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Smart Mobilities: A Gendered Perspective

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Abstract

Gender equality and sustainable development are two central priorities of the Sustainable Development Goals (SDGs), while Agenda 2030 stresses on *inclusion* both as an outcome and a process input. Simultaneously, urban and transport planning fields are confronted with the challenges of connecting the domains of infrastructure provision, sustainability, and *mobility for all*. The intersection of sustainability and gender-fair spatial (vis-à-vis mobility) development has so far been neglected and downplayed in both research and policy making at all levels. Rooted in the idea of smart, inclusive, and integrated transport, this paper sheds light on the linkages between *gender* and *transport*, and calls for new conceptualizations on smart cities, smart mobilities and gender equality. It highlights how *smart solutions* can be designed to retain *inclusivity* at its core. To this end, the paper cites examples on gendered dimension of smart mobilities at the hierarchies of data collection and analyses, planning and policy making.

Keywords: Gender, Transport, Mobilities, Smart Solutions, Smart City, Bike-Sharing, Car-Sharing, Trip Characteristics, Mode Choice

An Introduction: WOMEN AND TRANSPORT vis-à-vis GENDER AND TRANSPORT

We could have broached this topic simply as 'Women and Transport'; instead, the topic is often referred to as *Gender and Transport* or *Gendered Mobilities*. The primary explanation lies in the phenomenon of *gendering*, which is associated with the traditional role assigning and normalization of behavior, routines, and patterns to the different sexes, along with the differing preferences of men and women. While the Nordic countries are classic examples of equality between the sexes, examples highlighting differences between men and women on a variety of issues related to both structural conditions and preferences can be found in this region as well. Certain differences can be ascribed to the historical development of the societies, while others continue to persist due to differences in structural conditions, preferences and choices between men and women.

These sets of conditions and preferences have often been ignored in development planning, since most often the different sectors of development operate separately and direct their policies in isolated silos – education, health, employment, social welfare, etc. However, the sector underpinning all the development agendas – namely energy and transport – has traditionally operated in strict engineering domains while the societal and gendered ramifications of under-delivery of these services have been not understood, and have thus remained unaddressed.

Though the relationship between transportation and economic growth has been diligently studied, similar connections from a gender perspective are largely lacking. Typically, the economics of trade has been a male-dominated perspective. Throughout the world, we find that there exists a clear division of labor, with women being the primary caretakers of children and the home. Further, within the labor market, a clear division between sectors of employment exists. In these circumstances, we need to understand that the daily mobilities of women have traditionally been markedly different. They have not been related to manufacturing of goods, transportation of goods, labor accessibility etc., but have rather hinged on accessibility to local services and sectors where there is a heavy concentration of female employment. And thus, questions such as – What is the difference between the average trip length of men and women? Which transport modes do women prefer? What function does transportation play for women? Within an economic domain, what function do women play? If a woman saves 10 minutes, what does it mean? What are the systematic benefits? etc. – demand further consideration.

The issues of personal security and sexual harassment also remain a highly gendered topic, and do not affect the daily mobilities of men to the same extent as women. Even though women are relatively secure in the Nordic countries, the level of perceived physical safety varies.

A further layering to the discussion is provided by the *smart city* agendas and smart mobilities, which currently pervade discussions undertaken in the domain of urban and transport planning. The paper structures its arguments with due regard to the issues of digitalization and smart agendas currently under discussion.

The introductory section continues by presenting the main differences in travel behavior of men and women in light of their daily trip-making characteristics. Next, we briefly touch upon the topic of gendered mobilities to highlight the implicit

meaning of movement. Literature on *mobilities*, in short, attempts to highlight the multidimensionality of movement, and the *potential trips* that people wish to make but do not due to restraining factors. Section two introduces the topic of smart cities and smart mobilities. It further comments on the ways in which smart solutions per se are fast becoming exclusive tools for a particular group – young, educated, high-income, white men. The last section presents some thoughts on the way forward by highlighting the methodologies, data needs, and policy imperatives for the future.

Plotting the main differences

The main findings emerging from research studies and projects across the world present consistent patterns of women's daily mobility. These differences are evident on a range of topics characterizing travel behavior of women vs. men.

Even though the world is progressing towards equal labor force participation, studies highlight that women undertake fewer job and business trips but more shopping, care-related and escort trips (Best and Lanzendorf, 2005). Women are often employed in flexible or part-time jobs and often travel outside peak hours. Women undertake more complex trips, resulting in higher incidences of trip-chaining and complex activity patterns (Scheiner and Holz-Rau, 2011). These characteristics, combined with the issue of personal security, restrict night-time trips for women (Scheiner, 2013).

Though car license-holding for women in the Global North has risen sharply in recent decades (Hjorthol, 2008; Konrad, 201), this development has not automatically led to an equal distribution of car-driving between men and women. Women are still, to a greater degree, car passengers than men (Polk, 2003; Konrad, 2015). Women have a strong preference for sustainable modes of transport as they both use more public transport and have higher walking frequency as compared to men. Given their propensity to use more public transport, to walk more, and their high incidences of trip-chaining, women use multi-modes rather then one mode alone (Heinen and Chatterjee, 2015). When women do opt to drive, it has been documented that they prefer smaller cars (Choo and Mokhtarian, 2004).

Women travel shorter distances and their trip duration is also limited as compared to men. This is evident in their commuting or work-related trip patterns, but holds true for other trip purposes as well (Hjorthol, 2008; Bühler and Kunert, 2010; Scheiner et al., 2011). In comparison to men, long-distance commuting remains much more restricted for women (Sandow, 2008; Holz-Rau et al., 2011).

Given the unabated development of car-based societies, it is not surprising that certain travel trends exhibit converging tendencies over time for the respective genders. As Konrad (2015) and Scheiner (2018) comment, elements of license-holding, car availability, mode choice (car driving), trip distances, and trip duration seem to be converging over time. However, we need to analyze these converging tendencies in light of what Scheiner (2018) calls attention to – women perhaps are less habitual, more responsible, more sustainable, and more sociable (Matthies et al., 2002; Polk, 2003; Hjorthol, 2008). This effectively means that the converging and shifting of women's sustainable travel behavior towards a car-based, unsustainable one could be in response to the structural conditions that has underpinned city planning in the past decades. This shift has some serious implications, both from the perspectives of climate change and the inclusivity agenda. However, research simultaneously indicates that this (unsustainable) shift can be steered towards a more sustainable direction through the creation of conditions conducive to walking, cycling, and public transport.

Gendered Mobilities

The concept of mobilities brings forth the asymmetries of power and opportunities that have eluded the one-sided technocratic focus dominating the field of transport infrastructure provision and planning. Cresswell (2010) defines that movement itself (or lack thereof) as not possessing any inherent meaning, but needing to be understood and discussed as a socially contextualized phenomenon through both material and practices.

Discourses on the concept of mobility have traditionally described it as physical movement (operating in the domains of geography, urban planning and transport) on the one hand, and a change in social status on the other (a sociological construct). This barrier started to melt away with numerous attempts from both sides to integrate approaches and address space, place and locality as cultural and social categories (see Gregory and Urry, 1985; Urry, 2000; Latour, 1999, Bonß and Kesselring, 2001 and 2004). The cohesive nature of social and spatial mobility – stating that a change in geographical/spatial mobility patterns affects the individual space of options and action, thus producing varying terrains of social mobility – was also finally established. These understandings were taken further in the 'new mobilities paradigm' (Sheller and Urry, 2006a; Hannam, Sheller and Urry, 2006), which posits that movement, representation, and practice are embedded in uneven socio-political relations (Cresswell, 2006).

What this brings to the fore is that mobilities need to be studied, interpreted, and theorized in an embodied and contextualized experiences of movement through discursive representations (Mountz 2011) and through discerning its relationships with inequality and governmentality (Ohnmacht, Maksim and Bergman, 2009).

Jones (1987:34) puts forth the three components of individual action, potential and freedom of action to express mobilities. In short, these are interpreted as:

i. Individual action: in the form of observed movement or travel;

ii. Potential action: in terms of journeys that people would like to make, but are unable to because of limitations in the system and/or their own commitments restricting them in time and space, or financial restraints; and

iii. Freedom of action: which may never manifest in action, but gives the individual options from which to select and the knowledge that he/she could do something.

With relation to gendered movement, it is the individual action that has been studied in detail, but much remains to be studied in the realm of potential action and freedom of action. In the following points, Kaufmann (2002: 37) postulates the three determining factors shaping the mobility levels and patterns of the individual:

i. Access to mobility-scapes (representing transport and communication infrastructure as potential opportunities).

ii. Competence referring to the 'skills and abilities' necessary to use the accessible mobility-scapes.

iii. Appropriation, as a third factor, involving all behavioral components, such as the need and willingness to make use of the scapes in order to become mobile.

Nijkamp et al. (1990: 22–24) argue that an analysis of mobility and the underlying drivers of its demand should be undertaken on a broad scale in the context of the following four themes:

i. Socio-economic context of analysis, which focuses attention on the influences of exogenous socioeconomic conditions upon spatial patterns of interaction;

ii. Technological context of analysis, which deals with the implications of changes in the technological environment on the spatial behavior of individuals or groups in society;

iii. Behavioral analysis, which focuses attention on motives, constraints and uncertainties facing individuals, households and groups when taking decisions regarding transport, communication and mobility; and

iv. Policy analysis, which concerns the evaluation of actions, usually the application of policy instruments or measures of decision-making agencies regarding transport.

These reflections from theoretical insights suggest that mobility cannot be analyzed in a purely instrumental, objectivist mode. A differential accessibility to resources maps out different mobility regimes distinguishable at the levels of people, places, and processes. Mobility, thus, emerges as an enabling characteristic, a sought after rather than given 'good/commodity'. A mobility regime results from a number of factors, consisting of the physical shaping of cities and landscapes, the available transport and communication systems, the relationship between mobility and economic, social, and cultural activities, and the meaning attributed to mobility.

However, mobilities also need to be understood through understanding 'immobilities'. The mobilities approach facilitates this by stressing the need to understand the relationship between fixity and movement. Unpacking the relationship between society, mobilities and politics – or, rather, understanding the 'socio-political dimension of mobility' – can also aid in highlighting the nexus between mobility and immobility. It will further assist in figuring how such connections are either being taken into account while making development decisions, or, in the absence of such positive interventions, which alternate modes the affected populace are adopting in order to chart out their livelihoods and social setups. In order to see the gendered effect of such developments, one can borrow from the research of mobilities scholars and feminist geographers to understand how moving between borders affects the production, elimination or re-affirmation of social differentiation (Hyndman, 1997; Amoore, 2006).

Further, mobilities and governance remain deeply interlinked (Mountz 2011), urging us to revisit state policies and their associated outcomes. Examples cited in the next section highlight how smart mobilities or immobilities vary due to facilitations made by the various actors involved.

SMART CITIES AND SMART MOBILITIES

Smart cities is the buzz word in the world of urban planning today. And while the term *smart* remains contested, a few things are quite apparent:

- The term remains fuzzy; it appears that *smart* is primarily being interpreted in terms of digitalization and is increasingly being shaped to include 'automation' as well.
- Corporations developing these digital solutions, such as Siemens, Intel, HCL etc., gain a strong foothold in the urban planning world. Their ideal module seems to develop systems that can have a standard design solution and can be integrated at a global level.
- Smart mobilities are being is being developed in a similar framework where solutions such as GPS-fitted buses, real-time tracking etc. are being promoted as the smart solutions.

With this backdrop, an emerging criticism of the smart cities approach is the gap between the technical/digital approach, inclusion, and quality-of-life approaches. Lauwers and Papa (2015) claim the shift from conventional mobility planning towards smart mobility is primarily applying new technology to existing infrastructures instead of creating better solutions. For example, buses are being retrofitted with tracking devices rather than public transport supply being increased and outcome measures such as access to work, education, etc. being checked. In this sense, smart mobility concerns itself primarily with innovative technological or consumer-centric solutions rather than adopting a social sustainability lens to the entire mobility agenda.

There is ample evidence from the Global North that smart solutions can be highly exclusive since they fail to connect to the mobility patterns and needs of the different groups. Shaheen et al. (2014) studied 23 bike-sharing programs in North America and found that the main obstacles identified for low-income groups were the need for smart devices, debit/credit cards, minimum bank balance, or deposit against vandalism or theft. A bigger issue than access to digital services or a smartphone is the lack of digital literacy – the knowledge, comfort, and confidence to use smartphones. Even in developed economies like the Nordics, disparities in digital literacy exist, especially with regard to the current elderly population. These differences have a strong tendency to compound and reduce people's access to smart solutions and services.

Data on the use of car sharing, for instance, shows a relatively small proportion of women users. By contrast, 'ride-sharing'/'ride-hailing' operators such as Lyft or Uber indicate a heavy usage by women (Dogtiev, 2017). This sits well with the knowledge we have on women's mobility patterns – short trips, linking multiple trip purposes and destinations and escort trips, and accessing places not served by the traditional public transport routes or schedules.

Table 1: Gender split among private customers of various car-sharing providers in Europe around 2010

Car-sharing provider and/or location	Share of male customers	Share of female customers	Source
cambio, Brussels (Belgium)	58%	42%	Taxistop, cambio, 2009
Several providers (Italy)	58%	42%	Italian Ministry of Environment, 2009
Three providers in London (UK)	69%	31%	Synovate, 2006
Mobility, Switzerland	53%	47%	Bundesamt für Energie (Swiss Federal Office of Energy 2006)
Two providers in Frankfurt (Germany)	63%	37%	TraffiQ, 2007
Ten providers in Germany	58%	42%	Wuppertal Institute 2007

source: Loose, 2010: 54, quoted in Lenz (2020)

As Lenz (2019) notes:

> In addition, the Uber data-based study provides an insight into the patterns and motivations of women using ride sharing. Usage patterns reflect the mobility needs that are particular to women. The authors report that women tend to make shorter, more frequent trips than men, and of a greater variety of types, and, moreover, that they are more likely than men to use ride hailing to go to shopping, to travel to health services, and to visit relatives. At the same time women travel more with children than do men (30% compared to 22%) (IFC and Accenture, 2018: xii).

In mapping the main motivations of female users of ride-hailing services, IFC and Accenture (2018: xii) underscore the issue of safety. Since the ride-hailing services store detailed information about the driver, are digitally connected and can be tracked in real-time, they diminish the chances of unsolicited behavior with female passengers onboard.

In a study based on a survey collecting gendered responses data on the adoption and use of emerging mobility options and technologies in the Greater Phoenix Metropolitan Area, Capasso da Silva et. al. (2019) found that women are less likely (than men) to adopt shared rides in autonomous vehicle (AV) ride-hailing services with unfamiliar passengers. The authors emphasize two pointers for the eventual deployment of shared AVs: (i) the need to develop safety protocols and targeted campaigns for enhancing women's willingness to share AV rides, and (ii) special services such as female-only services might enhance automated mobility acceptance for women.

Continuing the intersection of gendered mobility and personal security, there are multiple apps being developed that can ease data collection, introduce new methodologies for analysis, and create workable solutions on the ground. For example, the app *Safetipin* was developed to facilitate mapping of unsafe spaces, corridors, and routes in a settlement. In 2014, this app for women's safety was launched in India to help women safely navigate the city by identifying its safe zones (Viswanath, 2016). It is a location-based mobile app that collects safety-related information and conducts safety audits of different places by calculating a safety score. Users of the app can identify how safe certain areas are and can plan their travel routes and timings accordingly. The safety audit is based on nine

parameters, and the resultant maps are highlighted in Figure 1–3 (for further discussion, see Priya Uteng et al. 2019b):

a. Lighting: refers to the amount of illumination after sunset
b. Openness: evaluates the availability of clear lines of sight in all directions
c. Visibility: assesses how visible one is to others on the street
d. Security: refers to the presence of visible security officers – either police officers or private security guards
e. Crowd: indicates the number of people in that space – higher is better.
f. Public transport (connectivity): based on the distance to the nearest public transit stop or station
g. Gender usage: evaluates the proportion of women and children in the crowd and surrounding area
h. Feelings (of safety): refers to how safe one feels in the area
i. Presence of footpaths or walkways: indicates whether footpaths and walkways are easily accessible

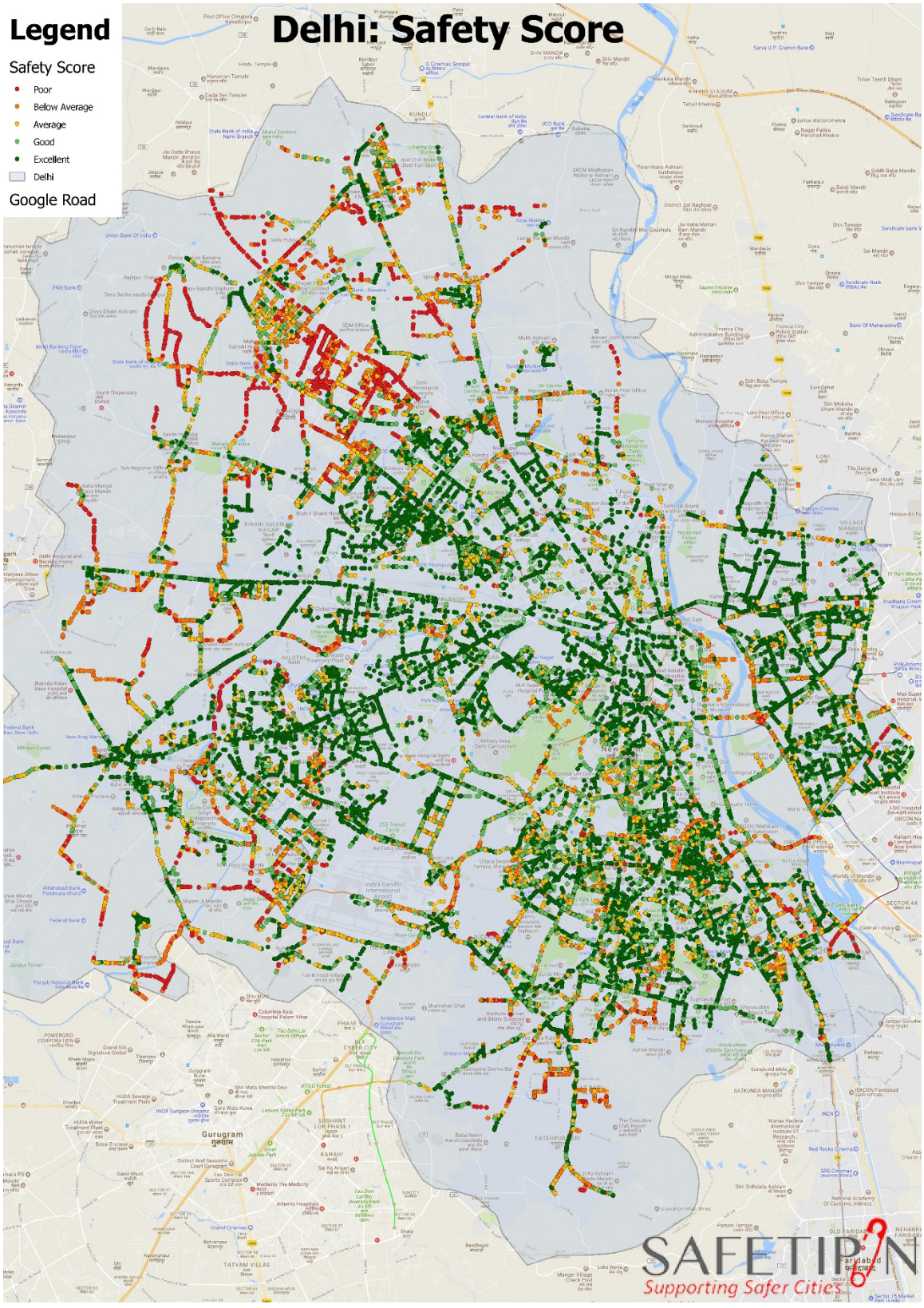


Figure 1: Safety score for Delhi
source: Safetipin (2017)

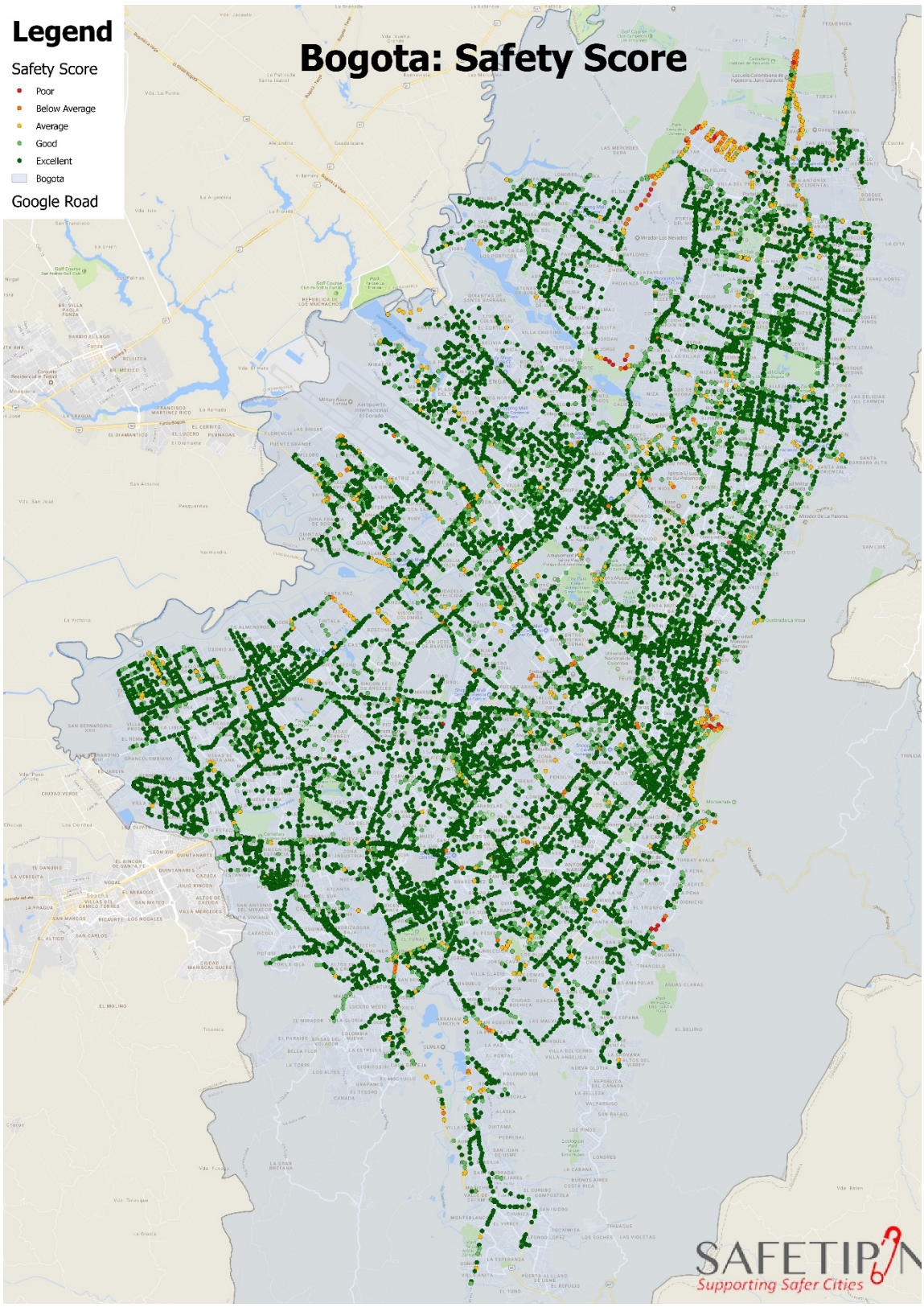


Figure 2: Safety score for Bogota
source: Safetipin (2017)

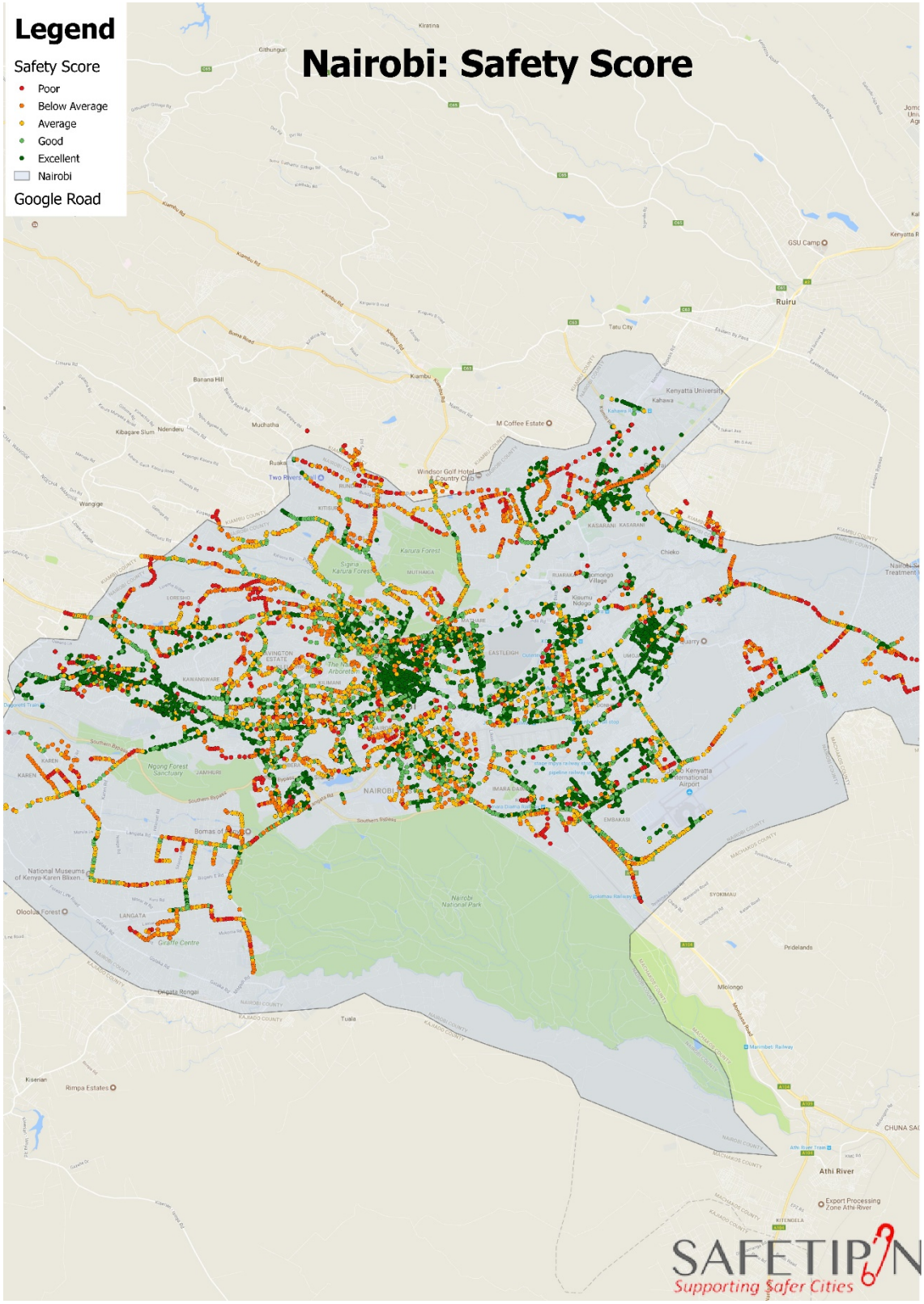
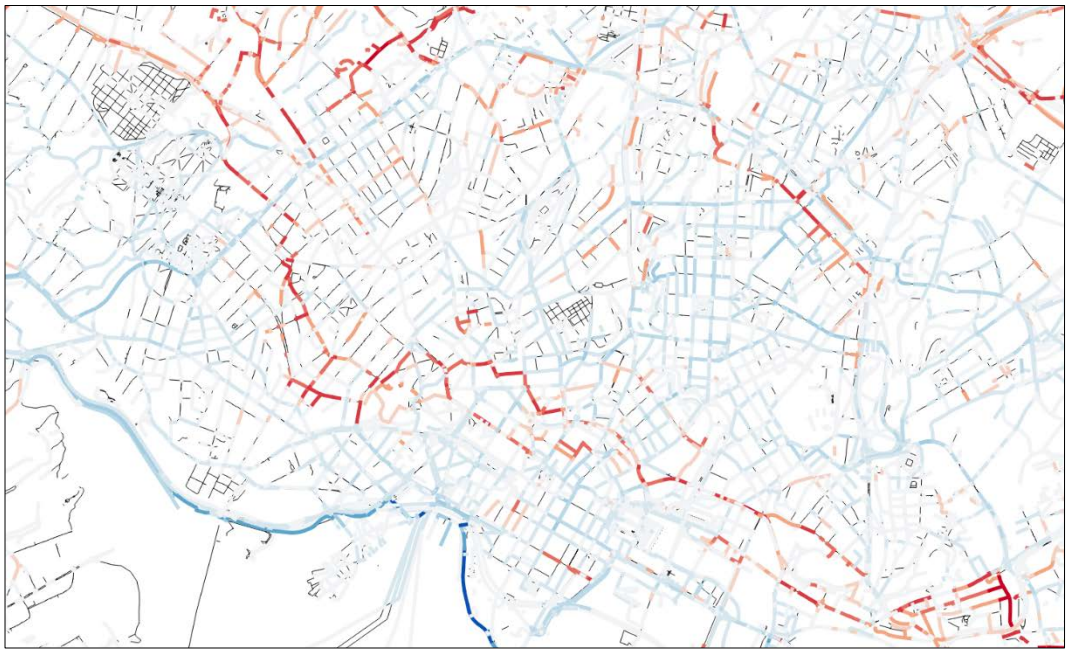


Figure 3: Safety score for Nairobi
source: Safetipin (2017)

Similar methodologies can be applied to plot perceived safety, preferences of routes etc. as part of the smart cities/mobilities agenda (for further discussion, see Priya Uteng et al. 2019c). Based on an interactive map-based solution, the following map from Oslo

highlights how preferences for cycling routes vary among men and women. A high density of female cyclists was recorded on roads passing through residential areas that were quieter and had low traffic volumes. For men, a higher volume was recorded on the cycle paths built along the main arterial network, running parallel to road networks with high traffic volume, but providing opportunities to cycle at higher speeds.



The colors illustrate the gendered distribution of preferences for particular routes and roads for bicycling. The color blue represents a relatively higher share of men bicyclists while strong red colour highlights female bicycling shares and preferences.

Figure 4: Varied bicycling route preferences by men and women, Oslo.
source: de Jong et al. (2018)

Similarly, analysis of approximately 7 million trips taken on Oslo's shared bikes for the year 2017–2018 revealed a highly gendered narrative. Since the shared bikes are operated through an app-based lock system, the system automatically captures the starting and end points of the trips.

In order to further plot the density of biking route preferences for women, we used the original dataset consisting of trips between city-bike stations as observations. Each observation includes information about start and end time of trip, location of start and end bike station, time duration of trip, and age and gender of the city-bike user.

The map shows the share of trips made by women on all the routes going through the specific line segment. For example, the thickness of the line between the two city-bike stations on the peninsula of Bygdøy indicates the share of trips made by women on all routes from city-bike stations all over Oslo to and from the outermost city-bike station.

These routes were further plotted against the zonal distribution of employment sectors dominated by the female working population.[1] We see a strong correlation between the

[1] The gendered division of employment between different sectors was based on the national statistics available from The Norwegian Directorate for Children, Youth and Family Affairs, available at:

zones with high concentrations of female employment sectors and the dominant female biking routes. There seems to be a high usage of city bikes by women for commuting purposes. However, there exists a dissociation between the peripheral location of female-dominant employment sectors (for example, hospitals) and the heavy central concentration (which also coincides with male-dominated employment sectors) of the docking stations of Oslo's city bikes.

Since Oslo's bike-sharing scheme is undergoing expansion, this mapping exercise should be taken into consideration while planning new docking stations. Tailoring gendered considerations can ensure that the uptake of bike-sharing by women is further maintained and bolstered in the future.

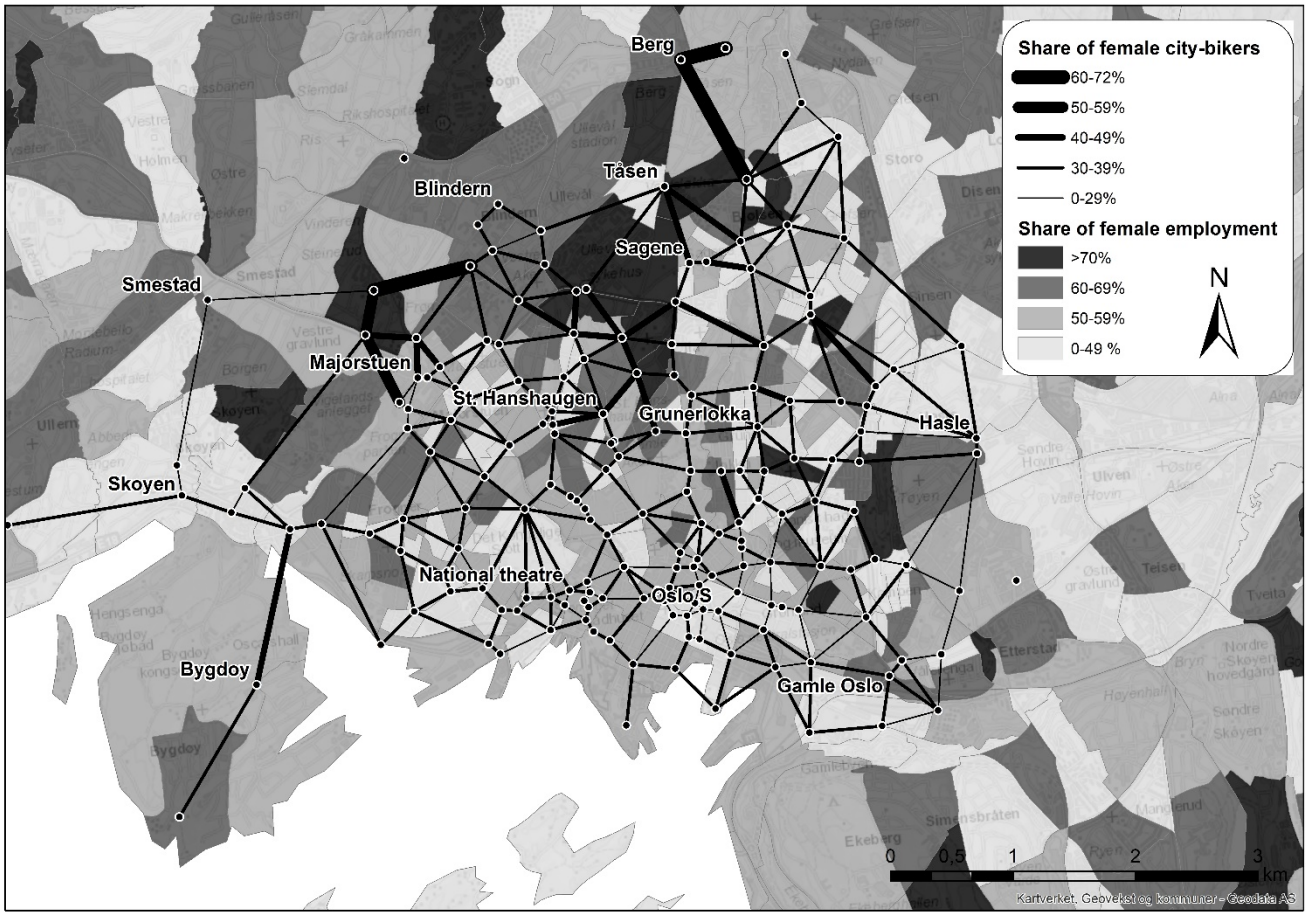


Figure 5: Popularity of routes vis-à-vis share of female employment in the different zones of Oslo
source: Priya Uteng et al. (2020)

As a final example, Broaddus and Jabbari (2019) plot the ways in which autonomous vehicles (AVs) could impact gendered trip patterns by eliminating or replacing escort and shopping trips in Miami, Florida. Their activity-based travel demand model allowed for analyzing the frequency, distance, and time of day of the trips, which were further analyzed to quantify, at the regional scale, potential time savings that might accrue to travelers if they were replaced by autonomous vehicles (AVs) or on-demand mobility services. The

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https://www.bufdir.no/Statistikk_og_analyse/Kjonnslikestilling/Arbeidsliv_og_kjonn/Kjonnsfordeling_sektorer/
The national averages of employment in the different sectors were applied to the jobs available in the different sectors in the different city wards of Oslo to plot the tentative concentration of female employment in the different wards of Oslo.

time-savings that would accrue to women and men from replacing personal trips with mobility services are calculated at the individual and system level. The paper concludes that the new shared mobility services offer an opportunity to serve decentralized demand with smaller on-demand vehicles, and the time savings that can accrue to women from eliminating or replacing the most gendered trips are significant. Their simulation results highlighted that the fleet serving men had more overall vehicle miles traveled and fewer trips per vehicle, while each vehicle in the fleet serving women was able to serve a higher number of short trips. Future research along these lines could delve more closely into the types of vehicles and service parameters that would best suit the needs of women and men as separate, and perhaps complementary, customer segments (ibid, 8).

WAY FORWARD

When we fuse the findings from women's daily trip patterns, the core idea of mobilities, and the current deployment and usage of smart mobility options, a clear pattern emerges: Smart mobilities, if interpreted purely in terms of providing solutions such as car-sharing, bike-sharing etc. without linking them with the inherent context of different users, will fail to be truly smart. Questions such as "Who are the potential users of a particular solution?" need to be addressed before launching a scheme.

Simultaneously, digital solutions provide ample opportunities to both collect data and undertake new kinds of data analyses. This section builds on the fact that rather than advocating simple data collection, it is imperative that collected data in surveys is segregated at the level of gender, activities (land-use) and time-use, which can essentially inform the transport planning authorities to take a more needs-oriented approach.

Integrating data collection across sectors holds potential for addressing the needs of women in a more robust and target-oriented fashion. Given such benchmarking, it will become easier to assess the specific kinds of alterations needed in the mobility systems to adapt towards gendered needs.

Further, there exists a need to link the 'soft' or qualitative information to the 'hard' data information. This can aid in developing a model that corresponds much more to 'everyday transport functioning' than the much-used, classical, techno-economical approach to transport model designing.

Before launching so-called smart cities/mobility projects, studies employing both traditional methods such as focus groups/questionnaire surveys/measuring actual behavioral response to different measures, and new methods such as mobile app-based data collection, should be undertaken to understand the existing travel behavior and adaptive preferences of different groups. Studies conducted along these lines (e.g. Gärling et al., 2000, Loukopoulos et al., 2004 and Loukopoulos et al., 2005) have found that discretionary trips have a greater number of adaptation alternatives available from which to choose than non-discretionary work trips do. This is applicable to the case of gendered mobilities, where a major share of women's trips caters to discretionary purposes of combining various household/social/shopping-related purposes. We conclude that analyses of travel behavior, constraints, and accessibility need to be triangulated and complement the following quantitative and qualitative data collection techniques. These methodologies need to be implemented both for the urban (including the peri-urban areas) and rural areas.

Travel survey data enriched with spatial data

Travel survey data contain relevant information on all personal daily mobility, including information on multimodal trip, transport modes, distances and times. Such datasets additionally contain an extensive list of respondent and trip background variables, including socio-demographics, occupational status, home and work locations (possibly multiple), weekly working hours, occupational status, education, income etc. We suggest using both the traditional and wherever applicable, the mobile interface to collect this dataset.

Existing studies demonstrate that the use of location-based technologies improves the accuracy of departure/arrival locations and times over traditional travel survey data (Cottrill et. al. 2013). Modules are already available to extract entire travel diaries by accessing the smartphone data provided by the telephone operators. This data can be further enriched with local and regional spatial data from external sources, such as Open Street Maps, and census, register and cadastral data.

Attitudinal and preference survey

Attitudinal and preference travel survey distributed over different types of residential environments (inner-city, outer-urban, suburban, peri-urban, rural) and population categories within these regions will assist in capturing habits, attitudes, well-being, perceived barriers and motivations with regard to the access to health, education, and employment opportunities (Ettema et. al. 2010). Background information on personal and household attributes, preferences and lifestyles with regard to themes such as mobility, access to important nodes, etc., should also be collected as part of this exercise.

Multi-sited ethnography combined with in-depth traveller interviews

The above-mentioned quantitative data inquiries should ideally be preceded and paralleled by the collection and analysis of qualitative data. This is necessary not only to provide a full understanding of mobility experiences, barriers and motivations underlying the decision-making process of multimodal route, access, egress and transfer practices, but also to ensure that key questions are adequately identified for application in designing of smart solutions.

Document analysis and informant interviews

Document analysis and informant interviews form an important research tool in mobility mapping through (i) examining documents and records relevant to regional and urban policy-packaging, and sectoral development decisions having a spatial dimension and (ii) key-informant interviews. Use of documentary analysis has become quite popular within transport research, especially if we are trying to evaluate the impact of an initiative – for example, a national government approach to increasing access to health facilities. Key informants – including politicians, policy makers, the local and regional authorities, and ministry officials directly involved in decision making on smart agendas – should be engaged to shed light on how decisions on smart cities are being made. This is a necessary step in designing truly smart *solutions for all*.

Exploring the links between activity participation and subjective well-being

The conceptual foundation of quality-of-life (QOL) and subjective well-being (SWB) should be employed to identify and estimate the links between gender, daily travel times,

time use, and the extent to which the overall quality of life is affected by smart solutions. Sweet and Kanaroglou (2016) find that travel times serve as inputs in activity participation and therefore – at least for women – indirectly contribute to higher levels of SWB. These findings suggest that focusing on activity participation as a chief policy objective in transportation planning could yield higher quality-of-life benefits than a policy focus on travel-time savings (ibid:10).

Transport planning has been dominated by the logic of travel-time savings, underpinning decisions on building highways, flyovers, and road expansion programs. The field has simultaneously and consistently failed to serve a majority of the population. We therefore propose a shift in the transport planning approach – shifting the focus from travel time reductions as the chief policy objective to a focus on activity participation, enhanced SWB and QOL. Upcoming and proposedsmart solutions should be analyzed with this framework in mind.

These solutions should be employed to map activity participation at the macro, meso and micro levels and policies designed for these three levels should be interlinked and complement each other.

Table 2: Typology levels

Spatial Level	**Methodology**	**Output**
Macro –Regional / City level	Mapping of the female-dominated employment and residential areas; mapping of the interaction of these areas, land use and accessibility; App-based survey plotting travel behavior, travel impedances, Public transport route-mapping, Time-use studies, Mapping Activity participation, Personal interviews, Ethnographic studies, Document analysis and Popular media discourse, History of planning to unearth biases.	Residential and employment location mapping; Accessibility mapping; Route-mapping; Time-use mapping; Mobility potential of women (and specifically low-income and elderly women)
Meso –Zonal level	Questionnaire surveys, Mapping Activity participation, Ethnographic studies, Focus groups.	Accessibility levels to i. Work; ii. Education; iii. Social opportunities; iv. Health amenities, v. Training facilities.
Micro –Ward level	Route-mapping – Safety audits, Walkability and Bikeability audits Assessment of walking and bicycling infrastructure; Mapping unsafe areas, routes, hotspots.	Micro-level information that can be collated and scaled up.

Accessibility mapping

Continuing the above discussion, the transport modeling approach is dominated by the logics of travel-time savings that underpin major transport infrastructure projects. Rarely are comprehensive land-use and transport interaction (LUTI) models employed to see the linkages between land-use/activity participation and transport infrastructure provision.

We propose that mapping of the interactions between accessibility with different transport modes for men and women to different land uses, and facilities such as schools,

employment and health centers, be undertaken to inform the design and implementation of transport infrastructure such as public transport routes, bicycle networks, etc.

In the following example, we present a similar exercise for Bergen, Norway, based on InMap (a simplified LUTI model), that links job accessibility by bicycle (and E-bike) and land-use plans. In this case, the supply of land was determined by the local municipalities through land-use plans, while the demand for the land was estimated as a function of the accessibility to jobs, trade, general services and health services in the areas.[2] The next step in these kinds of accessibility mapping exercises should be adding a layer of female- and male-dominated employment and residential areas.

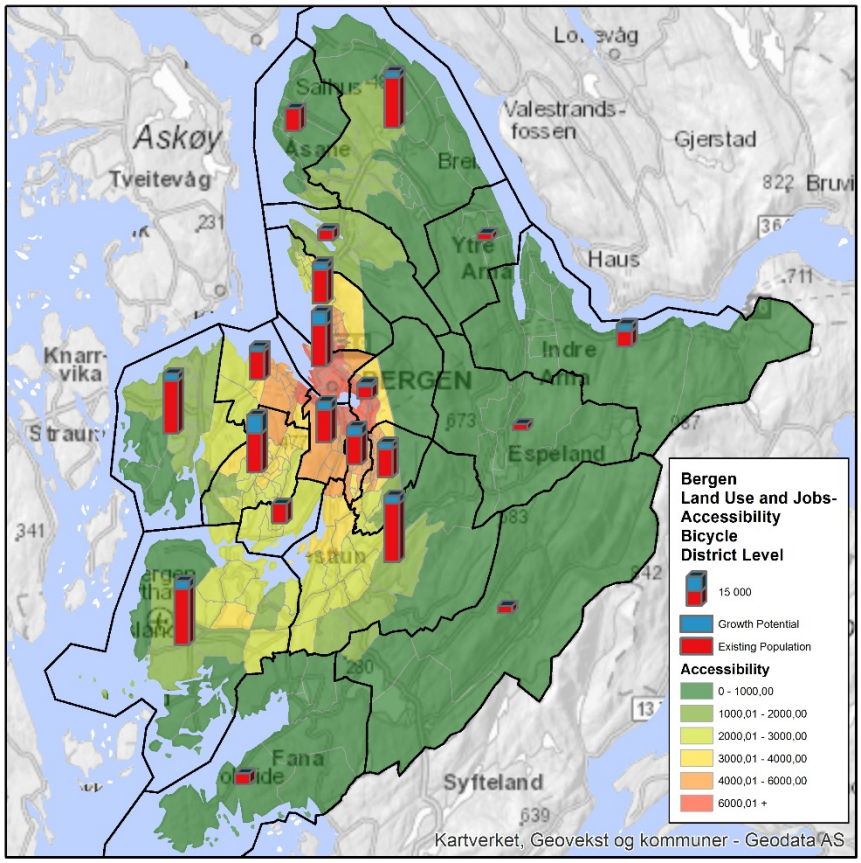

Figure 6 Accessibility with bicycle and growth potential, Bergen, Norway.
source: Priya Uteng et al. (2019c)

[2] From comparing E-bike accessibility with the land-use growth potential, we found that it is possible to develop land-use strategies to enhance the use of E-bikes. High job accessibility with E-bikes close to city centers supports the current general strategy of pursuing high density developments/transformation projects in these areas. The findings of this study suggested that in general the green field development areas were not found to provide any substantial accessibility with E-bikes.

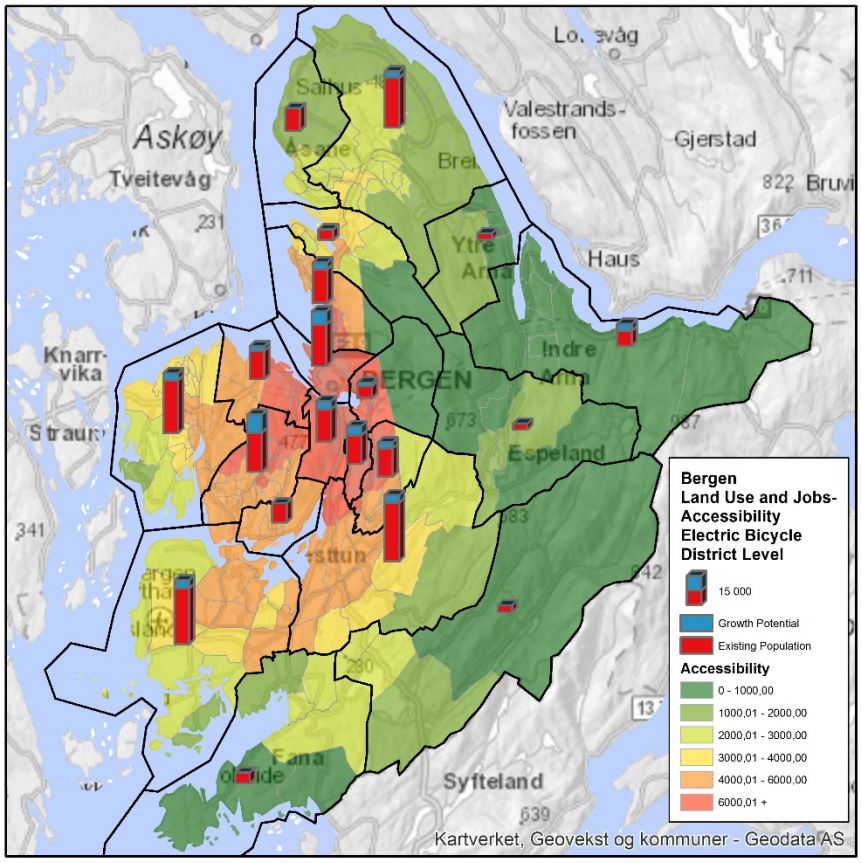

Figure 7: Accessibility with E-bike and growth potential, Bergen, Norway.
source: Priya Uteng et al. (2019c)

CONCLUSION AND RECOMMENDATIONS

We looked at the specificities of women's mobility and its implications for urban-transport planning along with smart cities agenda. A few of the consistent findings emerging from gendered travel patterns are that:

1. Women's travels are multi-purpose, complex and resource-constrained (vs. the male norm).
2. Women undertake a greater share of trips made on sustainable travel modes.
3. Even the new 'smart' modes are showing a gender bias in their use patterns.
4. Smart mobilities and smart cities do not automatically help the agenda of creating inclusive cities.
5. A continuous mapping exercise of needs and preferences, at the macro, meso and micro levels, is needed to design truly inclusive smart solutions.

To make the transport systems gender-responsive, it would be useful to have a simple and overarching framework that underlines the relevance of transport to women's employment/livelihoods/income security and domestic care work (i.e. 'production' and 'reproduction'). In other words, mobility is needed to facilitate women's access to markets, jobs and services (e.g. health centers, schools, childcare centers, shops, etc.). Additionally, the transport sector itself can be a source of employment for women, and more essentially, influencing the field of transport at large to be more mindful of women's needs and preferences. Traditionally, the transport sector remains heavily male-dominated in terms of employment and technical focus. Issues regarding safety, affordability, accessibility, availability, acceptability and accommodation are vital and need to be taken into transport design and planning. We need to build transport systems that take these gender specificities into account.

Photo 1: A step in the right direction
Photographer – Eivind Junker, NTNU

Further, the authorities need to engage with the foremost question of 'How to utilize the new and smart methodologies available to make data collection and analyses routinized processes?'.

We need context-specific policies, distinguishing in particular between urban, suburban and rural areas, to mainstream *gender* into transport, energy and spatial planning policies. We further comment specifically on what needs to be done differently in terms of mapping

the current and future infrastructure and service delivery in transport and urban planning policies.

1. Spatial development and relocation policies to cater to women's opportunities – with respect to basic facilities, education, health and employment

   A continuous and routinized accessibility mapping for different transport modes needs to be undertaken to inform both current planning and to assist in prioritizing areas for future growth. Such mapping exercises will both support women's daily mobility and bolster the "*nullvekst*" zero-growth agenda by highlighting areas most conducive for public transport, walking and bicycling.

   It is vital that land-use planning and development programs recognize and make space for creative solutions, since a standard, transport-model based, technocratic approach often fails to recognize women's needs and preferences.

2. Multi-sectoral approach – ensure mobility for women (both urban and suburban) to ensure their access to employment/markets, education, health centers

   Link policies of other social development sectors with the transport sector. Welfare and social provision programs can be built around the issue of access to promote access to basic facilities, education, health and employment.

3. Mapping areas, routes, and specific locations to enhance traffic safety and personal security

   Both personal security and safety in traffic are major concerns for women. Spatial and transport projects need to prioritize the creation of safe and secure spaces. Smart solutions such as the Safetipin app and route mapping need to be employed to map insecure/unsafe areas, and then rendering these areas safe need to be prioritized.

4. Designing the smart mobility and smart-city solutions with particular focus on creating inclusive settlements

   Smart cities and smart mobility solutions are fast emerging, but they remain locked in a corporate-driven agenda. It is important that the element of inclusive settlements is inserted in this development on an immediate and urgent basis in order to avoid further pitfalls. Research studies on car sharing, bike sharing, autonomous vehicles, both as independent units and as ride-sharing vehicles, and other upcoming transport modes need focused research from a gender perspective.

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