ICT FOR HYBRID SYSTEMS: THE ROLE OF INFORMATION IN REALISING MORE EQUITABLE ACCESS TO MOBILITY IN EMERGING CITIES

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ABSTRACT

Hybrid public transport systems, or systems that combine scheduled, formal and unscheduled, paratransit systems, in African cities present information challenges that might impede passengers' knowledge of the network and thereby ability to benefit from the full range of mobility options available to them. Though in theory, hybrid systems could offer wider mobility coverage across the city than the formal or paratransit systems alone would allow, imbalances in passenger information across the modes may act as a barrier to passengers in accessing the full system's benefits. Information and communication technologies (ICTs) offer an avenue for information provision across all the hybrid network's modes that could make it easier for passengers to understand how to tap into the full network to meet their individual travel needs. Though these tools could empower more equitable access to the hybrid system through information, ICTs bring with them their own set of challenges in way of relevancy of content, access to the technology itself, and skills needed to use the technologies. This paper explores these potential limitations of ICTs through Amartya Sen's capability approach development framework to better understand how ICTs might enable people to utilise the different options within the hybrid system to meet their travel needs.

1. INTRODUCTION

Emerging cities are beginning to implement formal, scheduled systems to deliver more equitable mobility networks. Several of those cities that have already rolled out scheduled systems have even attempted to integrate these with existing unscheduled, paratransit systems acknowledging the need for both system types, with Cape Town in many ways leading this integration process (Ferro, Behrens and Wilkinson, 2013). In Cape Town, this resulting hybrid network integrates paratransit into the formal public transport journey options and can be seen as a means of moving closer towards access to more equitable mobility. Equity, in the context of transport, can be defined in terms of accessibility, where accessibility is, from the perspective of the individual public transport user, a combination of (1) the distribution of services, (2) opportunities these services connect to, and (3) the potential to utilise the services (Pereira et al., 2016).

Though Cape Town's hybrid system may be designed to ensure wide service coverage (CoCT, 2014a), information may play a role as a barrier to passengers' ability to understand how to best access and combine the different travel alternatives to make a journey that best suits their travel needs, whether that be in terms of cost, travel time, etc. Lyons et al. (2001) found that limited information access is as serious as a barrier to public transport use as barriers to physical access are. Given the complexity of Cape Town's

hundreds of routes and the gaps in existing and/or easy-to-use publicly accessible information on these services, the information public transport users readily can draw on is limited, thus potentially limiting users' knowledge of the full network's journey options (Simon, 1982; Chorus et al., 2007).

Information and communication technologies (ICTs) offer an avenue for providing information across complex transport systems, thereby breaking down the information barriers to accessing and using different modes. ICTs can offer information on multiple modes from different providers in a single source, reducing the cognitive effort required to acquire information on alternative modes and combinations thereof to move through the city (Kenyon and Lyons, 2003). In recent years a number of transport information tools, particularly for pre-trip planning, have entered the Cape Town market that provide passenger information to the users on scheduled systems (e.g. GoMetro app, TCT app, unofficial MyCiTi app by Byron Coetsee) and in at least one case paratransit (e.g. Public Transport App). These ICTs are examples of how information can be provided to help the user navigate the hybrid system – that is, access information on the different journey options the various modes offer and understand the links between modes to make transfers.

These emerging ICTs provide transparency and simplicity to journeys across the hybrid system, but also beg the question how the benefits of these ICTs may be restricted based on an individual's access to technology and ICT skills, and even by the relevancy and soundness of the information content itself. This paper draws on Amartya Sen's capability approach to explore how ICT can enable hybrid system use through access to transport information, thereby enhancing equitable access to mobility in Cape Town.

2. THE ROLE OF INFORMATION IN HYBRIDITY

Though initially the MyCiTi bus services were planned to replace overlapping minibus taxi (MBT) services, Cape Town has since turned to a hybrid system in which scheduled, formal and unscheduled, paratransit operators provide complementary services (Ferro, Behrens and Wilkinson, 2013). According to the city's Integrated Public Transport Network Plan 2032, a hybrid system is loosely described as the combined use of a scheduled trunk route service and an (for the most part) unscheduled feeder service, respectively supplying 80% and 20% of the population within a 500-metre walking radius of a service (CoCT, 2014a). The hybrid system is guided by the same overarching vision as for the original plan in which MBT are gradually replaced (CoCT, 2014b). It continues to embrace principles of equity at its core as initially presented in the City's Integrated Transport Plan 2006 – 2011, which stated the aim to "provide a world-class sustainable transport system that moves all its people and goods effectively, efficiently, safely and affordably" (CoCT, 2006).

In parts of the hybrid system where there is modal overlap in routes (such as a parallel bus rapid transit (BRT), conventional bus, and MBT route) or where multiple modes serve the same origin and destination pairs, the Cape Town's network has a wide range of choices and combinations of trips that have different travel characteristics, meaning that the journey choices people have are expanded to also include MyCiTi BRT in addition to MBT, bus, and train services. For example, both the MyCiTi and MBT service the route between upper Kloof Street in Gardens and offer transfers in direction of Sea Point. Take for example, a trip in the morning at 9:00am from upper Kloof Street in Gardens to Cape Quarter in De Waterkant. To minimise walking distance and trip duration, but at a higher cost, a combination of MyCiTi and MBT is recommended. Alternatively, if low fares are the

highest priority, then taking the MyCiTi with a saver fare is the best option, giving the user the additional choice to either take one MyCiTi and walk the final leg for a total time of 24 minutes (according to the timetables and Google Maps results) or wait to transfer to another bus for a total trip duration of up to roughly 32 minutes. If travel time is the highest priority, then using two MBTs is likely to result in a journey time less than the MyCiTi option, but at 234% greater the cost (MBT times recorded in separate private research for WhereIsMyTransport).

Without information on the many individual public transport modes and the connections between them, the traveller may make decisions with incomplete knowledge, potentially lessening their ability to make choices of higher quality that better suit their travel needs (Lyons et al., 2001; Chorus et al., 2007). For public transport users, information can aid in pre-trip planning and on-route decision making by informing passengers on routes, timetables, fares, etc. associated with various alternatives as well as service updates affecting their journey (Kramers, 2014). As seen in studies from European and North American contexts, travel information can help incentivise behavioural changes in users to act on alternative choices (Taylor and Bonsall, 2001; Lyons, 2001; Chorus, 2006). Further studies have found that ICTs for public transport users can incentivise behavioural change and increase user satisfaction through increased reliable pre-trip information such as fares, service frequency, and service disruption alerts during the trip (Abdel, 2001; Kramers, 2014).

In the past few years, ICTs have been entering Cape Town's market to offer public transport information for pre-trip and on-route planning purposes. Examples include GoMetro's app for Metrorail services, the TCT app for MyCiTi services launched in 2014 (now deprecated), and Moovit's partial data on several modes. Several multimodal apps are built on WhereIsMyTransport's journey planning platform for integrated formal and paratransit data which include Byron Coetsee's unofficial MyCiTi app for bus information and Public Transport App for information across both formal and paratransit services. Recent data collection efforts run by GoMetro and WhereIsMyTansport recorded information on paratransit systems – information which was previously acquired through personal experience or word-of-mouth knowledge – and made it possible to communicate route, frequency and fare information through digital means. Integrating this data with data on scheduled systems through journey planning tools gives the user quick access to journey options that would have otherwise required the user to consult multiple information sources and to calculate travel options themselves. Integrating information from multiple sources into one source reduces cognitive effort to access trip information on alternatives as opposed to individual sources, making information more accessible on alternatives (Kenyon and Lyons, 2003).

However, whom these ICTs may stand to benefit depends on the who can access them. Currently the aforementioned initiatives providing a level of multimodal information on the hybrid system require users to access the ICTs through the internet via either a computer, tablet, or smartphone. However according to the 2017 National General Household Survey, only 75% of respondents reported to have access to internet through one of home, phone or other mobile access services in contrast to the 97% who have access to a cellular phone (SSA, 2018). Of respondents who reported to use public transport at least once in the week prior to the survey, 74% have access to internet through one of those means (Ibid). Although it would seem the majority has access to internet, further research would be needed to investigate if all would use internet, particularly mobile data, to access transport information. Furthermore, given that roughly one-fourth of Cape Town's population does not have internet access through a computer, smartphone, or other

device, there needs to be a deeper understanding of how access to ICTs may or may not affect people's ability to use the information they may need to better access and use the hybrid system. This becomes a concern especially given the growing number of ICTs providing transport information and raises questions such as will information increasingly be communicated through ICTs to the point where certain information (e.g. journey planning) exists solely through specific ICTs (e.g. iPhone apps)? Is there a difference in the quality of information that one can access through print means, e.g. paper map, and digital means, e.g. online route map or real-time information on delays, deviations, etc.? Technology adds a new dimension to information, introducing concerns such as who has access to the technological tools and skills, and thereby the relevant content that can aid them in benefiting from the hybrid system.

3. CAPABILITY APPROACH AND THE HYBRID SYSTEM

Rather than consider issues of access to the hybrid system in economic terms, or ability to pay, Vasconcellos (2011) argues that transport equity and accessibility to services must be considered in social terms, or ability to use. Information is one dimension that affects individual knowledge of the network, and thereby can help reveal travel options available to the user. However, as discussed, transport information that is packaged in ICTs, while potentially powerful as a trip planner or as a source of en-route travel information, may not be equally accessible to all public transport users. To better understand how people's differing abilities to access and use ICTs affects their individual capacity to meaningfully harness ICTs to leverage the hybrid system to meet their mobility needs, ICTs for transport information should be evaluated with a consideration of how abilities affect access to use.

To understand the role of ICTs first requires stepping back to understand where and how information fits as an enabler between the hybrid system as a good and enhanced well-beings as the intended outcome. If the hybrid system offers different combinations of modes to traverse the city to get from point A to point B, then it can be said to offer choice as opposed to a unimodal system which may only offer one option for fares, travel times, etc. The hybrid system can then be seen to expand the options people have to mix and match these modes to meet their travel needs and preferences – or expanded capabilities.

The capability approach, first articulated by Amartya Sen, offers a theoretical framework (see Figure 1) to evaluate aspects of people's well-being enabled through Cape Town's hybrid system. As opposed to other development frameworks such as utilitarianism that position development as a measure of economic means, Sen's capability approach emphasises the need for the "expansion of 'capabilities' of persons to lead the kinds of lives they value" (1999: p.18). Sen uses the term 'capabilities' to refer to the collective set of options a person is free to choose from, whereas 'functionings' is a subset of these capabilities and "reflects the various things a person may value doing or being" (1999: p.75). The capabilities available to a person compose their well-being - what people are effectively able to do and to be. Expanding capability through the removal of obstacles to well-being is key to enabling freedom for people to lead the lives they choose.

This idea of obstacles is particularly key to the capability approach, as unlike more economic measures of development, knowing the goods people own or means they have access to is not sufficient to determining which potential functionings a person can achieve. What is important is an individual's ability to convert a mean - a good or service - into a functioning through personal, social and environmental conversion factors. As an example, in the context of transport where the mean is a train, the capabilities this service offers varies, extending to potentially include mobility (the freedom to move swiftly), social

participation (onboard engagements), etc. That the train has a station in a particular location is not what matters. What is important are the opportunities that the train represents. Because of this, it is the ability to access that train that needs to be assessed, as access requires more than physical proximity between the station and potential users. Conversion factors such as financial means to afford the train fare, physical ability to board the train from the platform, and shelter for when it rains while waiting for the train's arrival are aspects that determine whether or not an individual is able to make use of the train to achieve desired outcomes. While the means are important, they are not in and of themselves indicators of whether well-being can be positively affected. Furthermore, people with identical capability sets can choose to pursue different types and levels of achieved functionings, as they make different choices following their different ideas of the life they desire to achieve. Sen (1999) stresses that it is important not to limit what life options people choose to pursue. Rather, emphasis should be on providing means that do not present unmanageable barriers and are complementary to the personal, social, and environmental conditions present so that individuals can realise functionings that those means theoretically could enable.

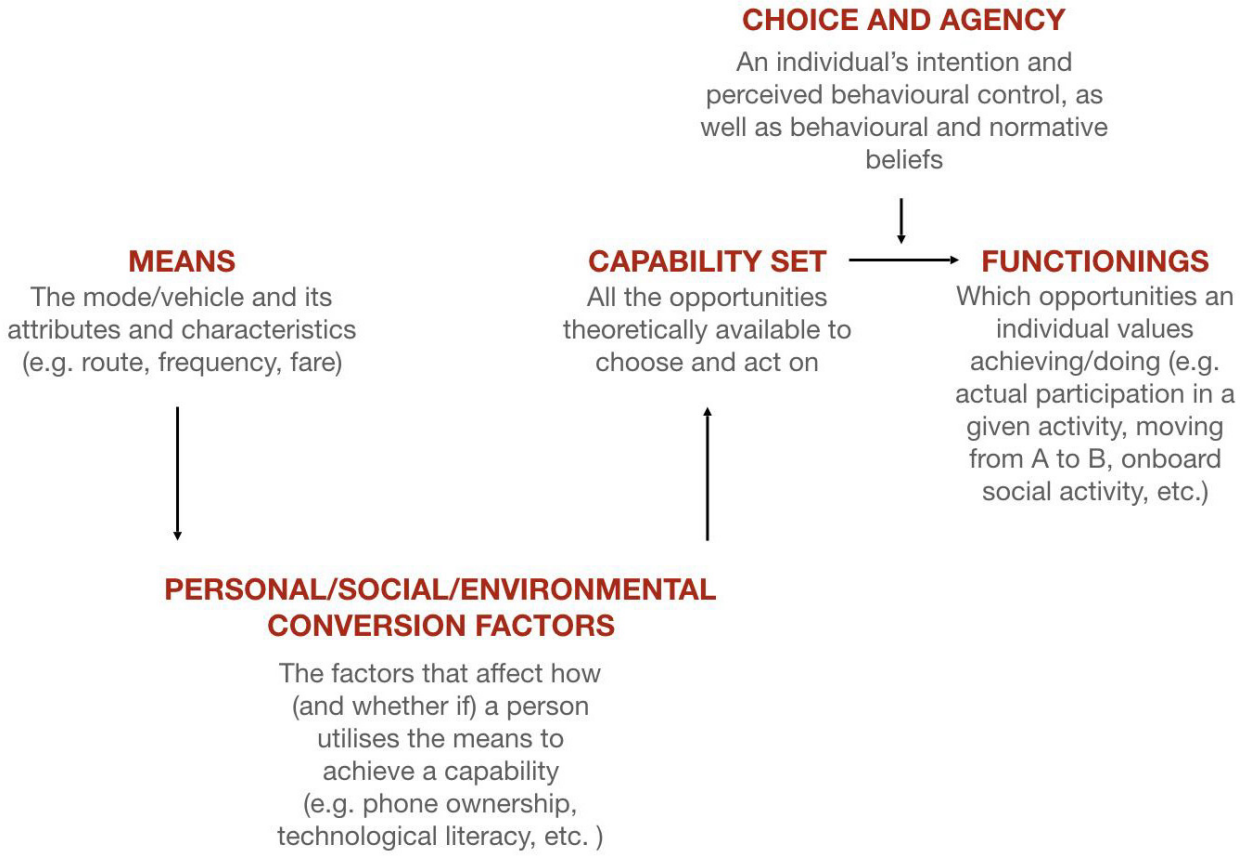

Figure 1: Capability Approach Framework

4. INFORMATION AND ICT IN THE CONTEXT OF THE CAPABILITY APPROACH

Information can act as an influencer on individual choice and agency, or capacity to act on free will, as well as a conversion factor in helping illuminate the different travel means available to access different opportunities in the city. In the context of Cape Town and the implementation of a more hybrid transport network, information or lack thereof affects people's understandings of the larger public transport network (Chorus et al., 2007) and aids in assessing the different combinations of journey options available to them (Kenyon and Lyons, 2003) to best achieve their desired functionings.

While the variety in travel choice that Cape Town's hybrid system offers could foster a more equitable mobility system, barriers to information may limit knowledge of choices available and thereby access to these journey choices. Moreover, the information available through ICTs on the hybrid system is not evenly distributed across modes (or, for that matter, even through non-ICT mediums such as route maps at stops, e.g. route information) and information tends to be biased in favour of scheduled modes. For example, there are several mobile applications - Moovit, Google Maps, MyCiTi Cape Town app - that provide timetable, fare, and stops information on trains and MyCiTi buses, but provide only partial, if at all, information on MBT and the Golden Arrow bus system. Such information sources all require access to physical hardware such as a phone or computer, barring people with no access to technology from this information. While information (e.g. timetables and routes) is provided in print at MyCiTi bus stops, information is considerably less available at stations/stops for other modes, making it difficult to access information on a single mode let alone make plans across multiple modes.

ICT can act as an enabler between the hybrid network and people's ability to navigate across its many travel options, if it is accessible to the user and its information content is relevant to the user's needs. In studies of ICT's impact on socio-economic development, Bjorn-Soren Gigler examined the ability of people to make use of ICT to achieve functionings. He introduces the terms 'informational capital', 'ICT capabilities', and 'informational capabilities' to place ICT's role for development within the framework of the capability approach. ICT capabilities and informational capabilities loosely refer to people's "freedom to use ICTs within the institutional and socio-economic setup of society" (Gigler, 2011: 8). Informational capital relates to the resources or assets a person has access to through the availability of information.

The relevance of available information and individual capability to contextualise the content within one's own socio-cultural context is what Gigler refers to as "informational capabilities" and underscores the increasing importance in identifying missing information bits that are critical to decision making processes in a particular context but not traditionally recorded such as on paratransit. In short, informational capability is the "combination between a person's existing livelihood resources in terms of information (information capital) and his/her agency (ability) to strengthen these assets and to use them in such a way that the use of information can help a person to transform his/her options in life in order to achieve the 'beings' and 'doings' a person would like to achieve" (Ibid., 8). Gigler expands that access to ICT in and of itself does not translate into positive outcomes, but access to ICT that meaningfully enhances people's informational capabilities is needed to impact well-being.

Furthermore, ICT must be adopted to match to both the technologies available and the skills of the intended users. Technology possesses a transformative nature, where any object can act as an enabler if it has the characteristics necessary for achieving desired functionings. Haenssgen and Ariana (2018) looked at the place of technology in the capability approach as transformative objects allowing individuals to engage in capability sets that are specific to geographical locations different to their own. They highlighted the potential influence different information formats, such as a map or mobile phone, can have in influencing the capabilities individuals can achieve. Delivering information that is both relevant and useful for enabling users to meaningfully use the hybrid system to suit their needs through ICTs that match their personal, social and environmental conversion factors is the essential final component in harnessing ICTs to realise a more equitable hybrid system.

5. CONCLUSION AND RECOMMENDATIONS

Cape Town's hybrid network poses information challenges as the network relies on both paratransit and formal modes with an uneven distribution of information publicly provided and accessible about their respective and interconnected services. Technology provides a platform for integrating information across disparate transport operators, and is an avenue for weaving together a system that can be understood as one continuous movement network. To enable such an information system that supports hybrid system use and a more equal distribution of information across populations, a multi-fold approach stemming from the capability approach should be taken. The first is that informational capital must be enhanced through access to information on both formal and paratransit systems. The second is a deep consideration of people's ICT capabilities or skills and technologies available to them. The third is ensuring that individuals can draw on the new information to enhance their ability to achieve the fullest understanding of the hybrid system necessary to achieve desired functionings. All of these considerations should precede the design and provision of technology itself, and should inform, rather than be dictated by, ICT implementations.

As Cape Town and other cities look to create hybrid systems through complementary formal and paratransit components, these three considerations can help inform which ICTs are best suited to distributing the benefits of access to transport information and thereby enhance people's ability to match travel options with travel needs. To better understand how information can better help people translate travel modes into mobility opportunities, further research needs to be done into several areas. While new technologies are entering the market to offer solutions to various transport challenges in emerging cities, there is limited research around how transport ICTs directly affect individual well-being in emerging contexts and in turn how ICTs affect people's abilities to move across formal and paratransit systems. Further research needs to be done into the information people need on scheduled and unscheduled modes within the context of a hybrid system, what ICT skills people in emerging contexts have to understand transport related information, the willingness of people in emerging cities to act on information to change travel patterns within a hybrid network, and what ICT tools are best suited to communicate information on hybrid systems while meeting users' ICT capabilities.

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