable mobility through public transport: An analysis of the public transport ecosystem and digital policy interventions to increase its usage in Bengaluru" is my own work. I confirm that each significant contribution to and quotation in this thesis that originates from the work or works of others is indicated by proper use of citation and references.

Tallinn, 05 July 2024

Manjunath Vyshakh Nag

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Survey Questionnaire -Public Transportation use in Bengaluru. (For Master Thesis research)

This **survey** is part of the research being conducted for **academic purposes** to assess the major constraints that affect the usage of Public Transport in Bengaluru (Namely BMTC Buses, Metro and Auto Rickshaws).Please answer the first part of questions about yourself and then the second part of questions starting with question number 10, please choose the option which you consider is the most appropriate from your experience. **There are a total of 30 questions and all require a response each except three questions numbered 8, 17, 23 and 28 which are not marked with the asterisk**.The **estimated average time** you would need to answer the complete survey would be **15-20 minutes**. There are five options and please choose only one which you feel is the most suitable based on your experience and opinion. The option '**Completely insignificant' carries 0 points** and the '**Completely important' has been allocated 5 points**. Based on the cumulative scores and also on the basis of different socio economic parameters the overall data will be analysed and the results about the opinion and citizen perspectives on the issues of public transportation use, constraints and digitalisation issues will be assessed. **The survey will be completely anonymous and will be used only for the academic research purpose**. **I whole heartedly thank you for taking out your time to help me out in this research.**

* Indicates required question

1. **PART 1- SELF QUESTIONNAIRE** *

1. Can you please indicate your age interval

Mark only one oval.

- ◯ 18-25 years
- ◯ 26-45 years
- ◯ 46-60 years
- ◯ Above 60 Years
- ◯ Prefer not to say

2. 2. Please indicate your gender *

Mark only one oval.

- Male
- Female
- Other
- Prefer not to say

3. *

3. Please indicate the Profession / Activity you are engaged in.

Mark only one oval.

- Govt Employee
- Private Employee
- Self Employed
- House Manager
- Student
- Other/ Do not wish to specify

4. 4. How often do you use BMTC Bus for commute? *

Mark only one oval.

- Never
- Occasionally (1-4 times a month)
- Sometimes (5-8 times a month)
- Often(9-12 times a month)
- Always (On a daily basis for some purpose)

5. 5. How often do you use Bengaluru Metro for commute? *

Mark only one oval.

- Never
- Occasionally (1-4 times a month)
- Sometimes (5-8 times a month)
- Often(9-12 times a month)
- Always (On a daily basis for some purpose)

6. 6. How often do you use Auto Rickshaw for commute? *

Mark only one oval.

- Never
- Occasionally (1-4 times a month)
- Sometimes (5-8 times a month)
- Often(9-12 times a month)
- Always (On a daily basis for some purpose)

7. 7. Do you/your family own a private vehicle? *

Mark only one oval.

- Yes
- No

8. 8. If yes in the case of previous question; what type of private vehicle do you own?

Mark only one oval.

- Two wheeler (One only)
- Two wheeler (More than 1)
- Four wheeler (One only)
- Four wheeler (More than one)
- Both Two wheeler and four wheeler

9. 9. What is the major activity for which you will usually commute (Any means of transport) *

Mark only one oval.

- Work
- Study
- Leisure
- On a need basis
- Other: _____

10. **PART- 2** *

Please answer the questions with regard to your experience and opinion. There are five options and please choose one option which you feel is the most appropriate in the context.

10. Consider the following frequently reported constraints with respect to commute in city buses (BMTC). Please respond as to how relevant do you consider these issues in your view?

Mark only one oval per row.

	Completely insignificant	Rather Insignificant	Neither important nor insignificant	Rather Important	Completely Important
Reduction in Status					
Congestion/Rush					
Irregular Schedule					
Longer travel time					
No end to end travel					
Insufficient number of Buses					
Lack of Digital payment systems					
Cleanliness					

11. 11. Why do you think there is an increasing trend of using Private Transport and Private vehicles over the use of Public transportation (BMTC Bus, Metro and Auto rickshaws)? *

Mark only one oval per row.

	Completely insignificant	Rather Insignificant	Neither important nor insignificant	Rather Important	Completely Important
Private Vehicle is a status symbol in Indian society					
Flexibility offered by private vehicle					
Shorter travel time and Traffic Jams					
Comfort of Private vehicles (Like AC,Music, freedom)					
Women Safety issues					
No end to end commute facility					
Insufficient number of Buses to handle capacity					
Cost issues					

Cost issues					

12. 12. How important do you consider is the participatory decision making aspect and citizen involvement is needed in designing bus routes or policy measures affecting BMTC Buses? *

Mark only one oval.

- Completely insignificant
- Rather insignificant
- Neither important nor insignificant
- Rather important
- Completely important

13. 13. How important is the collaboration aspect among BMTC Buses, Bengaluru Metro and Auto Rickshaws to facilitate the increase in usage of these public transport by more number of people? *

Mark only one oval.

- Completely insignificant
- Rather insignificant
- Neither important nor insignificant
- Rather important
- Completely important

14. 14. How important do you think is the digitalisation initiatives to make the BMTC buses more attractive and to increase the usage of them? *

Mark only one oval.

- Completely insignificant
- Rather insignificant
- Neither important nor insignificant
- Rather important
- Completely important

15. 15. Consider the following digitalisation initiatives by the BMTC or City buses. What according to you are the most suitable and relevant among them which can increase the ridership? *

Mark only one oval per row.

	Completely insignificant	Rather insignificant	Neither important nor insignificant	Rather important	Completely important
Namma BMTC App					
BMTC Website Info					
CCTVs in Buses					
Digital stoppage displays in Buses					
Digital payments for Tickets					
Integrated Smart Card					
Wifi in Bus stations					
Location tracking of Buses using GPS					
Live route map and congestion info					
Digital time and information boards at every bus stop					

every bus stop

16. 16. Have you used the 'Namma BMTC' application which gives schedules and user tracking of the busses? *

Mark only one oval.

- Yes
- No

17. 17. If Yes for the last question, can you please describe your experience and also that experience contributing to your increased user ship and attractiveness to travel in BMTC busses

Mark only one oval.

- Completely disappointed
- Rather disappointed
- Neither disappointed nor very useful
- Rather useful
- Completely useful

18. 18. Consider the following frequently reported constraints with respect to commute in Bengaluru Metro(BMRCL). Please respond as to how relevant do you consider these issues in your view? *

Mark only one oval per row.

	Completely insignificant	Rather Insignificant	Neither important nor insignificant	Rather Important	Completely Important
Reduction in Status					
Congestion/Rush					
Longer travel time					
No end to end travel					
Less frequency of Metro trains					
High Cost of tickets					
No connectivity to my area					
Metro stations are far from my place/Office					

19. 19. How important do you consider is the participatory decision making aspect and citizen involvement is needed in issues concerning Bengaluru Metro like new route planning, new facilities, improvement of service etc? *

Mark only one oval.

- Completely insignificant
- Rather insignificant
- Neither important nor insignificant
- Rather important
- Completely important

20. 20. How important do you think is the digitalisation initiatives that have been implemented make the Metro more attractive and motivates to use them? *

Mark only one oval.

- Completely insignificant
- Rather insignificant
- Neither important nor insignificant
- Rather important
- Completely important

21. 21. Consider the following digitalisation initiatives by the BMRCL/ Bengaluru Metro. What according to you are the most suitable and relevant among them which can/has increased the ridership? *

Mark only one oval per row.

	Completely insignificant	Rather insignificant	Neither important nor insignificant	Rather important	Completely important
Namma Metro App					
BMRCL Website Info					
CCTVs in Metro coaches					
Digital display boards					
Digital payments for Tickets/QR code tickets					
Integrated Smart Card					
Wifi in Metro stations					
Digital information boards and voice instructions inside the Metro					
Digital automatic entry/ Exit gates					

entry/ Exit gates					
Digital luggage scanner and metal detectors at the entry of metro stations					

22. 22. Have you used the 'Namma Metro' application which gives information on Bengaluru Metro services? *

Mark only one oval.

- Yes
- No

23. 23. If Yes for the last question, can you please describe your experience and also that experience contributing to your increased user ship and attractiveness to travel in Metro?

Mark only one oval.

- Completely disappointed
- Rather disappointed
- Neither disappointed nor very useful
- Rather useful
- Completely useful

24. 24. Consider the following frequently reported constraints with respect to commute in Bengaluru Auto Rickshaws. Please respond as to how relevant do you consider these issues in your view? *

Mark only one oval per row.

	Completely insignificant	Rather Insignificant	Neither important nor insignificant	Rather Important	Completely Important
Reduction in Status					
Congestion/Rush					
Longer travel time					
Rash and dangerous driving					
Charging abnormal and higher rates					
Refusing to be hired for specific locations					
Trustworthiness of Drivers					
Pollution and lack of comfort in travel					
Cannot travel more than three persons					
Women safety issues					

25. 25. How important do you think is the digitalisation initiatives that have been implemented with respect to Auto rickshaws make it more attractive and easy to use? *

Mark only one oval.

- Completely insignificant
- Rather insignificant
- Neither important nor insignificant
- Rather important
- Completely important

26. 26. Consider the following digitalisation initiatives by the Auto rickshaws and their unions. What according to you are the most suitable and relevant among them which can/has increased the ridership? *

Mark only one oval per row.

	Completely insignificant	Rather insignificant	Neither important nor insignificant	Rather important	Completely important
Namma Yatra App	◯	◯	◯	◯	◯
Ola and Uber app Autos	◯	◯	◯	◯	◯
Digital driver display boards in Autos	◯	◯	◯	◯	◯
Digital Metres	◯	◯	◯	◯	◯
Accepting Digital wallet and UPI payments	◯	◯	◯	◯	◯
Ride share and ride track in apps	◯	◯	◯	◯	◯

27. 27. Have you used the 'Namma Yatri' auto application which gives information and ride booking for Bengaluru Auto Rickshaws? *

Mark only one oval.

◯ Yes

◯ No

28. 28. If Yes for the last question, can you please describe your experience and also that experience contributing to your increased user ship and attractiveness to travel in Autos?

Mark only one oval.

- ◯ Completely disappointed
- ◯ Rather disappointed
- ◯ Neither disappointed nor very useful
- ◯ Rather useful
- ◯ Completely useful

29. 29. Do you think launching one single application which gives an integrated coverage of routes by combination of Bus, Metro and Autos and ensuring end to end travel will become popular or increase public transport usage in Bengaluru? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't predict

30. 30. Did these questions and self reflection while answering the survey make any difference to you or thoughts in wanting to use more of Public transportation for your commute in Bengaluru? *

Mark only one oval.

- ◯ Yes
- ◯ No

Code System	Memo	Coded Segments	Documents
Code System		363	8
The lack of features and utility of Namma BMTC aPP		1	1
Safety of pedestrians and the construction debris issues		1	1
Road safety and risks assocviated with unplanned crossings		1	1
Long term constructions of streets and problems-Constraints		1	1
All comes down to a lack of service mentality problem		1	1
Red tapism+No accountability+ Lack of vision		1	1
Street lighting infrastructure issue. BBMP		1	1
Role of traffic police department and their contribution		1	1
Priority bus lanes 1/3 can be a solution		1	1
Ineffectiveness of Journey planners in Bengaluru		1	1
Multiple branches and no accountability among authorities		1	1
Traffic issues and punctuality issues		1	1
The construction and bus shelter infrastructure constraints		1	1
A project to have connecting infrastructure		1	1
Active mobility should compliment public transport		1	1
Sustainable mobility is not solely BMTC and BMRCL		1	1
Connectity between modes are not seamless		1	1
Lack of convenience to shift modes		1	1
Feasible infrastructure to enable multimodal connectivity		1	1
Seamless ticket booking, tracking info		1	1
The focus is on cars and not on buses		1	1
Dismantled the priority bus lane project		1	1
Citizens appreciating Priority bus lanes		1	1

Code System	Memo	Coded Segments	Documents
No proper pedestrian infrastructure problem of construction		1	1
Bengaluru is a very participative city, leverage it		1	1
Data collaboration, BMTC,BMRCL,Parking etc		1	1
Advantages of data sharing and open data		1	1
Public transports are not service oriented		1	1
Advantages of open data and need in Bengaluru		1	1
Need of data sharing and accurate and eligible data		1	1
Tiered level of service		1	1
Mixed ideologies and no specific directions		1	1
Advance seat booking recommendation such facilities		1	1
No motive and sincerity from politicians		1	1
Bureaucracy and red tapism. No continuity		1	1
Lack of capacity and vicious profits		1	1
Going beyond profit and collaboration key		1	1
Construction and no proper infrastructure. No linked plan		1	1
Innovative recommendation of a tiered level of service		1	1
The service should be important and not profit		1	1
Profit is the wrong metric that it should be measured on		1	1
Importance of pushing BMLTA and no implementation		1	1
No business friendly environment for private sector to come in		1	1
Lack of private sector players and barriers for entry		1	1
No capacity augmentation and BMTC stagnation		1	1
Infrastructure improvement of buses and better convenience		1	1

Code System	Memo	Coded Segments	Documents
No connection between land use and transport planning		1	1
Importance of collaboration and in silo working		1	1
Lack of coordination and will reasons		1	1
Role of technology for punctuality		1	1
Relaibility of information is the problem		1	1
On time punctuality of Buses		1	1
Schedule and punctuality important to achieve it		1	1
No bus tracking done in a right way and amount		1	1
Constraints for BMTC Buses Citizen view		1	1
Capacity augmentation of BMTC		1	1
Provision of convenience and comfort important		1	1
Punctuality, time and schedule important aspect		1	1
Pricing importance for Indian scenario		1	1
Making it easy and convenient for people		1	1
Availability of information readily		1	1
Example of Chennai for some sort integration		1	1
This would nudge the people to think of adopting public transit		1	1
Innovative recommendation for all public transport lanes		1	1
Reaon bus lanes can become useful		1	1
Request to lkobby for priority bus lanes for buses and autos		1	1
Need for catch up vision and young blood in bureaucracy		1	1
No disincentives and policies for cars		1	1
Convenience offered by public transport lower than car		1	1
Cars have a satus associated with it in India		1	1

Code System	Memo	Coded Segments	Documents
Indian citizens are cost conscious (Developing) country		1	1
Recommendation-Joint pass BMTC and Metro		1	1
Every solution like this depends on integration		1	1
Bundling of rides another recommendation		1	1
Regulations and Entrepreneur friendly		1	1
Clarity can only lead to a digital solution like MAAS		1	1
Making public transport a compelling option for people		1	1
Resource redistribution for more buses		1	1
Second recommendation , establish BMLTA quick		1	1
The current way of operation would never increase ridership		1	1
Private operating under BMTC		1	1
Suggestion of adeopting a hybrid model of public private		1	1
Significant cultural difference and barriers		1	1
Private operators case from London		1	1
BMTC modal share is coming down considerably every day		1	1
Advantage of daily passes but extend to all		1	1
Current pricing problems fundamentally		1	1
Current system and its flaws		1	1
The fare and pricing system should be harmonsied European way		1	1
Performance measurement should be different the way in India		1	1
The metric of success should be service and not profit.		1	1
Grudging relations among all stakeholders		1	1
More business decisions than just political decisions		1	1
Everything has to be enforced by a Judiciary		1	1

Code System	Memo	Coded Segments	Documents
Making their onboarding simple is the way ahead		1	1
The skewed policy Auto Rickshaws are operating under		1	1
The lack of BMLTA and its effects		1	1
The definition and category of Auto Rickshaw is not defined too		1	1
Regulatory Vacuum for Auto Rickshaws		1	1
The software as a service model		1	1
The role of community action for succeeding		1	1
The rate charging system for Autos		1	1
The model and process of development of Namma Yatri		1	1
The problem that led to Namma Yatri application		1	1
The problems Auto face is deeper, they not heard		1	1
The integration entropy		1	1
The collaboration dystropy in Bengaluru		0	0
tHE PROBLEMS THAT THEY FOUND OUT		1	1
Alternative mobility group DULT		1	1
Certainity is a measure for people to use		1	1
Multiplicity of departments and no single authority		1	1
The problem with digital metres in Auto Rickshaws		1	1
CNG benefits for Autpo Rickshaws		1	1
Auto rickshaw is a more environmentally stable mode today		1	1
Auto rickshaw has migrated to more cleaner fuel		1	1
Auto Rickshaw never a relaible mode		1	1
Auto rickshaw has been a last resort		1	1
Digitalization wont be effective with the capacity not being		1	1
Lack of capacity and no augmentation Bus		1	1
Need for an autonomous body free to take decisions		1	1

Code System	Memo	Coded Segments	Documents
Serendipity and luck cant be the factors for governance		1	1
The performance of DULT depends on the head at that day		1	1
DULT has just been nominal for fund purposes		1	1
Last mile connectivity problem		1	1
Infrastructure that supports active and public mobility		1	1
Efficiency of integration always the weakest link		1	1
The integration concept beyond horizon		1	1
Everybody has access to two wheelers		1	1
No sketch level planning of city and transport development		1	1
Land use and transport are closely integrated and master plan		1	1
Collaboration is a no brainer		1	1
The BMLTA has not even been constituted		1	1
Lack of collaboration and individual motives		1	1
Making the decisions of BMLTA incumbent		1	1
Close involvement with the BMLTA legislation		1	1
Lack of integration in planning example		1	1
The policy of selling moe vehicles as motive		1	1
Biggest Problems two		1	1
Profile of the participant		1	1
The real drive to collaborate should come from a top down		1	1
Need for and importance of multimodal transport		1	1
Public transit in essence is multimodal and a combination		1	1
Combination of integration and technology and collab		1	1
Infrastructure integration		1	1

Code System	Memo	Coded Segments	Documents
Seamless and integrated travel benefits		1	1
Data sharing benefit for research and academia		1	1
Data sharing benefits all agencies		1	1
Importance of data sharing		1	1
Data collaboration along with governance collab		1	1
Open data and data sharing importance		1	1
Revenue collection is the prime driver of collaboration		1	1
Amutual win win scenario for all with public transit utility		1	1
Increasing ridership for profitability		1	1
Specific roles for specific carriers		1	1
Mutual win win situations should be created		1	1
Consensus oriented planning to keep all interests		1	1
Collaboration doesnt come without profitability		1	1
The need to involve public and private actors		1	1
Need for collaboration between all actors		1	1
Intention to collaborate is present but not implementation		1	1
Importance of collaboration for attracting riders		1	1
Dedicated lanes connected to Hubs		1	1
Network of Bus lanes to bring in predictability		1	1
Variability of travel times a major factor		1	1
Dedicated bus lane initiative		1	1
The most effective solution to expand and reduce vehicles		1	1
Least effective, cost and time		1	1
Most effective method in modelling to increase		1	1
Efforts and diffrenet modelling scenarios		1	1

Code System	Memo	Coded Segments	Documents
The need of coordination and collaboration of bus with metros		1	1
The problem of expanding the service network to cater all		1	1
Urban sprawl and growth of city		1	1
Important reason for decline in use of public transport		1	1
Importance of financial support for sustaining them		1	1
Financial sustainability aspect of public transport		1	1
Reasons for decline of ridership		1	1
Large usage of public transport		1	1
Different estimates on the percentage of people using		1	1
The important need to expand its reach		1	1
Importance of public transit for Bengaluru		1	1
Primary purposes why public transit is used		1	1
Different stakeholders of the public transit system		1	1
The size of Bengaluru public transit network		1	1
Purpose of his research		1	1
The importance of EV vehicles and need to push them more		1	1
Use of nudging and it the core function		1	1
Solutions to reduce private vehicle use. Need multiple approach		1	1
Absence of Public transport in a effective way		1	1
Personal and economic factors that promote car use		1	1
Direct effect of digitalization on Public transport and higher		1	1
Importance of digitalisation for Public transport		1	1
Increasing digital awareness and its status in Bengaluru		1	1
Importance of digitalisation in general		1	1

Code System	Memo	Coded Segments	Documents
Research in progress with academia and DULT		1	1
Mobility related push for research and DULT		1	1
Importance and promotion of research by DULT and progress		1	1
The core functions of BMLTA as per the act		1	1
Constitution and role of BMLTA envisaged		1	1
Collaboration is the core of DULT activities		1	1
Different digitalisation initiatives in progress/Implemented		1	1
Uses of Digitalization in different stages of project		1	1
The core perceived function of BMLTA		1	1
Legislation of BMLTA and implementation still happening		1	1
The core problem which requires a unified authority		1	1
Varying structure and multiple mandates for functioning		1	1
Multiple stakeholders present in Urban mobility planning		1	1
Benefits due to collaboration		1	1
Taking feedback on legislations and public involvement		1	1
Examples of DULT collaboration efforts		1	1
Meaning of participation and different ways of participation		1	1
The framework and capacity building for Public engagement		1	1
The process of participation DULT uses		1	1
The benefits of involving stakeholders for planning		1	1
IMPORTANCE AND NEED OF A PARTICIPATORY PLANNING APPROACH		1	1
Primary functions of DULT		1	1
Only state to have such an agency		1	1
Objective of DULT		1	1
Legal provision for DULT setup		1	1

Code System	Memo	Coded Segments	Documents
Willingness to collaborate and contributiuon to SM		1	1
Contribution to sustainability		1	1
Traditional and historical bond of Auto rickshaw		1	1
Comprehensive mobility plan and wanting to be stakeholders		1	1
Role and advantage of BMLTA and willingness		1	1
Insecurity of livelihood for Auto drivers		1	1
The most prominent profitability problem		1	1
Importance and acknowledgement of collaboration		1	1
Difficulty due to fractured associations		1	1
Future planned initiatives from IT		1	1
Importance of digitalisation in the field of Autos		1	1
The development of namma yatri app process		1	1
The profitability decline and repurcussions		1	1
Problems that reduce the ridership of Auto rickshaw		1	1
The problems fiscal faced by Auto drivers		1	1
Traditional roles which are intact		1	1
Reduced role of Auto Rickshaws		1	1
Popularity of Metro and cabs over Autos		1	1
Sustainability and cleqaner fuel being used for Autos		1	1
The importance of Auro rickshaw for livelihood		1	1
Different type of services they provide		1	1
The important role of Auto rickshaw for the city		1	1
Profitability and metro ridership increase		1	1
Standardising and making operations efficient		1	1

Code System	Memo	Coded Segments	Documents
Facts and plans on increasing metro frequency		1	1
Increase in ridership of metro over years		1	1
Advantages carbon footprint and ease of travel		1	1
Health and time accuracy of metro as strength		1	1
Advantages of using Metro and its role		1	1
Operational capacity and future plans of Metro		1	1
Collaboration with private developers and startups		1	1
Advantages of Digital initiatives		1	1
Importance and the role of digital initiatives		1	1
Citizen feedback and greivance redressal		1	1
Initiatives of Metro for citizen engagement		1	1
Master plan and comprehensive plan of the city		1	1
Role of DULT and enforecement way		1	1
Role of DULT or coordinating agency		1	1
Example of Collaboration and the way forward		1	1
Willingness of Autos to collaborate with this initiatives		1	1
Advantage of a common mobility card and role of integration		1	1
Need for IT platform and digitalisation		1	1
Lack of integration and need for multimodal transport		1	1
Role of reallocation of roles and collaboration		1	1
Socio economic advantages of metro		1	1
Revenue generation prospects and fiscal benefits		1	1
Capital intensive and long term Metro projects		1	1
Initiative being undertaken by Metros		1	1

Code System	Memo	Coded Segments	Documents
Role of a comprehensive mobility plan and inclusion of all		1	1
Induction of electric buses. Clean fuel buses		2	2
Serious problems and recommendations for them		1	1
Role of other modes to connect metro as the hub		1	1
Limitation of Metro-Last mile connectivity		1	1
Advantages of Metro and green mobility		1	1
Role of Metro in multimodal system		1	1
Inevitability of a Multimodal system for Bengaluru		1	1
Urbanisation and means of transport in large indian cities		1	1
Initial teething problems with BMTC appa nd reliability		1	1
Opinion on social media usage for publicity and awareness		1	1
Fiscal constraints and problems associated with it		1	1
Recommendation for increasing ridership		1	1
Current operational digital initiatives		1	1
Difficulty of digital payments and data driven methods		1	1
IT for organisation work		1	1
Benefits and advantages of Digitalisation in Bengaluru		1	1
Collaboration with Auto Rickshaw		1	1
Collaboration with BMRCL for schedule optimisation		1	1
ETM synchronization and issuing mobility cards		1	1
Women safety and road safety improvement		1	1
Non accuracy of the live tracking system		1	1
BMTC app and live tracking and its efficiency		1	1
Integration of tracking initiatives		1	1
Pass tracking and accounbtability		1	1

Code System	Memo	Coded Segments	Documents
Initiatives to make the passes issue easier		1	1
Software for schedule optimisation.		1	1
Reduction of average ridership of Bus after Metro		1	1
Current ridership and ridership target for future		1	1
Efficiency of BMTC low due to city commute		1	1
Less fleet and strength of the fleet of buses		1	1
Expanding the coverage of BMTC operations		1	1
Responsibility of Director IT, BMTC		1	1
Expanding area of coverage BMTC		1	1
Constraints		1	1
Capital assistance and incentivisation from Govt		1	1
Restrictive and penal measures for road use		1	1
Metro is a long time project		1	1
Road capacity fixed hence number of vehicles should be limited		1	1
Local collaboration for projects		1	1
Data sharing		1	1
Plans of collaboration and MAAS		1	1
Importance of people		1	1
Collaboration-Civil society and NGO		1	1
Importance of citizens/people		1	1
Collaboration-BBMP		1	1
Sustainability		1	1
Three A-Affordability, availability and accesibility		1	1
Capacity augmentation as solution		1	1
Capital incentive and funding		1	1
Ridership of people		1	1
Bus bunching		1	1
Collaboration with academia		1	1
Less fleet strength than mandated		1	1
Comprehensive Mobility Plan-Fleet strength		1	1

Code System	Memo	Coded Segments	Documents
Capacity augmentation		1	1
Importance of digitalisation and implementation		1	1
Not supported or imp+lemented well-Digitalisation		1	1
Digitalisation-Digital payments		1	1
Digitalisation-cctv- women and passenger safety		1	1
Road safety accidents		1	1
Image betterment		1	1
Digitalisation-CCTV		1	1
Display board digitalisation		1	1
Digitalisation-BMTC App		1	1
Feeder services		1	1
Needs higher level support		1	1
Solutions to motivate people		1	1
Dedicated Line		1	1
Dedicated lanes-Snowball effect		1	1
Private vehicle increasing- difficult to implement		1	1
Difficult to implement		1	1
Dedicated Bus lanes		1	1
Collaboration-Feeder		1	1
Expanding area of operation		0	0
Expanding area of operation		0	0
Reduction of schedules-Constraints		0	0
Population growth and urban sprawl		1	1
New model for inducting buses - solutions		1	1
Scrapping policy		1	1
Constraints		1	1
Capital assistance from Govt		0	0
Fiscal constraints and profitability		1	1
Factors for motivation		1	1
Sustainability		1	1
Competition		1	1
I cannot support Auto rickshaw, and make people make use of au		0	0
Aim of collaboration		0	0

Code System	Memo	Coded Segments	Documents
Constraints		1	1
Demotivate people from personal vehicles		1	1
Restrictive measures Automobiles		0	0
Similar to developed country		1	1
Inevitable future		1	1
provide last mile connectivity		1	1
No last mile connectivity		1	1
Competition		1	1
Major areas		1	1
Long term		0	0
Long time project		0	0
Not started		1	1
Combination of modes		1	1
Key term-Multimodal		1	1
Multimodal Transport		1	1
Future solution		1	1
Limitation on vehicles		1	1
Road capacity fixed		0	0
Road capacity		0	0
Importance of Public transport		1	1
Recommendation- Limiting private vehicles		0	0