Editorial Board

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EDITORIAL

Urbanization, mobility, energy and sustainability: opportunities and challenges — note from the Editor

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Welcome to the first issue of the *Journal of Sustainable Urbanization, Planning and Progress* (JSUPP). This new journal's mission is to provide leadership in research in the areas of urbanization and planning around the world and progress made in Asia in particular.

Urbanization is a process by which there is increase in the number of people moving to urban areas or cities in search of jobs, education, and better quality of life, leading to transformation of land use for residential, commercial and industrial purposes. In recent years, there has been greater increase in the rate of urbanization all around the world. This sudden increase in urban population in the world had several unplanned consequences such as the increase in slums, air pollution, urban sprawl and traffic demand, and environmental degradation along with demand for rising income and more comfort. Population explosion in urban areas has led to many ill-effects and it has become difficult for governments in most countries to handle overcrowding, traffic congestion, slums and air and water pollution. In addition, the classical problems arising out of an unmanaged and sudden unintended population increase are unemployment, change in family and social structures and increase in crime rates. Rapid urbanization often leaves no time for governments to plan for service delivery to the residents in cities. Under these scenarios, it is inevitable that cities, which are not prepared for this kind of onslaught, are facing a crisis. All of these have detrimental effects on the quality of life of the citizens and in particular, their health status. While the challenges are in terms of negative impacts to the environment, high cost of living and overcrowded neighborhoods, there are opportunities in that it brings competencies in urban centers and offers conveniences not available in rural areas. Planning for urbanization and better management of cities is important for the quality of life of those living in cities and towns, and also for a better economic and environmental climate as a whole for the country. For sustainable planning in these overcrowded cities, one needs to look closely at the available resources and understand the relationship between urbanization, mobility, energy and sustainability.

The form of urbanization has great influence on transport patterns and energy supply and in turn on the spatial development of cities. Today's urban performance indicators depend on a city's physical infrastructure or "physical capital" and its knowledge, communication, and social infrastructure in the cities, or "social and intellectual capital". The availability and quality of social and intellectual capital along with physical capital plays a decisive role in urban competitiveness. This journal attempts to showcase research which helps in understanding the dynamics of the relationship between the urbanization process and the available intellectual, social and physical capital of cities and in turn evaluate the urban performance of these areas. The topics covered in this journal are highly multidisciplinary advocating excellence in sustainable planning and processes in an urban setup. The journal also covers case studies of the progress made in different cities around the world and in particular Asia.

This inaugural issue addresses urbanization, mobility, energy and sustainability issues and brings out the opportunities and challenges in planning and progress

made in some of these attempts in cities or urban areas. Six papers are presented in this inaugural issue. The issue brings out urbanization issues like planning process, energy, health care, transport and mobility in contrasting geographies — cities in developing countries such as India and developed countries such as Australia, Japan and Germany.

In the first invited paper, Prof. Peter Newman discusses the four stages of planning and progress for sustainable urbanization and talks about the modernism as the guide for infrastructure planning in most modern cities since the 1940's. The paper highlights that the new era will hopefully fulfill the desires set out for the sustainable urbanization. The author brings forth the concept of "fit-for-purpose solutions" for the 21st century which will enable our cities to adjust to these big challenges.

The second paper by Minh-Chau Tran reviews walkability as a component of health-promoting urban planning process. The paper attempts to reconnect urban planning to public health. The article aims to position this issue in a wider interdisciplinary context and to focus on the effects of the built environment on health in order to sort out the relevant features of the built environment on different spatial scales.

The third paper by T. G. Sitharam and Jaya Dhindaw highlights the urbanization process in India and discusses the causes of urbanization and the present status. The authors have identified the impediments of the urbanization process along with advantages and opportunities. The paper in particular focuses on energy and India's dependence on coal and highlights transportation as a key stakeholder in the energy sector. The paper highlights the benefits and challenges of urbanization and the need for low carbon energy in India.

The fourth paper, from Sekhar Somenahalli *et al*., highlights the accessible transportation and mobility issues in the ageing society of Australia. The paper highlights the important policies and laws prevailing in Japan. This paper is based on a recent survey of older South Australians and a series of in-depth discussions conducted with key stakeholders, both in Australia and Japan, by the author. The paper summarizes findings that provide answers and new approaches to the challenges from a policy and legislative perspective.

The fifth paper, presented by Deepak Baindur and Pooja Rao, talks about equity in public transport in India. This paper investigates internal and external factors that led to the steep and recurrent fare increases in the Bangalore city bus services, which are operated by Bangalore Metropolitan Transport Corporation, in the period from 2012–2014. Based on available data, the paper provides insights into transport pricing and associated equity issues. The key findings from this study are that the low-income bus users have adapted to reduce their travel costs through changes in travel behavior, travel pattern and modal shifts.

The sixth and the last paper, from Satya Sai Kumar Jillela and Peter Newman, brings out the innovative value capture for rail transit financing. The authors explain the different methods of value capture (VC) practiced around the world and in India and how it is applied in different projects. This topic is very relevant to financing massive public infrastructure projects such as railways and roadways in developing countries.

RESEARCH ARTICLE

Sustainable urbanization: four stages of infrastructure planning and progress

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Abstract: Urbanization has accelerated in the 20th century. This paper will try to examine the stages we have gone through in this past half century and where we seem to be going on infrastructure planning in this century. It will trace the history of infrastructure planning from the modernist period that began in the 1940's to the postmodernist period from the 1980's, followed by the emerging sustainability period in the early 2000's and now as we face an uncertain future, the disruptive innovation period. The paper emphasizes transport and land use planning along with some consideration of energy, water and waste and uses the dominant planning paradigm of the time to frame the discussion and observe how that has influenced the resulting infrastructure outcomes. Illustrations are used from the author's home town of Perth based on practical experience in the planning system.

Keywords: sustainable urbanization, infrastructure, modernist

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1. Introduction

Urbanization has accelerated in the 20th century so that from 5% of people living in cities in 1900 we reached 50% not long after the end of the century. The current predictions are that there will be 75% of people living in cities across the world in the lifetime of most professionals and planners. This paper will try to examine the stages we have gone through in this past half century and where we seem to be heading on infrastructure planning in this century.

Infrastructure planning is essential for any city. Cities throughout history can be seen to have had planned roads, sewerage and water supply[1]. Without such planning the city is only informal, i.e., a series of slums, and there were many cities with over 80% informal building that have survived, but with great inequities and huge problems correcting their infrastructure[2]. Thus, it is efficient and equitable to plan for infrastructure.

The paper will trace the history of infrastructure planning from the modernist period of the 1940's to the postmodernist period of the 1980's, followed by the emerging sustainability period in the early 2000's and now as we face an uncertain future, the disruptive innovation period. This paper will emphasize transport and land use planning along with some consideration of energy, water and waste. I will use the dominant planning paradigm of the time to frame the discussion and observe how that has influenced the resulting infrastructure outcomes. Examples will be used from around the world, including my home town of Perth, which has been planned from 1833.

2. Phase 1: Modernist — 1940's to 1980's

Modernism is the most dominant planning paradigm of the 20th century. Much has been written on this. My perspective in terms of the practice of planning and infrastructure is that it provided a certainty that was based on a semi-scientific approach and for the first time it separated out functions, especially transport and land use. The Athens Conference of CIAM which was essentially the work of Le Corbusier in the 1930's produced the concept of the Functional City with land use for living, working and recreation, separated from transport as a different function[3]. This set the scene for comprehensive urban planning of the post war period that focused on how to separate out these functions and make each one efficient and sufficient to meet the needs of future urban populations. It is a powerful paradigm that has lasted till this day.

A fundamental tenet of the Modernist city was the commitment to space. No longer did the structures of the industrial city and its tenements hold us back. We could have a 'healthy supply of clean air', a more natural city; the motto of the UK Town and Country Planning Association was 'nothing gained by overcrowding'[4]. But 'crowding' was what defined old cities that had created centuries of urban fabric based around walking and, for the past 100 years, transit fabric with tram-based corridors and railway suburbs that clustered closely around stations. The automobile was now needed if we were going to build space into cities. Thus cars began to be assumed as the basis of access in the new Functional City.

Infrastructure planning thus had to provide the space for the roads that linked the large residential blocks, large industrial sites, large commercial areas and large open spaces for urban hygiene. The great expansion of our cities outwards began and the need to try and clean up the older parts of the city also began as they were not nearly spacious enough and had messy mixed uses, causing many problems. Most of all they were not built around the car so they needed space for roads and parking to enable them to meet their new functional objectives. Car dependence was thus a product of the infrastructure planning for the Functional City. And the old urban fabric of the walking and transit city became something of a play-thing for traffic engineers and transport planners. It was simply a space to be able to join up traffic flows without respect for its historic functions and cultures (Figure 1).

Modernism in general seeks to find 'the one best way' and deliver a manual of how to do this. Thus town planning and infrastructure planning rapidly developed a set of Manuals for delivering the Functional City. These Manuals of Modernism included the following:

- The best way to predict automobile traffic based on the Four Step Model through population and wealth predictions with simple rules for building high capacity roads connecting A to B in as simple a line as possible.
- The best way to separate out land uses and provide for the car based on various semi-scientific Statutory Planning rule books.
- Formulae for creating the best provision of open space as a percentage of any new development.
- Similar engineering models that could predict water, sewerage and solid waste requirements based on population predictions.

The Functional City and its Manuals of Modernism spread across the world like wildfire. Universities began teaching traffic engineering and town planning with all of its pseudoscience. Town Planning legislation enabled the processes to be made legal and the professionals who produced the numbers were treated like the doctors of city growth.

Figure 1. The overpass in Kolkata that collapsed in April 2016. The fact that such a road solution (through the old walking city fabric) could be considered in 2016 shows that the Modernist approach to infrastructure is still alive and well.

My experience of my home town of Perth was to see the suburbs of the 1960's and onwards as though that was the normal way to build a city. The city had a new Metropolitan Regional Plan in 1955 done by one of the world's great modernist planners, Gordon Stephenson. It used all the science of town planning and took the two old walking cities of central Perth and central Fremantle as well as the transit city from the 1890's tram and train suburbs, and grafted on a new automobile city on top of the old urban fabrics. Freeways were drawn up across the city and new suburbs were laid out for the next 50 years of wealthy city growth.

In the 1970's as the first oil crisis struck and the first questions raised by people like Jane Jacobs (1961) in *The Death and Life of Great American Cities*[5], questions arose about the level of scientific basis and truth of these predictive Manuals of Modernism. Personal interests directed me to begin collecting data on cities across the world to observe how well they did with these new freeways and low density sprawling suburbs; data collection has continued to this day[6–8].

The Manuals of Modernism were not just enabling car-dependent land use and infrastructure; they were also creating better areas of open space and better regulated building construction. Perth's regional open space acquisition proceeded rapidly over the past 50 years. The best aspect of this has been the acquisition of all river and beach frontage land which has been a great success story in Perth's Modernist phase of planning. However not all regional open space has been the most ecologically sensitive land, more like the 'land-left-over open space'. That was not seen as an issue in the Functional City model as you just needed ample spaces to ensure the health of people. There was no idea then that spacious car-dependent urban sprawl would be seen today as a major public health problem due to obesity, diabetes and depression, all related to the lack of human walking activity.

3. Phase 2: Postmodernist — 1980's to 2000's

Postmodernism was literally a time of uncertainty about the kind of Modernist Planning that had been unleashed. It was not certain what lay ahead but this movement did not much like what had been let loose on the world's cities.

Many European cities in this period set aside the predictions of the Four Step Model and decided instead to build up their original urban fabric rather than tear down what they had through freeways and road reserves and car parks. In the U.S. the differences between the cities was marked with New York following the Jane Jacobs' philosophy and preventing the great freeway plans of Edwin Moses from bisecting their city, while Los Angeles and Detroit did the opposite and followed the detailed plans laid out by the Manuals of Modernism.

In Canada they did not have the money thrown at their cities like in the U.S. and hence Toronto and Vancouver retained much of their European urbanism while watching with some disdain as their southern neighbors rolled out the bitumen. In Australia, the cities were also very mixed. Adelaide refused to fill in their famous green space around the central city with a freeway as predicted by their Wilbur Smith report. In Perth we were also becoming a bit nervous about our famous modernist Metropolitan Regional Plan. This was the time that the Metropolitan Plan and its departmental processes had taken all the rail reserves out of the original Plan and had begun to set aside massive road reserves for the future. I had a conversation with the head of transport planning in the Department of Planning at that time who told me he had personally removed all the rail reserves and had implemented road widenings on every highway to 6 lanes; there were massive freeways and the interchanges he designed were created using a 50c piece or a 20c piece. All of these were based on the predictions of the Four Step model that showed large road capacity increases would be needed. In particular he said, "Perth will never need a rail system".

In 1979 the State Government closed the Fremantle Railway as it was not going to be needed in the future. Perth was going to be a car city and it would only need a few buses for those who could not drive or could not afford a car. Moreover it needed a freeway down through the western suburbs as predicted by the model and the best place to put it was along the railway line.

Something seemed very wrong to me. However, I was not trained to observe the beauty in the Plan or to foresee the science in the road capacity predictions. It seemed improper as an academic in environmental science studying oil vulnerability in cities, and it seemed wrong as a Fremantle City Councilor trying to look after the old walking city fabric of Fremantle and the old rail corridor that had created the western suburbs — all threatened by asphalt. In particular it seemed wrong when the price of oil quadrupled in the second global oil crisis and the world entered a global

geopolitical future where oil and car dependence suddenly was not so certain.

My uncertainty was shared. The public reacted to the plan as it had been progressed with huge concern that we were taking a wrong path. The State Government was thrown out in 1983 and a new era began that tried to patch together a new plan. A new study was done that showed it was not economics that had closed the rail line so a plan to electrify the system was put in place and not long after a plan was done to take the rail line deep into the car-based suburbs to the north. These suburbs were the products of Stephenson's Plan and the Manuals of Modernism. But they were failing. Employment was not going into the dispersed suburbs so everyone funneled into the Mitchell Freeway each morning and home again in the late afternoon and very quickly it had filled.

The politics of the car-based suburbs drove the State Government to build a 'railway to nowhere'. How could a railway to the northern suburbs ever work when all the models showed that people with wealth would only use a car? But it did work. People moved onto the railway in much larger numbers than any expert or model had predicted. Then by the early 2000's it was the turn of the southern suburbs to request their share of urban rail. It was good politics so it was committed to but it didn't fit the models, the theories or the manuals.

As part of the Postmodernist era the question was raised whether we were overdoing it with our roads. My colleague Jeff Kenworthy was asked to conduct the Road Reserves Review for the State Government; he observed that road reserve spaces set aside across the metropolitan region were equal to around 90 square kilometers[9]. A vigorous case was made to keep these spaces, just in case. But the party was largely over and very few new big roads were planned until a recent phase of Federal Government funded projects created a sudden return to modernism.

There was indeed a halt to several of the major road projects — a freeway beside the river and through the middle of Fremantle were rejected in the ballot box and removed from further consideration. Similar responses were happening across the world's developed cities[7]. The loss of urban fabric and natural environment in these road projects seemed to have been forgotten in the rush to provide scientifically-based solutions to growing car populations. They were excised from urban plans despite the cries of the purists who believed in the inherent truth from the universal truth of the Four Step Model.

We produced two books at that time as we found it hard to understand what was going on and needed to find numbers on how different cities were handling this phenomenon of car-based planning. Both were based on the concept of 'automobile dependence', a concept that we had created to try and comprehend the nature of this problem[6,7]. The concept was based on quantitative data comparing 30 to 40 cities around the world in their transport and land use patterns and used examples of cities that were standing up to this Modernist force. The concept is now used by nearly every city in the world (including Perth) as they all try to address the multiple issues surrounding too much car use in cities. But this did not mean a halt at the momentum of the Modernist city program; current views showed that there was not a good handle on the type of city needed and certainly the Manuals of Modernism were not replaced, though the cities tended to go a bit more underground on their plans.

How could cities find a way through the conflict between Modernism and Postmodernism in their infrastructure planning?

4. Phase 3: Emerging Sustainability — 2000's to Today

The next phase of planning led to the greater definition of the type of city that urban residents wanted: a more sustainable city. The Postmodern era had left a vacuum and the Bruntland Commission filled this. A global conflict had developed between the forces of progress (often labeled the economists but mostly pushing the Modernist view of the world) and the forces trying to stop progress (often labeled the environmentalists but really those who were Postmodern), the UN Commission on Environment and Development (1987) resolved this conflict by saying that there is a need for development but it must be sustainable development[10]. It was no longer possible to do what the forces of Modernism wanted nor could you just stop everything, thus there is a need to reinvent the future differently. A new planning paradigm began to emerge.

However, this sustainability concept was not clear in what exactly needs to be done and certainly there were no manuals to follow. Everyone proceeded to develop strategies and try to see how the environmental and social aspects of development that had been neglected by the Manuals of Modernism could now be re-invented or rehabilitated. The processes of planning

became convoluted as the Manuals of Modernism predicted what was needed and then the structures of local, state and national governments had to try and consider how social and environmental factors could be used to modify the plans.

What did this mean for cities? What did this mean for planning and infrastructure? Cities, states and nations began trying to find a new way of development and it was not easy. I wrote my first paper on planning for sustainable development at a Royal Australian Planning Institute Conference in 1993 and the book *Sustainability and Cities* in 1999, but translating this into mainstream planning had to wait until the 21st century when cities and higher levels of government began producing more substantial planning documents. In western Australia, I was asked to produce the State Sustainability Strategy[11] and this gave me an opportunity to see how a different set of manuals could indeed still create wealth but did not neglect social and environmental well-being.

Clearly sustainability demanded a much greater recognition of:

- the local community and the urban fabric that had grown around it,
- the value of the natural environment, and
- the importance of reducing our reliance on fossil fuels and other resources like water.

Around the world cities began to grapple with these concepts and some found a new consensus emerging that the city could still grow, indeed it must, but it had to do much better at reducing car dependence and the urban sprawl that was intertwined with this. Cities in North America such as Portland and Vancouver, in Europe such as Freiburg and Copenhagen, and in Asia such as Singapore and Hong Kong, began to develop a new set of Sustainable Urbanization Manuals[7,12–14].

Cities began to see the value in their old urban fabrics with the need to redevelop back in and create much better quality public transport, walking and cycling in their cities. The public responses to planning insisted that planners now had to do something about place-making in special places, and had to try and control urban sprawl. The ideas were there but could they be delivered?

For many cities the ideas of Sustainable Urbanization were highlighted by the need to integrate transport and land use rather than allowing modernist urban scatter. Many cities tried experiments in integrating transport and infrastructure but usually failed, such as the attempt in Perth where a new Department of Planning and Infrastructure was created but did not last more than a few years. The experiment failed as the top-down policy of integration was always agreed to but the bottom-up did not. They knew what they should do but the Manuals of Modernism remained firmly in place on both sides. And so the juggernaut of car dependent sprawl continued.

Water is a different story, though it had its origins in the same modernism from the 1940's. Without going into details, the water profession has generally found an easier transition to Sustainable Urbanization. In Perth the water story was quite dramatic; in 2001 it did not rain at all. The State Government went into crisis mode and set up a cross-government approach to saving water and looking at better alternatives. The Water Manuals did not have much to offer as constraints on resources were not part of the Modernist view of the world. But all kinds of conservation measures (and then seawater desalination technology) were found to work and since then the Water Manuals have large sections on reducing, reusing and recycling.

Solid waste has had a similar Modernist work-over though perhaps not as spectacular as the water success story[15]. However, every now and then a crisis due to land constraints for landfill undermines the progress based on previous assumptions. Energy for power also began to be seen as something that could involve much less waste and much more local and renewable sources[7,8,13].

Infrastructure planning in most areas was not quite so certain anymore and was beginning to emerge within a sustainability paradigm. However the Modernist Manuals for transport and land use have largely remained in place throughout this period though the first signs of change have begun to be observed. Throughout the world's developed cities, three things began to happen simultaneously: car use peaked and declined, public transport, cycling and walking began growing dramatically; and cities began to come back in faster than they were going out[8,16]. The causes of these changes were multiple and include the following:

- Economic factors relating to the value of dense centers for the new knowledge economy jobs that need people to meet face-to-face,
- Urban regeneration becoming a greater force than urban sprawl with associated exponential declines in car use as densities increased,
- The new smart phones and tablets that enabled people to keep in contact with friends and work

colleagues at any time and place and which work least best while driving, and
- The culture of urbanism found to be so desired by the young and wealthy.

The Manuals of Modernism do not understand such trends or their causes. Wealth has always been coupled with car ownership and use, larger houses and suburban bliss. The demand for a more urban and less suburban city is now being embraced by people in ways that Modernism could never have done.

But how mainstream is it becoming?

5. Phase 4: Disruptive Innovation — Present Day to Immediate Future

The notion of Disruptive Innovation was first espoused by Clayton Christensen at Harvard Business School in 1995[17–19]. He suggested that innovation did not have to be seen as a top-down process of technologies that were invented to cleverly and rationally replace those of the previous era. He suggested that innovation came instead from demand by people who saw an innovation and found it met their needs better than the mainstream market could see and began to purchase the innovation, despite it being seen as more expensive by those in control. Soon the innovation flips the whole system into a new way of providing services and the economy is mainstreamed with a new way of doing things.

Examples are given by Christensen of the 3.5-inch disk which was preferred over the 5.5-inch disk for memory storage despite it being more expensive per unit of memory. However the 3.5-inch disk was cheap enough and more convenient and eventually gave rise to the notebook computer, a major system change. The mainstream provider of the 5.5-inch disks went under — this is called the Kodak Effect.

The application of Disruptive Innovation to cities is only just being attempted, such as those highlighted by Seba (2014)[20], but I believe it may provide us with a much better insight into how our cities are likely to unfold and how the Manuals of Modernism will finally be rewritten. Let me apply this to energy and to transport/land use.

Energy is rapidly moving towards the use of renewables, especially solar photovoltaics (PVs) on roof tops. In Perth the city has now 550 MW of PV on household rooftops, which is the size of a large coal-fired power station. These PVs are mostly on the larger but poorer houses in the outer suburbs[21]. For most utilities facing this transition the temptation is to first deny it is happening as solar is known to be more expensive. But people keep buying it because they have lower bills so it seems cheaper, starting a niche market that rapidly grows. Already the signs of an emerging system flip are showing and yet we are still not preparing for it[21].

Utility engineers and the politicians they advise are still using the Modernist Manual which explains how a centralized power system works in an attempt to try to make solar fit. And it will not work. They need to construct a new Manual that enables a more distributed and participatory energy system to emerge[22]. This system will continue to have a grid but it will have many more localized systems run by communities, industries and local governments; it will be based on smart control systems and battery storage and will eventually be 100% free of fossil fuels. This will be well in place by 2030 and will be unstoppable unless the Manuals of Modernism are applied as a fundamentalist set of rules.

The same will happen in our cities as they phase out oil and large-scale car dependence including the asphalt-oriented Manuals. The disruptive innovations of urban rail, especially light rail, and their associations with local walking and cycling within a dense urban center in a series of linked centers is the city of the future being imagined in most cities[8]. The light rail phenomenon continues unabated in US cities where in ten years patronage increased 190%, heavy rail 53% and buses decreased 3%, during the era of peak car use. Across all the world's cities the emergence of urban rail as a faster option than cars stuck in traffic has now been quantified: urban rail in the past decade is now on average more than 20% faster than traffic and in some cities 50% faster[8].

In China there are 81 cities building or completed metro rail systems and in India there are over 50 cities building metros. Throughout the Middle East and Africa, as well as the emerging cities of Latin America, urban rail is the preferred option as they can outrun the terrible traffic congestion.

In Perth this is very clear with the new rail systems to the north and south which average over 90 km/h and have top speeds of 130 km/h, going straight past the freeway 'car parks' at peak time[23]. Nothing in the Modernist Manuals and the Four Step Plan would have predicted this.

Urban rail is disruptive because it is generally more capital intensive than buses and most transport planners who use the Manuals think that buses should be

just as effective. But buses are not competitive with urban rail quality and rail capacity is significantly higher and when provided immediately attracts the kind of land use intensities that cities are trying to attract. This is the system change that urban rail induces; it brings people back in to more crowded and less spacious locations because that is where they want to be. This new system keeps young talent in the city and the urban economy thrives without the need for cars (and oil). Exponential declines in car use happen when centers are built around a corridor of rail. Urban rail is now growing dramatically across developed cities and emerging cities as a result.

In Beijing the first signs of a peak in car use can now be seen (Figure 2). Similar trends are likely across all of the world's emerging cities and further undermine the Manuals of Modernism that are still in use.

The future direction of cities that are following the trend away from car dependence is to be more polycentric based around quality electric rail. Perth has such a plan[24]. The polycentric, smart city of the future, with its focused land use and integrated transit-oriented development, is nothing like the Modernist Functional City with its commitment to endless space and car dependence. It will be:

- high density and mixed in its rediscovered and rehabilitated walking city fabric (not just in the CBD),
- medium density in its transit city fabric along corridors dominated by fast urban rail and accessible to all in the surrounding areas, and
- low density in the adjacent car-based suburbs (but with electric vehicles run by solar homes) where intensive use of renewables and other community-based technologies will be creating small local economies.

Driving this change will be the mainstreaming process that replaces the Manuals of Modernism:

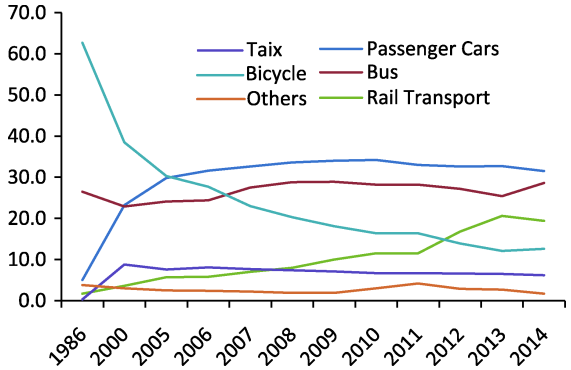

Figure 2. The peaking of car use in Beijing. This is likely to be the future in all similar emerging cities.

- The Four Step model will be replaced by a model that shows how the three urban fabrics of the walking city, the transit city and the automobile city will have their own regulations and performance criteria, with significantly less car use in the first two fabrics and modified requirements for space in the automobile city fabric.
- The Statutory Planning models will all be changed to reflect these three urban fabrics and their different requirements for density, mix and car dependence. As automobile city fabric begins to be redeveloped (already happening in the 1950's and 1960's suburbs), there will be a new set of regulations that can enable more walking city fabric in centers and more transit city fabric in corridors to enable the polycentric city.
- The open space plans will both respect the important natural features of an urban area and enable the kind of amenity that is necessary for each community and the density of their activity. In walking city areas the need for intimate urban parks and bigger footpaths will be more important than the need for some regulated percentage of open space.
- The water, energy and waste plans will have predictive power based on reducing, reusing and recycling as well as new smart, renewable technologies that fit into each area of the city differently.
- The consultants and models that are able to create Fit-For-Purpose solutions, as suggested above, will be responding to the Disruptive Innovations of the 21st century and enable our cities to adjust to these big changes.

6. Conclusion

The Manuals of Modernism have been the guide for infrastructure planning in most modern cities, since the 1940's. These Manuals have survived the era of Postmodernism and the era of Emerging Sustainability. They are unlikely to survive the era of Disruptive Innovation as the trends opposing their models are running heavily against them.

The new era will hopefully fulfill the desires set out for Sustainable Urbanization with a strong emphasis on outcomes. It will have a new set of manuals to guide the future of cities. The Manual for Transport could be called 'Fit-for-Purpose Transport Planning' and the Manual for Statutory Planning could be called 'Fit-for-Purpose Planning'. The first is hopefully

going to be much bigger than the second.

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RESEARCH ARTICLE

Healthy cities — walkability as a component of health-promoting urban planning and design

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Abstract: Health impairments due to inactivity are related to the car-oriented urban development of recent decades, along with sedentary lifestyles. A health-maintaining environment must therefore not only reduce direct health risk factors (pathogenic concept), but also contribute to health chances that may indirectly support health (salutogenic concept). Walking has been identified as the most influenceable behavior; it is also the most environmental-friendly mode of transport, social and health. From the planning view, the concept of walkability therefore aims at a built environment facilitating physical activity. It is increasingly recognized that walkability has become an important topic in the field of planning, urban design and health, since the built environment affects certain behaviors. From practice, concrete guidance is demanded as to the type of urban design features to be captured or applied to evaluate the walkability or to create active cities. The measurement of features of the built environment plays a special role in this context, but also the question of how research results can reach policies as well as planning and building practice.

Keywords: health-promotion, urban design, urban planning, built environment, walkability, physical activity

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1. Introduction — Reconnecting Urban Planning and Public Health

The rapid increase of people living in cities will be among the most important global health issues of the 21st century[1]. Though in developed countries, as well as in many developing countries, the standard of living and economic prosperity are increasing compared to the past, it is not always and necessarily going hand in hand with the "quality of life" and health of the population. Improved urban supply and disposal systems, as well as living conditions, have led to health enhancement of the urban population. This — in combination with the progress in different sectors such as health care, hygiene, nutrition and working conditions — resulted in an increase of life expectation. This surely might be a merit of the traditionally close collaboration between the professions of urban planning and public health with the common goal of reducing harmful impacts of industrialization and urbanization.

According to the planning ideology of the car oriented city in the 1960s, urban spaces have since then been created with negative impact on health. At the same time the close connection between both professions broke off. Public health concentrated on individual biomedical factors. Urban planning lost sight of its original mission of tackling the health problems of the least well-off and merely focused on spatial and functional structures[2]. Health experts have now identified new primary health risks and adverse health effects that are closely connected to car-oriented urban development in recent decades[3]. Yet, still many parts of the world currently follow the traditional car friend-

ly city model with separation of functions and sprawl, ignoring human scale and resulting in oversized roads for motorized individual traffic. Since in many countries development and modernity are still associated with technology, external financing favors large construction projects such as urban highways, elevated pedestrian pathways or skyways[4] (Figure 1).

This has resulted in unhealthy living environments due to congestion, noise emissions, street fatalities, increase of CO_2 and global greenhouse gases, and at the same time support unsustainable, inactive lifestyles and inequity in street use. In cities of northern China, levels of the most dangerous particulates reach almost 50 times of the maximum limits stipulated by the World Health Organization[5]. As a result, there has been a shift from primarily infectious diseases to more non-communicable chronic diseases such as cardiovascular disease, diabetes or neurological disorders[6]. There is also a lack of social interactions in cities that evidently increases mortality risk significantly[7]. Moreover, a continuous increase of obesity around the world within the last decades is associated with the built environment[8,9]. This is not only observed in Western countries but also in China, Vietnam or India[10]. "Yet health policies in most rapidly urbanizing countries remain dominated by disease-focused solutions that ignore the social and physical environment. As a result, health problems persist, and health inequities have increased"[1]. From an individual point of view, health development leads apart from reduced life span to reduced quality of life. From a social point of view, it is the high financial burden of the health care system, which leads to growing research in this field.

Because negative health developments still proceed in many developing countries which run parallel to urbanization processes, even though with a time lag compared to developed countries, the challenges, effects and health outcomes worldwide are expected to be comparable in spite of differences in spatial scale and size. However, the strategies and policies to tackle these health issues are different due to culture and mentality.

The causes for health and illnesses cannot be explained on an individual level anymore. Rather, it is found that health occurs as an interaction between individual, social and built environment. Individual measures alone are not sufficient to allow urban population to lead a healthy lifestyle. Rather, fundamental environmental changes are necessary in order to permanently establish healthy behavior for all[11]. A health-maintaining environment must therefore not only reduce direct health risk factors such as noise and particular matter (pathogenic concept), but also contribute to health chances that may indirectly promote healthy behavior (salutogenic concept) on which the

Figure 1. Car-oriented urban development in Shanghai (Source: Alexander Schmidt)

focus of this article is explained here. The health promoting city not only stays an issue for the health sector but is also part of the mission statement of a sustainable urban development.

This article primarily deals with the concept of walkability and outlines an overview of the walkability research. Based on current studies, it is exemplified by the type of features of the built environment, the level of walkability that can be identified, the challenges of creating activity-friendly cities and neighborhoods, and approach of the research results that are able to satisfy the policy as well as planning and urban design practices.

2. Conceptual Issues – Health-Related Factors in Urban Planning

A comprehensive understanding of urban structure, design of spaces and city planning processes as critical determinants of population health is crucial[12]. On World Health Day 2010, the World Health Organization recommended the following five calls to action to build a healthy and safe urban environment: (i) promote urban planning for healthy behaviors and safety, (ii) improve urban living conditions, (iii) ensure participatory urban governance, (iv) build inclusive cities that are accessible and age-friendly, and (v) make urban areas resilient to emergencies and disasters[13]. To address the lack of a conceptual framework for integrating health into spatial planning decisions, Barton[14] developed a conceptual model of settlements that places human health and well-being at its heart (Figure 2). The model combines an ecosystem analysis expressing the relationship between people and their environment with a public health approach, which identifies the relevant social and environmental determinants of health. This does not include heredity factors since the focus of this health map is on the social and environmental determinants of health[14].

Regarding the effects of the built environment on health, numerous evidence-based findings exist[16,17]. For example, individual behavior and lifestyle are affected by the presence, safety and quality of routes and uses, by the density and structure of cities, and by the distances to certain destinations. Broader environmental conditions, including air, water, soil and climate, are affected by planning policy and can even be critical to health in some contexts[18]. A study lead by WHO identified twelve health objectives for planning, related to equity, exercise, social cohesion, housing, work, accessibility, food, safety, air quality,

Figure 2. Health map. Own illustration based on Barton[14] developed from the model by Dahlgren and Whitehead[15].

water, earth and climate[19]. This provides an agenda for analyzing health impacts. A holistic approach for health promoting urban planning should ideally consider all of these factors and at the same time integrate their interrelations.

Since this article represents the urban design perspective, further focus lies on the sphere of the built environment[20]. The built environment of a city incorporates not only buildings, streets, squares, and green spaces as well as urban planning features like land use, density, infrastructures and transportation systems, but also urban structures and urban form.

3. From Car-oriented to Health-promoting Active Cities and Neighborhoods

It has been proved that health derives from the interaction between the individual and its social and built environment[19,21]. Car-oriented urban spaces increasingly impede daily physical activity, coincidently with our modern inactive lifestyles. The lack of green open spaces, for sojourn and physical activity and safe traffic areas for environmental-friendly local mobility negatively affects the health and quality of life of city dwellers. This results from a minimum of daily walks[22]. In many countries 80% of adults do not achieve the recommended level of activity of 150 minutes of exercise a week[23]. Correlations between the lack of exercise and a high risk, for example, of developing cardiovascular disease and cancer, are well known[24]. Lack of physical activity is the developed world's fourth largest risk of death after smoking, high blood

pressure and overweight/obesity[25].

Walking has been identified as the movement behavior that can be influenced most easily and is also the most common and simplest form of physical activity. It is increasingly recognized that the pedestrian is not only an important object of traffic planning and that walking is more than just another form of mobility; it is also a human behavior and thus has internationally become an important topic in the field of urban planning, urban design, mobility and health, since the built environment affects behavior[26]. Recently, more and more interdisciplinary research is dealing with interrelations among activity-friendly urban spaces and long-term benefits for society[21]. At the same time, the readiness to develop new forms of mobility and the reclaiming of urban spaces for pedestrians and cyclists seem to give additional impetus to this trend (Figure 3).

3.1 Walkability — More than Just Walking Friendly

The concept of walkability pursues a holistic approach and aims at an environment encouraging active living taking into account different spatial levels (macro and micro levels). Generally, walkability describes the level of pedestrian-friendly urban structures and spaces motivated and promoted active mobility[27,28]. Design recommendations is not limited to using individual measures such as the improvement of traffic lights or speed limits, because it is not only about security for pedestrian traffic, but at the same time about the creation of urbanity, identification and quality of life through activity-friendly public urban spaces.

People who live in a pedestrian-friendly designed environment participate much more in social life and have greater confidence in their environment. That proved a significant gain in “social capital” and thus a better quality of life[29]. To date, we speak of walkability and its different dimensions[30] (Figure 4). Against this backdrop walkability is understood as a comprehensive approach for a livable sustainable city and does not only mean walk-friendliness.

3.2 Walkability Research — A Multidisciplinary Field

Walkability as a research field was first initiated in public health from concerns about the constantly rising obesity rates worldwide. Since the 1990's multidisciplinary walkability research has accumulated, namely of the Health Sciences as well as the traffic planning and later also of urban planning, especially in English-speaking countries[9,31]. The idea of walking to be facilitated by good planning and urban design is also not new in many countries, e.g. in Germany[32–34]. Although overall awareness of the importance of health in the last three decades has grown in the field of urban planning, walking basically seemed to play a minor role as a mode of transport in planning. Because today in developing countries there is supposedly no direct acute health hazard emanating from the built environment compared to the industrialization phase, “urban planning can apparently (...) only broach health problems as design problems (...) where health is objectified, measurable and generalizable”[35].

Walkability research in the fields of traffic planning and health science is therefore focusing strongly on the measurable extent or likelihood of walking in relation to different environmental characteristics based on analysis models[36,37]. Measuring walking behavior serves to inform policy and planning and to evaluate its impact[38]. An increased interest in research on an international level was very promising, reinforced by

Figure 3. Car-oriented street space versus people-oriented street space. (Source: Institute of City Planning and Urban Design)

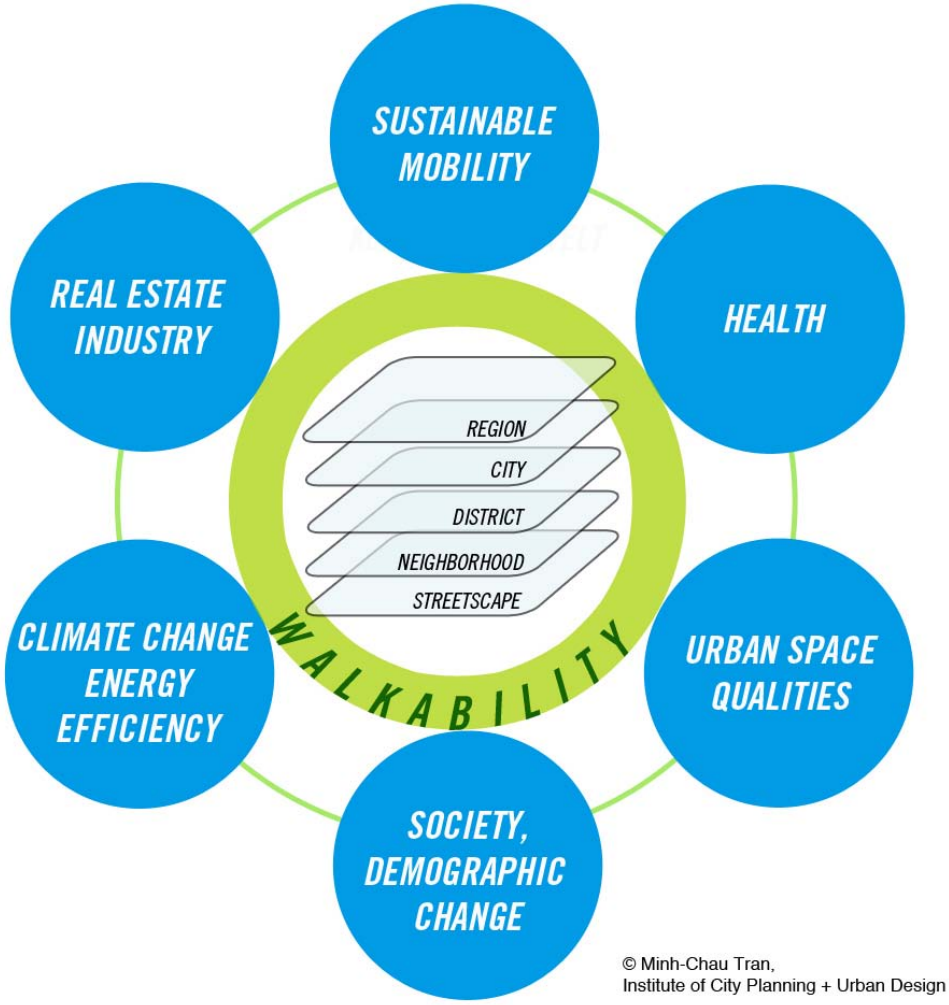

Figure 4. The dimensions of walkability. (Source: Institute of City Planning and Urban Design)

new evaluation methods and technologies[38]. This research showed, for example, interrelations between population density, connectivity, mixed use and walk frequency[9].

These results underpin empirical studies in objectively measurable ways. However, they fall short as urban walking areas are too complex for quantifications. Walking does not comprise only purpose-oriented utilitarian walking, but allowed the utmost spontaneity and communication of all types of mobility.

Therefore, in the field of urban design there are studies that examine the measurable and qualitative characteristics on site[39]. Here, subjective qualities such as human scale, transparency and linking street spaces are measured with the objective to establish operational definitions for measuring urban design qualities of these spaces. These qualities are closely linked to basic urban principles that were formulated in various senior key publications in the fields of architecture and urban design, and are still valid to this day[25,40–42]. By observational studies they deal primarily with the influences of urban space on behavior patterns and social activities in order to better understand the use of public spaces.

Finally, the consideration of objectively measured environmental characteristics and the subjective perception of the environment are essential for a more comprehensive understanding of walkability.

3.3 Balance Matters — Urban Design Characteristics to Evaluate Walkability and for the Planning of Walkable Neighborhoods

Despite the increase in evidence-based knowledge and the desire to actively intervene with the help of study results for a change in urban planning policies and practices, there seem to be a lack of clarity about the urban features needed in the weighting to promote active behaviors. Urban planners and policymakers

call for clear instructions from research regarding principal urban design features that promote health and healthy behavior, such as walking[43]. In addition, it was often unclear about the appropriate methods that should be selected or are present to capture these characteristics best. There are a number of different methods to measure the characteristics of the built environment. This can be divided into three categories: (i) interviews or questionnaires that capture primarily perceptions, (ii) methods that collect (existing) data, often by using geographic information system (GIS) analysis, and (iii) systematic observations or audit tools[37,44].

The Five "D"s

Empirically proven criteria for walkability are the five "D"s: Density, Diversity, Design, Destination accessibility, Distance to transit[39,45] (Table 1).

The five "D"s have the greatest impact when they act together. It therefore requires a balance of residential use, jobs, services and facilities in the vicinity of public transport stops and within walking radii and a fitting of all these elements in a fine-grained urban environment and in a cityscape that improves walking experience on street scale[39,45]. In relation to large-scale, car-oriented urban structures in the United States or Australia the density and diversity of European towns and cities have considerable potential to promote small-scale mobility in everyday life. Their structures and designs can serve as best examples.

4. Case Study on Neighborhood Scale Linking Built Environments with Health Effects

The current case study presented exemplifies a method applied on neighborhood scale about the connection of built environment features and health effects that could be assessed and evaluated.

This recent study by Sallis and colleagues[46] aimed at proving the evidence about the connection of built environments and moderate to intense physical activity by studying different built environments across 14 cities in ten middle-income and high-income countries. It was the largest study so far. Through linking objectively measured physical activity with objectively measured built environment features, it was observed that urban environmental factors account for large differences in the physical activity levels of adults.

The analyses were based on the International Physical Activity and Environment Network (IPEN) adult study and included 6822 adults aged 18–66 years. Neighborhoods divided into four different stratification groups were identified in order to maximize variation in neighborhood walkability and socioeconomic status (SES): (i) Higher walkability and higher SES, (ii) higher walkability and lower SES, (iii) lower walkability and higher SES, and (iv) lower walkability

Table 1. Overview of the five "D"s, the associated indicators and possible methods of measurement. (Source: Compiled on the basis of Ewing/Cervero (2010)[39], Campoli (2012)[45])

Criterion	Indicator	Method
Density	**Degree of density, e.g., population, housing units or jobs per hectare or km^2** As a measure, which is applicable to many of the characteristics of the built environment, density describes the intensity of a specific element or an activity.	e.g., GIS analysis
Diversity	**Level of diversity in land use and thus of people and places (Land use mix)** Diversity, or the mix of uses, creates a dense texture of destinations. A good mix of uses as to how residents can find more everyday products and services in their neighborhoods, and do not need to travel by car. The degree of diversity, or how many uses co-exist in one location and how close they are to each other, is crucial.	e.g., GIS analysis
Design	**Presence and design of streets, walking and cycling paths as well as interconnecting streets** To lower vehicle miles traveled (VMT) two strategies are important here: The network of streets (connectivity) in order to shorten travel distances, and creating pedestrian- and cycle-friendly roads to improve the quality of the journey. Intersection density has been identified as one of the most important indicator of the built environment for reducing VMT. Among the "D" variables street design is most difficult to measure due to complexity. It includes, for example, road and sidewalk width, safe crossing opportunities, street accompanying trees, shelter at bus stops and first floor design.	e.g., GIS analysis, on-site assessment by walk audits and checklists, interviews, surveys
Destination accessibility	**Distance or duration to key destinations of daily supply** The accessibility of destinations, or how close places are located to destinations people go to most regularly, is most strongly associated with reduced VMT. This variable may be measured by the distance to a central business district, the supply center or by how many jobs or attractions are within a three-minute drive or a fifteen-minute walk	e.g., GIS analysis, test walks
Distance to transit	**Distance from the starting point to the nearest public transport stop** Distance to transit, or public transit accessibility, is the key to attract more passengers. A dense network of routes and stops will ensure that public transport users have no long distances to travel to or from stops.	e.g., GIS analysis, testing, on-site assessment

and lower SES. The level of walkability was defined by using the neighborhood walkability index score. This included the variables of net residential density, intersection density and mixed land use developed within a geographic information system.

Physical activity was measured by using electronic accelerometers that recorded motion every minute, which is a valid and accepted method. Participants completed a survey and wore the accelerometers for 4 to 7 days around the waist, except during sleep, swimming and showering. Study dates ranged from 2002 to 2011 across countries.

Built environment variables were created with GIS software. Buffers around each participant's home within 0.5 km and 1 km, reachable by the street network, were defined to estimate accessible neighborhood features. The comparable variables used were: net residential density, street intersection density, retail and civic land use ratio to buffer area, public transport density, public park density and distance to nearest transport.

Statistical analysis was carried out to link environmental variables and physical activity (min/day) by implementing generalized additive mixed models. Four variables showed significant positive association with higher physical activity levels: higher residential density; higher number of intersection accessible to pedestrians; higher density of public transport; and more parks within walking distance (0.5 km) that were free and open to all. Mixed use was surprisingly not related to physical activity though this factor is one of the more consistent correlates of physical activity. This is explained by the lack of small scale data and the limitations of GIS measures where the data were based on a number of parcels of land, not on a number of shops or offices which might be more strongly related to use frequency and thus higher activity level.

Further results showed that adults living in walkable neighborhoods were 68–89 min/week more physically active than those in the least activity-friendly neighborhoods. This shows that built environments are able to assist residents to achieve 45%–59% of the recommended 150 min/week[23]. This study showed "clear evidence for the role of the built environment in enhancing physical activity levels for entire populations, across socioeconomic classes and cultures, and thereby preventing non-communicable disease."[47]

5. How to Build Places that Facilitate Active Mobility in Everyday Life?

An important goal is to have these evidence-based research results embedded into planning and design practice. The objective of planning science in this field is, *inter alia*, to identify those characteristics and urban design configurations that prompt the decision to move actively and that influence the perception of pedestrians, and to operationalize them for the planning and urban design practice. Besides raising awareness for this topic, other necessary steps include identification and assembling of stakeholders and alliance partners, planning/projection, implementation and operation.

5.1 Methods to Obtain Addressee-focused Arguments

The challenge, among other things, is to convincingly point out the link between, on the one hand certain urban design and open space configurations, and on the other hand the actual impact on health-promoting behaviors and further social gains. In this policy, the following requirement plays a crucial role: "To what extent the growing social importance of health can be reflected in urban planning itself, (...) ultimately probably depends on whether the health aspect receives political support from local decision-making bodies." [48]

Urban planners and policy makers themselves have pointed out that much practical evidence is required to evaluate the effectiveness of existing planning policy[43,49]. Therefore, one of the next steps could be to develop metrics to evaluate "success", also economically, to address other parties such as investors, future residents and public representatives who make financial decisions, "What is the value added by designing for health? (…) – does it include enhanced productivity, longer lives, lower health care expenditures, more robust tax bases?" [17]

5.2 Awareness of Walkability Through Appropriate Participation Formats

At the same time, the question was crucial, as to determine whether the abstract results of these measurements can be applied in the concrete building design practice and whether the needs of different population groups can be considered. The difficult task of building physical activity, such as walking, into people's daily lives, is therefore likely to require innovative participation and communication formats and the appropriate tools in the future. Therefore, not only the aspect of spatial and building design, but also the common design of spatial processes with the local people on site is crucial to create health-promoting cities within the meaning of the Toronto Charter

(2010)[50]: "Make the healthy choice the easy choice!" Political education is a prerequisite when it comes to mobilizing planning and policy on the one hand and the people on the other for implementing health-promoting construction measures. The first step is to raise awareness among the participants and stakeholders for this topic.

5.3 Walk Audits, Temporary Urban Interventions and "Natural Experiments"

A powerful tool for raising awareness is systematic on-site assessments (walk audits), guided by an auditor, for example, an expert from the urban planning field, so that elaborated suggestions for improvement are adapted to the individual conditions of each area. There are walk audit tools consisting of checklists, questionnaire tools or computer-assisted audit techniques. A new set of digital tools for collecting data of the built environment and linking it with measured people's health outcomes as a reaction to certain urban situations offers new possibilities; specially designed apps on mobile phones and biosensors allowed for recording participants' movements and measuring their excitement, interest, and levels of stress, locating and visualizing them in a map such as in the experiments conducted by Ellard and Montgomery in New York, Berlin and Mumbai.[51]

Urban temporary intervention in public space is another instrument of procedural urban development seen as part of planning and participation processes. This could give impetus to possible long-term health-promoting behavioral change. Temporary street closures for automobiles, for example, can appear as a test and preliminary step to future project opportunities, how streets can be designed to be more pedestrian-friendly and thus inviting the people to reside (Figure 5). With relatively few resources conditions can be created for more security and social participation in public space. People can perceive, feel and live their new space. Temporary conversions can activate streets and present local retail and community facilities. Through this process there will be a direct feedback from the users, and the effectiveness of the measures can be examined. In practice, these temporary changes have often given impetus to a permanent transformation: What had initially been regarded as an experiment by the city was rebuilt into a permanent solution following a positive evaluation. This method could meet "long-standing calls for 'natural experiments' in research."[17]

Windows of opportunities should be recognized and utilized by these ideas as be linked to existing initiatives or urban redevelopment projects. Thus, this provides a specific opportunity for research to carry out "natural experiments" to evaluate before and after effects concerning health impacts, even if transport policy or structural changes are not primarily aimed at changing health behavior. These pre- and post-evaluations provide valuable information, which typical cross-sectional studies are unable to provide.

6. Conclusion

Apparently it is a worldwide phenomenon that planning and urban development are not committed enough to health issues but still to the automobile and to urban mobility, which is dealt in a highly sectoral way and not considering social and health implications. In the end, for all sectors dealing with the planning and design of health-promoting cities and neighborhoods it is a matter of pursuing the common goal of reducing health threatening conditions, promoting human health, and at the same time increasing the

Figure 5. Urban intervention "Urban Living Room" in Essen — before / after. (Source: Institute of City Planning and Urban Design)

quality of life for urban population. Cooperative research approaches based on findings in urban planning, urban design, transport planning, health sciences and socio-spatial research represent an important step in the efforts of creating healthier and more livable cities and neighborhoods.

But for those research findings to reach those in practice, who plan, design and build our cities, neighborhoods and street spaces, appropriate investment and communication formats and other support as by urban sociologists, educators and communication scientists are required. Strategic measures beyond mere changes in the built environment may also call for educational campaigns in public health, the exchange of information about health promoting urban planning as also the use of new media, changes in legal requirements, the encouragement of public dialogue and creating opportunities for participation and co-deliberation.

After 60 years of implementing the concept of a car-friendly city, it is time to return to a health-promoting and human oriented city. Facing energy shortages and social justice, it is important to apply a human scale in order to create healthy living and working conditions for all.

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RESEARCH ARTICLE

Benefits and challenges of urbanization and low carbon energy needs in India

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Abstract: Urbanization has occurred rapidly in India principally due to social, economic and political drivers and has offered improved quality of life, access to amenities and economic opportunities for many. However, this has been accompanied by challenges that include insufficient energy, lack of urban infrastructure, and poor delivery of basic services, resulting in undesirable environmental impacts, congestion, and urban sprawl. India's urbanization has placed tremendous demand on the country's resources. Providing energy to all while maintaining a low carbon footprint is a global priority. Although economic development is anchored by both urbanization and industrialization, urbanization itself is a major determinant of energy use, including energy use related to transportation. Deficiencies in urban planning and management have to be overcome if India's urban environment is to meet the rising expectations of an expanding urban population and provide an environment consistent with rapid, inclusive and sustainable growth. India's energy demand in 2030 is likely to be double that of current demand. Achieving a greener future in a sustainable way with low energy costs can be addressed by measures such as preferential policies towards renewables, investment in technology and empowerment of local government to meet the low carbon energy needs in India.

Keywords: urbanization, low carbon energy, transportation, technology, renewable energy, sustainable

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1. Urbanization in India

1.1 The Story so Far

The phenomenon of 'urbanization' or population shift from rural to urban areas is occurring at an unprecedented rate in India. According to the 1901 Census, the population residing in urban areas in India was 11.4%. This count steadily increased post-independence and crossed the projections in the 2011 Census to reach a staggering 31.2%[1,2]. With 12.5 million people, Mumbai (Figure 1) was the largest metropolis by population in India, followed by Delhi

Figure 1. Urbanization's physical manifestation in Mumbai, India (http://www.iaacblog.com).

with 11 million inhabitants. With the fastest rate of urbanization in the world, as per the 2011 Census, Delhi's population increased by 4.1%, Mumbai's by 3.1% and Kolkata's by 2% when compared to the 2001 Census. At these growth rates, by 2015, the population of Mumbai will stand at 25 million, that of Delhi and Kolkata at 16 million each, while that of Chennai, Bangalore and Hyderabad at 10 million[3]. According to a 2007 State of the World Population survey report by the United Nations, 40.8% of India's population is expected to reside in urban areas by the year 2030. In absolute terms, this means that the country's urban population will increase from 340 million to nearly 600 million in the next 15 years. As per McKinsey Global Institute's report[4], India will have 68 cities with a population of more than 1 million, 13 cities with more than 4 million and 6 megacities with 10 million or more people. Also, at least 5 states will be more than 50% urbanized with Mumbai and Delhi figuring among the top 5 largest cities in the world. Moreover, cities development will account for 75% of the national Gross Domestic Product.

However, to put this into perspective, this proportion of urban population is much lower than the current level of other emerging market countries, for instance, China (48% urban population), Mexico (78% urban population), South Korea (83% population) and Brazil (87% urban population)[5]. Census 2011 lists 7,935 towns (urban areas) in India, a count that has increased by 2,774 since the 2001 Census. Many of these towns are part of urban agglomerations, in which, it is a part of two or more physically contiguous towns or a town with a minimum population of 20,000 along with its outgrowths, while the rest are independent urban areas.

Urbanization in India has kept pace with India's economic growth which accelerated close to 8% per annum in the 2001–2011 decade, compared with 5.5% in the previous two decades[5]. Recently, India's Finance Ministry said that the country's economic growth could accelerate to as much as 8.5% in the coming fiscal year, which could make it the world's fastest-growing large economy. Nonetheless, this growth over a relatively short period has not only led to an improvement in overall wealth but also caused deficiencies in energy, urban infrastructure and service delivery leading to environmental degradation, congestion and urban sprawl.

1.2 Causes of Urbanization — How did we Arrive Here?

So, what has caused such a drastic change in the demographic scenario of the country over the last decades? Research and analysis shows that the principal underlying causes of urbanization in India are social, economic and politically driven.

Economic:

- Industrialization and the resultant expansion in employment opportunities.
- Economic and educational opportunities along with better standard of living.
- Access to technology and better infrastructure facilities in the urban areas.
- Growth of the private sector after the year of 1990.
- Development of transit and transport infrastructure aiding movement and migration.

Social:

- The continuing influx and migration of people post-partition of India.
- The attraction for cities and its perceived status and comfort.
- Increase in birth rates in urban areas.

Political:

- Important urban centers are de facto political capitals/seat of government.
- Expansion in government services and infrastructure.
- Eleventh five-year plan that promoted urbanization for the economic development of India.

1.3 Consequences of Urbanization — What are we Faced with?

The rapid rise in urban population in India has resulted in several unforeseen or unplanned consequences such as the increase in slums, poor standard of living, increase in air pollution, urban sprawl and traffic demand, and environmental degradation along with demand for rising income and comfortable living. There are also the classical problems arising from an unmanaged and sudden unintended population increase such as unemployment, change in family and social structures and increase in crime rates. Under such scenarios, it is inevitable that cities unprepared for this kind of onslaught are facing a crisis, all of which has a detrimental effect on the quality of life of the citizens, thus, perpetuating a vicious cycle.

2. Impediments of Urbanization — the Challenges

As India attempts to achieve faster and more efficient

growth, it is indisputable that cities have and will continue to play an important role as the engines of its economic growth. India's urbanization, which is similar to other developing countries, has indeed placed tremendous demand on the country's resources and is not without its share of challenges (Figure 2).

The main challenges are as follows:

- Deficit in urban infrastructure and poor service delivery — including drinking water, waste water treatment, solid waste management, affordable housing, food security and public transport; all of which have the greatest impact on the lower-income urban population.
- Pollution from industries and vehicles that have an impact on the health of all urban dwellers and the resultant investment required to combat illnesses.
- Investment climate is adversely affected by the absence of planned urbanization.
- High cost of living and increase in the number of urban poor as the cities are not inclusive — this in turn leads to a rise in slums or overcrowded neighborhoods with poor sanitary conditions and lack of basic infrastructural facilities.
- No growth boundaries or master plans — lack of detailed, enforceable planning. Land use planning is irrational and the existing plans do not have proper implementation.
- Outdated governance structures that do not encourage capacity building and self-governance
- Social isolation along with the physical form of urban areas leading to high crime rates.
- Negative impacts on environment — water bodies, public spaces, air quality, green spaces and increased energy consumption.
- Difficulty in meeting the mobility needs of the urban population through mass public transport leading to shift towards private modes (Figure 3).

3. Advantages of Urbanization — the Opportunities

Despite challenges, urbanization has several benefits especially if it is occurring in a planned environment with foreseeable outcomes. The opportunities it presents are as follows:

- It brings in competencies as people migrate from rural to urban areas — it creates employment opportunities in urban centers and offers conveniences that are unavailable in rural areas.
- Brings in efficiency in land utilization and service delivery functions — it involves lesser per capita cost and effort in providing basic services like water supply and electricity.
- Provides access to amenities, resources and facilities that are not easily available in rural areas —access to education, research, health, social services and cultural activities is much more readily available.
- Increases the standard of living compared to that in the rural areas.

Figure 2. The challenges presented by urbanization.

Figure 3. Impact of urbanization on transportation.

- Fosters economic growth and growth in trade and tourism — urban areas act as hubs of investments, high-tech industries and sharing of natural resources
- Provides an environment for social integration — whereby people of various backgrounds, groups, religions and income categories live and work together
- Act as knowledge hubs — providing the resources needed to train and develop human resources, so that people may exchange ideas and pursue careers of their choice, thereby improving their economic conditions
- Provide access to transit and transport networks at reduced costs including overhauling the efficiency of railways to move people and goods.

Therefore, planning for urbanization and better management of the cities is not only important for the quality of life for those living in our cities and towns, but also because it contributes to a better economic and environmental climate for the country as a whole.

4. From the Energy Standpoint

According to United Nations, cities account for nearly 75% of global energy consumption and 80% of greenhouse gas (GHG) emissions. In 2030, GHG emissions in Indian cities could increase to 1.6 billion tons (CO_2 equivalent) from 230 million tons in 2005. This amounts to 1.1 tons per capita and represents GHG emissions from transport, buildings, public areas and city design.

Heating, ventilation and air conditioning are gradually making way into India in a big way to ensure comfort and create a pleasant environment for people, besides improving the air quality of the spaces. However, it consumes large quantities of energy produced in the country. To put it into perspective, the energy consumption in India is the fourth largest after China, USA and Russia[6]. As of 2013, in India, the total primary energy consumption from various sources was as follows: crude oil 29.45%, natural gas 7.7%, coal 54.5%, nuclear energy 1.26%, hydroelectricity 2.0%, while wind power, biomass electricity and solar power is 595 metric ton of oil equivalent (Mtoe).

That year, India's net imports were nearly 144.3 million tons of crude oil, 16 Mtoe of liquefied natural gas (LNG) and 95 Mtoe coal, totaling to 255.3 Mtoe of primary energy which was equal to 42.9% of total

primary energy consumption. About 70% of India's electricity generation capacity is from fossil fuels, with coal accounting for 40%[7,8]. This means that despite having huge coal reserves, India is largely dependent on fossil fuel imports to meet its energy demands. By 2030, India's dependence on energy imports is expected to exceed 53% of the country's total energy consumption.

5. Transportation as a Key Stakeholder in the Energy Sector

Urban areas typically have high concentrations of people and economic activity which in turn causes high levels of movement of people and goods, thereby having an impact on the energy use of transport and its GHG emissions. With an estimated 40% contribution to emissions, vehicle ownership, vehicle use (number of trips and trip distances), modal split and fuel economy are the major determinants of road energy use[9]. Thus, urbanization increases not only the quantity of passengers and goods but also the distances over which these passengers and goods are carried. Urbanization increases transport energy use in three ways: firstly, it facilitates economic specialization and labor division which in turn increases the movement of goods, secondly, food needs to be transported from outside the urban areas in order to feed the urban population, further increasing the use of fuel-powered modes, and thirdly, residences and workplaces are often segregated and separated in urban settings leading to longer commutes, thus encouraging the use of fuel-powered faster transportation modes. Although economic development is anchored by both urbanization and industrialization, urbanization by itself is a major determinant of energy use. Although production efficiencies may be achieved, it is often at the cost of energy use for external factors such as transportation. Thus, in urban areas, activities which traditionally used manual labor move to the use of energy-intensive modern technologies. Amongst these, personal transportation remains the largest source of change in energy use. As wealth increases, people migrate to personal modes of transport, thus tilting the scales in favor of fuel-powered modes in cities. However, to tilt this balance back, rail-based mass transportation systems like metros, suburban commuter rails and bus rapid transport systems need to be promoted in order to increase the efficiency of the fuel usage. A major source of carbon emissions are direct emissions from vehicles, thereby making transportation a key player in energy consumption.

6. The Need for Clean Energy/Transportation Fuels

"The low-carbon economy envisions a better quality of life enabled by economic and technological innovation along with reduced natural resource consumption and pollution." — UK Energy White Paper[10]

Given the above facts, the recent global environmental focus is evidently on minimizing the human-inflicted carbon footprint by reducing or even eliminating the use of nonrenewable energy resources. In 2003, the UK government issued the 'UK Energy White Paper: Our Energy Future — Creating a Low Carbon Economy', which first proposed the low carbon economy concept[10]. In the white paper, low carbon economy is defined as one in which 'society creates higher standards of living and a better quality of life through improved economic output underpinned by advanced technological innovation and new business and job opportunities, while at the same time reducing natural resource consumption and environmental pollution'. Achieving a greener future in a sustainable way with low power costs is expected to be addressed by measures like the replacement of fossil fuels with clean energy, energy conservation and use of energy efficient systems, processes and equipment.

The ever increasing numbers of vehicles and fuel requirement has compelled the research on alternative sources of transportation fuels in recent decades. This has led to the emergence of many potential alternatives such as biodiesel, methanol, ethanol, butanol, dimethylether, diethylether, bioethanol, synthetic natural gas (SNG), Fischer–Tropsch diesels hydrogen, straight vegetable oils (SVO), hydro-treated vegetable oil (HVO), F-T diesel and hydrogen[11]. Over time, many techniques and methods have been developed and still continue to be developed for betterment in terms of yield, economic cost and sustainability. It is becoming more important to study the feasibility of substitution of crude oil/petroleum with alternative fuels, which are available or can be produced locally on a substantial scale for commercial utilization. While several alternative derived fuels present potential, the relative high cost in comparison to petroleum presents a major obstacle in their widespread use. Thus, these alternative fuels need to be further explored and production technologies have to be upgr-

aded in order to meet the fuel quality requirement as well as economic feasibility.

On other viable renewable energy sources, India has a tremendous locational advantage to consider solar energy as a powerful alternative to conventional sources. Recent investment pushes in large solar projects, solar parks, microgrids and solar rooftops are being backed by heavy investments and policy frameworks. Net metering, whereby solar photovoltaic system owners can sell excess solar energy to the utility company or buy deficit energy from the utility company using a meter to track this energy exchange, has been implemented in several states in India such as Karnataka, West Bengal, Andhra Pradesh and Maharashtra. Similarly wind power has been making huge strides towards becoming a significant contributor to the distributed energy systems. With the 5th largest installed wind power capacity in the world, it presents in several states and is already contributing to nearly 2% of the national power needs[12]. High capital costs and land intensive installation are some of the barriers to this technology. Although endowed with economic viability in India, hydro power is yet another energy source that has not been fully exploited to its potential of about 1.5 Lac MW (150,000 MW)[13]. This is primarily because of ecological concerns apart from the non-reliability of this source in case of droughts and other environmental externalities.

Re-thinking on the energy sources and fuels is as important as equitable and smart mobility systems as part of smart cities to combat the negative impacts of urbanization. The demand for petroleum-based fuels has seen a sharp rise due to the ever increasing automation and motorization worldwide. The future availability of the various energy sources and its environmental impact will determine the sustainability and advancement of our global future. As per research, fossil fuels contribute to nearly 80% of the global energy consumption, of which around 58% is expended by the transport sector alone[11]. Therefore, meeting the energy needs of our population in a sustainable manner and reduction in emissions is the mainstay of the research on energy and urbanization.

7. The Role of Coal in Addressing Energy Needs

In terms of resources, India has the world's 4th largest coal reserves and it is the bulk of primary energy contributor with over 50% share. However, as per data from 2013, India ranks 5th in global coal production at 228 Mtoe (5.9%) when its inferior quality coal tonnage is converted into tons of oil equivalent[6]. Accounting for 59% of India's installed electricity capacity, coal-fired power plants are also used for cement and steel production in substantial quantity[14].

The retail prices of petrol and diesel are relatively high in India to make electricity (derived primarily from coal) driven vehicles more economical. Gasification of coal or lignite produces syngas or coal gas which is a mixture of hydrogen, carbon monoxide and carbon dioxide gases. Coal gas can be converted into SNG by using Fischer–Tropsch process at low pressure and high temperature. Coal gas can also be produced by underground coal gasification where the coal deposits are located deep in the ground making it uneconomical to mine. However, compressed natural gas (CNG) and LNG are economical alternatives to diesel oil only when there is an escalation in international crude oil prices. Under such a scenario, synthetic natural gas production technologies have tremendous scope to meet the transport sector requirements by fully utilizing the locally available coal in India. For example, Dankuni Coal Complex is producing syngas which is piped to the industrial users in Calcutta. Many coal-based fertilizer plants which are non-functional can also be retrofitted economically to produce SNG as LNG and CNG fetched good price by substituting imports. Another hugely potential alternative is the clean coal technology development which refines coal and unloads the carbon so as to reduce emissions greatly which addresses the air-quality issues related to coal-burning. However, the environmental mitigation of risks associated with carbon capture and storage intrinsic to this process has still not developed to the extent to make it viable for mass utilization.

Under the current scenario, there are a few limitations to making coal the centralized mainstay in addressing the energy demand in India.

- It is a non-renewable energy source.
- Burning coal emits harmful products and GHG's which may lead to acid rains and other environmental threats.
- Clean coal and coal conversion to liquid or gas is an expensive technology which needs further improvements to make it viable.
- Current coal mining techniques can damage the landscape and have an impact on local ecology.
- Transporting coal is cost-intensive and can also cause additional pollution in the form of emissions from transportation vehicles (e.g., trucks, rail).

- The mining industry presents health and safety issues for miners.
- Current power plants do not have the capacity to handle loads needed to meet demand.

8. What Next? The Way Forward

So, how can we optimize energy consumption and emissions from the country's urban centers? Well-managed urbanization can reduce the demand for energy and thereby reduce emissions. Careful planning of city transport needs is particularly important as urbanization gathers momentum and cities have to cope with rising internal transport needs. These have to be met in a manner that economizes on energy and also avoids congestion and pollution, all of which depends upon an effective public transport system. Thus, in the transport sector, energy consumption can be checked to a great extent by promoting safe, low cost mass transportation systems both rail- and road-based in urban areas. It requires close cooperation among different government departments and to make use of carefully designed systems of taxes and cross subsidies to encourage the right kind of transport development.

Higher pollution tax on coal and a big push towards renewable energy sources are the present government's formula for powering cleaner economic growth. To this end, the Government of India plans to set up five new ultra-mega power projects, each consisting of 4000 MW in the 'plug-and-play' mode and the same information was announced on February 28, 2015 while presenting the General Budget for 2015–2016. In the domain of energy, a target of 175,000 MW renewable energy capacity by 2022 would help India's roadmap to cut its carbon footprint. India attempts to reduce its greenhouse gas emissions by doubling of green cess on coal, funding investment in renewable sources and clean coal technology for power plants. Solar power will take the lion's share of the renewable energy target at 100000 MW, followed by 60000 MW of wind energy, 10000 MW of biomass and 5000 MW of small hydro projects up to 25 MW each. India also envisages increasing the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9% within 25 years[15]. Natural gas is yet another fuel that can contribute to the energy needs complementing and supplementing the other energy sources mentioned here. Although natural gas is a non-renewable source of energy, it is cleaner than petroleum and is present in large reserves in India; making it an attractive alternative. Therefore, research and development of these energy sources need to be pursued and the efforts need to be supported and promoted at the state and municipal levels.

In the domestic sector, energy use can be reduced and optimized by adopting technologies and processes to promote green architecture and city design. Design of buildings should be aimed at reducing the impact of the built environment on human health and natural environment. National and international rating systems such as GRIHA and LEED have been developed to promote sustainable design through system efficiencies leading to minimal or zero off-site discharge. Integration of land use and transportation is an essential component of urban planning which leads to efficiencies of place-making and energy consumption and should be a priority in all planning-related policies and decisions. The Indian government has made ambitious public commitments to both sustainable energy and urban development. It has already announced its plans to build 100 smart cities across the country by 2024 in a collaborative public-private partnership.

Given that 35.5% of the population still lives without access to electricity supply, the approach towards addressing the energy demand needs to be multi-pronged[16]. Coal, which is the mainstay of the local product, needs to be explored as a clean 'Made in India' technology. Investments into clean coal should be encouraged and leveraged to understand and address the ease of use, its adoptability by user and viability for mass production, subsequently optimizing the current set-up and investing into new ones as well. Further, going forward, India's policy should be to incentivize research and development of clean and renewable energy sources such as solar, wind, hydro and nuclear power.

9. From a Policy Standpoint

Rather than an insurmountable challenge, India should view urbanization as an opportunity to save energy and reduce emissions. Additionally the following policies should be adopted and implemented to reduce energy consumption:

- Frame preferential policies and provide more financial subsidies to develop new and renewable energy. For example, in order to ensure environmental security, the government should promote the innovation, research and development of decentralized wind power and rooftop solar.

- Existing major resources such as coal should be developed in capacity in parallel so as to reduce emissions. More than lip-service funding must be provided for the same situations.
- In order to accelerate the extensive application of highly resource-efficient and environmentally sound technologies in urban areas, the government should promote technological innovation and capital flow through policy incentives and financial support such as intelligent transportation systems, promoting energy-efficient vehicles for mass transport, improvement in road conditions and proper road management systems. In addition, the government should encourage implementing financial subsidies and preferential tax policies, such as a consumer savings based model in mass transit.
- Rail transport needs to be overhauled with new technologies to optimally utilize the existing resources in developing advanced and efficient rail systems to move people and goods in the urban areas, whereas the surrounding suburban areas need to be developed.
- Recognizing that industrial production will continue to play a big role in urbanization, the government should fund and support the application of technologies that save the energy consumption in production. In addition, the government should introduce energy-efficiency indicators and regulations to enforce and monitor business' energy consumption behavior.
- Focus on sustainable urbanization through devolution of power to local government so as to enable better environmental legislation which is enforceable. For example, any policy aiming to curb the impact of urbanization on energy demand must address its associated externalities of urban sprawl and automobile dependency.
- Energy research results in a lot of public good such as economic competitiveness, national security, and environmental protection that private markets do not care much about. Thus, Government of India should focus and embrace energy research in a big way to look for alternative new sources of pollution free, inexhaustible energy including solar, wind and low energy nuclear reactions (LENR) with a view towards distributed energy generation plans.

Higher quality of life is realized in tandem with policies that reduce the demand on resources. Deficiencies in urban planning and management have to be overcome if India's urban environment is to meet the rising expectations of an expanding urban population and provide an urban environment consistent with rapid, inclusive and sustainable growth. If cities are to grow and provide an impetus for growth, they need to attract investment — and to do so; the cities must compete with each other in terms of the quality of the urban environment it provides. India's energy demand in 2030 is likely to be doubled that of current demand. The role of advanced engineering and innovative technologies will increase significantly in coming years for harnessing renewable energy and to make transformation of low carbon energy to a more sustainable economy. The likely growth trends in major non-renewable energy sources like coal and renewable feed stocks are highlighted in Figure 4. The population of vehicles on Indian roads will be more than 300 million by 2030. Priority should therefore be given to the making of road and rail transport systems in India with more energy efficient and less dependent on fossil fuels. Hence, urban energy planning and urbanization management will become future challenges of paramount importance in order to create the right framework conditions for a sustainable energy in future.

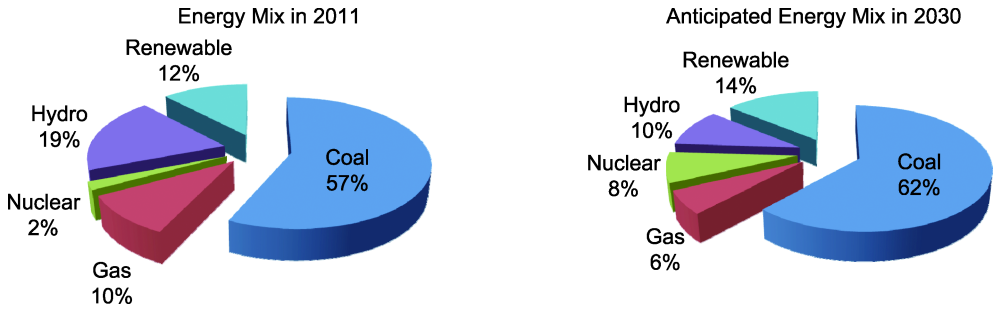

Figure 4. Anticipated energy mix for power generation in India (2011–2030).
Source: Indian National Academy of Engineering report 2015

"Deficiencies in urban planning and management have to be overcome if India's urban environment is to meet the rising expectations of an expanding urban population and provide an urban environment consistent with rapid, inclusive, and sustainable growth." — Isher Judge Ahluwalia (Chair, Indian Council for Research on International Economic Relations)

Conflict of Interest and Funding

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RESEARCH ARTICLE

Accessible transportation and mobility issues of elderly — how does Australia compare with Japan?

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Abstract: Accessible transportation is a key aspect of independent living. As the impact of population ageing on future transport systems is expected to be increasingly felt over the next few decades in a number of countries, including Australia and Japan, it is logical to recognise the importance of formulating appropriate transport policies in ageing societies. However, few studies in Australia have focussed on this issue as most of them have been devoted to the physical dimensions of health. This paper is based on a recent survey of older South Australians and a series of in-depth discussions conducted with key stakeholders both in Australia and Japan, conducted by the principal author. This paper highlights the accessible transportation and mobility issues in Australia's ageing society by shedding light on some of the important policies and laws prevailing in Japan, which have already reached the proportion of the older population that Australia is projected to be 10 years from now. Our findings would provide answers and new approaches into the challenges from a policy and legislative perspective to help formulate recommendations for the stakeholders.

Keywords: ageing, universal design, transport polices, mobility scooter usage issues, driving licence issues of elderly

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1. Introduction

It is well documented that the absolute number and share of older people are on the significant increase in developed countries[1–5]. There is also evidence that mobility declines with increasing age[1,3]. In this context, it is important to examine the issues relating to accessible transportation and mobility needs of an ageing society. Accessible transportation is a key aspect of independent living. Accessible transportation includes public transport services and terminals, personal vehicles and road infrastructures especially pedestrian infrastructures. A majority of older Australians prefer to live independently with their spouse or alone, rather than to live with other people[6]. Older people who live with others, either family members, a

spouse or in a care facility are more likely to have support networks to assist with daily living such as shopping, cooking, personal care, mobility and transport. However, for the older person (especially females) living alone, life can be even more challenging especially if reliable support networks are not in place and if the person experiences health and mobility limitations. If their transport mobility needs are not adequately met by transport services, they will become socially excluded. Older people's transport needs are diverse and treating all persons over 65 years as one homogeneous group is also not appropriate. As the impact of population ageing on future transport systems is expected to be increasingly felt over the next few decades in a number of countries including Australia and Japan, it is logical to recognise the importance of formulating appropriate transport policies in ageing societies.

This paper is based on a recent survey of older South Australians and a series of in-depth discussions conducted with key stakeholders both in Australia and Japan, conducted by the principal author. This paper highlights the accessible transportation and mobility issues in the ageing society of Australia by shedding light on some of the important policies and laws prevailing in Japan, which have already reached the proportion of the older population that Australia is projected to be 10 years from now. Japan was selected because it has demographics and ageing trends similar or more acute to those in Australia and has strong traffic safety records. Moreover, both countries are highly developed and have a long life expectancy[7]. Our findings would provide answers and new approaches into the challenges from a policy and legislative perspective to help formulate recommendations for the stakeholders.

2. Universal Design

2.1 Universal Design Issues — Australia

Although the concept of universal design emerged mainly with people with disabilities in mind, universal design helps everyone with support and assistance including the elderly, pregnant women, children and people with a temporary illness or injury[8]. Until recently, transport planners have focussed on the ageing and transport issues in terms of social equity dimension; however, the current argument is that this issue has wider ramifications, especially the role of transport on health and overall quality of life in an ageing society is an important one[9]. Nevertheless, few studies in Australia have focussed on this issue as most of them have been devoted to the physical dimensions of health. In Australia, urban transport is a state and territory responsibility although Australian Government policies do affect the level and pattern of urban travel demand[10]. Infrastructure Australia is a national body assisting governments to develop a strategic blueprint for unlocking infrastructure bottlenecks and modernising the nation's economic infrastructure. Austroads, the Association of Australian and New Zealand road transport and traffic authority, functions much like the American Association of State Highway and Transportation Officials (AASHTO) in the USA. In general, Australia has followed the Federal Highway Administration (FHWA) model very closely on handbook and training course development paired with changes in existing standards to better address the specific needs of older road users[11]. The Australian transport policy framework is not specifically targeted to senior citizens. In relation to the disability access framework, Australia (and South Australia) has formulated Acts, Policies and Strategies, Plans, Standards and Guidelines, both at national and state levels. However, there is no data relating to the progress of implementation of the framework.

The *Disability Discrimination Act 1992* (DDA) is part of the package of federal anti-discrimination laws providing protection for everyone in Australia against discrimination based on disability. Disability Standards for Accessible Public Transport have been prepared under the *Disability Discrimination Act 1992* to specify rights and responsibilities about equal access and the opportunity to use public transport for people with a disability[12]. These were the first Disability Standards to be introduced in Australia[13]. Traffic Engineering Standards such as the Austroads Guidelines and the Australian Standards have not been given the force of law under the DDA except where they are specifically referenced by the Disability Standards for Accessible Public Transport (DSAPT). However, one main issue is that compliance is not enforced unless a complaint is made. Transport Standards has a 30-year implementation timetable; however, the progress so far is an uneven and a piecemeal approach rather than a wholesale implementation.

There are a number of other issues with regards to the implementation of transport standards including (i) the lack of baseline data on public transport patronage usage by people with disabilities, (ii) the extent to which rail infrastructure in the States and Territories is

accessible is not fully satisfactory — as per the ACG report[13], less than 40% of railway stations all the states are fully compliant, and (iii) reporting on accessibility and compliance is the responsibility of state governments, without any uniform national framework being in place.

2.2 Universal Design Issues — Japan

The Ministry of Land, Infrastructure, and Transport (MLIT) is responsible at the national level for making transport policies and coordinating other agencies in implementing them. Japan has a unitary system of government in which local jurisdictions are largely financially dependent on the national government. At the local level, metropolitan districts, urban prefectures and rural prefectures serve mainly as an extension arm of the national government. In contrast, Australia has a federal system of states and territories and administration is more decentralised. However, for any national projects implemented at the local area, the national government is still involved in implementation.

In Japan's ageing society, for people to continue enjoying happiness throughout their lives, the national government enacted 'The Basic Law on Measures for the Aging Society' (Law No.129, 1995). This law is designed to promote, in a comprehensive manner, measures to appropriately deal with the ageing society. As per this law, the national government has the duty to enact and implement comprehensive measures for an ageing society which conform to the basic objective states in a number of articles of this law. In the year 2000, the 'The Transportation Accessibility Improvement Law' was enacted to promote easy accessibility to public transportation for the aged and the disabled. This law promotes barrier-free facilities in train stations, bus terminals, ferry terminals, airport passenger terminals, trains, buses, ferries, and aircraft. The law sets progress targets to be achieved within a decade of its implementation including removal of barriers from terminal stations and vehicles. It also stipulated that municipalities should formulate fundamental policies for barrier-free facilities and ensure that areas around railway stations are accessible to all. The Transportation Accessibility Improvement Law 2000 and "Heart Building Law" (Haato biruhou) were combined into one new law in 2006[14]. This new law aims to achieve comprehensive development for accessible buildings and transport amongst other facilities. This law (revised in 2011) now stipulates that any passenger station which serves 3000 people or more per day should implement barrier-free designs.

The measures in Japan included spatial planning around the passenger terminals, and this approach is not seen in Australia. The Japanese Ministry of Construction has specified minimum sidewalk widths, path gradients, and height of the sidewalks for barrier-free access. For example, they have changed the minimum width of sidewalks from 1.5 to 2.0 metres to allow two wheelchair users to cross in front of each other. They have also changed the downhill gradient of sidewalks to roadways from 8% to 5% and the standard height of sidewalks from roadways from 150 mm to 50 mm, as per the new law. The ministry has initiated a project to install escalators or elevators. It covers all train stations with more than 5000 users a day and staircases that are five metres or greater in height. The cost is being shared equally by the national government, local governments, and railway companies[15]. The penalties proposed in this law offer momentum for the introduction of barrier-free facilities in public transport systems[16]. The accessibility standards, similar to the Disabilities Act standards in Australia also serve the needs of older road users by specifying kerb heights, tactile markings, and sidewalk widths to aid older people with mobility limitations. Many prefectures and municipalities have enacted the 'Welfare City Planning Ordinances'. Bus companies have adopted lift-equipped and low-floored buses, and the central government enacted a guideline for installing elevators in railway stations[15]. Japan is also making widespread use of text messages and symbols in pavement markings. Good progress is being made with respect to achieving barrier-free facilities. For example, there are about 9500 railway stations in Japan and out of those, 2800 key stations are being used by 5000 passengers or more per day. Currently, 85% of these stations are barrier free. Similarly, more than 90% of bus terminals have barrier-free facilities, 97% of the key railway stations and 86% of key bus terminals are equipped with tactile guide blocks. Japan has also developed Universal Design (UD) taxis and it is estimated that 28 000 UD taxis will be needed in Japan by 2020. Similar targets are in place for ferries and aircraft.

3. Mobility Scooters

3.1 Mobility Scooter Issues — Australia

A mobility scooter is a mobility aid equivalent to a

wheelchair but configured like a motor scooter and is usually battery powered. Mobility scooters (or 'gophers', as colloquially known in South Australia) or buggies are a convenient alternative way to travel to shops or around the community for people with walking difficulties[17]. They are increasingly popular among older Australians[18,19]. The *Australian Road Rules* states that a person using a mobility scooter is classed as a pedestrian and the maximum speed on level ground cannot exceed 10 km/h. Riders do not need a driver's licence and they must observe the same road rules that apply to pedestrians and must not travel along a road if there is a footpath or verge area adjacent to the road. However, at many instances, mobility scooters are known to be used on road pavements which are unsafe. Moreover, some mobility scooters have low ground clearance which can make it difficult travelling in some suburbs without proper kerb cuts. Of the Australian states and territories, only Queensland requires registration of mobility scooters[20] and riders need a medical certificate to prove that the scooter is for mobility purposes. The scooter also needs to be inspected before use in Queensland but not in other states[21].

The South Australian Motor Accident Commission provides third party bodily injury insurance for claims involving incidents that occur on the road or footpath where the rider of the mobility scooter was at fault. However, this insurance is not mandatory. Due to concerns over safety issues and problems with bringing prosecutions against irresponsible users under existing laws, there is an on-going debate in Australia to consider whether to make third party insurance mandatory, consider the introduction of compulsory training for users and discuss how to bring scooter users under wider road traffic legislation. Australia's first national survey of mobility scooter users[22] reported that mobility scooter users cannot be characterised just as elderly road users with over 50% of scooter users aged less than 60 years. Another surprising finding from this survey is that a large proportion of scooter users live in rural areas, which has ramifications regarding training, safety and servicing of these vehicles. Although there are no crash records involving mobility scooters for all of Australia, Figure 1 depicts the situation in Adelaide, which has a population of 1.2 million people. Though currently the situation is not alarming, in the next 10 years it will be similar to Japan.

3.2 Mobility Scooters Issues — Japan

In Japan, the aged services community view mobility scooters as an important alternative form of transportation to retain personal mobility. There are nearly half a million mobility scooters recorded at the point of shipment with around 15 000 vehicles added annually. The specifications for mobility scooters are defined in Japan Industrial Standards (JIS) T9208, established in 2009[23]. The maximum allowed speed for mobility scooters is 6 km/h and is treated as equivalent to a pedestrian (as in Australia) and hence are not allowed to ply on roads. There are two types of categories; namely, type 1 and type 2. Type 1 can pass through a 1.2 m right angle passage without counter steering whereas type 2 can pass through a 1 m passage. People can take both types of mobility scooters on most trains; provided the train station can accommodate them, i.e., having adequate facilities such as elevators. However, the Shinkansen bullet trains, which have passenger cabins separated from the entrance space for getting on and off, will only allow type 2 mobile scooters due to limited space of the entranceway.

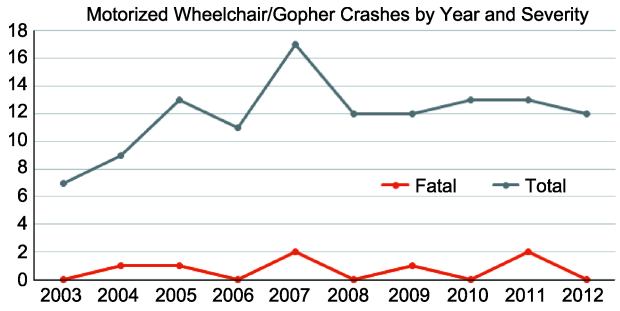

Figure 1. Reported motor scooter accidents in Adelaide, South Australia.

The long-term care insurance policies helped older people to acquire any assisted devices. Long term care insurance is a system in which society as a whole supports people and their families who are faced with a situation in which someone needs long-term care. Under this system, all residents who are 40 years old and older pay an insurance premium. In order to use a service provided by the long-term care insurance, residents have to apply for a certification that they require long-term care or support. Based on the decision by the Long-term Care Approval Board, the applicant will be judged either unqualified (self-reliant), some support required or long-term care required.

In accordance with the provisions of the Japanese Consumer Safety Act and the Consumer Product Safety Act, mobility scooter accidents are reported to the Consumer Agencies. Figure 2 shows the reported accidents from 2003 to 2007. It is important to note

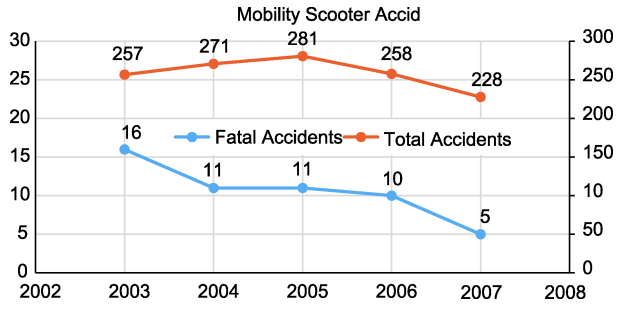

Figure 2. Reported motor scooter accidents in Japan (Source: The Association for Technical Aids Guide).

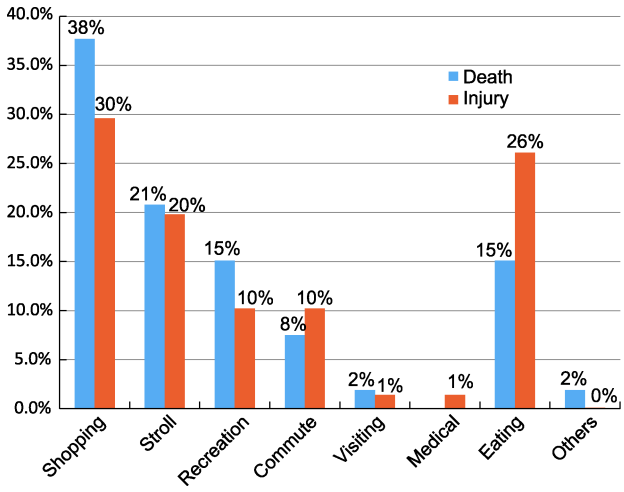

Figure 3. Purpose of the trips among motor scooter accidents (Source: The Association for Technical Aids Guide).

that the total number of accidents and fatal accidents involving mobility scooters is on a gradual decline. The reasons for this are not fully clear, but it could be due to the change in laws regarding long term care insurance policy that were implemented in 2001, i.e., the mandatory requirement for potential buyers to get a certificate from the care manager for renting such devices might have resulted in lower sales and thus lower numbers of accidents.

It is also clear from Figure 3 below that a significant percentage of mobility scooter accidents occur while on shopping trips. This guide also reported that most of the fatal accidents (73.6%) occur at intersections.

The National Institute of Technology and Evaluation reported that 75% of mobility scooter accidents in Japan were caused by incorrect operation or negligence by the drivers[23]. It also reported that accidents can be prevented if proper training and awareness is inculcated among the users, especially new riders. There are some programs initiated by the Japanese police for safe use of electric wheelchairs and mobility scooters by promoting traffic safety education but few people have participated in these training programs.

Another important issue relating to the accidents is that new riders, i.e., those who are using mobility scooters for less than a year, accounted for 40% of the accidents[24] as they are not familiar with the usage of the vehicle. As shown in Figure 4, there are around 4.8 million people requiring long term care, a significant percentage of whom are female especially in the over 80 age group. Even with some regulations in place, the demand for mobility assistance devices will continue to grow and accordingly efforts should be made to register them and also in building safer mobility scooters. There are some efforts in this direction[23] to develop mobility scooters with automatic deceleration using laser scanners to improve its operation and safety without reducing the convenience. Such systems

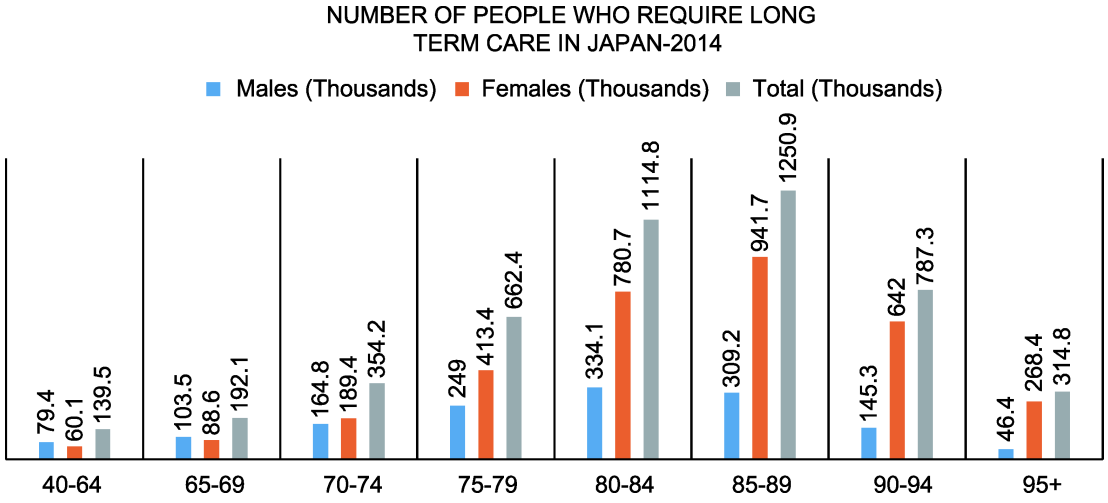

Figure 4. Number of people who require long term care in Japan — 2014.

use laser scanners mounted in front of the mobility scooter to detect obstacles automatically and then gradually reduce the maximum speed to one-third of the initial speed.

The city of Tsukuba (Ibaraki Prefecture), Japan and Toyota Motor Corporation (TMC) have recently demonstrated trials of the "Winglet", a personal transport assistance robot ridden in a standing position[25]. If successful, this might be attractive to the young elderly for undertaking short trips on sidewalks.

4. Adelaide Seniors Travel Survey (ASTS)

4.1 Data Collection

The following section reported an analysis of the primary data from the Adelaide Seniors Travel Survey (ASTS) conducted in 2012 by the principal author. The survey was targeted at people aged 65 and above. It sought details of respondents' travel patterns during a normal week as well as their opinion on a number of related issues. The ASTS survey was a self-administered questionnaire survey conducted with the aim of recording travel behaviour, residential relocation after retirement and opinion about the use of mobility scooters and transport issues of older people who live in Metropolitan Adelaide.

The study area for the survey was restricted to the Adelaide Statistical Division (ASD). Since the elderly are not a homogeneous group, a sample was chosen that reflected diverse lifestyles. As a first step, older adults (over 65 years of age) were grouped into 3 categories: the young elderly (65–74), the elderly (75–84) and the older elderly (85 years and older). The sampling frame consisted of randomly selected residents aged 65 and over from each postcode in the ASD taken from those elderly residents who were members of the National Seniors Australia (NSA), an organisation representing the interests of people aged 50 years and over. Stratified sampling was used to ensure that there was even representation in the sampling from each of the postcodes in the ASD. Survey forms were posted to 1000 registered older adults (aged 65 and above) from the NSA database with the proportion of surveys posted to each of the above three age groups equal to the proportion in the 2006 Australian Census. The survey form was also published online and approximately 600 other registered older adults representing each of the above three categories were sent an e-mail requesting them to fill the online survey questionnaire. In order to collect travel responses representing all days of the week, respondents were asked to fill their travel details for one day of the week, i.e., the day of the week that their birthday fell on the year 2012.

The period for completion and return of surveys was 16 weeks (from 1st June to 1st October 2012). The response rate for postal surveys was about 26% based on the valid questionnaire sets for the posted forms. There were a total of 264 returned questionnaire sets, but only 259 were considered valid. In the case of this online survey, there were only 26 (around 3.8%) valid responses out of the 600 older people contacted through e-mail. In total, 285 (259 + 26) respondents' data is analysed in this paper.

4.2 Results of the ASTS

This study showed that more than 54% of the respondents share a house with someone and nearly 46% of the respondents live alone. When the living arrangements of old people were divided on the basis of gender, there were some very interesting findings; i.e., males tend to live in a shared household with 74% of them living either with their partner/spouse. However, out of the total of female respondents, over 73% of females live alone. A further breakdown of the figures according to the age group showed that 12% of solo elders are male in the age group of 65–74, 28% are males in the age group of 75–84 and 5% are males in the age group of 85 and over. Similarly, 37% of solo elders are females in the age group of 65–74, 28% are females in the age group of 75–84 and 8% are females 85 years and older.

Females in the age groups of 75–84 are potential customers for owning mobility scooters because a significant number of them live alone, have some form of difficulty in using conventional transport mode (Figure 5) and are more likely to lose their licence. Moreover, the elderly female population in that group is increasing more rapidly in Australia and more specifically in South Australia (Figure 6).

Figure 7 showed older people's opinions about convenience, speed and safety of mobility scooters. Around 35% of older respondents had a neutral opinion about these issues. Safety of mobility scooters was of concern to some older people, as compared to convenience and speed.

Many respondents agreed that mobility scooters can provide independent travel to older and disabled people. However, many also indicated a need of training for mobility scooter drivers. Most respondents do not have a mobility scooter (Figure 8). However, one concerning issue that might have an impact on policy

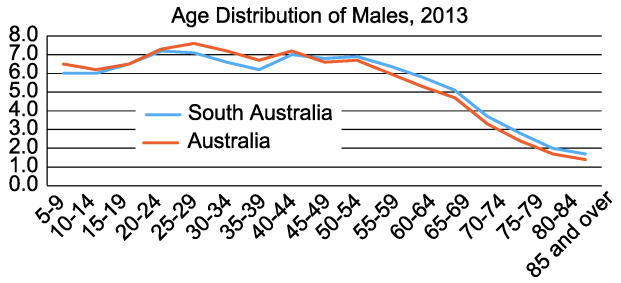

Figure 5. Age distribution of males in Australia and South Australia, % (Data source: DPTI 2013).

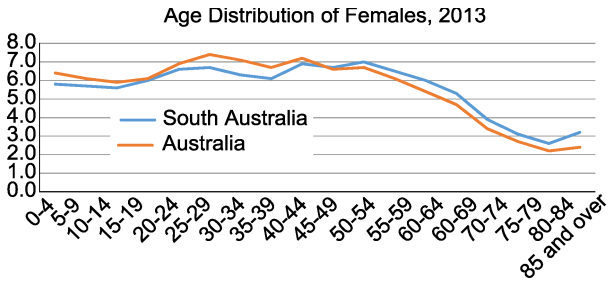

Figure 6. Age distribution of females in Australia and South Australia, % (Data source: DPTI 2013).

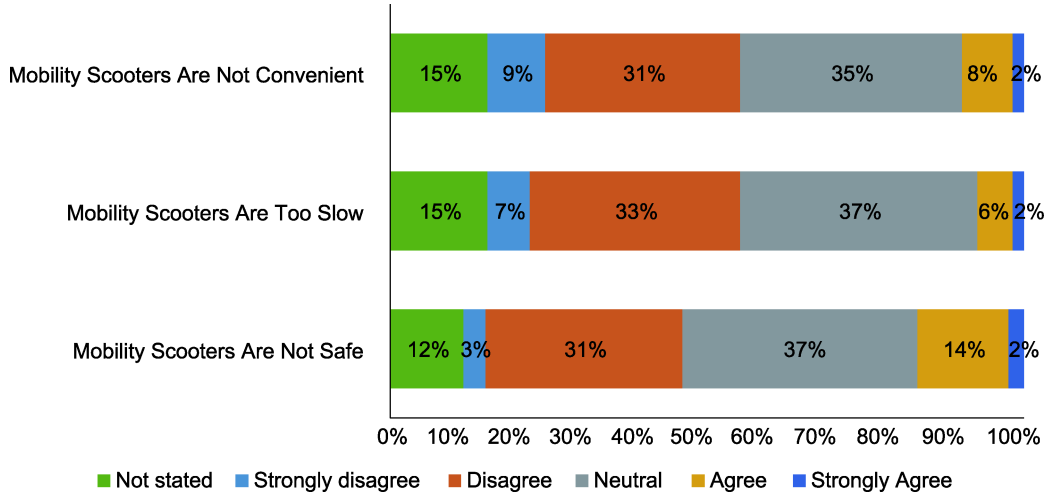

Figure 7. Opinions about mobility scooters, %.

was that 9% of them intended to buy one and 57% would consider buying one if needed, e.g., when they no longer drive a car.

Seniors were asked what factors limited their use of public transport. 46% of seniors did not have any condition that limited their use of transport (Figure 9). Among the seniors who had issues with using transport, many reported difficulty in walking, standing and climbing steps. A small percentage of pairments seniors had conditions such as visual or hearing im and communication difficulties, which all limited the use of public transport.

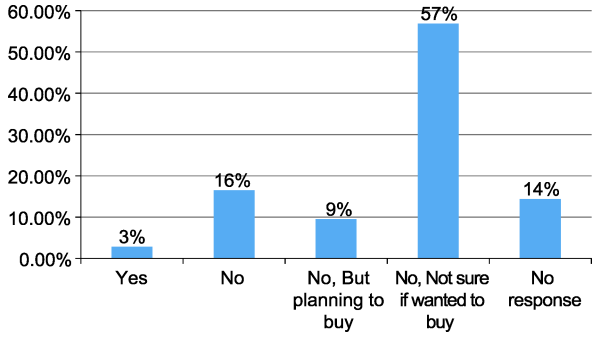

Figure 8. Ownership of mobility scooters.

When these results for seniors were categorised into three different age groups, the proportion of people without a condition decreased with age (Figure 10). There was a large increase in the percentage of seniors in the 75–84 and 85+ age groups who have difficulty climbing steps compared with the 65–74 age group. A significant percentage of people who are 85 or older had a hearing impairment. People aged 85 or older also had difficulty walking and standing compared to people in the 65–74 and 75–84 age groups. The number of people with vision impairment was similar across all three age groups.

5. Driving Licence Issues of the Elderly

5.1 Driving Licence Issues of the Elderly — Australia

From the 2012 ASTS, a large majority of the respondents (89%) who are retired still have their driving licence. Out of the 285 respondents, 91% owned a car and when car ownership was divided on the basis of gender it was revealed that males also had a higher percentage (95% against 88% for females) of car

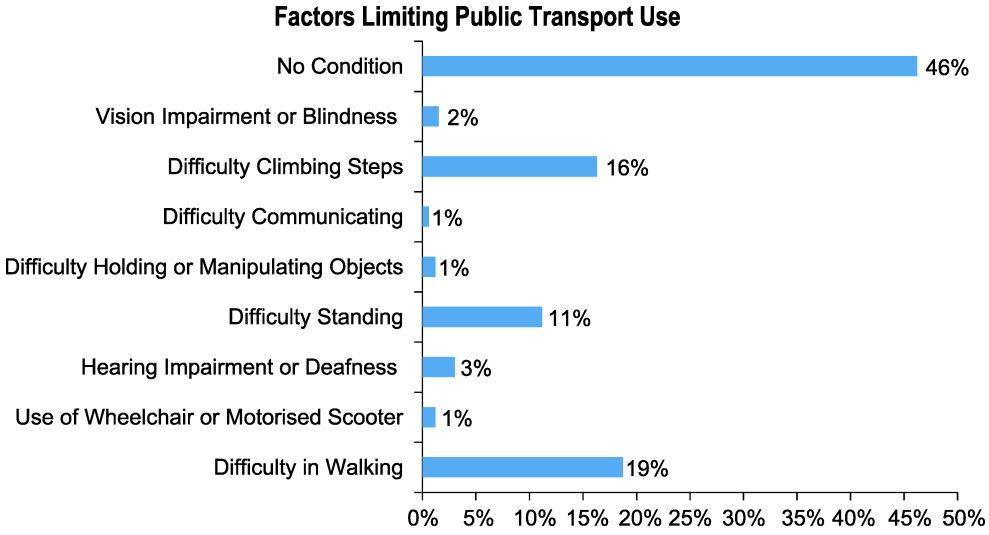

Figure 9. Factors limiting public transport use, %.

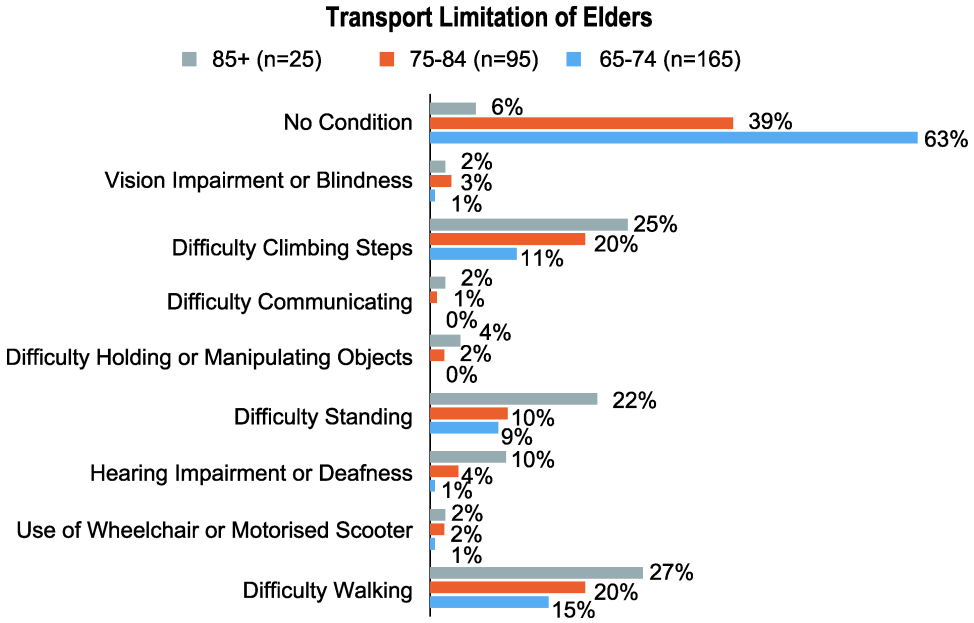

Figure 10. Factors limiting public transport use vs age.

ownership. The Australian Bureau of Statistics[26] also reported that as women in Australia age, their use of a passenger vehicle to get to work or study increased and their public transport use decreased. As per ASTS, the percentage of males owning a license is higher than that of females (Figure 11). Not having a licence can act as a hindrance in mobility for older people given that most of the old people depend on a car as their preferred mode of transport.

There is no uniform policy in all Australian states on the issue of driving cessation, and various state governments are not clear in their approach in making

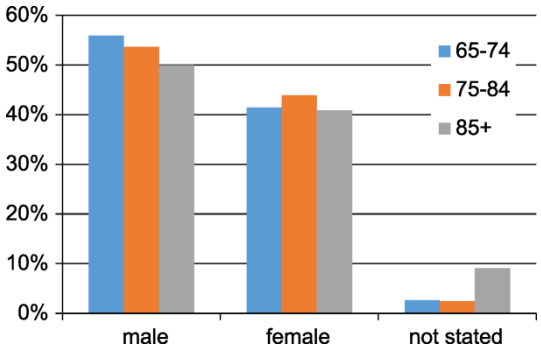

Figure 11. Percentage of older males and females owning driving licence.

a balance between public safety and individual mobility. Transport alternatives for older people who no longer drive stands to become an increasing issue for the State Governments in Australia. Public transport and walking are not frequently used modes of transport for the elderly as a whole in many Western nations including Australia[1]. Once people lose their driving licence, people may become socially isolated. In relation to South Australia, whilst the road safety crash risk for older drivers is not as high (Figure 12) as young drivers (16–19 and 20–24 age groups), research has shown that crashes involving older drivers are increasing and are becoming of higher severity, probably due to the frailty of these older users. In relation to gender, females (Figure 13 and Figure 14) in the age group of 80–84 are involved in crashes more often when compared to their male counterparts. It was also reported that older drivers were more likely to be involved in fatal and serious injury crashes at intersections (52%) than other drivers, i.e., 52% of older driver crashes occur at intersections compared to 35% of all crashes[27]. The reason could be that as intersections and junctions are complex traffic environments, a driver has to attend to a variety of information sources while under time pressures and perhaps the ability to do so decreases with age.

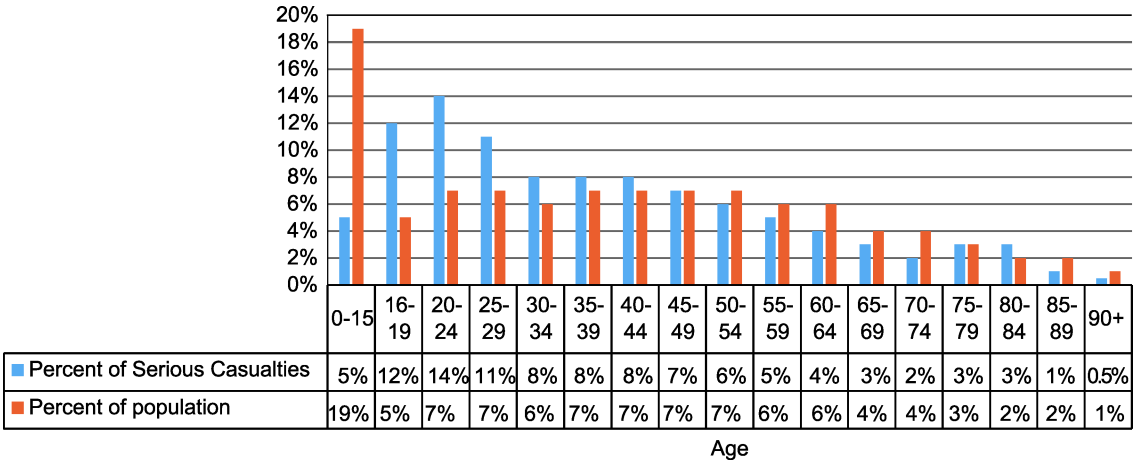

Figure 12. Serious casualties by age and population distribution — South Australia, 2008–2012 (Data source: DPTI 2013).

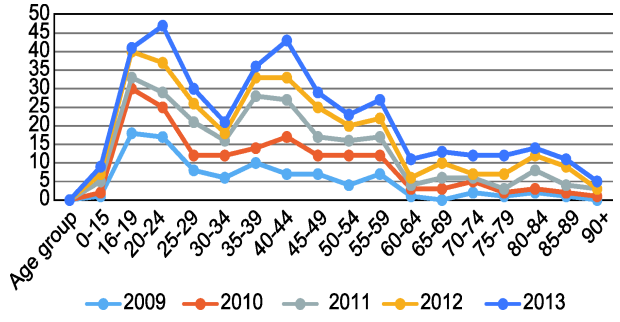

Figure 13. Road crash fatalities of males in South Australia.

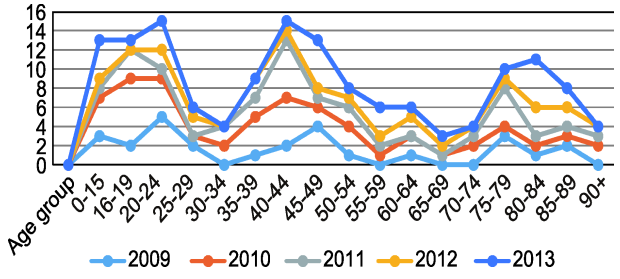

Figure 14. Road crash fatalities of females in South Australia (Data source: DPTI 2013).

5.2 Driving License Issues of the Elderly — Japan

In Japan, the law requires driver retesting at age 75. Elderly drivers between the ages of 70 and 74 are required to attend a seminar (that offers safety tips for driving) in order to continue their driving licence. As accidents involving older adults accounted for 13% of all accidents in the Tokyo 23 special wards district, the Tokyo Metropolitan Government has implemented an incentive program to encourage drivers aged 65 and over to voluntarily surrender their driving privileges. The idea of voluntary forfeiting the licence program is in response to the increase in number of accidents involving the elderly as well as the growing number of elderly drivers on the roadways. An earlier similar scheme was not popular as older drivers were keen to retain their driving licence for identification purposes. However, the authorities now issue driving career certificates which can act as an alternative form of identification and also offer discounts at various stores. When drivers over 65 years of age surrender their li-

cences, they can now receive a certificate of their entire driving career. There are believed to be about 300 000 elderly drivers with dementia in Japan. Although drivers over 75 years of age must have a doctor's examination, there are indications that symptoms like dementia are overlooked. Thus, this preventive safety measure/policy aims to encourage drivers to stop driving while still physically and mentally fit. In addition to the incentive program to voluntarily surrender licences, a labelling system is now used in Japan to identify drivers over the age of 75. This system is developed by the Public Safety Commission in association with the National Police Agency. The driver must position the labels on both the front and rear of the car. The labelling program extends beyond the elderly; novice drivers, the hearing impaired, and handicap drivers. The current licence forfeiture program is still relatively new; therefore, its popularity with drivers aged 65 and over is not clearly established. Unofficially, there are reports that only around 10% of older drivers have registered for the program.

6. Discussion

6.1 The Australian Perspective

Australia, like Japan, should formulate transport polices that treat ageing issues as an opportunity rather than a burden. In South Australia and in Australia generally, progress in urban infrastructure planning around the needs of an ageing population is not yet satisfactory. For example, there is no consistency in implementing the installation of Tactile Ground Surface Indicators (TGSI) which could improve the life of people with vision impairment. Although vision impairment is not a major issue at present, it will be a more important issue in the near future. Similarly, there is a large increase in the percentage of older people in the age groups of 75–84 and 85+ who have difficulty climbing steps and there are many transport facilities which are still not suitable for an aged population with climbing difficulties. Some railway stations have been made more accessible but many stations still have many stairs with no lifts, and it is important that these are addressed as a matter of priority. State governments need to implement policies and design practices for the elimination of barriers and the installation of barrier-free facilities in public transport systems. Considerable investments and time are required to develop the infrastructure in order to attain the same standards that are now available in Japan. When accessibility needs of the elderly and disabled are addressed during planning and construction, universal design costs are manageable and not expensive. For example, earlier studies[6] have shown that providing fully accessible facilities increases building costs by as little as 0.5% to 1% if planned, designed and implemented from the outset.

There is an ongoing debate in Australia regarding the rise in number of older people who use mobility scooters for transportation. As they have become more popular, mobility scooters have become more controversial. As there is no licence and insurance requirement, these mobility scooters are gradually becoming popular. There are no industry statistics that give an accurate sense of how the market is growing. While there is a consensus among older people that mobility scooters offer independent travel especially for the disabled, concerns about safety are evident. The analysis suggested a need for training mobility scooter drivers and increasing the visibility of mobility scooters, e.g., the compulsory use of flags. Older Australians (more so South Australians) prefer to live independently with their spouse or alone rather than to live with other people. Older people who live with others — either family members, a spouse, or in a care facility are more likely to have support networks to assist with daily living such as shopping, cooking, personal care, mobility and transport. However, for the older person (especially females) living alone, life can be more challenging, especially if reliable support networks are not in place and if the person experiences health and mobility limitations.

This is where spatial factors can play an important role in the quality of life. Living close to family, friends, medical services, and shopping facilities can mean the difference between the quality of life and detrimental social and health implications. Understanding the demographics of older people can assist with planning for future policy and service provisions. Many older people consider mobility scooters as having the potential for increasing independent travel in their later age. However, concerns about safety and the need for driver training are highlighted. Our survey results indicated that while only 9% of South Australian elders were planning to buy mobility scooters, some 57% were still undecided. The results suggested that the use of mobility scooters is likely to increase in the near future. Mobility scooters are mainly intended as an aid to mobility and not as a person's main or only means of transport. However, in

the future if no alternative transport options are available for older people, older adults especially more females may be tempted to use mobility scooters for longer trips which will lead to more serious and fatal crashes.

There should be clear ideas and polices on what should be done in terms of licensing, training or enforcement. Only Queensland has taken the lead by implementing a process for registration of mobility scooters. Though earlier literature[4] suggested that older people chose to limit their driving as they age, resulting in declining ability and increasing dependence on friends, relatives and neighbours, the results from this study showed that a significant number of older people continue to drive as they age. Older people tend to use their cars. The ASTS survey results indicated that they are still keeping their licences active and use their private car for most of their travel needs. The use of public transportation was much inferior to the private car with only 4% of the elderly using it daily — in fact the ASTS indicated that more than 30% of South Australian elders never use the public transportation in their daily travel needs. This may be due to the distance of bus stops from residences as shown from the ASTS survey where 35% of the elders needed to walk at least 10 minutes to the nearest bus stop, and 38% have to walk more than 15 minutes to the nearest tram or train stops. As a significant number (18%) of people reported health issues that will limit their ability to walk, it is important to provide better public transport coverage (especially rail) to the suburbs where older people reside. There should be schemes for increased involvement of doctors and opticians in deciding whether drivers are safe to continue driving and perhaps some consideration of compulsory eye tests for people over 70 years old. Such programs will ensure that elderly drivers remain competent and ensure their own safety as well as the safety of others. Although there are similar programs in some states, there is no uniform policy for the entire nation. Similarly, there are no crash records focussing on mobility scooters and it is important to record and publish these periodically to understand the extent of the problem and trends.

All efforts should be made to assist older people to continue driving as long as possible as there is no adequate public transportation for the ageing population. The study results have highlighted the need for enhancing parking for older people. Car dependence among older people is evident as a vast majority of them drive for travel. Therefore, providing more designated senior parking at shopping centres, senior citizens' centres and council facilities would benefit older people. Unlike Japan, there are no dedicated parking bays for older drivers. As a short term initiative, it might be worthwhile to allow people aged over 70 to use (share) the parking bays intended for disabled drivers. In order to implement such schemes as in Japan, there should be appropriate labelling schemes.

6.2 Japanese Perspective

Japan has begun to make dedicated, progressive changes to national policy which takes into account the needs of the increasing elderly population. The unique approach of Japan's transport policy is that it has started to treat the ageing issue as an opportunity rather than a burden, i.e., seeing an ageing society from a positive angle by creating a platform and harnessing resources and technologies. Therefore, it feels that by implementing measures to improve the quality of life of the elderly, they can achieve an overall higher quality of life for all. Japanese policies emphasize the participation of women and seniors in society. So it is very important to build barrier-free passenger and traffic facilities, vehicles, homes and public facilities. Another important difference in Japan's public transport's policy is that the developments are planned as social infrastructure responsive to the ageing society and not just to increase competition with car usage. Safety and social inclusions are high on the agenda. The economic objectives in Japanese transport policies include the need for enhancing global competiveness, environmental objectives include achieving environmentally-friendly transportation, a developing environment that offer peace of mind to seniors and finally social objectives to include safety and dealings with an ageing society. From this, it is clear that ageing society concerns constitute the central theme of Japanese transport policy whereas senior citizens' issues do not form a central part of it.

Many policies including programs relating to land use and transport integration have been well articulated in Japan. When drivers elect to stop driving, the policies recognise that their transportation needs must be met by other means. One of the effective transport service implementation in Japan includes community-based transportation services which tend to take over where public transportation fails to reach. These services include programs where volunteer drivers using their own cars provide door-to-door transporta-

tion services for nearby elderly residents. However, in rural areas there are few choices for the drivers who give up their driving licences as community-based transportation services do not cover all areas of Japan. Researchers in Japan are also exploring mobility from the viewpoint of quality of life (QoL) and position it within urban space structure, i.e., where QoL is derived based on the accessibility to services within a metropolitan area[28].

Conflict of Interest and Funding

No conflict of interest was reported by the authors.

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RESEARCH ARTICLE

Equity in public transport — a case of Bangalore's city bus transport

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Abstract: In most urban areas, buses are the most heavily used form of public transportation[1] and more so in Indian cities where buses make up for over 90% of public transport ridership[2]. In the selected Indian metro cities, where formal bus based PT systems are operated by public agencies, they are over-reliant on state support to sustain operations as fare box collections are inadequate in spite of having relatively high ridership. The main challenge for all this is to achieve long term financial sustainability of public transport systems while providing good quality and affordable bus services.

This paper investigates internal and external factors that led to the steep and recurrent fare increases in the Bangalore city bus services in the period from 2012–2014 which are operated by Bangalore Metropolitan Transport Corporation. In order to estimate the impact of the recent bus fare increases that have had on the economically weaker sections of the society dependent on these services, the paper presents the results of a random sampling survey study carried out in a central locality in the city that has a large slum area.

The key findings throw light on the various ways in which the low income bus users have adapted to reduce their travel costs through changes in travel behavior, travel pattern and modal shifts. The cost of the behavioral changes through lost opportunities and the cost of the modal shifts of the persons earlier favoring public transportation draw attention to the significance of public transport fare policies. Furthermore, the management and operations of the BMTC agency show scope for improvement which can translate into better revenue generation and consequent reduction in fares.

Keywords: public transport, bus fares, travel behavior, affordability

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1. Introduction

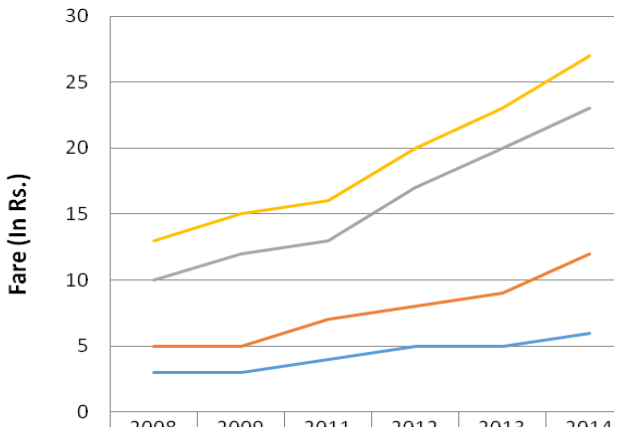
Increased urbanization and rapid motorization in Indian cities are causing challenges of ever increasing disparity between redistribution of economic opportunity and growth. As motor vehicle activity increases and as transport infrastructure increasingly caters for personalized motor vehicles, other transport modes such as walking, cycling and public transit which are relied on by low-income groups and the poor are adversely affected[3]. In Indian metropolitan cities such as Delhi, Bangalore, Mumbai, Kolkata and Chennai, this situation is further worsened by already high population densities, poor transport infrastructure, and lack of affordable housing for the poor, forcing them to relocate to city's peripheral regions. Consequently, this scenario has further marginalized the poor from access to desired destinations and opportunities. The direct consequence is that their social welfare is negatively impacted. Low-income groups

without a private vehicle are also associated with weaker social ties and small social networks. Hence, affordable public transit is critical to meet basic living needs and enhancing quality of life among city's low income population.

In Indian metropolitan cities, bus based public transit are the primary public transit mode that attract a major modal share except for Mumbai where suburban rail attract a higher mode share. Bangalore has one of the better run city bus transport systems in the country. It is operated by the Bangalore Metropolitan Transport Corporation (BMTC), a wholly owned company of the Karnataka state government. BMTC is the sole public bus transport provider in Bangalore, serving urban, suburban and rural areas through a mix of services to suite different commuter segments and their specific travel needs. BMTC services, carries about 5 million passengers each day, which is over 50% of the approximately 8.5 million population of Bangalore[4]. Comparing BMTC's operations with other State Transport Undertaking (STU)'s operating in other metro cities in India, BMTC is the largest STU in the country owning a bus fleet (of roughly about 6,700 buses in 2015). The ordinary bus fleet constitutes around 80% of the total fleet and therefore constitutes the bulk of the BMTC services. The agency provides an intricate and high network of routes (approx. 2,500) within the metropolitan region. The routes that were developed on requests of commuters for point to point connectivity have resulted in replication which the BMTC is aware of and has initiated action in rationalizing routes and developing a more structured direction oriented bus routing network.

Presently, there does not seem to be any structured fare policy that guides fare setting and collection methods in BMTC. BMTC follows the traditional bus fare charging structure based on stage system with a telescopic structure, i.e., fares increase proportionally to the distances traveled although the cost per marginal unit of distance decreases as the trip length increases. Fares change with each stage which is approximately 2 km although they can be shorter on particular routes. Fare revisions in BMTC's ordinary services are guided by notifications released by the state government under the provisions of the Motor Vehicles Act, 1988 (Subsection (1)(i) of Section 67)[5]. These notifications set the maximum rates of fares for ordinary service stage carriages in the state. According to the fare revision notifications, fares can be changed only when the combined burden of diesel price increase and rise in Dearness Allowance rates for the agency's permanent staff exceeds the agency's total financial burden by Rs.11 crore (a crore = 10 million) in a year. BMTC has adopted the Association of State Road Transport Undertakings formula for fare revision which is as indicated in Annex 1[6]. However, state government approval is required for implementing ordinary bus fare hikes. Procedurally, the agency makes fare change proposal to the Principal Secretary of Transport who then seeks the final approval from the State Transport Minister to implement the proposed fares. For other services offered by BMTC, the agency is independent to set its own fares.

BMTC conducts a financial review twice a year to determine whether a change in the fare structures (per passenger km) is necessary. Since BMTC has the liberty of distributing the quantum of fare increase between different types of services such as ordinary, deluxe, express, and luxury, the agency tries to minimize the impact of large fare hikes especially for ordinary services. In the last decade, BMTC fare rate changes indicate that price per km of bus transport in Bangalore increased by about 75% in the period 2002–2011. During that period, BMTC fares changed 11 times roughly once a year on average. Until 2011, the BMTC bus fares were gradual and tactfully revised for 2nd stage onwards keeping the base fares relatively untouched. In addition, fare hikes were limited to a maximum of 2 revisions in a year as it was a politically sensitive issue (Figure 1).



	2008	2009	2011	2012	2013	2014
Stage 1	3	3	4	5	5	6
Stage 2	5	5	7	8	9	12
Stage 10	10	12	13	17	20	23
Stage 20	13	15	16	20	23	27

Figure 1. Increase in BMTC's ordinary fares from 2008 to 2014 (Source: Newspaper articles and BMTC notifications).

From 2011–2014, the BMTC bus fares increased by 70%–80%, which was 5 times higher on average across all services and stages from 2011 rates. From the 3-year period (2008–2011) evident in Figure 1, BMTC fare hikes increased between 20% and 30% while in the latter 3-year period (2011–2014), the fare increased around 70%, thereby triggering strong public reactions. The rate hikes were not uniform across all stages. Fare increases in higher stages have been much steeper as seen in Figure 1. BMTC agency justified the fare revisions by declaring that "unprecedented" increased in diesel prices and staff costs in the period of 2011–2013 incurred a loss of around Rs.130 crore for the BMTC.

BMTC's ordinary bus services are popular amongst the economically weaker segments of the city's population as they provide a wide service network across the city and also the cheapest transport mode available in the city. The recent fare hikes were strongly opposed by the public resulting in public protests and negative media coverage. However, these abrupt and steep fare hikes have not been overturned by the agency or the state government. This research focuses on the understanding of the impact of the recent ordinary bus fare hikes on the travel behavior of its commuters especially for the economically weaker sections (EWS) of the society. In order to address this question, the following objectives for this case were identified:

- To understand their travel needs, affordability and preferences for using PT by EWS commuters
- To understand the target group's perceptions of BMTC services and fare structures
- To identify possible adaptation strategies (change in activities and travel behavior) to minimize travel costs

The paper is structured in the following way. The next section conducts a brief literature review on the issue of transport equity and international experiences on the impact of bus fare hikes on the low income commuters. The next section explains the methodology employed in identifying the vulnerable bus commuters, conducting the primary surveys and analyzing the data. The next sections deal with the analysis and results of the surveyed data that provide insights on the commuters and their travel behavior. The paper ends with conclusions indicating the limitations of this research and way forward. In addition, it indicates the use of this research to better understand the behavior of urban transit commuters.

2. Literature Review

Transport equity refers to the distribution of costs and benefits and whether that distribution is considered appropriate and fair[7]. Most practitioners and decision makers sincerely want to achieve equity objectives; however, in assessing transport equity, there are various types, impacts, measurement units and categories of people to consider. Vertical transport equity with respect to income and social class type investigates transport affordability and the impact of transit fare structures on low income communities. A large and growing literature addresses the subject of equity[8,9]. Studies have applied the concept of transport equity to issues such as pricing road congestion[10,11] and public transit covering transit investments[12], finance[13], time-of-day pricing[14] and distance-based fares[15].

Several studies have investigated equity in transit fare policies. Cervero *et al.*[16] investigated new pricing policy proposals submitted by three transit agencies in spring 1980. They found that the 3 proposals for fare increases across-the-board appeared promising in terms of revenue yield, but were more regressive than existing structures, redistributing disproportionately more income away from low-income, transit-dependent users.

Deakin and Harvey[10] articulated the need to be cognizant of the equity implications of fare changes' policies. They noted that public transit price increment is a serious concern for low-income people who have a limited ability to 'choose' to pay the higher costs and hence would be priced out of travel options. Higher transit costs fares are a worry for moderate income people, especially those who have little flexibility about when or where they have to travel and hence might have to devote a larger share of their monthly income to transportation.

The TCRP's Report 94[17] observed that, in the United States, transit agencies face the threat of legal challenges to propose the fare increments in several cities. Hence, many transit agencies, especially those in other large cities, need to pay greater attention to equity concerns in considering possible fare changes. These observations seem to be replicated in Bangalore where BMTC is threatened by public interest litigation and negative media coverage on the increments of bus fare from public interest groups. Although this may not have influenced BMTC's partial rollback in 2014 of hiked bus fares, it has certainly put political pressure to not do the same in the future.

The Census of India 2011 published district wise

travel distance data from home to workplace by travel mode[18] for all districts in India. Travel distance data for Bangalore urban provide a good empirical base for comparison with other survey data, although travel distances can greatly vary depending on locations of study delimitation e.g., in city center or its periphery. Other studies that analyze urban mobility in Bangalore district are the Bangalore Mobility Indicators 2008 and 2011 studies[19,20], which were conducted by the Karnataka Government to track the progress of various interventions initiated in Bangalore and highlight issues like congestion and accessibility at different locations in the city. Since 2011, Bangalore's mobility indicators have not been updated in spite of the city's sustained rapid expansion and population growth.

3. Methodology

Equity in transport can be examined by looking at the distribution of its impacts by location in the region (e.g., central city vs suburbs), by gender of the traveler, by race and ethnicity, and so on. In doing so, we developed the following methodology to identify the location, target group and carried out field surveys and interviews:

- Selection of a study area with a sizable slum population within the city
- Identification of the bus riders belonging to the EWS groups in the selected study area
- Evaluation on the needs of commuters with a focus on bus fare structures, services, fare collection methods and affordability
- Identification of adaptations made by bus commuters with respect to their daily activities and travel behavior to minimize their travel costs

The survey had to cover BMTC ordinary bus commuters from lower income group. Hence, we decided to identify slum localities in the city. Various sources showed different distribution, location and sizes of slums in Bangalore. The source that we used for gathering slum data was the National Slum Dwellers Federation (NSDF) that provides both the demographics of the slums listed and also the location and boundary in the NSDF's GIS database. According to the NSDF's database, Bangalore had 312 slums in 2014, relatively dispersed across Bangalore. In selecting the location for conducting the survey, we selected a ward closer to the city center that had a slum area as well as organized and unorganized commercial establishments within the ward.

Based on these criteria, Srirampuram area in central Bangalore was selected as the study area (Figure 2). This decision had several advantages. First, the area has a sizeable amount of slum population, workers (in one of the largest city malls (Mantri mall) and in randomly selected small businesses in the area) and bus commuters (including a few commuters changing buses) in the area. Second, the BMTC bus provides good accessibility to this ward with at least 250 BMTC bus routes plying and at least 6 bus stops in the Srirampuram ward within 500-meter walking distance from any location within the ward, thereby increasing the probability of finding low-income commuters relatively easy. Third, the location would allow us to capture both the low-income group (slum dwellers) and the lower middle income group (labor and staff in commercial establishments within the ward).

The goal was to capture mainly bus commuters that belonged to the low- or lower-middle income group. The method employed to capture the bus commuters, was through location sampling / intercept point sampling, i.e., sampling at the bus stops in the ward, inside the identified slum settlements and Mantri Mall using a combination of random sampling and snowball method. In Mantri Mall, the housekeeping and the sales staff were targeted for the surveys. In addition, metro construction workers, food outlet employees, staff of the Indian oil petrol station at Srirampuram were also approached for the interviews. A total of 65 sample surveys were taken from 19–21 November 2014. Sample surveys were conducted entirely through semi-structured interviews at bus stops and within commercial establishments with randomly identified respondents. Referrals were used in Mantri Mall in order to identify the staffs that were using public transport.

4. Survey Results and Analysis

The population of Bangalore has been growing at over 3% per annum since its independence[21,22]. The city had a population of 1.6×10^5 in 1901 has reached 9.62×10^6 in 2011, of which 1.4×10^6 population live in slums spread across different parts of the city[4]. The sex ratio is 916 females for every 1000 males. With a decadal growth rate of 46%, Bangalore was one of the fastest growing cities in India[4]. The average population density has risen from 2,985 to 4,393 persons/km^2 between 2001–2011[22]. The average monthly income of the urban poor of Bangalore is Rs.7,191/= with a monthly expenditure of Rs.6,481/=. Majority of the households' expenditure are for food items (48%), health

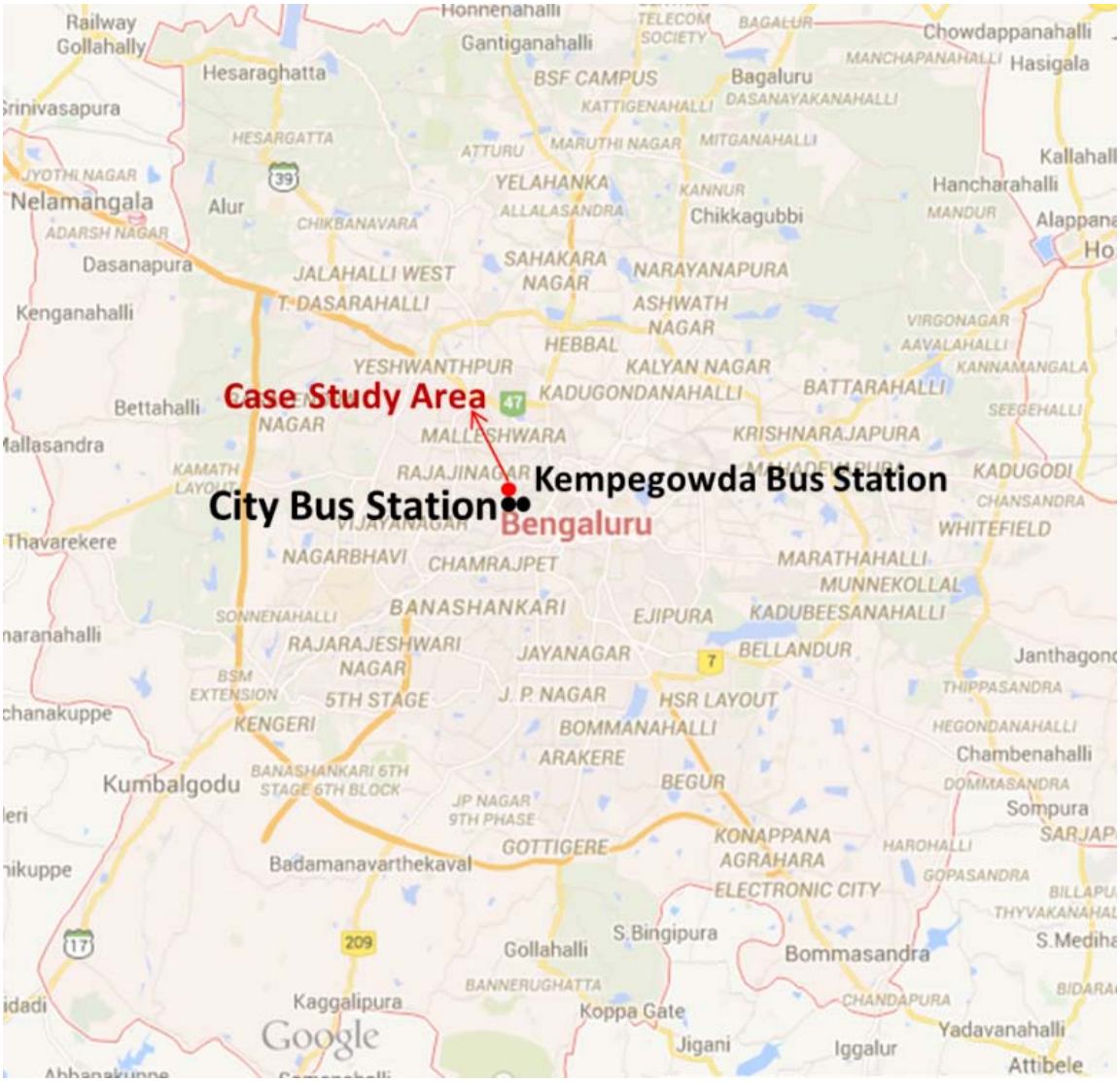


Figure 2. Location of Srirampuram ward in Bangalore city (Source: Google Maps)

(6%) and education (4%). Their spending on transport conveyance (8%) and rent (10%) in Bangalore is much higher than other parts of India on average for these services[22]. Bangalore Urban district modal split according to 2011 Census data indicated that bus-based transport (28%) and walking (29%) constituted the main modes of transport, with 2 wheelers' transport (23%) as the dominant private mode of transport for the urban population (Figure 3).

The survey respondents constituted 63% women and the rest were men (Figure 4). In addition, most of them were employed in jobs which had daily fixed timings. There were few of them, who worked on call-based jobs and thus did not have to travel every day to a particular place of work. More than half of the respondents were in the age group of 20–30 years

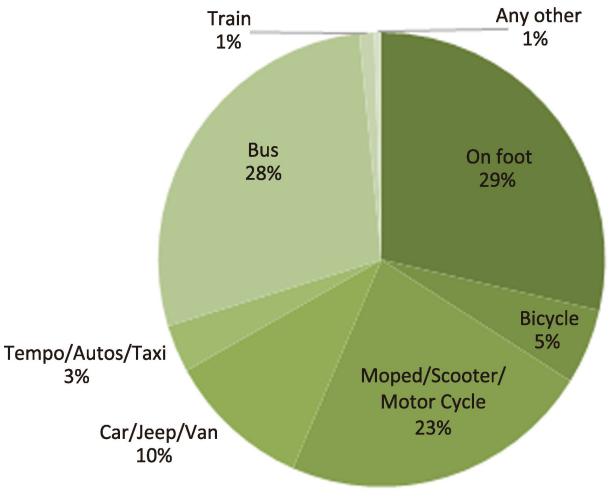


Figure 3. Modal split of Bangalore Urban district.

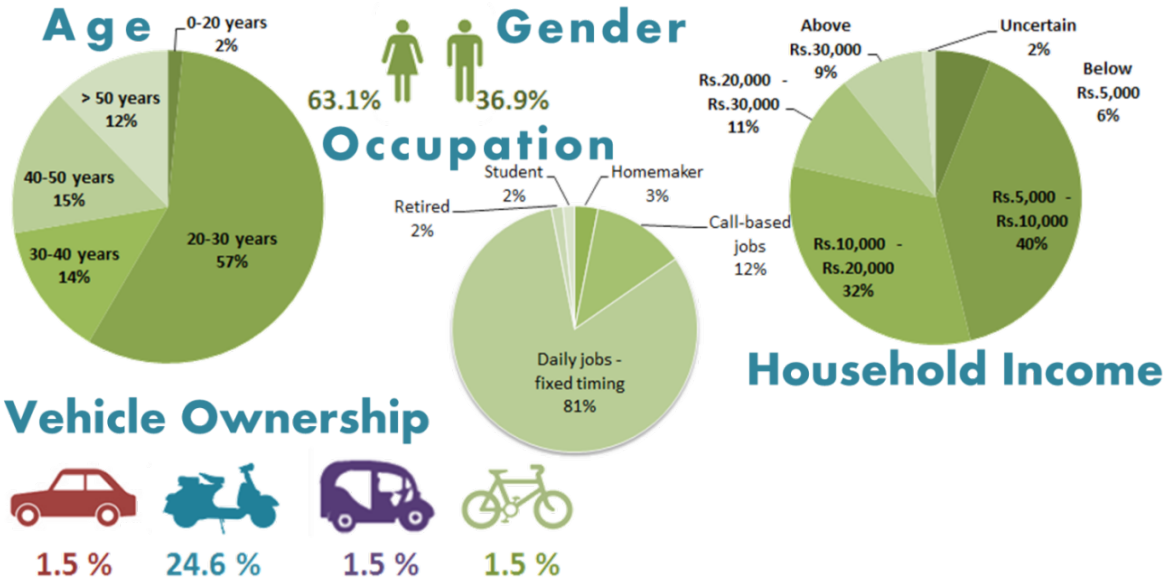


Figure 4. Demographic profiles of the survey respondents.

(Figure 5). All the commuters who were under 20 years of age were found to have student passes. The only issue observed was that the bus passes were issued to college and school students, which after much delay thereby, forcing the student commuters to pay the ticket fare for the initial months.

One-third of the respondents had a monthly household income in the range of Rs.5,000 to Rs.10,000 per month while the other one-third had in the range of Rs.10,000–15,000 per month. More than 75% of the respondents had their monthly household income less than Rs.15,000 per month (Figure 4). The vehicle ownership was correspondingly low with only one-fourth of the respondents' households owning a two-wheeler transport. This was primarily because the interviews were conducted on those who traveled by bus and thus such individuals did not own any vehicle.

Most of the respondents were commuting to and from their workplaces on a daily basis. The remaining respondents were mostly the elderly, traveling for the purpose of social visits. Only around 32% of the respondents had monthly passes which represented their bus travel's fare while more than 60% of them bought tickets each time they travel (Figure 5).

4.1 Travel Distance

In this section, the travel distance results indicated the distance that respondents traveled from their residence to workplace by bus mode. From our survey, it was observed that the majority of the interviewed respondents (almost 70%) traveled less than 10 km on a daily basis (Figure 6). There was a sizable workforce (~22% of respondents) who traveled between 10 and 15 km daily for work. However, there were a number of them who traveled more than 20 km, while very few of the respondents traveled up to 40 km for their work trips,

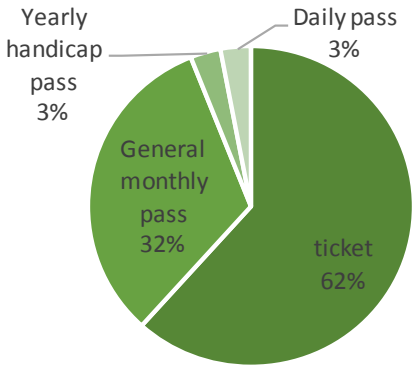


Figure 5. Bus fare payment method of surveyed respondents.

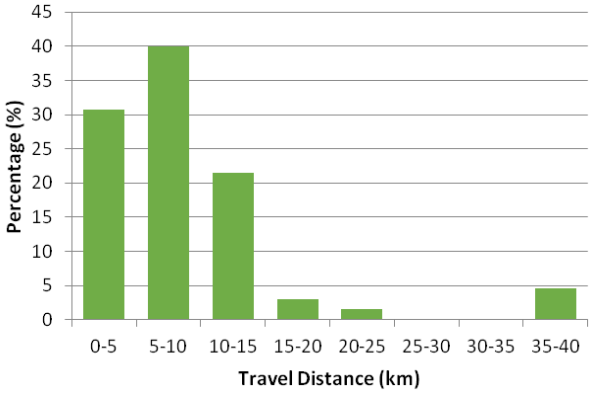


Figure 6. Daily travel distances of the respondents by BMTC bus.

of which constituting around 4%–5% only.

Those who traveled long distances were constituted of regular work based commuters and occasional social commuters. Regular work based commuters traveling long distances did so because of the availability of direct or convenient bus connections between home and workplace. Very few respondents complained that even though the bus services were not good, they were forced to travel long distance from neighboring villages and have to make more than one interchange in search of employment. While occasional bus commuters who were traveling for long distances preferred to travel during weekends, holidays or during off-peak hours on week days to reduce their travel's time and travel in comfort.

The bus-based travel's distance data from our survey was compared with Census 2011[18] data in order to determine whether there was similarity or not, in the frequency distribution using a chi-square test (Table 1). For a significance level of 0.05, the results indicated that both the datasets were similar, thereby validating our travel distance survey results.

4.2 Travel Expenditure

Urban transport expenditure is a major financial burden to many commuters, particularly for lower income households. Figure 7 illustrates monthly transport expenditures relative to total monthly household income by income class. Lower income households spent a far higher proportion of their income on transport than wealthier households, indicating that these costs are regressive. The financial burden is significantly affected by the type of transport system in an area. Low-income households generally looked for employment within walking or cycling distance thereby avoiding travel costs. Retrospectively their accessibility to economic opportunities gets limited. In most cases, the other members of the household also incurred travel expenses, which also add to their total travel expenditure. From our survey results, it was apparent that low-income households spent at least one-tenth of their incomes on transport but this percentage reduced to less than 5% as household incomes increase to Rs.30,000 per month. House rental also constituted a major part of their household expenditure. Although a small proportion of respondents were living in their own homes, the majority were living in rented places. It was observed that the lowest income category were either living in accommodation provided by the employer or had their own homes. For the respondents with a monthly income of Rs.5,000–Rs. 10,000, up to 40% of their average salaries were spent for renting a place closer to their workplace. Most of them tended to share rental homes to keep their travel expenditure low. Due to high rental rates especially those houses that are closer to the city center, the respondents claimed to have no choice but to spend so much money for house rental. For a few respondents, almost none of their money was saved after spending on food, transport and rental home.

Nearly 38% of the respondents that commute by ordinary BMTC buses claimed that they spent much on monthly passes, but are forced to use other modes of transport which appeared rather frequently (Figure 3). This is mainly due to the recent hikes in ordinary bus fares combined with poor frequency of buses after their duty hours (such as late nights and during off-peak periods) on specific routes or cancellation of bus schedules during public holidays or Sundays; putting inconvenience to the regular commuters. In these circumstances, they are forced to use other available transport modes such as hiring auto-rickshaws or traveling by private buses, BMTC A/C buses or sometimes even inter-city trains for their mobility

Table 1. Chi-square test result

	Travel distance by bus mode					
	0–5 km	5–10 km	10–20 km	20–30 km	30–50 km	> 50 km
Expected	31%	32%	23%	7%	5%	2%
Observed	31%	40%	22%	2%	5%	0%
Difference (Obs−Exp)	0%	8%	–1%	–5%	0%	–2%
Difference^2	0	64	1	25	0	4
Difference^2 / Expected	0.00	2.00	0.04	3.57	0.00	2.00
Obs. Chi Square	7.62					
D.o.F	5					

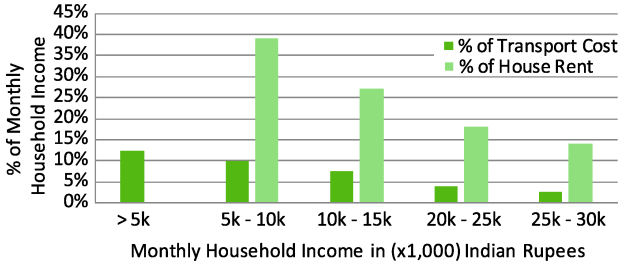


Figure 7. Proportion of monthly household income spent on transport and rent for different income class.

needs. This seems to happen, at least a couple of times each week and thus their monthly travel expenditure goes significantly higher than the monthly bus pass charges. This additional expenditure varies from Rs.300 to almost Rs.1,200 per month thereby increasing their travel expenditure to as high as Rs.2,200/= per month (Figure 8). Due to these reasons, there is a high propensity for such commuters to opt for private two-wheeler transport whenever their economic condition improves.

Only 33% of the commuters have their monthly passes issued for their travel fares while more than 60% of them traveled using the tickets they have bought. It can be seen that most of the commuters who did not own the monthly passes, would either travel in a single bus trip without any transfer or just traveled for short distances. Only commuters whose travel distances were greater than 15 km or traveled by more than one bus per trip opted for the monthly bus passes since it is feasible to do so. As the majority of respondents purchased bus tickets for their journeys, most women respondents complained of fare pilferage by bus conductors. The most common complaint was that bus conductors refused to return the balance money when higher denomination currency was given.

It was observed that the majority of the respondents traveled to or from the nearby areas situated at the north-west part of Bangalore, of which has a good bus connectivity to Srirampuram area. The commuters from South-West part of Bangalore also formed a sizeable

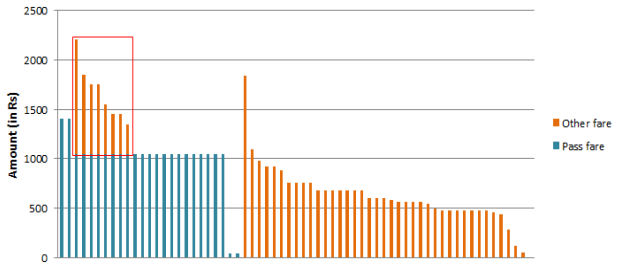


Figure 8. Travel expenditure of the respondents.

group and entered Srirampuram area for employment. However, few of the respondents traveled to and from the neighboring towns of Bangalore to Srirampuram as direct bus services existed and it was convenient for them to travel even though the rate of bus frequencies were poor.

In the Srirampuram slum settlements, large proportions of women were either homemakers or involved in work which was done from home. On the other hand, the men in the slum settlement worked in the garment industry, local shops, incense stick production, laundry work, etc. that are within 10–12 km from their homes. Others were engaged in skilled and semi-skilled activities such as plumbing, masonry, carpentry etc. that require them to travel to different destinations in the city. For these activities, they preferred to use private transport or auto-rickshaw as information of BMTC bus network was rather complicated and not well-communicated to the public. Moreover, it gives them point-to-point transport whenever they need to travel to their workplaces.

4.3 Gender and Age — Geographic Distribution

All the commuters who traveled long distances from or to the nearby towns were young men in their mid 20s age group. The older commuters also tended to travel long distances, however, they traveled occasionally for social/religious/health-related visits and did so in the off-peak hours. A few women commuters who have to travel longer distances were also the occasional commuters or having very limited waiting time for the buses. All interviewed women respondents worked or stayed within 10–15 km radius of Srirampuram for obvious reasons of safety, security as well as to limit their travel times (Figure 9).

The majority of the commuters traveled on a daily basis, i.e., >5 times in a week. The infrequent travelers, as indicated earlier, were generally older commuters and on social visits. There were a large number of people, who traveled on a daily basis, but their destinations changed based on the location of work. This was mostly found in the case of persons whose occupations were as painters, masons, housekeeping, technicians, etc.

4.4 Traveling and Waiting Time

The waiting time of the commuters is not dependent on the geographic location of their origins/destinations but on the BMTC schedules on their specific routes. Most of them have a waiting time of less than 10 minutes.

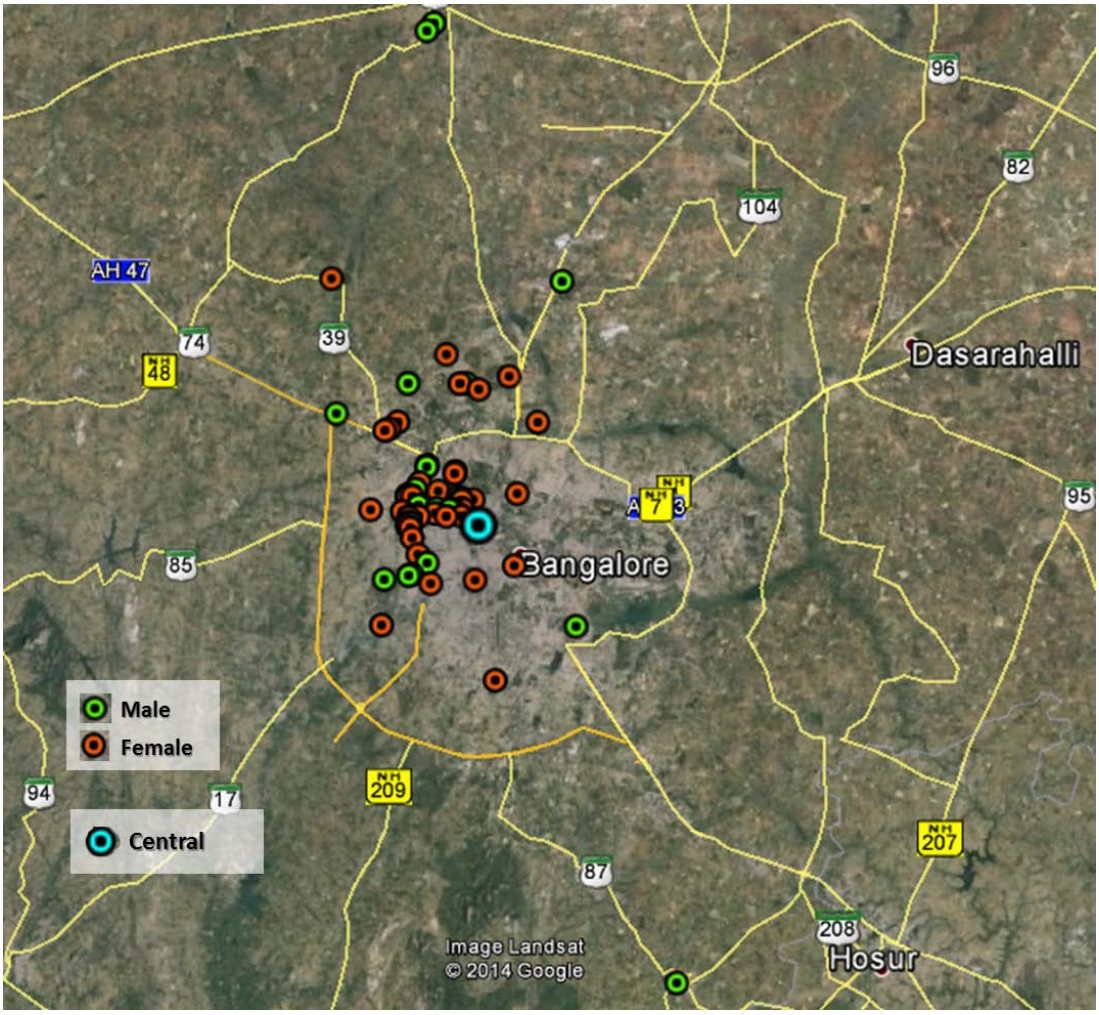


Figure 9. Geographic distribution of respondents based on gender.

However, several commuters have to wait up to 50 minutes for the direct bus to arrive. In many cases, respondents preferred bus transfer and therefore traveled to Kempe Gowda, i.e., the main city that occupies bus stations besides being a major transit hub for bus in the city center. Here, they transferred to one amongst the many connecting buses available to their workplaces or homes, thereby reducing long waiting times for a direct bus. The total travel time (commuting time + waiting time) of the respondents is at least one hour. Almost 30% of them traveled for 2–3 hours every day. A few of them even spent up to a total of 6 hours on traveling (Figure 10). If you consider factors such as value of time along with the higher bus fares, the additional cost of traveling by private vehicles especially the two-wheeler transports, then you will get compensated easily.

There is a general perception amongst planners and decision makers that people do not like bus transfers

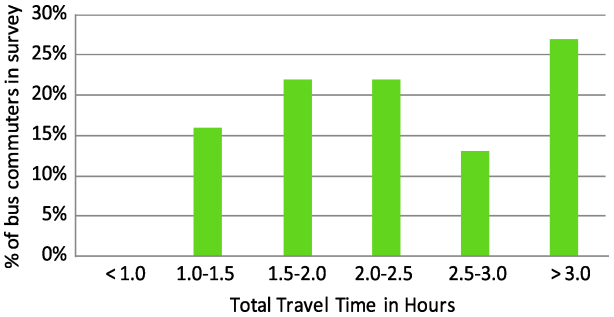


Figure 10. Distribution of relative frequency of total traveling time of the respondents.

and therefore they tend to avoid adding more buses due to issues of convenience, longer waiting period and the need to pay a transfer penalty. From our survey, it was observed that this is partly true. The majority of the respondents (64%) used direct buses primarily because direct services presently exist although bus schedule frequencies vary from high to infrequent

services in several localities in the city. Figure 9 shows that majority of the respondents living in the North to West of Srirampuram used direct services indicating that there could be a denser network and probably with better frequency of direct bus services to Srirampuram from these directions. Since Srirampuram lies within 2–3 km from the main city's bus station, most northbound buses have to transit within this area.

4.5 Propensity to Shift Transport Modes

It was empirically observed from our survey that there is a general propensity of bus users to shift from NMT to public transport as well as to paratransit and private transport with the increased in the household incomes. The income thresholds that trigger the transport's mode shift slightly vary with gender. Modal shift takes place at slightly lower thresholds for working men than working women. During interviews, it was empirically observed that working women preferred to use public transport rather than other modes of transport due to safety and security reasons even when they can afford to drive a motorized two-wheeler (M2W). There seems to be a perception amongst working women that BMTC buses are safer than traveling by NMT, auto rickshaws, private taxis or even self-driven private transport especially when it is dark or lonely.

Even when the household incomes improved and increased, the working women generally used the public transport rather than rode a M2W, whereas the male workers have more tendencies to shift to a M2W as soon as they can afford a vehicle. The women workers also considered the option of a shared auto rickshaw much more than men, who preferred to purchase and use a M2W. Besides that, it was reported during interviews that in many households with working women, the male members that own private vehicles often drove to their college or for working trips in order to drop or pick up working women to or from their workplaces.

5. Conclusion

Through this study, we were able to have better understanding of the traveler's behavior and city bus transport usage by gender and particularly the low-income workers from a neighborhood within the city. From the findings, it was evident that the network and affordability of city bus transport provides vital access to livelihoods in the city. The bus network forms the determinant in identifying employment opportunities for the majority of the respondents. This study validates the findings of the Bangalore Mobility indicators study that the average travel distance in the city is 10–12 km as the majority of the ordinary bus commuters in the survey traveled at these distances to reach their workplaces. Whichever neighborhoods that are well connected by frequent and direct bus services, those population travel to each other neighborhoods in order to fulfill their social and economic needs. On the other hand, young male commuters are willing to travel long distances in search of employment even it is up to 25–30 km in each direction if there are options for public transport that are either direct or with a maximum of one interchange. This indicates that whenever the bus services are made convenient (by providing direct connectivity) the propensity for higher mobility amongst the low-income population residing in these neighborhoods is observed. On the other hand, low-income working women invariably opted for employment within 10–12 km radius from their residences for certain reasons namely, safety, security and added responsibilities of running a family at home after working hours. For women, BMTC services are perceived as the safest transport mode in the city compared to intermediate public transport or private two wheeler transport. In the absence of city bus transport, they formed small groups with known acquaintances and hired IPT services to reach their homes. From this study, it is evident that women travelers formed a captive bus commuter segment with general perception on city bus as a safe and secure transport mode that need to be enforced by the bus agency. The findings of this research provided valuable insight to urban transport policy makers and particularly, city bus agencies on the impact of their decisions on bus ridership, mobility and access of economic opportunities to socio-economically weaker sections of the urban population. This paper also introduces a novel methodology to understand the travel geography, travel purpose and ridership profile of commuters that will provide valuable information to the transit bus agencies in redesigning their routes, schedules and communication strategies for the sustainability of their bus ridership and increasing its mode share in Bangalore. A drawback of this study was the inability to compare the travel behavior of low-income workers located near the city center with those residing in city periphery. This will be the scope of further research.

In conclusion, the public transit network plays an

important role in providing employment opportunities to the city's neighborhoods, especially for the economically weaker sections of the society who cannot afford other transport means. Although long direct bus routes to the city center provide subsidized access to jobs for population residing on the outskirts of the city, it also results in increased mobility and consequent increased in per capita travel distances and overcrowded public transport infrastructure. Furthermore, it could perpetuate public demand for subsidized transport and connectivity to areas even further away from city center, which may not be an interest for long term sustainability of city bus transport.

Conflict of Interest and Funding

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Appendix A. BMTC's Fare Revision Formulae

A.1 Fare Revision on Account of Increase in Diesel Prices

F (DPA) = (F – D) + [(RPD/BPD) × D], where

F (DPA) = Revised fare in terms of Paisa per passenger kilometer

F = Average cost per passenger kilometer at the time of previous fare revision

D = Diesel cost per passenger kilometer at the time of previous fare revision

RPD = Revised price of diesel

BPD = Basic price of diesel when the last fare revision was permitted

A.2 Fare Revision on Account of Rise in Dearness Allowance (DA) Rates

FR = F + [CPKM (L)/CPKM] x P × F/100, where

F = current fare per kilometer

FR = Revised fare paisa per passenger kilometer

CPKM = Total cost per kilometer at the time of previous fare revision

CPKM (L) = Staff cost per kilometer at the time of previous fare revision

P = Percentage increase in staff cost due to DA increase over the staff cost at the time of previous revision

RESEARCH ARTICLE

Innovative value capture based rail transit financing: an opportunity for emerging transit cities of India

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Abstract: Emerging cities of the 21st century are attempting to build rail transit as a key driver to maintain their city's competitiveness and help catalyze livable and sustainable development opportunities around station areas. Indian cities are doing this in a big way with about 50 cities embracing urban metro rail transit systems. The rail projects are approved politically but need financing to build such highly capital-intensive rail transit systems. The use of value capture (VC) mechanisms is gaining momentum across cities worldwide as a solution to transit funding and financing. The first cities in India are now deploying various VC based financing mechanisms. This paper therefore aims to review the experiences of VC based innovative financing practices in selected Indian cities. The research summarizes the key issues and lessons learned from these experiences to help define the way forward. The paper finally concludes that VC practices in India are still at an embryonic stage but the results are encouraging with huge untapped potential to co-create rail transit centered sustainable growth. Moreover, the review findings and lessons learned will help enhance the understanding of the challenges in emerging transit cities of developing countries.

Keywords: unlocking land values, value capture, transit cities, Indian cities, land use, rail transit funding, metro rail, urban rail, active VC mechanisms, passive VC mechanisms

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1. Introduction

Most emerging cities of the 21st century in developing countries are poised for accelerated growth and have the kind of densities that are ideal for transit systems. Many are thus contemplating rail transit-driven sustainable urban mobility solutions as one of the key drivers to address a range of urbanization challenges. There is a growing recognition among cities across developed and developing nations that urban rail transit system is a key driver to maintain any city's economic competitiveness and helps catalyze livable and sustainable communities around station areas[1]. Transit Oriented Development (TOD) options are designed globally to integrate rail with built environment, energy, economy and other transportation services in a way that addresses sustainable city development goals[2].

There is a second urban rail revolution trending across the world. Newman *et al.*[3,4] noted that the 'trend back to rail' is perhaps to be expected in relatively dense cities and countries in Europe, the Middle-East and Asia. However, perhaps the more surprising trends have been in the US, Canada and

Australia, where traditional car-dependent cities that were once only considered suitable for bus transit in their suburbs are now seeing a future based around rail[3–5].

Indian cities, following the global trend, are now rapidly embracing urban metro rail transit systems in a big way. For example, in India, the current urban rail (metro) is operational in 7 Indian cities, with another 9 cities currently constructing metros and a further 14 cities with rail transit in the planning stage. A further 16 cities have rail transit under initiation and eight regional rail corridors from Delhi are also being planned[5–7].

As these urban rail projects are highly capital intensive projects, most city governments cannot provide the funding for such transit systems and largely depend on grants from state or central governments or on borrowings to create new urban infrastructure with limited success[8]. This is a problem worldwide leading to the question of "how can urban rail transit systems be funded and financed?"[9]

Innovative financing mechanisms to build such projects and sustain them are being sought around the world. A new approach to financing urban rail infrastructure is needed as there has been a dramatic turnaround in rail's fortunes globally as well as an increased awareness of its value to 21st century cities' sustainability goals[3].

In this context, monetization of urban land values through induced and activated land use change is gaining attention worldwide as a new revenue generation source. Through capturing the increased value in urban land due to improved accessibility from building rail transit infrastructure, cities are now discovering a new way to improve their capacity to find the finance for building the infrastructure. Facilitating rail transit based infrastructure investments through value capture is relatively new[10]. It is not new to recognize the value of integrating transport and land use but the need to integrate these two with financing is relatively new, and is conceptually more challenging[2,3,11–13]. Studies in US and Australian cities indicate that proximity to transit often increases property values enough to offset all of the transit system capital costs captured through a portion of their incremental value[12,14]. This has led many cities across the world, including Indian cities like Mumbai, Hyderabad, Ahmedabad and Bangalore, to attempt tapping urban land values as an alternate sources of revenue but with varied experience[15].

This paper therefore reviews the Indian city practices of innovative financing mechanisms that have been implemented. They are examined from the perspective of their potential and their challenges. This paper further analyzes the key issues and lessons learned, after which it concludes with recommended ways forward. The lessons captured will provide a guiding platform for future VC based financing of emerging transit systems in developing countries.

2. Traditional Financing Practices for Urban Rail Transit

Traditionally, property tax and government owned land assets are creating an economic base for many city local governments. In India, typically, the general revenue sources for city local government include charges such as property taxes, amenities fees, scrutiny fees, subdivision fees, development charges, building permit fees, betterment charges, grants — water supply, sewerage, housing, and deposits — security deposits (building permissions/tender), as well as government grants and loans. These revenues are now grossly inadequate even to maintain the existing infrastructure, let alone have any funds left for creating new infrastructure. There is a big, growing gap between supply and demand, leading to delays in construction or in short, inadequate increments of network[15].

Turning to the private sector for financing can only work with urban rail if there is a necessary return. Most rail systems, even the profitable ones in Japan and Hong Kong, cannot make such a return from the fare box. The only way to enable sufficient return is if the private sector can make a profit out of land around stations. A confluence of all these factors has prompted an urgent need to look for innovative funding and financing mechanisms through unlocking land values to build such projects and enable them to be sustained.

3. VC Through Unlocking Land Values for Urban Rail Transit

The main idea behind value capture is that urban rail will increase land values when it is built; this must be beyond what would happen anyway due to rising incomes and other economic activity. These increases in land values can be captured directly by the private sector or by various government mechanisms and put into a Transit Fund that can then be used to fund and raise finance for building and operating the rail system. Thus it can involve private sector financing (for

building, owning and operating) as well as government sources of funding and financing, which in all cases will require a mechanism to capture the value created as a first step in unlocking the finance.

Many studies have established the relationship between urban rail services, accessibility, and residential and commercial property values that are able to provide the basis for mechanisms that can capture some of this value as an alternative funding. Capturing the value in an acceptable, transparent and equitable way involves multiple methods and complex mechanisms. In fact, there is no one-size solution that fits all needs in financing a new rail project through VC. The applicability of a specific VC mechanism may or may not be applicable in another project due to a number of factors such as location, legislation, project type, willingness-to-pay, ease of adaption, administration, duplicability and many more; these are all areas that need to be looked into on a case-by-case basis[5].

The most important way to categorize VC is into passive and active VC mechanisms. Active VC revenue sources are mostly revenue flows from active intervention such as buying property or creating a special levy on the station precinct whereas passive VC revenue flows are more asset value dependent so funds come from tax based revenue flows without intervention to actively pursue the value directly[6].

Active VC mechanisms can be collected directly by the consortium building the system or can be collected by government into a fund used to pay the consortium chosen to build the transit and land development. The revenue can be generated from government owned property or from private land where owners are brought into a profit sharing agreement with the consortium that has been chosen to build the system; all land owners will benefit from the transit accessibility-driven increased land values. The revenues can be accrued if governments either sell their land holdings or sell the development rights to the land holdings. In case of deep cut subway transit projects, the newly created underground space holdings around transit station area can yield more revenues through shopping or business activities as revealed in the case of subway projects of Hong Kong, SAR China, Japan and London. The public transport financing practiced by Mass Transit Railway Corporation (MTR) in Hong Kong SAR, China and the Japan Railway Construction Agency (JRCA), a public corporation of Japan Railway are good examples of this active and developmental based approach. Hong Kong's MTR co-developed the sites along the transit corridors and above the transit station rather than selling those sites. In 1993, the corporation financed about 22% of operating cost of their transit system through property rental income. Similarly, the greater Tokyo's private railways have practiced transit value capture through development on an even grander scale, building massive new towns along rail-served corridors and cashing in on construction, retail and household service opportunities created by these investments[6,16].

Other active VC mechanisms can include betterment tax, benefit area levies, infrastructure levies, parking levies, special assessment districts, developer contributions, density bonuses or sale of air rights. In Australia, the Gold Coast Transport Levy, which is collected across the whole of the Gold Coast municipal area, was used to help fund and operate a new light rail. The Transport Levy was able to provide the ongoing costs of operation and was used to induce state and federal capital for building the system. A Public-Private Partnership (PPP) model was made feasible based on such active intervention to create a fund to be used for raising the finances[6,17–19].

Passive VC mechanisms are mostly on private land where the revenue flow is focused through ad valorem tax instruments, namely capital gains tax, stamp duty tax, land tax, GST on land sales and any other land-based taxes. These will rise due to the increased accessibility from the urban rail service and will flow into various levels of government. It is scientifically estimated the increased flow of funding can be hypothecated into a Transit Fund and used to attract financing from banks involving various combinations of the private sector and government. Passive VC mechanisms still require government actions but not directly in the marketplace; they can therefore be more politically acceptable but only if the government can afford to raise the loans. They do require Treasury Departments to hypothecate revenues and this may impact on credit ratings[6,17–19].

Both active and passive value capture can enable more significant private involvement in the urban rail projects. If private financing is being used it is possible to involve private consortia in a PPP where not only do they bid to build, own and operate the rail system but they can also do entrepreneurial land development as part of their bid[20]. Thus a combination of active and passive mechanisms could all be used to create a government Transit Fund or to enable a chosen consortium to raise the funds themselves from

land development and operational income or a combination of the two mechanisms to raise the finance[6].

Some of the land based VC mechanisms used to generate public revenue in developing and developed nations context are briefly highlighted below[15,21]:

- In Bogotá, betterment fees and contribution de valorización, had together contributed US$1.0 billion from 1997–2007, and US$1.1 billion has been planned for 2008–2015. This fund was used to finance improvement programmes for a city street and bridges. Beginning in 1997, municipalities were authorized to capture 30 to 50 per cent of the land value increments resulting directly from public investments in infrastructure or indirectly through planning and regulatory changes.
- In Cape Town, the sale of Victoria and Albert Waterfront property by Transnet generated US$1.0 billion in 2006 and was used to recapitalize Transnet and support its investment in core transportation infrastructure.
- Hong Kong's Mass Transit Railway Corporation co-developed the sites along their transit corridors and above their transit stations rather than selling those sites. In 1993, the corporation financed about 22% of the operating cost of their transit system through property rental income. MTR Hong Kong derives a major proportion of its revenue from land through lease/sale of property with grant of densification and development rights.
- France has established a public transport funding system known as "Versement Transport (VT)". It is a specific tax paid by public or private companies that have more than 9 workers located within an area covering 10,000 inhabitant´s that benefit from the transit. This levy cross-subsidies either operational costs or new transport infrastructure.
- In Copenhagen the appreciated land value resulting from a metro rail line of 22 km has been unlocked through direct payments (10 per cent), real estate taxes (10 per cent), and operating profits from the metro (30 per cent)
- In the metropolitan region of Sydney, a betterment levy of 30 per cent was imposed on specified rural lands and the proceeds from the levy were earmarked for financing city improvements.
- In many cities in the United States, development impact fees are an important instrument for unlocking land value and are used to generate revenues for funding or recouping the costs of capital works or extensions of existing infrastructure attributable to new development.
- In Munich, use of a revenue model for land based VC is imposed on urban developers. If a developer is interested in obtaining the license to construct a neighborhood, first he has to obtain the land value from a real estate experts' panel. After the land has been rezoned and has started with construction, the land value will increase. The difference between those two values is a measure that local government organizations may claim, till two-thirds of this change, as a source to provide public infrastructure.

Table 1 summarizes various VC mechanisms as compiled by McIntosh *et al.*[6,17] from various academic studies, and relevant secondary sources.

For India, a series of studies have been done to examine these mechanisms. For example, in Ahmedabad[22] a research study reviewed the implemented metro rail transit systems since 1965 across 141 cities worldwide to see the popularity of VC implementation mechanisms. The study found that only 38 cities out of 141 cities reviewed have formally applied various land based VC mechanisms to raise non-fare box revenues. About 65% of those cases are from developing countries. Figure 1 shows the proportions of popularly used VC instruments across these 38 cities, including both passive and active VC mechanisms.

From the above various literature reviews, it is evident that there is no one VC solution that fits all as a predefined VC prescription but the use of joint development that directly funds a transit system out of the increased value in the land is by far the biggest mechanism. The underlying success factor is that stakeholders are willing to pay provided they are convinced about the value proposition. Prior to the implementation of the VC mechanisms listed, each mechanism should therefore be required to be evaluated against an existing policy evaluation framework and local conditions[6].

4. Land Based VC Experiences in Indian Cities

Indian cities are building metro rail transit systems as a multi-functional solution to a range of rapid urbanization challenges and mobility issues. The rail projects are approved politically but are in need of financing. Though it is a drive initiated by the Government of

Table 1. Compilation of VC mechanisms implementation from academic studies, and related websites (adapted from McIntosh *et al.*)[6,17]

	VC mechanism	Implementation & Transit	Comments
Passive Government Property	Sale of surplus property/development rights/ air rights	• Hong Kong SAR, China (Metro) • Washington, D.C., USA (Metro) • Sydney, Australia (Heavy Rail)	These VC instruments can be used when vacant public land or government property is available and got transit proximity asset value increase.
	Sale of naming rights to stations	• New York, USA • Philadelphia, USA	
Active Government Property	Direct development of government property	• Hong Kong SAR, China (Metro)	These are more induced VC mechanisms and maximize the returns on the government land or property available and also own the asset value.
	Joint development	• Hong Kong SAR, China (Metro) • Tokyo, Japan (Metro) • London, UK (Metro)	
	Returns on public parking fee	• Portland, USA (Street car/LRT)	
	Government property leasing	• Philadelphia, USA	
	Advertising revenue at station areas	• Popular international practice	
Passive Non-Government Property	Tax increment financing	• Widely used in USA, UK & Australia	Primarily focused on additional portion accrued due to increase in land values to the existing ad valorem taxes
	State transfer duty/sales tax	• Atlanta, USA (Heavy Rail) • Dallas, USA (LRT)	
	State land/property tax	• Dallas, USA (LRT) • Portland, USA (Street car/LRT)	
	Local government taxes	• Portland, USA (Street car/LRT)	
Active Non-Governmental Property	Special assessment districts	• London UK (Metro) • Seattle, USA (Streetcar/LRT) • Portland, USA (Streetcar/LRT)	These are integrated transit and land use development oriented VC mechanisms.
	Special area rates/service charges	• Atlanta, USA (Heavy Rail) • Dallas, USA (LRT)	
	Infrastructure tax hypothecation	• London UK (Metro) • Portland, USA (Streetcar)	
	Developer contributions	• Popular practice	
	Density bonuses	• New York, USA (Metro) • Curtiba, Brazil	
	Local parking levy	• San Francisco, USA	

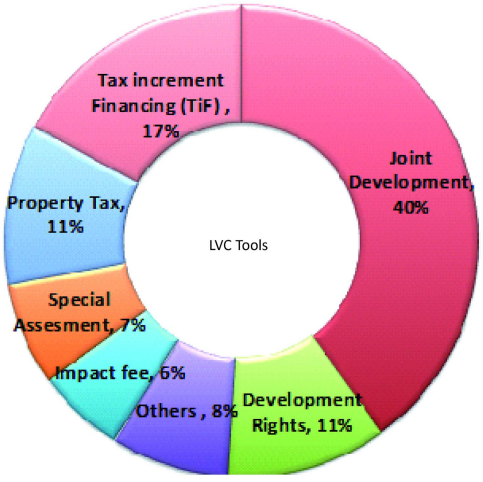

Figure 1. Proportions of popularly used land based VC mechanisms worldwide (adapted from Vivek *et al.*[22]).

India, providing such capital infrastructure investments for burgeoning cities is a major financial challenge. According to the 12th Five Year Plan (2012–2017) draft Working Group report, it is estimated that Indian cities require investments to the tune of about US$58 billion. Therefore, many of them are heavily dependent on Central government subsidies and grants to build such systems. Recognizing the significance of raising finances, the Government of India envisaged through the National Urban Transport Policy (NUTP) of India, 2006 and further emphasized in the draft 12th Five Year Plan (2012–2017) of India, the need to raise finances through innovative alternate financing mechanisms. These principally include development of land and a land value capture mechanism with a focus on non-fare box revenues. The data in Figure 2 illustrate the share of non-fare box revenues generated as a percentage of total operating revenues across selected metro transit projects globally[22].

Most new tram or train projects in the 19th century used land development as the direct basis for building their transit systems. Ahluwalia and Mohanty[23] show that this was also the case in India. A number of developing countries are now following this course as part of the mix for capital financing of urban infrastructure projects. In the Asia region, Singapore, Hong Kong and Tokyo have all funded mass transit

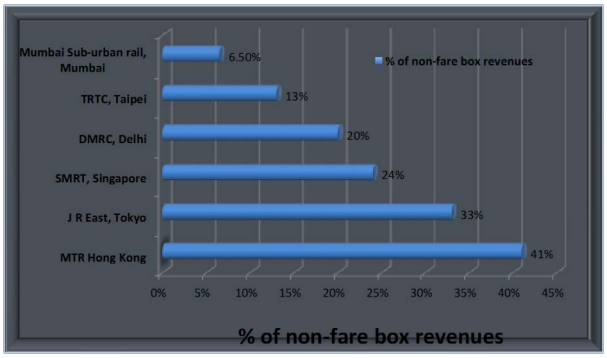

Figure 2. Percentage of non-fare box revenues earned by selected metros[22].
Source: PWC Analysis Annual Report on Urban Rail in India, CEPT study[22]

projects with private dollars based on the expected increases in property values. The following sections briefly highlight the examples of a few Indian cities that have begun to tap into urban land values as a way of financing urban rail.

Value capture in India has been used to finance urban infrastructure projects in the context of development of highways, especially ring road development, building rail transit systems, provision of civic amenities and affordable housing infrastructure projects. Table 2 below shows that land based VC mechanisms were adopted in five out of nine metro rail projects in India[5,15,23].

Some Indian states have made legislative amendments to enable urban local bodies to levy impact fees, premium FAR sales, and betterment charges. Many state governments have permitted the ULB to levy impact fees to mitigate the impacts of construction of commercial buildings that lead to increased traffic and necessitate decongestion measures. Such a fee is also levied for the sites abutting certain important potential roads where the land values increase post road construction and demand for commercial activity will creep in. For example, the legislatures of states of Karnataka and Andhra Pradesh have enacted such VC instruments through an amendment to their existing legislation.

Table 2. Indian transit cities status on VC concept adoption

City/Metro rail	VC applied?
Delhi Metro	Yes
Bangalore Metro	Yes
Mumbai Metro	Yes
Ahmedabad Metro	Yes
Hyderabad Metro	Yes
Gurgaon Rapid Metro	No
Kolkata Metro	No
Jaipur Metro	No
Chennai Metro	No

Source: Compiled information from secondary data source[5,15,23]

The Government of Andhra Pradesh has applied financing mechanisms to levy betterment charges originally through the Hyderabad Municipal Act, 1955. The Hyderabad Municipal Corporation has been using incentive zoning for the past 15–20 years with relaxation in planning norms including grants of Transferable Development Rights (TDR) for widening major roads. Greater Hyderabad Municipal Corporation levies an impact fee to generate resources for infrastructure development. A special development charge per square meter is levied on any development occurring within the 1 km growth corridor on both sides of the ring road. Hyderabad Municipal Corporation has employed a value capture mechanism based on cost recoupment via a betterment levy or special assessment tools for funding infrastructure needs to the extent of $115 million[15,21,23]. Likewise, a 300 m belt all along the metro rail corridor in Hyderabad is designated for multiple uses and an impact fee is levied per square foot of total built up area at the time of issuing the building permission. In addition, a city level infrastructure fee based on land use is levied across all buildings of more than 5 floors or 15 meters in height. Most of these levies are fixed as one time charges on spatial parameters like per square foot or square meter charges[15].

Similarly, the Government of Karnataka made amendments to the Karnataka Town and Country Planning (KTCP) Act to enable capturing the land value through various methods like auctioning of sites, additional FAR, levy cess and surcharge, TDR and additional property tax in the catchment area of their Metro.

Bangalore's sale of excess land along the airport transport corridor generated US$500 million as a part of a traditional public-private-partnership (PPP) to fund and finance the infrastructure[21]. Section 18A of KTCP Act provision enables the collecting of a cess and surcharge for water supply, ring road, slum cess, and MRTS cess, with a maximum cap of 10% of market value. Section 20 of the KUDA Act 1987 provides the ability to charge a betterment tax in addition to a betterment levy. These levies direct funds to the accounts of public bodies like Bangalore Metro Rail Corporation Ltd. (BMRCL), Bangalore Development Aut-

hority (BDA) and Bangalore Water Supply & Sewerage Board (BWSSB). For instance, under the KTCP act, levy of cess and surcharge at 5% of market value of land or building is charged to create a dedicated metro infrastructure fund. These revenues are shared by the metro transit agency BMRCL, BWSSB, and BDA at a proportion 65%, 20% and 15% respectively. In the last 5 years, the revenue received from 5% levy of market value is about Rs. 1250 crores (equivalent to about US$185 million)[24].

Additionally, the Floor Area Ratio (FAR) values were raised to 4 from 2.5 within a 500 m distance along the Metro rail corridor and a levy cess of 10% of market value for residential and 20% market value for commercial on the additional FAR granted is charged. Bangalore accrued to the tune of about Rs 432 crores (equivalent to US$63.5 million) in last 5 years from the cess on additional FAR granted. This again was shared across BMRCL, BWSSB, Bangalore Bruhat Maha Palike (BBMP) and BDA at a proportion of 60%, 20%, 10% and 10% respectively.

The BMRCL also issues TDR (Transfer of Development Rights) to secure land for the metro rail alignment in lieu of compensation for the acquisition of land and private infrastructure bonds. Notably, Karnataka is the first state in India to impose the 5% cess on the guidance value of all new layouts. The collected amount has to be deposited into a Metro Infrastructure Fund (MIF) and from this pool the revenue is shared in the following ratio as BMRCL 45%, BDA 20%, BWSSB 20% and BBMP 15%. The amount collected is utilized for the provision of infrastructure in those new layout areas only. Thus new areas can be developed well before people move into new areas and thus make for a planned layout making provision for all civic utilities, pedestrian paths, cycle paths, as well as earmarking the metro alignment[15,21,23,24].

Peterson and George[21] report that shares from the Mumbai Metropolitan Regional Development Authority (MMRDA) auction of 13 hectares of land in Mumbai's financial center, generated US$1.2 billion to fund and finance projects in the metropolitan transportation plan via the issue of municipal bonds. This revenue generated was 10 times its total capital spending in 2005–2006 and 3.5 times the total value of municipal bonds issued by all urban local bodies and local utilities in India during the decade 2001–2011. This clearly establishes the fact of VC potential in India.

Mumbai metro focus on advertisements and auction the naming of stations; other non-fare box instruments include premium FAR, TDR and land sales. In Maharashtra state, Pimpri-Chinchwad city, FSI was increased from 1 to 1.8 along the BRTS alignment to raise resources. The proceeds were transferred to an Urban Transport Fund.

In the capital city, the Delhi Metro Rail Corporation (DMRC) has been mandated to incur an initial 7% cost of the project through property development, 30-year concession and long term lease for commercial development on vacant lands and development on vacant pockets respectively. Delhi Development Authority (DDA) is responsible for formulation of redevelopment schemes and modification of land use accordingly within the Delhi Metro "influence zone" (500 m). DDA also plans "Metro realty hubs", the first project under a new Transit Oriented Development policy for Delhi. Real estate charges thereby are to be performed by the authority on any profitable projects which may return investments in a latter period[25].

The Nagpur city Improvement Trust Act (1936) has the regulation of 'Betterment Charging', which provides a legislative framework to implement value capture mechanisms. However, the Nagpur local agencies have not been able to implement this regulation due to the absence of a holistic framework and robust implementation mechanism[7].

Another VC practice includes land pooling through the town planning scheme that enables the best redevelopment potential around stations. This has been popularly practiced in the state of Gujarat. In such schemes, the government purchases agricultural plots on the city's periphery, constructs infrastructure, then sells the now richer land back to the former owner. The farmer gives a portion of the new value, as a betterment fee, then keeps or sells the remainder. Conceptually, this approach is a win-win for both parties and offers a way to uplift the urban poor. Town Planning Schemes (TPS) have been used to acquire undeveloped land in kind to build road infrastructure in Ahmedabad city which is within Gujarat state. Out of the total road length of 76.3 km of the outer ring road, 57 km were acquired through TPS. Core features of TPS include minimal displacement of people and the inclusion of self-financing, which enables everyone to benefit[23].

5. Lessons Learned from Indian Cities VC Practices

Although it is a small start among Indian cities, the land based VC concept is still an evolving alternative.

The majority of the practices viewed VC mechanisms as only an additional tax financing tool which has led to underestimation and under-utilization of the true potentials offered by the momentous urban rail boom in India. The VC mechanisms are generally not highly regarded as they so far lack clarity, and are unable to develop a strategic VC perspective from planning to implementation stage of the project. The majority of VC practices introduced are only from fiscal policy or administration and legislative perspectives but lack beneficiary or stakeholder participation which is a key driver for VC success. Many of them lack clarity on redistribution of captured gains beyond sharing the funds. Most of the projects overlooked the necessary support investments for transit infrastructure integration and the urban design for sustainable community development aspects around station areas.

Some of the issues and key lessons are summarized below:

1. Most of the VC mechanisms implemented do not cover the full costs of a transit system and are grossly inadequate to cover ongoing transit operations as mostly they are only upfront one-off contributions.
2. No attempts seem to have been made to involve the transit beneficiary community or resident tax payer community in the VC process and its design.
3. Few Indian cities try to tap the indirect benefits of a transit system due to lack of legislative powers, effective policies and skills.
4. Many transit agencies and urban local bodies in Indian cities lack VC skills in house nor have yet realized such significance. Thus many cities in India are looking for guidance, framework and capability building in the VC implementation from planning to implementation stages.
5. Most projects not followed any scientific VC assessment methods on fixation of amount of VC based tax. Majority fixed based on adhoc decision, earlier experiences, political acceptability and based on a consulting study input.
6. There is no one size VC solution that suits all. Thus participatory approaches to VC involving the beneficiary community may yield good results as India's democratic processes are deeply embedded (refer to CUSP video[26]).
7. Legislation may be needed for transit agencies to levy cess or define taxes.
8. VC implementation calls for seamless coordination between multiple participating agencies involved and require a centralized nodal governance model with stakeholder representation and transparent operations.
9. FSI sales or Premium FAR sale are popularly used across many cities. These however need to be regulated between civic agencies as the additional FAR means there is a need for additional civic infrastructure like fire stations, police stations, water and power requirements and street lights.
10. Many sources of VC are still untapped in India — levies like vacant land charges, betterment levy, cess on new development, cess on fuel, parking taxes, congestion charges, auction based motor vehicle registration, quota systems.
11. If applied strategically the VC can be transformed as a potential financing mechanism, but risks and challenges involved in each project should be carefully analyzed and addressed upfront from the planning stage itself. A clearly defined risk mitigation plan should be prepared upfront to ensure effective implementation. Such risks include unpredictable volatile real-estate market, gentrification, zoning regulations, political interference, forward looking leadership and unwillingness to pay by stakeholders, long gestation periods and revenue deficit, to name a few challenges.
12. Accountability and collaborative institutional setup for the fund management and transparency in allocations and fund administration are also a key for VC success.

Overall, the VC practices in Indian cities are still at a nascent stage and are evolving. They are indeed looking for guidance, capabilities and a framework to adopt VC approaches and strategies.

6. Conclusion

Emerging transit cities if planned strategically with participatory VC based approaches can not only maximize their revenue potentials but can offer a tremendous opportunity to promote a sustainable development along the corridor. Smolka[27] highlighted that practicing successful implementation demands political resolution between local government and state government leaders, a fluid dialogue among fiscal, plan-

ning, and judicial entities and management skills to deal with many complex factors and diverse stakeholders. The key conclusion from various VC best practices is that there is a huge potential that exists for a VC based funding opportunity in India and other emerging nations and cities. If it can be tapped with a strategic approach from the planning to implementation, the cities involved will have significant development benefits. The stakeholders, the beneficiary community and taxpayer community participation and involvement in structuring VC from planning to execution stages, is also crucial to VC success. However, if private sector funding is to be sought directly through land development opportunities it will be essential to involve private sector bids at an early stage to enable the best redevelopment options to be targeted. The way forward of the research is to develop a VC framework for the emerging transit cities, which offers a step-by-step guidance to help define the VC based urban rail transit funding and financing processes from VC planning to VC operations.

A combination of private and public capital, involving both active and passive VC mechanisms, may work as the best approach in providing the highest potential value proposition.

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