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Ride-sharing: A potential means to increase the quality and availability of motorised trips while discouraging private motor ownership in developing cities?

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ABSTRACT

Ride-sharing, although much older than many may think, has recently made a comeback through internet and smartphone (hailing) technology. The literature does not provide consensus regarding the (dis)benefits of ride-sharing. Furthermore, the limited number of studies identified are examples from the developed world, which are not necessarily transferable to the developing world context.

This paper estimates the potential for ride-sharing in Cape Town and its economic, social and environmental impacts. It was found that there were various potential ride-share markets. There are low-income households that are unlikely to own a car anytime soon. These households are potential users for ad-hoc trips that are currently dormant. Furthermore, there is a growing amount of people that omit using their own vehicle, but rather use ride-share services. In the long-term, this group might even give up the private vehicle.

For low-income households, the ride-share services mostly address a social need, where the potential impacts for high-income households are economic and environmental. The paper concludes with a systematic scoring of four modes on all economic, social and environmental issues, resulting in non-motorised transport and ride-share being positive, while private car and public transport are negative, in the developing world context.

1. Introduction

Many transportation systems around the world suffer from numerous externalities. Generally, the three most significant externalities are road collisions, congestion and the associated air pollution. Between 2003 and 2013, private car ownership in South African households increased from 25% to 35% (NHTS 2003; NHTS, 2013). Increased mobility demand in South Africa is due to three main phenomena – the population is still growing, currently at 1.6% (World Bank Data, 1960–2016), the number of trips per person per day is increasing (NHTS, 2003; NHTS, 2013) and, perhaps, most importantly, the middle class is growing significantly (Business Tech, 2015; Kotze et al., 2013). This rapid growth of transport demand and private vehicles in recent years has resulted in noticeable increases in congestion in the major cities in South Africa.

The user pay principle (see for example: West, 2005; Zhang & Lu, 2012) is one approach implemented internationally to reduce the negative externalities of motorised trips. Cordon based systems, such as the ones in London and Singapore, have been quite successful. However, in many cases, network wide tolling systems have been implemented, which do not address congestion, as such, but rather aim to generate implementation or maintenance financing. The acceptance of network wide tolling systems vary (Jones, 1995; Schade & Baum, 2007). In South Africa the first network wide road tolling system was implemented in the Gauteng Province (around Johannesburg), aiming to generate mainly maintenance funding. However, the Gauteng tolling system has faced huge public resistance and payment compliance is very low. In Cape Town, the public resistance to the tolling scheme, in the planning stages, resulted in a court case stopping implementation.

The implementation of public transport systems is arguably the most important alternative to private car use and its externalities. TransMilenio in Bogotá, for example, was credited with a 32% decrease in commute times, a 40% reduction in air pollution, and an 88% drop in traffic-related deaths along the BRT corridors (Muñoz-Raskin, 2010, pp. 72–84). In the South African context, however, choice users (individuals not restricted to cheap, uncomfortable, unsafe, and unsecure public transportation) are not part of the public transport user group (based on National Household Travel Survey (NHTS, 2013).

Recently, ride-sharing has (re)surfaced as a potential scheme to combat the private car use externalities. The notion of ride-sharing, or

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so called “shared mobility” is part of a broader concept often called the “sharing economy”. Shared mobility ranges from the *sharing of vehicles* through carsharing (e.g., Zipcar, car2go), as well as ride-sharing or ride-hailing (e.g., Uber, Lyft, also called Transport Network Companies (TNCs). The common feature of ride-hailing services is the ability for a traveller to request a driver and vehicle through a smartphone app whereby the traveller's location is provided to the driver through GPS (Clewlow & Mishra, 2017). The focus of this paper is commercial ride-sharing (not carsharing or carpooling by neighbours going to the same destination) using hailing technology. The hailing technology is recognised as an enabler but is not unpacked further.

Ride-sharing is much older than many may think. When Austria made an ultimatum to Serbia, in the last week of July 1914, the outbreak of World War I was imminent. The resulting fear in global market instability set off a massive financial panic. The recession that followed would have been significantly worse for the US economy, if it was not for the uptake of the automobile (Dayen, 2014). Due to the recession, entrepreneurs in San Francisco began offering seats in their cars for the same price as a street car fair, known as a jitney. Within nine months, the ‘jitney’ craze had spread all the way to Maine. By 1918, new liability regulations succeeded in reducing ride-sharing by 90% (Eckert & Hilton, 1972). Since then, ride-sharing's popularity has typically depended on government policy. Ride-sharing remained low in the US, until the federal government reversed tack during World War II. Facing the need to conserve resources for the war effort, there were various campaigns, trying to encourage drivers to take passengers along (Cozza, 2012). Interestingly, carpooling was promoted in cooperation with oil and car companies (Amey, 2011). The partnership between private industry and the government, along with the substantial ad campaign and sense of national emergency, proved extremely effective in changing consumer habits. However, ride-share diminished during the post-war economic boom. But government support picked up again in 1974 after the Oil Embargo (Cozza, 2012). According to the US Census Bureau, by 1980, 23.5% of Americans were carpooling. Participation again declined as the price of oil fell precipitously in the 1980s, disposable incomes rose, and government support disappeared, resulting in low carpool levels – the US Census Bureau reported 11% in 2011 (Cozza, 2012). In recent years, some governments have banned Uber and other hailing systems as the current legal systems fail to cater for client, employer and employee relationships.

The literature does not provide consensus regarding the (dis)benefits of ride-sharing. According to some (Alexander & González, 2015; Amey, 2004; Liu, Hong, & Zhang, 2016) successful ride-share schemes could reduce congestion and related fuel consumption and emissions during peak travel periods, reduce parking costs for travellers and employers, and provide a reliable alternate mode to private car ownership. However, Clewlow and Mishra (2017) found a decrease in public transport ridership and 49%–61% of ride-hailing trips would have not been made at all, according to their data. The latter could be seen as a negative impact in a developed world context where mobility poverty is less of an issue, however, in the developing context, ride-sharing might be the system needed to enable the poor. The daily average trip rate (for all purposes and all modes) in the Soweto Township, for example, is one trip per person per day (Case, 2013, pp. 1–188). In practice, this means that many do not make any trips, as commuters will make at least two trips a day. In comparison, countries, such as Finland, Germany, Italy, Sweden and Switzerland, report between 2.8 and 3.6 trips per person per day (Ahern et al., 2013). While public transportation hinders mobility and accessibility in South Africa, the traditionally low car ownership hinders mobility even further. This is an important difference to keep in mind when transferring knowledge from, for example, American cities, where even the lowest-income group of individuals (70% of households) are reported owning a car or having access to a car (Blumenberg, 2016). In South Africa, this is substantially different, as mentioned before. It is, therefore, very likely that the South African society reacts very differently to ride-sharing possibilities.

Developing countries have many micro-enterprises and some large firms, but far fewer small and medium enterprises. In high-income countries, small and medium enterprises (SMEs) are responsible for over 50% of GDP and over 60% of employment, but in low-income countries they are less than half of that: 30% of employment and 17% of GDP (Ayyagari, Beck, & Demirguc-Kunt, 2003). This SME gap is called the 'missing middle' (see Fig. 1).

In the South African context, the term ‘missing middle’ is used for ‘middle’ income households that do participate in the economy, but do not earn enough to take part in various (socio-economic) opportunities. Even access to higher education for children of these households has been questioned in the past two years.

The question for this paper is: which private vehicle owners and non-vehicle owners are able and willing to change to ride-share services? Various factors, such as life-cycle, socio-economic and gender-related factors are likely to enable these individuals to use ride-share, who would otherwise:

- use unsustainable modes (namely private car trips), due to the perception of traditional public transport being unsafe or uncomfortable (the NHTS (2013) identifies crime and reckless driving by bus and paratransit drivers as common reasons why public transport is not used),
- not make the trip, due to financial, safety or security reasons (the NHTS (2013) reports minibus taxi/bus too expensive).

Thus, the objective of this paper is to assess the ride-share potential in the developing world context. Cape Town is used as the case study, assessing the effect that increased ride-share would have on the society, the economy and the environment.

2. Research method

This study commenced with a literature review (see Fig. 2), which is mostly described in the introduction of this paper. The authors explored the history of ride-share, to gain insights into the current challenges and local context. The potential impacts of ride-share were also identified. This information was used to inform the analysis required to identify current ride-share in Cape Town and potential ride-share markets. Using the NHTS, mode shares, travel purposes and income levels, among others, were identified for various population groups. The NHTS is carried out once a decade in South Africa. Trend analyses between 2003 and 2013 were conducted, where necessary. In most cases, only 2013 data is reported upon. The authors have used the raw NHTS data to establish presented statistics. The South African Bureau of Statistics, together with the National Department of Transport, are responsible for the collection of the NHTS data.

In the second part of this study further literature was collected to identify key performance indicators related to ride-share. This was used to identify the potential for ride-share in Cape Town. As quantitative data is currently not available yet, a qualitative analysis is included in this paper. Ride-share assessments were based on feasible growth of these trips. The impact of increased ride-share, in the Cape Town context, was then established. The conclusions and recommendations were drawn from all previous steps.

3. Results

3.1. The current ride-share market in Cape Town

South Africa has a different reality to developed cities. As mentioned earlier, these main characteristics could include unsafe, inconvenient and often limited public transportation services, as well as a weak economy. These are fundamental differences to developed cities, which may be the reasons for the ride-share support in these circumstances. However, how important ride-share may become in South

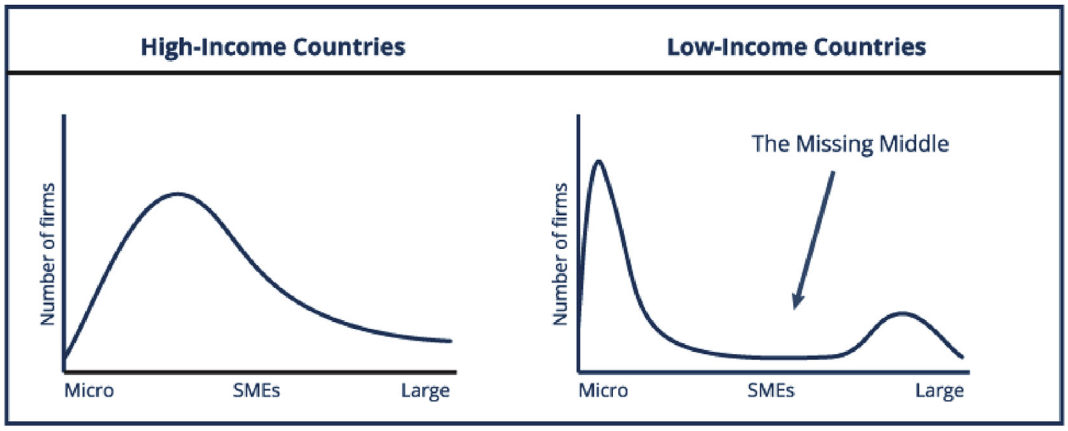

Fig. 1. International firm side distribution (source: Entrepreneurial finance lab research initiative, centre for international development at harvard university).

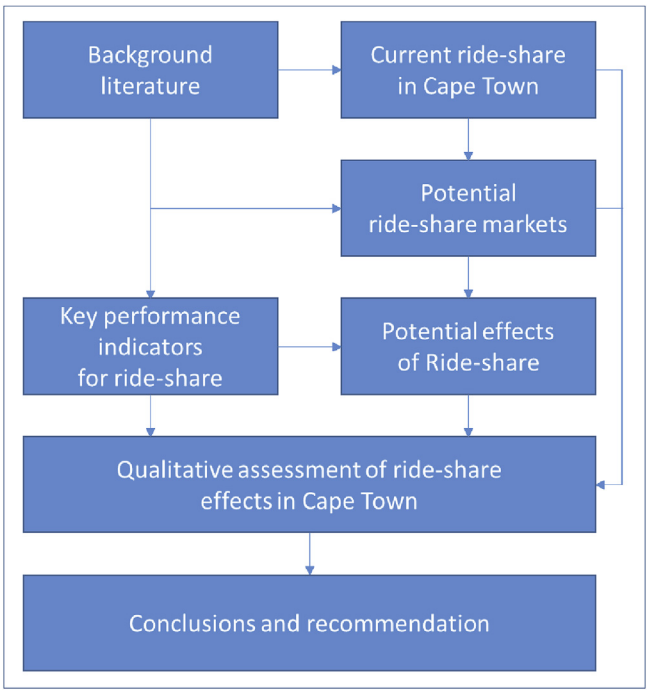

Fig. 2. Study approach.

Africa is not well understood or documented. The first step would be to determine the potential for ride-share through mobile platforms, using available data.

While it can be argued that ride-sharing is significantly different from the use of traditional minibus taxis, in South Africa they currently serve (close to) point-to-point transportation needs of individuals (over 65% of people can reach minibus taxi services within 5 min (NHTS, 2013), which is, essentially, what traditional taxi services provide. However, minibus taxi services serve various users at the same time. Traditional hailing systems don't do this. However, more recent options, such as UberPool and other more sustainable ride-sharing options that encourage increased car occupancy through the combination of ride request along the same corridor, include this feature. In the South African context ride-share pooling is still in its infancy.

Therefore, the assumption was that most ride-share users will come from the traditional taxi services (metered taxies and cash based short distance taxi services in townships (Sustainable Livelihoods Foundation and the Department of Political Science at the University of the Western Cape, 2013), called amaphela (i.e. cockroach)), plus other previously uncaptured users who were not satisfied with the traditional taxi service and prices. Additional users may be attracted to ride-sharing that was not previously captured by taxi services, however, due to the significant difference in costs between public transport trips and private motorised trips, it was assumed unlikely that it would be affordable for those reliant on public transportation trips, due to the large increase in cost to these individuals. One assumption that was made, is that it is more likely that individuals who would be able to afford ride-sharing prices (ride-share prices are less than the traditional metered taxis, which are very expensive and rare, but more expensive than the short distance taxi services in townships and more expensive than minibus taxis) and be willing to use these services in South Africa, would be switching from private motorised trips or would be induced/new trips. This change between transport modes are, possibly, due to increased convenience, safety, and availability that ride-sharing services offer. Private motorised trips are dominantly fulfilled by privately owned vehicles with a much smaller percentage being fulfilled by taxi services. Between 2003 and 2013, the total portion of traditional taxi trips in Cape Town was stable, around 2% of all trips (NHTS, 2003; NHTS, 2013). Given the lack of change between 2003 and 2013, the authors have used the 2013 database to produce any further statistics. The arrival of ride-sharing applications is, therefore, not included in the data sets. This is simply because ride-sharing, namely Uber, only began to be launched (Russell, 2013) after the publication of the last NHTS (2013).

Analysing for which trips people are likely to use ride-share, it became apparent that this is unlikely to be for work or educational purposes. Obviously, private arrangements (i.e. carpooling) are made where people give their 'neighbour' a lift. As indicated, this paper does not include an analysis on carpooling. However, commercial ride-share is not likely to be used to get to school or to work, although this would lead to the greatest reduction in vehicle kilometres travelled. However, this may be one aspect that is significantly different since the arrival of ride-sharing applications, due to the increased convenience of these services. However, due to the significant increased costs of these trips, which are often conducted during morning peak surge times, it is unlikely that these trips would be daily commutes for the majority of individuals. Commercial ride-share is likely to be used for infrequent trips – most commonly shopping (29%), medical services (14%), the welfare office (14%) to collect grants, the police station (14%) to report crimes, the municipal office (14%) to report issues with municipal services and financial services (14%). A mere 1% of people are likely to use ride-share to go to religious services (see Fig. 3).

Based on the established taxi trips, the potential for ride-share trips in Cape Town are mostly for short trips. From the data, it is estimated that 44% of trips would last 15 min or less, while another 47% of ride-share users' travel would be between 16 min and 30 min. A further 6% of ride-share trips could be between 31 min and 45 min and only 3% of trips are likely to last longer than 45 min.

The income analysis of these users reveals that most of them had a

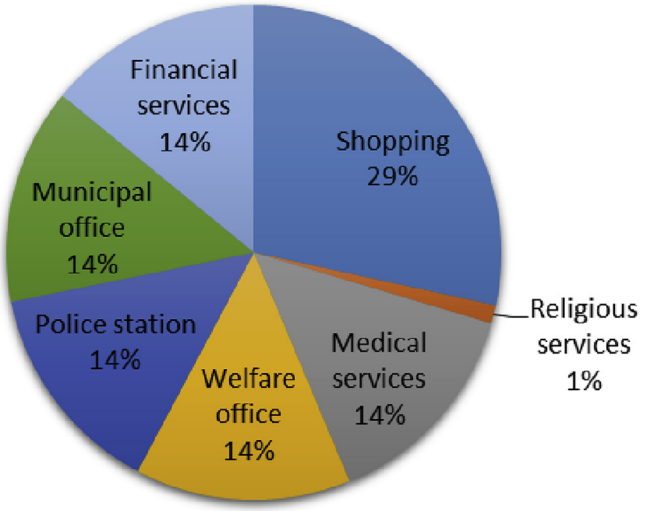

Fig. 3. Purpose of trips using ride-share (source: NHTS, 2013).

household income of less than R8 000 (NHTS, 2013) per month, which is approximately €560. These users are clearly part of the missing middle, although there are some cheap ride-share services in townships that are also utilised. Fig. 4 provides an overview of the income of ride-share users.

3.2. Potential ride-share markets

UberPool and uGoMyWay, among others, serve different markets then UberX, or other similar services. UberX will attract private car owners, due to the greater convenience and lower price than traditional metered taxis. UberPool and uGoMyWay potentially attract the missing middle that do not have the means to purchase a private vehicle yet. The level of disposable income and actual car ownership are, therefore, important indicators for the identification of potential homogenous user groups. Fig. 5 provides an overview of four income categories. The lower income group, earning on average R1 000 (approximately €70) per month, make up 40% of Cape Town households of the 1.068 million households, while the other income groups all represent 20% of households each.

Some 87.4% of low income households do not own a car. This group will continue to use the cheap ride-share services, available in the townships. Furthermore, they will continue to use these services for occasional trips (once a month or less) and, other than that, due to an increase in the population. It is very unlikely that this income group will use Uber. Even the households that have an average income of R3 000 (approximately €210) per month, are unlikely to use Uber. However, it is likely that service providers, like uGoMyWay, will draw these households towards their services, in the future, as this service is more affordable.

The second highest income quartiles, earning on average R6 000 per month (approximately €420) could, potentially, be Uber users, given the income spread among existing ride-share users. It is likely that the purpose of ride-sharing will still be occasional trips, as found in Section 3.1. However, the improved security and increased availability has started to see a use for educational trips (high school and higher education).

Almost 35% of high income families do not have a car in the household. The members of this group are the most likely to use Uber. However, when analysing the mode used by the high income quartile, it appears that 54% of people in these families are car drivers, while another 3% have company cars. Although this group might not own their own vehicles, they clearly have access to private cars. Currently, only 1% of the people in high income families use metered taxis (see Fig. 6). Despite the potential users of Uber in the high income households, there are no obvious fractions of this group that would start using Uber regularly.

For the income groups that do not have a high income, the average income varies from R300 (approximately €21) to R6 000 per month (€420). The modal share is very different (see Fig. 7). Walking (35%) and road based public transport (25%) are the most important modes, while car drivers only account for 15% of low income household members.

For the further analysis, the authors have selected all households that do not own a private vehicle, as they are most likely the early adopters of ride-share services. Furthermore, based on Fig. 4, it was concluded that members of households with an income of R8 000 (€560) or less per month, are most susceptible to ride-share, approximately 365 000 households in Cape Town. The authors hope to confirm this in the quantitative analysis. Taking into consideration that South Africa is struggling with economic growth, and has recently entered its second recession since adopting democracy in 1994 (Rossouw, 2017), this may be a conservative estimation. As mentioned earlier, economic

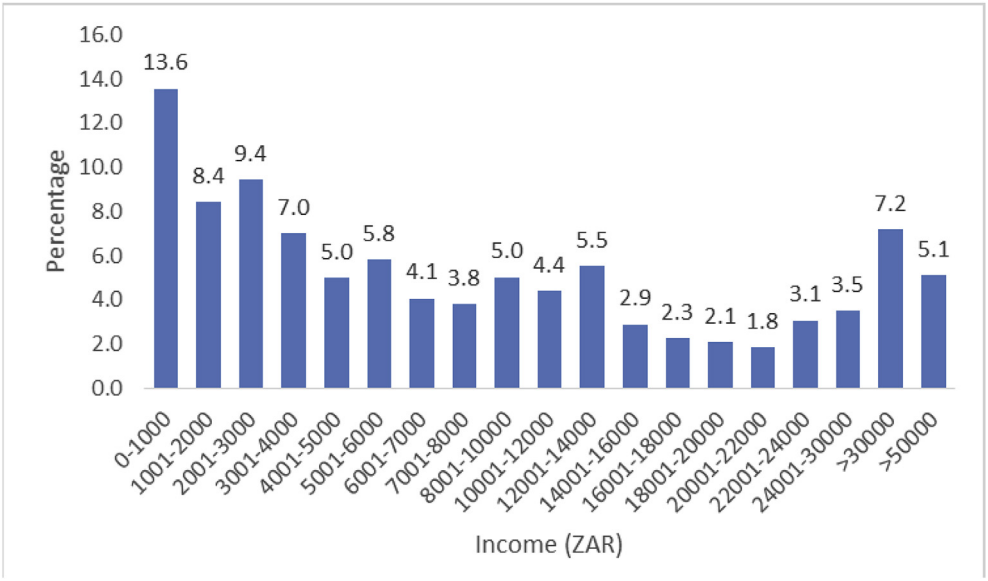

Fig. 4. Income category for potential ride-share users (source: NHTS, 2013).

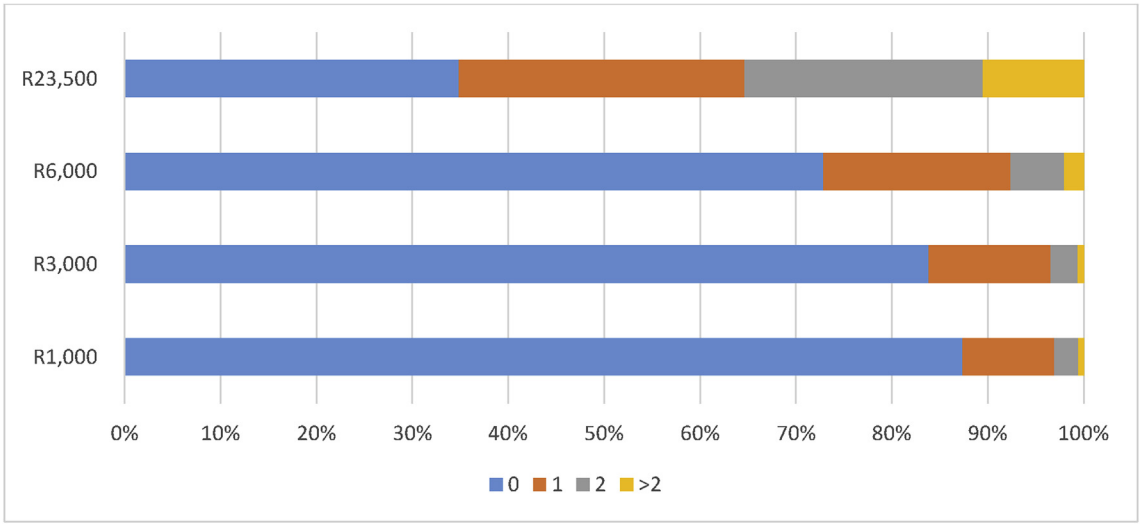

Fig. 5. Car Ownership for Different Income Groups in Cape Town, Average Income per Group is Displayed (Source: NHTS, 2013).

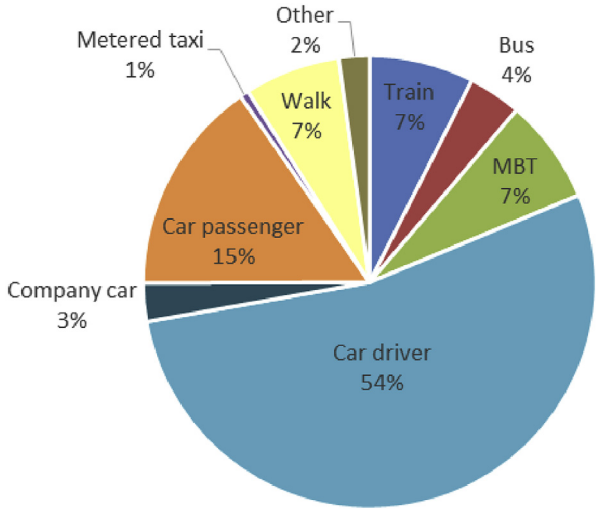

Fig. 6. Mode share for 20% highest income households in cape town (source: NHTS, 2013).

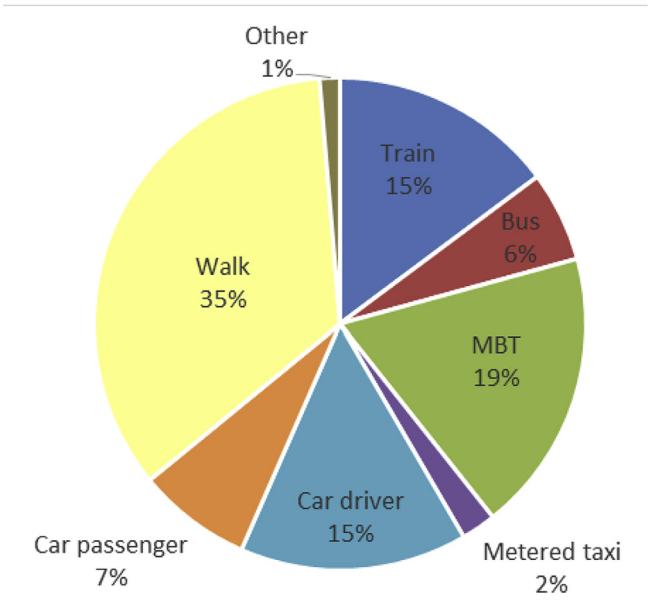

Fig. 7. Mode share for 80% low income households in cape town (source: NHTS, 2013).

downturn is one of the aspects that facilitated the "jitney" to grow, and is an aspect that may provide favourable conditions for ride-share to increase faster than expected in South Africa.

3.3. Potential effects of ride-share

The implementation or growth of ride-share systems has social, economic and environmental effects. A very important **social** benefit is the fact that users have additional travel options. In a city, such as Cape Town, where many are categorised as 'stranded', this is an important benefit. According to Rayle, Dai, Chan, Cervero, and Shaheen (2016) ride-share is filling the transport demand that was not previously served or was not served well. This contextual aspect of cities that do not have sufficient public transportation may be one of the most important aspects of supporting ride-share services to better meet the needs of individuals that do not have private vehicles. While developed cities have well-established public transport systems, this critical difference in developing cities may provide sufficient justification and reason to support ride-sharing, especially in the short-term.

Being a passenger in a ride-share vehicle is also less stressful than using other modes of transport, including public transport and walking, due to its related crime risk (although recent violence towards Uber drivers might counterbalance this advantage in the future). South African drivers are rated among the most aggressive (Lowenstein, 1997; Meel, 2007; Sukhai, 2006), and with congestion levels rising, aggression and frustration is likely to increase. Less frustration is directly related to productivity improvements and health benefits, according to the literature (Gupta & Star, 2014), although if Non-Motorised Transport (NMT) trips are replaced there could be negative health impacts. The decrease in pollution (see environmental benefits) lead to improved air quality. Improved air quality improves liveability and creates health benefits. Unfortunately, it is near impossible to quantify the benefits of increased choices, reduced frustration and improved liveability. However, health benefits of reduced air pollution have been quantified. Health benefits account for over 90 percent of total monetised benefits, according to Pearce (1996). Based on 1999 values, Hubbell (2001) valued the per capita benefits of air pollution reduction at $200.

Less pollution is only realistic if trips or congestion are reduced. Congestion reduction is likely, according to Alexander and González (2015). Empirical evidence shows Uber leads to a significant decrease in traffic congestion and carbon dioxide emissions in the urban areas of

the US (Liu et al., 2016). If the pollution reduction is due to a reduction in congestion levels, then there is also a time benefit for ride-share users. Travel time benefits can also occur for previous public transport users. However, inefficient ride-share driver behaviour could reduce or eliminate these benefits.

There are other social benefits that are also quantifiable. Ride-share has the potential of reducing road crashes, especially when drivers that are under the influence of alcohol or drugs choose to ride-share. Saving one life in South Africa has recently been quantified at R5.5 million (€385 000). However, in the US, the Jitney drivers were known to drive aggressively, and accidents were frequent. However, with the current ride-share services focusing on safety and customer satisfaction, most noticeably using rating systems that are now common in ride-sharing services, safe and responsible driving is strongly encouraged, while negative behaviour is quickly addressed. However, social issues remain, for example, the transport of female passengers raising concerns in some social circles (Hodges, 2006). Similar road safety and security issues occur in South Africa's public transport system, more specifically in the minibus taxi (paratransit) industry. Paratransit in Africa is characterised by accessible, cheap and flexible informal transport for the urban poor. Paratransit is, however, often characterised by low quality vehicles and chaotic management practices. If upmarket ride-share systems want to grow, these negative connotations need to be avoided.

A further benefit to the society, although on a micro level, is the potential reduction in costs. Fellows and Pitfield (2000) identified individual journey cost reductions. Furthermore, the cost of purchasing, maintaining, operating and insuring a private vehicle can be substantial. Parking costs are often mentioned, in addition to traditional vehicle ownership costs. The cost burden of owning vehicles is significant, especially for lower income households (Daus, 2016). Considering the severe differences in quality of life in South African cities, ride-share may be one way to address some of the inequalities for some of the individuals.

The **economic** impacts of ride-share are substantial. Centralised car ownership, also for ride-share purposes, should be more efficient than decentralised ownership (Amey, 2004). This creates economic (and possibly environmental – as there is a potential reduction in car manufacturing) benefits. Although specific to the developing world context, given the low toll payment compliance in Gauteng, for example, collection should be easier from companies, such as Uber, than from private vehicle owners, as Uber will recover the fees from ride-share users.

On the other hand, one of the government concerns related to the jitneys was the concern over safety and liability (New York Times, 1915). Furthermore, tax income is lost, due to tax avoidance (Eckert & Hilton, 1972); which is common in the South African paratransit industry too. Safety and security risks carry a significant economic burden. Furthermore, a decrease in public transport ridership creates a loss of revenue for the transport, due to any potential user shift that may occur.

There are many **environmental** impacts, related to ride-share systems. As mentioned, congestion reduction can lead to less air pollution and, therefore, contribute to global warming. If the trip length reduces, which is hard to prove, there will also be a fuel use reduction and, therefore, natural resource preservation. In San Francisco, ride-share has reduced car ownership, and encourages more judicious and selective use of cars for different trip purposes (Alexander & González, 2015; Daus, 2016; Liu et al., 2016). The opposite could also be the case, as ride-share could increase congested travel times (induced traffic) or move people back to private vehicles, due to ‘surge pricing’ (Daus, 2016; Schaller Consulting, 2017).

Furthermore, by providing more convenient, less expensive ride-sharing services, Uber and other such services may, potentially, divert NMT and public transport, with the risk of these modes being further marginalised (Alexander & González, 2015; Daus, 2016; Liu et al., 2016). Ride-sharing may result in higher traffic volumes and increased congestion as NMT and public transport are converting to ride-share trips (Alexander & González, 2015; Liu et al., 2016).

3.4. Qualitative calculation of ride-share effects for Cape Town

The content of this paper is partly based on PhD research that Ms Baufeldt is conducting. The aim is to validate the potential demand for ride-sharing identified in Section 3.2. However, the data collection phase still needs to commence. As an interim, it was decided to collect qualitative data based on expert opinion. The criteria values were based on a qualitative scoring by a team of experts. A total of 13 professional engineers, government officials and academics within Cape Town's transportation sector were approached. The experts were known to have at least 15 years' experience in the field of travel demand management and/or transport modelling. A total of seven specialists shared their opinions timeously for the finalisation of this paper. Their opinions were averaged and used. The authors are aware of the limited sample size, which may influence the results. However, the preliminary analysis gave interesting insides.

The aim of the PhD is to conduct a holistic assessment of the potential of ride-sharing in the Cape Town context. There are various methods that can be used to conduct holistic assessments, such as Cost Benefit Analysis (CBA), Multi Criteria Analysis (MCA) or Sustainable Livelihood Approach (SLA). Based on the fact that only qualitative data is available, at this stage, it was decided to conduct a MCA.

The criteria, considered in this assessment, are identified in Section 3.3. The only criteria that was not included was the ‘ease of collecting tolls’, as this is not applicable to the Cape Town context.

The values in the criteria were established in two ways. In some instances, it was possible to establish values for all four modes (car driver, road based public transport, NMT and ride-share). For other criteria, it was possible to calculate the difference between ride-share and the other modes, based on a mode shift. The mode shift calculations assume a 1% increase of ride-share. These trips are assumed to come from public transport (0.5%) and from NMT (0.5%). Given the income profile of likely ride-share users, a move of car drivers is not foreseen in the short term.

The qualitative information was used in a multi-criteria analysis based on the weighted sum theory (Vermeulen, 1986). In the weighted sum analysis, negative criteria will have a negative sign (−), while positive criteria will have a positive sign (+). The qualitative information ranged from triple negative to triple positive. For the standardisation, triple values are 1 (or −1), doubles are 0.66 (or −0.66) and a single value is 0.33 (or −0.33). The value 0 is used if the scenario value difference was calculated. Standardised values and the multi-criteria analysis result can be seen in Table 1.

Multi-criteria analysis also uses a weighting. During a previous research project, when an NMT assessment tool was developed, the Centre for Transport Studies at the University of Cape Town carried out an extensive literature review regarding criteria weighting, also specifically for Cape Town's context. In that study, health and economic criteria were valued twice as important as other criteria (Cooke, Baufeldt, Vanderschuren, & Zuidgeest, 2017). The authors decided to use the same principle in this study, as this weighting fits the local conditions and policy framework best. The applied weightings are also included in Table 1. Based on the weighted sum theory, all criteria values are multiplied with the weighting. The total values for each mode are displayed in the table.

Unexpectedly, there is a clear divide between the modes. Driving a car and using public transport in Cape Town is negative, taking all social, economic and environmental criteria into account. This is likely due to the highly inefficient and unsustainable nature of private motorised transport trips, while the safety, security and poor service of the public transportation trips also results in an unattractive result.

On the other hand, NMT and ride-share are positive when weighting all criteria. This may be because these modes have a better balance

Table 1
Ride-share qualitative multi-criteria analysis based on expert input (n = 7).

Category	Criteria	Car Driver	Public Transport	NMT	Ride-share	Weight (%)
Social	Travel options[1]	0	0	0	0.66	4.35
	Stress[2]	−1	−0.66	−0.33	0	4.35
	Productivity (personal income)[2]	−1	−0.66	−0.3	0.66	4.35
	Liveability[2]	−1	−0.66	−0.33	0.66	4.35
	Health[2]	0	0.33	0.66	0	8.70
	Crime[2]	−0.33	−1	−0.66	−0.33	4.35
	Travel time[2]	0	−0.33	−0.66	0.66	4.35
	Safety[1]	0	0	0	1	4.35
	Costs[2]	0	0.66	1	−0.33	8.70
Economic	Centralised fleet[2]	0	−0.33	0	0.33	8.70
	Liability[1]	0	0	0	−0.33	8.70
	Tax avoidance[2]	0	−0.66	0	0	8.70
	Economic burden of safety[1]	0	0	0	1	8.70
Environmental	Air pollution[2]	0	−0.33	0	−0.66	4.35
	Global warming[2]	0	−0.33	0	−0.66	4.35
	Diversion from sustainable modes[2]	0	0.66	1	−0.66	4.35
	Congestion[1]	0	0	0	−0.66	4.35
[1] = Delta, [2] = Standard	Total	−14.4783	−14.3913	8.73913	8.7391304	100

between convenience, cost and comfort, while also producing less negative externalities. NMT, especially, is likely to be more positive, due to the sustainable nature of the trips, as well as the health benefits of these trips to the individuals.

Driving a private vehicle and public transport are negative, whereas NMT and ride-share are positive. It is quite astonishing that the negative values in Table 1 are almost identical and that the positive values are also almost the same. Whether ride-sharing could also encourage NMT trips within the Cape Town context is yet to be proven. However, it stands to reason that if a non-private car owner, who is a choice user using ride-share, is likely to start completing shorter trips by NMT means, it is assumed that they are secure in knowing that for longer or undesirable walking trips, these can be reliably and conveniently fulfilled by ride-sharing.

4. Discussion

Ride-share is not a new concept, neither globally nor in South Africa. The introduction of the internet and smartphone technology have increased the accessibility of ride-share systems. At the start of this paper two potential user groups were identified, i.e. the mobility poor that now have improved information on 'affordable' mobility, and choice travellers, which are concerned about the security of shared transport. The potential move towards ride-sharing by the mobility poor has been proven on the analysis of current (NHTS, 2013) ride-share use and potential shifts.

Decision making by choice travellers, in the developing world context, is fundamentally different to the developed world, as the level of safety, security and comfort of alternative modes does not meet the choice traveller's minimum requirements. For choice travellers, in the South African context, ride-share services have only become interesting due to the security improvements provided by mobile app services offered by TNCs. Actual and perceived security risks play a major role in mobility choices (mode, route etc.) these travellers make.

The latter needs to be kept in mind when exploring the acceptance of new technologies in the developed versus the developing world. A promising recent development, for example, is Mobility as a Service (MaaS). Maas is a personalised, one-stop travel management platform digitally unifying trip creation, purchase and delivery across all modes (Wong, Hensher, & Mulley, 2017). This could even include access to services that reduce the disutility of travel by providing improved services while travelling (such as wifi, the possibility to have a shower, etc.). Due to the contextual differences, the adaptability of choice travellers to these improved services is likely to differ between the developed and developing world.

5. Conclusions and recommendations

Analysing the potential ride-share market, it became clear that:

- Acceptability in the developed and the developing world is very different,
- The mobility poor and choice travellers accept the new technology for different reasons,
- This mode is not likely to be used for work or educational trip purposes,
- This mode is mostly used for shopping and access to services (medical, welfare, municipal, financial and the police station).

When assessing the homogeneous income groups that potentially use ride-share, households with an income up to R8 000 per month (€560), i.e. the mobility poor, are most likely to shift. Based on the NHTS (2013) these income groups represent approximately 365 000 households in Cape Town, accounting for approximately 1.278 million people.

The literature revealed 17 criteria in the social, economic and environmental categories that are applicable to Cape Town (see Table 1 for more information). Based on the qualitative analysis of the average values for these criteria, provided by a group of seven experts, it was established, through a multi-criteria analysis, that the overall scores for car driver and public transport are extremely negative, while the scores for NMT and ride-share are relatively positive. Unexpectedly, the scores for NMT and ride-share are almost identical.

The MCA was done based on qualitative expert opinion. The authors are aware that a full data collection exercise is required before any results can be used in practice. The results presented in this paper, therefore, need to be interpreted as an indicative result, which may be interpreted that ride-sharing, even in its most unsustainable form, may have an important short-term role in meeting the needs of individuals in developing cities.

Additionally, considering the growing transport demand in Cape Town, the increased transportation supply should help individuals

optimise their time and travel costs while, hopefully, reducing stress and increasing comfort as per the individual's needs. New technologies, such as MaaS, are likely to play a role. However, the acceptability for users in the developing world context needs to be investigated further.

The authors hope that this paper will contribute to the discussion around ride-sharing research and the various possible future transport solutions. Although the applied method has shortfalls, it has proven to be a useful tool in situations where limited data is shared or available.

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