Co-producing urban transport systems: adapting a global model in Dar es Salaam

Malve Jacobsen

Department of Geography, University of Bonn, Bonn, Germany

ABSTRACT

By advancing a socio-technical perspective on transport and mobility, this article traces the realization of bus rapid transit (BRT) in Dar es Salaam, Tanzania. Referring to the framework of co-production, it is argued that transport systems can only come into being through the flexible interaction of humans and technology. Global consultants claim that BRT is an ideal choice for cities that strive for affordable, fast, and sustainable solutions in times of climate change and urban growth because this model enables a rapid and sustainable transition of urban transport. In practice, BRT systems often do not come into existence as planned and do not fulfill the promises offered by consultants who are often involved in their conception and construction. Drawing on interviews and participatory observation, this article elaborates how the recently implemented BRT system in Dar es Salaam depends on the interaction of technology and society. It is only because humans took over when "smart" technologies were dysfunctional or absent that BRT operations could be secured and contribute to a transition of the city’s transport sector. Accordingly, a sustainable transition depends more on socio-technical practices, the fluidity of the system, and the adaptation of its users rather than on global standards or technological innovation.

Introduction

While debates on smart and sustainable mobility are not new, they have gained momentum in recent years and both “smart” and “sustainable” have become buzzwords in transport research and planning. More specifically, “Smart Mobility is often presented as one of the main options to seek more sustainable transport systems” (Benevolo et al. 2016, 16; see also Zawieska and Pieriegud 2018). Deriving from transport and mobility research, the sustainable mobility paradigm (Banister 2008) and the new mobilities paradigm (Sheller and Urry 2006; see also Cresswell 2011, 2010) invite efforts to go beyond classic approaches of transport research. Integrating the mobility of people, things, and ideas across spatial and temporal scales facilitates understanding that “transport is now enmeshed in other forms of circulation and flow” (Schwanen 2016, 132).

Another recent development of transport and mobility debates is the opening toward countries of the Global South. Researchers leading these discussions have come to realize that transport in urban Africa, Asia and Latin America is not just about bicycle Rickshaws, broken minibuses, and unplanned stations. Schwanen (2018, 2) problematizes the “historical hegemony of predominantly western worldviews, concepts, theories, methods and research practices” (see also Cresswell 2016). However, theorizing from the Global South and postcolonial endeavors still struggles for acknowledgement in mobilities research and transport geography. Scholars tend to draw a vague line between how urban transport is differently organized in the Global South and Global North. The main tendency is expressed in the distinct modal shares. The majority of cities in the Global North have high use of private vehicles and integrated public transport systems that are subsidized by the state. In contrast, urban transport in the Global South is often characterized by a high rate of non-motorized transport (i.e., pedestrians and bicycles) and public transport systems that are organized on a decentralized basis, comprising minibuses and (old) rail networks. Urban centers in the Global South have applied numerous innovative transport concepts for improving air quality, increasing traffic safety, and supporting affordable public transport. However, storytelling persists about “the backlog of investment
in transport and continued rapid urbanization” (Pirie 2014, 133; see also UN Habitat 2013) in cities of the Global South.

Nonetheless, transport and mobility is progressively appearing as a central topic in global discourse. Politicians and consultants increasingly consider urban transport as an opportunity to foster sustainable development worldwide so that international organizations and development cooperation agencies actively engage in the field of urban mobility. Moreover, sustainable development has become the official task for governments worldwide. With the sustainable development goals (SDGs), international organizations have finally succeeded in integrating urban mobility on the United Nations agenda (UN Habitat 2015). As this political attention has practical implications, the Institute for Transportation and Development Policy (ITDP) describes the integration as an “historical step” (ITDP 2016). Particularly in urban Africa, development cooperation agencies, UN Habitat, and ITDP have implemented various programs for sustainable development during the last decade, addressing explicitly public transport. Programs aim to strengthen means of transport characterized by low-carbon emissions: non-motorized transport, public transport, and e-mobility. Because decarbonizing transport might be achieved by combining economic, planning and technological solutions (c.f. Banister 2011), these means of mobility have found fertile ground in times of global agendas centered on the reduction of greenhouse-gas emissions (GHGs).

This article addresses questions centered on how sustainable transport systems are introduced into urban Africa. Taking the case of bus rapid transit (BRT) in Dar es Salaam, Tanzania, it elaborates on how the co-work of different technologies and humans enables a sustainable transition of urban transport. After presenting the state of research on BRT in the Global South and the methodology used in this study, the next section of this article delineates how planners and politicians focus on the (assumed) benefits of BRT technologies for improving urban transport. Taking a closer look, the question arises whether transport technologies like an intelligent transport system (ITS) indeed realize their promise in terms of scheduling, ticketing, and information provisioning, and how they interact with prevalent practices and mobility cultures.

**Research on BRT in the Global South**

Despite the spread of BRT systems in the Global South since the early 2000s, this transport model is a comparatively new research topic in the social sciences. Most academic work has addressed BRT projects in Latin America because the first popular systems were implemented in Curitiba, Bogotá, and Quito. To date, only a handful of scholars (Jacobsen 2015, 2020; Rizzo 2017, 2018) have conducted in-depth research on Dar es Salaam’s BRT system. From a Marxist perspective, Rizzo discusses the city’s BRT system in relation to the local minibus system, emphasizing the role of labor and neoliberalism. In addition, Joseph et al. (2020), and Mfinanga and Madinda (2016) studied the BRT in Dar es Salaam in the context of the city’s minibus system and its transition.

Work on BRT systems has been primarily carried out by transport scholars and geographers, and they have focused primarily on the practical aspects of different operations and occasionally employed more analytical approaches. Practically oriented research on BRT in the Global South has been mainly inspired by classic transport and governance studies (see e.g., Ferbrache 2019; Höhnke 2012; Muñoz and Paget-Seekins 2016; Poku-Boansi and Marsden 2018). These researchers have been concerned with the (mal-)functioning of individual BRT systems and some studies have relied on comparative approaches. Key topics have been BRT’s potential to catalyze a transition from so-called informal transit to centrally organized public transport modes (e.g., Pojani and Stead 2018; Vergel-Tovar 2018) and to enhance social equity and access to public transport (e.g., Vecchio 2017; Venter et al. 2017). Other issues have included the relationship of these systems to land-use planning and urban development, as well as their role in managing mega events (e.g., Ferranti et al. 2020; Kassens-Noor et al. 2018; Wood 2019). The generally applied character of many research projects has led to recommendations of how to improve BRTs and normative statements on how to enhance the BRT model and success of specific BRT systems (e.g., Mallqui and Pojani 2017; Nguyen and Pojani 2018). A more critical approach has looked at the circulation of BRT policies within the Global South, since BRT has become one of the most prominent examples of mobilities policy research (see Ardila 2020; Jacobsen 2020; Wood 2014a, 2014b). This body of literature discusses questions of political power by critically investigating the impact of policy mobilizers such as consultancies and think tanks and the role of knowledge and best practices. For instance, Wood (2014a) elaborates on how South African cities learned about the BRT system from their South American counterparts which is a process that has been strongly shaped by so-called global BRT experts.

Hence, research on BRT in the Global South deals either with more technical questions of how to
plan and operate the systems or with political questions on the distribution of the global model. Only a relatively small body of literature has sought to link the technical, social, and political dimensions of BRTs (Jacobsen 2017; Ureta 2014, 2015). Combining perspectives from science and technology studies (STS) with mobility studies, work by Jacobsen (2020) focused on BRT systems in the Global South, taking Dar es Salaam as a starting point from which to bridge the gap between global diffusion of the BRT model and local infrastructure politics. This article demonstrates one aspect of this broader research project by focusing on the socio-technical practices in Dar es Salaam that enabled the BRT system to come into existence. Using the concept of co-production, I show how the operation of this transport model depends on socio-technical interaction and that we need to regard the technical features of these systems as active and fluid actors in urban transport.

Methodology

This article draws on empirical research conducted between 2015 and 2019 in the context of a broader project on policy assembling in urban Africa. I was concerned with mobility in two respects: the Dar es Salaam Rapid Transit (DART) as an urban system of mobility and BRT as a globally mobile policy model. The main field work was carried out in Dar es Salaam in 2015 and 2016 and I closely investigated implementation of the policy model in the East African city. Rather than being a straightforward process of description, I understand ethnography as a way to problematize the world that includes ambivalence and multiplicity (see Hine 2007; O’Reilly 2009). Using ethnographic methods, I participated in and observed the system’s becoming and stabilization, spoke with numerous passengers, transport operators, local politicians, and international consultants. I followed different stages of planning, implementing, and operating DART, joining media-effective inaugural events and everyday operations. One key method that I applied was “riding along” – a hybrid between participant observation and interviewing – which aims to access aspects of lived experience in situ in order to understand how individuals engage with their physical and social environments (Kusenbach 2003; see also Bissell 2010). I traveled with the buses along the corridor and spent many hours at depots, stations, and terminals. Every day in the Tanzanian metropolis, I took field notes and photographs. I conducted 75 guideline-based interviews and fully transcribed them. Since 2015, I also followed local media and was a member of a WhatsApp group that serves as a discussion and information platform for politicians, consultants, and operators concerning DART’s milestones and the system’s general issues of operation. I processed field notes, interviews, newspaper articles, policy documents, and WhatsApp chats with computer-assisted qualitative data-analysis software and developed a coding system.

Bus rapid transit: No alternative?

A global BRT consultant told me in 2015 that African cities had “no other option than doing a BRT if they want to remain functional.” As one of the fastest growing cities in Sub-Saharan Africa, the need for mobility has been rising rapidly in Dar es Salaam. At the same time, neither urban roads nor public transport has been extended and sufficiently improved (Melbye et al. 2015; Mkalawa and Haixiao 2014). As a side effect of economic growth and an expanding middle class, private car ownership has been steadily increasing (NBS 2013, 26; Salon and Aligula 2012, 72). However, the ownership of private cars is still comparatively low with only 11% of trips involving such vehicles, whereas 62% of trips are carried out by minibus (Behrens, McCormick, and Mfinanga 2016; Nkurunziza et al. 2012, 13). The continuous increase of private cars on the roads, as well as rapidly rising volumes of people and goods traveling to and through the city, has made congestion a serious problem within the urban agglomeration (Mirailles 2012, 8; Msigwa 2013, 22).

The Tanzanian government’s major decision on restructurizing Dar es Salaam’s roads and the city’s transport sector already fell for a BRT system in the early 2000s after global consultants offered the city council the opportunity to be one of Africa’s pilot cities for BRT (see Figure 1). The Tanzanian government formulated the “DART mission” for the first BRT system in the country called DART with the intention to improve urban mobility by providing accessible and affordable transport, to reduce poverty, to lead to sustainable economic growth, and to improve living standards (DART Agency 2018).

Traveling technocrats (see Larner and Laurie 2010) from the World Bank, international transport consultancies like ITDP, and the Colombian politician Enrique Peñalosa have in recent years been promoting the multiple benefits of BRT, particularly in the Global South. This BRT “consultocracy” (Ward 2011, 76; see also Prince 2012) consists of a relatively small number of protagonists that share the common goal of implementing BRT systems across cities of the Global South, standardizing the global model and “making buses sexier” (Peñalosa
According to these BRT proponents, BRT systems bring the advantages of rail systems to the road: They are a centrally operated high-capacity transport systems, with pre-board payment and buses on so-called dedicated lanes, which enable the buses to operate independently from traffic (ITDP 2018b). ITDP is the central organ of this network, self-represented as a nongovernmental organization (NGO) that provides advocacy on sustainable transport (ITDP 2018d), holding strong ties with development banks and favoring BRT over rail (Jacobsen 2015; Wood 2015). ITDP attributes BRT with high-quality transport services that “make cities more livable, inclusive, accessible and sustainable” (ITDP 2018a). The other BRT protagonist, Peñalosa, was the mayor of Bogotá (serving two nonconsecutive terms) and the city’s BRT system Transmilenio has achieved the globally distributed stature of a best practice BRT. In public talks, he explains how BRT produces new social values because the system prioritizes people instead of cars. He aims at transforming cities by advising city officials “on how to build sustainable cities that cannot only survive but thrive in the future” (TED 2013). Other famous BRT proponents promise that “BRT is not just about transporting people... BRT has shown to be an effective catalyst to help transform cities into more livable and human-friendly environments” (Wright and Hook 2007, ii–iii). Thus, the BRT consultocracy equates public transport with BRT, links BRT and sustainability, and ignores rail-based systems that could contribute to a sustainable transition of urban transport.

BRT has become a model of success in the last two decades. This achievement is not only due to political support and constant storytelling, but also because this model actually fits well into recent demands of the Global South. The model promises high quality at low cost: a rapid transition of urban transport through rapid buses on dedicated lanes. In most of these cities, BRTs replace minibus systems once the transport demand exceeds their capacity (see Figure 2). Dar es Salaam has become one of those cities, being hallmark by severe congestion problems that have led not only to loss of time for people on the road, but also to air and noise pollution. Consequently, the Tanzanian country director of the World Bank has presented BRT as a necessity for the city: “The BRT is one of the most critical investments that can be made in Dar es Salaam, given the high rate of growth of the city” (World Bank 2017). BRT proponents moreover legitimize this mode of transport by enhancing the advantages of the system’s technology: the application of an ITS with real-time data analysis distinguishes BRTs from minibus systems, which in contrast are described as chaotic, uncomfortable, and unreliable (Hertel 2008; see also Rizzo 2017).

That BRT has become “the vogue” in the Global South (Pirie 2014, 136) can be explained not only by the BRT consultocracy, but also by the urgent need to make urban areas more sustainable in terms
of reducing GHGs. The consultants’ definition of BRT is strongly focused on technical characteristics like the off-board fare-collection system, dedicated lanes, and high-capacity buses, as well as the system’s potential to foster social, ecological, and economic sustainability. However, BRT proponents do not clarify the details of this particular conception of sustainable development. In order to make DART globally recognizable and to demonstrate the system’s sustainability, ITDP honored Dar es Salaam with its Sustainable Transport Award in 2017 (ITDP 2018a). The organization speaks highly of the manifold changes that the BRT corridor has (supposedly) brought to Dar es Salaam, implying social and economic progress:

Dar es Salaam’s sustainable transport corridor is a watershed moment for East African cities. Citizens for the first time are experiencing truly dignified, safe, healthy experiences as they walk, cycle, and take public transit. Women often outnumber men on the BRT, which serves markets, job centers, schools, neighborhoods. It’s the lifeblood of the city (ITDP 2018c).

Taking a step back, the image of the sustainable BRT model, as well as the sustainable DART system, begins to crumble. Most BRT systems run with combustion engines because investing in e-vehicle bus fleets or constructing rail structures is not feasible (yet), be it in Bogotá, Jakarta, or Dar es Salaam (Poon 2018; UITP 2019). In addition, BRT systems have difficulties realizing a modal shift and reaching the users of private cars – the majority of BRT passengers are former minibus users (Satienannam et al. 2016). Also in Dar es Salaam, private car ownership continues to increase despite the new BRT system. To counter these trends, non-motorized transport facilities like pedestrian footpaths and bike parking at stations are increasingly included in BRT planning.

In the light of ongoing urbanization, BRT’s limited passenger capacity is the key counterargument of BRT opponents. Transport planners told me that BRT can only satisfactorily serve cities with a population of less than six million, if it is the primary means of public transport. Hence, many city governments see BRT as a short- or medium-term solution due to its limits in passenger capacity, and maintain plans for a metro system in the long run – including Bogotá (Bernhardt 2019). Moreover, many BRT systems do not deliver on what they promise in terms of absorbing the minibus workforce (see Rizzo 2015, 2017). In Dar es Salaam, only one powerful minibus company was integrated as a bus operator into the DART project, and compensation did not reach the minibus drivers and conductors, but only the minibus-company owners (Jacobsen 2020). Another important factor is the physical infrastructure itself, which not only has to be built, but also to be maintained and repaired. As a result of little investment in these activities, numerous BRT systems look older than they are. Also DART’s buses, stations, and lanes have been prematurely ageing so that transport consultants questioned whether the calculated lifespan of twelve years for the buses and thirty years for the concrete corridor will actually be reached. Another concern is the network itself: DART was planned as an integrated bus system that spans over the whole city, operating on the main axes. After almost twenty years of planning, only one of six phases is operational with limited feeder services. Minibus services continue to operate parallel to DART, and while construction of the second phase started in 2019, it

Figure 2. Minibuses leaving a bus terminal in Dar es Salaam (author’s photo).
remains uncertain whether all six phases of the project will be fully realized as initially planned (DART Agency 2019).

**Global models: mobilization and co-production**

Global BRT consultants aim to standardize this transport model to make it similar in various cities (see ITDP 2016, 2017). However, many BRT systems are not fully implemented according to the global BRT standard or in accordance with their own designs. The distribution of models and plans to different contexts involves displacement and adaptation, and integrating them into a specific context involves several steps of translation. As a technology’s script can only represent the particular context in which it was developed, it has to mutate so that it can be adapted to other circumstances (Callon 1986). By implication, policy mobilization and adaptation is only possible through the model’s inherent flexibility. De Laet and Mol (2000) argue that the more fluid a technology is, the more successful it can be in terms of its adaptation and use (see also De Laet 2000). Hence, the process of planning, implementing, and operating an urban transport system is characterized by fluidity and mutation. Only if all actors involved – humans as well as technologies – agree on flexible adaptation, can the new system be integrated into the socio-technical landscape.

In terms of knowledge production and circulation, the mutual dependence and the co-production of nature, technology, and society comes into effect (Jasanoff 2015). Co-production is discussed in the academic fields of STS, sustainability science, and public administration – with different foci, but united by the idea that users and citizens can effectively contribute to the production of knowledge and how this knowledge is put into practice. While the notion of citizens as co-producers of public services still seemed “quite odd” for public administration in the 1980s (Whitaker 1980, 240; see also Brudney and England 1983), more recent research argues that practices of co-production lead to more inclusive and sustainable outcomes (Miller and Wyborn 2018). Co-production is a symmetrical approach in which agency is distributed between the technical and the social domains. However, power asymmetries among different human actors can exist so that certain ideas and practices prevail over others.

Jasanoff (2004) emphasizes that this approach criticizes the separation of culture, subjectivity, and politics from nature, reason, and policy. Linking back to core ideas of STS, this understanding sees knowledge and action as interdependent, which means that (technical) knowledge is embedded in and embeds the social: She writes

Co-production is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it. Knowledge and its material embodiments are at once products of social work and constitutive of forms of social life; society cannot function without knowledge any more than knowledge can exist without appropriate social supports (2–3).

Therefore, co-production also means that the users of a technology are its co-producers (see also Parks et al. 1981), and that users “de-scribe” technical devices designed by engineers (Akrich 1992; Akrich and Latour 1992). The mutual development of technologies can hence be linked to governance and questions of public participation.

The co-production approach might help in the development of more inclusive planning approaches that go beyond mere participation measures (Albrechts 2013; Mitlin 2008). However, Ureta (2015, 168) critically notes that researchers need to go “beyond the usual naïve claims about the benefits of ‘diversity’ and ‘participation.’” He stresses that participation also means exercising power, which consequently means that appreciating democracy is not sufficient. Instead of criticizing technocracy and discussing “the real needs versus utopian schemes” (162–163), it could be fruitful to first acknowledge the complexity and heterogeneity of (non)humans within a planning endeavor, as heterogeneity automatically goes along with struggle (see also Cruikshank 1999).

Applying the concept of co-production to mobility studies thus implies understanding users as co-producers of transport systems. The users of a BRT system are manifold and various and include not only passengers, but also station attendants, data analysts, bus drivers, government officials, global consultants, street vendors, and so forth. Referring to Latour’s principle of symmetry (1987), Pineda (2010) substantiates the co-production of a city and its public transport system. Taking the case of Bogotá’s BRT system Transmilenio he shows that neither the city nor the BRT system preexists the other, since they mutually form themselves.

**Co-producing BRT: empirical results**

The remaining parts of this article elaborate on the co-production of Dar es Salaam’s BRT system in the early days of its operation in 2016.

**The intelligent transport system**

By focusing on a key technical component of the BRT model – namely the ITS – it is demonstrated
that socio-technical practices in Dar es Salaam deviate from both the global BRT model and from DART-specific plans. This non-conformity is mainly due to DART’s incomplete ITS at the time the system was launched. However, through the flexible co-work of humans and technologies, DART has been operational despite the lack of supposedly essential technical components. It is further shown that DART is facilitating a transition of urban transport even though the new transport system resembles the city’s minibus system in various respects.

An ITS analyzes the location of buses (or trains), the number of passengers aboard, fares collected, and actual travel times so that service can be adapted according to real-time data. Transport scholars and practitioners claim that operating urban transport centrally enables an optimized utilization of the system. From their perspective, this does not only make economic sense, but also helps to reduce traffic, and hence to lower carbon emissions (see Nelson and Aditjandra 2012). Data are collected in and redistributed from an operations control center (OCC) so that the various users of the system – operators as well as passengers – are aware of the buses’ punctuality, the next station, and the route’s destination. Such a center is a “key site that enables the city’s infrastructural life by securing urban flows and maintaining the city’s circulations” (Luque-Ayala and Marvin 2016, 196) and ITDP (2018b) describes a BRT’s control center as the “brain that controls the nervous system.” This metaphor connotes that BRT cannot operate without an OCC. Also the Tanzanian BRT system was planned to be centrally organized from an OCC, as a bus-operations specialist explained to me a few months before the system’s inauguration:

> From the control room, we can monitor the service level of the buses, arrival and departure time, waiting time at the stations… On a larger scale, you need some good software, which will do the all-up management, the depot management, the bus management, the crew and staff management. A lot of things become part of the scheduling.

The buses themselves carry technological devices such as global position system (GPS) trackers and real-time displays, which are new to the majority of drivers and technicians working for the bus operator. In order to learn how to apply the ITS, Tanzanian workers participated in workshops in Brussels and experts from France and South Africa offered ITS trainings in Dar es Salaam. Particularly through its ideals on modernity, centrality, and control realized by the ITS, BRT demarcates itself from minibus systems. In this context, interactions between humans and transport technologies have changed fundamentally in Dar es Salaam, and will be changing continuously. However, long-established and new structures of the two systems co-exist because both systems operate in parallel. For instance, turnstiles with scanners for barcodes and smart cards regulate entry into the DART system, while minibus conductors process the payment transactions of minibuses. The three crucial activities of DART’s ITS – scheduling, ticketing, and information provisioning – have all been installed and used differently from initial plans and consultants’ advice.

### Scheduling

During the first months of DART operations in 2016, the OCC was not in place as planned. The heart of DART’s operations, the system’s “brain,” was only a corner with some desks and computers of an open-space office at the bus depot of the operator (see Figure 3). Communication and data exchange was not possible between control center, buses, and stations. Nevertheless, DART became operational without much chaos. Bus services were supplied despite absent computers, displays, fiber connections, software, and trained staff. This fluid adaptation was primarily enabled by operational staff that applied minibus practices to DART – the employees of the Tanzanian transport company were accustomed to operating without computer programs. So far, bus scheduling had been done with hand-written tables, if at all. Hence, DART’s drivers did not miss what was supposed to be displayed on the console of the bus, and the inactivity of the control center led to demand-based operations. In fact, the flexible handling of this challenging situation by scheduling DART’s services according to the actual demand was more beneficial for both passengers and the bus operator than following ready-made plans based on mere estimates.

Only the leading operations specialist found it difficult to deal with this form of scheduling. He had been specially employed to install DART’s OCC due to his experience creating the prestigious control center in the Indian city of Ahmedabad. His strategy differed considerably from the approach of the operator in Dar es Salaam. The specialist was desperately waiting for the control center to be fully installed so that he could transfer his calculations of fuel consumption and the organization of bus inspections from manual to automatic. While he thought in terms of programs and spreadsheets, the bus operator’s CEO was convinced that his own eyes could tell him whether more buses were needed on the BRT corridor or not. Only half a year later, software and displays were installed, while staff training continued. The mood of the OCC staff
changed from being frustrated that the installation took so long to euphoria about the real-time movement of the buses becoming gradually visible on the OCC’s displays. Over the course of the first year of operations, the control center was partially installed but scheduling had not been automated.

An additional challenge of scheduling DART has been the shortage in buses followed by overcrowding. The operational design calculated a demand of approximately 300 buses (DART Agency 2014), but the bus operator has only half of this amount at command. Overcrowding not only leads to uncomfortable and unsafe bus journeys but also to irregular departures, as passengers need longer for embarking and disembarking the vehicle (see Figure 4). These bus services, reminding one of minibus practices, were reflected in public discourse, and Tanzanian newspapers reported that passengers preferred minibuses over DART (Michael 2018). However, people – being used to overcrowding and infrequent bus departures – continued to use DART’s overcrowded buses, which still offered a comparatively higher standard than the city’s minibus system and a shorter travel time due to DART’s dedicated lane.

DART’s users – staff as well as passengers – did not compare BRT operations in Dar es Salaam to the system’s operational design or the global BRT
model but rather to minibus operations, and acted accordingly. Therefore, the fluid handling of scheduling DART during the first months of operation, enabled by the flexible interaction of bus operator’s staff and passengers with the necessary technical components, has made DART operational despite the initial lack of the system’s “brain.” In addition, this co-production of DART’s operations made DART resemble a minibus system, even though BRT systems differ in many ways from minibus systems.

**Ticketing**

Also the second component of the ITS, which concerns how Dar es Salaam’s passengers pay for the service of the novel transport system, has evoked new relations between technology and society. Apart from dedicated lanes and higher passenger capacity, ticketing is a major distinction between minibus and BRT systems. Particularly through an automated fare-collection system (AFCS), BRT systems operate more efficiently and less corruptly, as global consultants claim (ITDP 2017, 622). DART was planned to be equipped with such an AFCS including smart cards (see Figure 5), but the fare-collection system has been installed only gradually and to a limited extent. Additionally, equipped with four ticket booths at the terminals and two ticket booths at the stations, the physical infrastructure and the operator’s staff has been unable to cope with the daily ridership, the long validation time of tickets (due to a partially weak electric and wi-fi network), the comparatively high number of passengers using paper tickets, and the odd fare of 650 Tanzanian shillings (TZS) (approximately US$0.28) — that demands a lot of coins for change. Hence, congestion has relocated from the road to the ticket counters, particularly during peak hour because selling and buying tickets takes time. During the first weeks of operations, ticketing was moreover challenged when connection problems of the network reappeared frequently, or when ticket counters ran out of paper rolls or change.

The introduction of smart cards went backwards and forwards which deviated from how the process was inscribed into DART’s technical and operational design. When launching DART in May 2016, smart cards had been sold for half a day before the bus operator stepped back and started to sell solely paper tickets. The operator had realized that smartcard readers had not been fully installed, which would have been necessary to offer this ticketing option. Over a month later, smart cards were reintroduced. However, in late 2016, the operator ran out of smart cards. Everyone who had not yet gotten one of the 200,000 cards has to continue traveling with paper tickets — even more than three years later — because no additional smart cards were introduced. Smart cards have become so valuable that they are sold on Dar es Salaam’s black market, research partners told me. Reasons for the continuous demand of smart cards are threefold. First, passengers perceive them as a convenient payment method. Second, starting a bus trip from a feeder stop is only possible with a smart card because feeder stops do not have ticket counters. Finally, passengers aim to benefit financially from the smart cards because reduced combination tickets for trunk-feeder transfer are not (yet) available with barcode tickets. Contrary to this, reduced fares for students are only offered with barcode tickets because the ITS (so far) cannot distinguish between different status groups. Thus, neither of the payment methods functions for all kinds of users’ needs and conditions.

Nevertheless, the bus operator, as well as passengers and business people, have found a variety of strategies to cope with these temporal absences of network connection, change, and smart cards. For instance, freelance moneychangers set themselves up in front of the ticket booths at a bus terminal, offering what they typically offer to minibus conductors who run out of change: a stack of nine 100 TZS coins sold for a 1,000 banknote. The bus operator quickly prohibited this business with the argument that this it was not consistent with the idea of a modern transport system. Hence, other solutions had to be found, particularly by station attendants who sell the tickets. So it happened that when passengers could not pay the exact fare and station attendants were short of change, the ticket price unofficially rose from 650 to 700 TZS. In order to mitigate this issue, the bus operator mounted sheets of paper at the ticket booths indicating the different buying options: for customers with exact fare (650 TZS), for students paying the reduced fare (400 TZS), and for customers who need change. In order
to increase efficiency, ticket vendors interacted even more flexibly with the AFCS at some stations. In the ticket booth, one ticket vendor sold tickets to passengers who needed change. The second vendor, who had printed a heap of tickets in advance, sold them in front of the ticket booth to customers who could pay the exact fare. The vendor, surrounded by impatient customers, handed out tickets and shoved the money into her pockets that served as a temporary cash register. When tickets were printed in advance, this strategy led to irritations: turnstiles did not let people enter or exit the stations, as tickets had already expired the maximum travel time. On other occasions, power cuts occurred. Small generators provided electricity for ticket-vending machines so that barcode-ticket sales could be secured. Since turnstiles did not work, smart cards could not be used. Every passenger needed to buy a barcode ticket, whose validation date and time were manually controlled by station staff, using the lights of their mobile phones after dusk.

Hence, the ticketing system and the bus operator, as well as station attendants and passengers, went into a fluid interaction to make DART operational despite the lack of crucial AFCS components—temporarily or permanently. This co-production guaranteed DART’s services. Even though global BRT consultants have not welcomed this concomitant inconsistency, the system has proved to be able to function even without central technological components.

**Information provisioning**

Information provided by humans and sheets of paper instead of displays is another consequence of the gradual implementation of DART’s ITS. The initial plan was to have displays at stations and inside buses that give real-time information on next stops, departures, and delays, and that contain advertisements to offset some of the costs of the public transport service. The customer-operations manager from the AFCS supplier elaborated several months after DART’s inauguration,

> At each station, we are going to install smart TV... It will help passengers to get to know information if bus is coming or if route is cancelled. And if it’s coming, at what time the bus will be here. That is another stage, you don’t see it now, those smart screens. But soon, they will be there.

This “other stage” that he described has still not been realized. DART’s passenger information has been manual and partly inconsistent: Buses were equipped with sheets of paper in the windscreens indicating the buses’ route number and destination. On off-peak occasions, station attendants lead the passengers to the correct docking bay and wave the approaching BRT bus nearer. This practice of telling the driver to stop is inspired by minibuses. In the buses, automatic announcements have been introduced gradually, but remain absent at stations and terminals. Sheets of paper at different sections of the terminal tell the destination of the bus (see Figure 6)—an “innovative idea,” as the chief operations officer told me. For instance, the section close to the entry point at Morocco Terminal is for buses to Kimara, buses heading for Gerezani service the middle part, and buses to Kivukoni use the rear part. However, the sheets of paper led to confusion so that the operator had to change one of the signs after a couple of days of operations: “Kariakoo” became “Gerezani” (see Figure 7). The destination “Kariakoo” led to confusion because passengers expected these BRT buses to go to the Kariakoo Terminal, which is a minibus terminal and hence not part of DART’s infrastructure. DART’s stakeholders did not perceive sheets of paper inside buses and at stations as a provisional solution—in contrast to global BRT consultants. ITDP had mounted “proper station signage” at its own costs shortly before the Mobilize conference took place in Dar es Salaam in 2018, as ITDP’s director of the African office told me. This conference is a prestigious event organized by ITDP. It attracts international guests from global transport networks and was supposed to serve as promotional event for DART.

The importance that global BRT technocrats attach to electronic audio and visual announcements, system maps, and signage at stations and on buses, is not a given for the manifold users of DART. However, large technical systems like a BRT system, serving hundreds of thousands of passengers daily, have difficulties operating efficiently without centrally collected and distributed data, as the CEO of the governmental DART Agency elaborated in September 2016:

> We have a challenge with the scheduling and dealing with the peak hours and completing the installation of ITS. Because, apart from the scheduling, I think the crowd control and so on could be easier if we had enough displays of the information system. Like, when we had bus stops, people scramble for buses because they only see for what has come. They don’t know what’s coming next or what time it could come. But if there was an information system displaying, saying that: ‘The next bus will arrive in two minutes. And another one in five minutes.’ So, one wouldn’t be scrambling. But right now, no one knows what’s there.

Concerning passenger information inside the buses, several bus drivers I talked to during the first months of DART’s operations questioned the need
for automatic announcements and electronic displays. According to them, passengers knew DART’s routes and stops, which were planned based on the city’s minibus network. In fact, minibuses get along well without signage because conductors give notice of the destination and next station. Also DART’s passengers have never expected displays at stations or in buses, and they do not hesitate to ask the driver or fellow passengers where the bus is going. Thus, by translating minibus practices into DART’s operations, passengers, and employees of the bus operator co-produce DART’s ITS.

**Conclusion**

The interaction of society and technology enabled the realization of DART despite the gradual and incomplete installation of the ITS and the manifold deviations from initial plans and designs. Since the system’s inauguration in 2016, people and technological devices have interactively put DART into practice. Hence, BRT operations could be realized in Dar es Salaam. DART has initiated a transition of the city’s transport sector only because humans took over when technologies were absent or dysfunctional. The city’s mobility cultures have adapted to the new transport system, creating a fluid formation of local minibus practices and the global BRT model. Linking STS approaches with mobility studies and ethnographic data from Dar es Salaam, this article has demonstrated that co-production (see Jasanoff 2004, 2015; Miller and Wyborn 2018) is essential for an urban transport system to become and remain functional.

Co-producing technical systems is a hybrid process, which demands and offers a high degree of openness of all actors participating in the adaptation of models and plans. Despite global consultants’ attempts to standardize the global BRT model and the use of its technologies like the ITS, implementing BRT has been a dynamic process in Dar es Salaam. Certain practices have become more or less permanent even though they developed as temporary solutions, and other practices have changed several times since inauguration. However, precisely because of its flexibility and the co-work of different actors, the transport system could be adapted to the specific context. This means that the more flexible technical systems are, the easier they stabilize. DART’s various users equipped the system with practices that work well in the minibus sector – instead of rejecting the system as long as it lacked key technical components. The fluidity of minibuses and their users hence had a favorable effect on the realization and operationalization of DART.

The case of DART has shown that a sustainable transition depends not only on global expertise and technological devices, but also on socio-technical practices, fluidity of the system, and adaptation of users. Even though DART’s ITS is primarily defined by “smart” devices like “smart screens” and “smart cards” and the OCC as “the brain,” “smart”
technological devices per se are no guarantee for a (rapid) transition toward a sustainable future. DART’s scheduling, ticketing, and information provisioning has only been possible through socio-technical practices that were activated by humans who stepped in when the technology was not working as planned and could enable the systems operability. Through these essential practices, humans made the inchoate technology functional – practices that are rendered invisible in narratives of global BRT proponents.

Thus, a technology’s embeddedness into the social is key for a sustainable transition, and co-production is a prerequisite for a transitional process. Contrary to the promises of global BRT consultants, DART has not led to a rapid, but rather to a partial, back-and-forth transition of urban mobility. The impact of the system in Dar es Salaam on the social, economic, and ecological dimensions of sustainable development remains open. Nevertheless, the DART project has had a tremendous effect on the city’s transport sector, bringing along new forms of socio-technical practices and government control, as well as new ideals of modernity and sustainability.

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Notes
1. For instance, the collaborative project Promoting Sustainable Transport for East African Cities (SUSTRAN) by UN Habitat and the German Agency for International Cooperation (GIZ) works on sustainable transitions of urban transport in the region. The program is part of the larger Sustainable Urban Transport Project (see GEF 2016; UN Habitat 2013).
2. Interviews and conversations were conducted in English, Kiswahili, or German. For this article, the author translated direct quotes from Kiswahili to English.
3. BRT proponents are well equipped with arguments. When BRT opponents argue that rail systems like light rail transit produce less carbon emissions, the counterclaim is often made that the total amount of energy consumed for constructing rail is significantly higher than for paving a BRT lane.
4. This bus shortage goes back to longstanding power games between the Tanzanian government, the World Bank, and local transport companies (see Jacobsen 2020). As of October 2020 the bus fleet had not been increased – neither to the estimated nor to the actual demand.

ORCID
Malve Jacobsen http://orcid.org/0000-0002-9076-8632

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