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Women's Perspective of Personal Safety on Public Transport in Ireland

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We showcase female users' perceptions of rail transport. This study investigates women's views on the overall service offering when accessing public transport and the relationships between perceptual conditioning and travel choice. We analyse passenger safety boundaries and concerns relating to environmental, security and accessibility parameters of public transport. While recent literature provides a baseline of the perceived, theoretical and experienced fears and apprehensions relating to public transport use, we offer a hierarchy of macro-themes emerging from our user-bases' most prominent travel misgivings.

Keywords: Women, Public Transport, Personal Safety, Perception, Fear, Harassment, Behavioural Change

1. Introduction

The last four decades are bookended by reactions to well publicised world events concerning women's safety, with discussion surrounding fear, safety, and the threat of sexual violence at the heart of the literature context on issues of gender in transport**.** Stanko (1993); Levy (2013); Lewis (2018).

Women report an acute concern for their safety in using public transport (PT), manifesting in behavioural changes as to when, how and why women interact with PT. TII (2020). Harassment and violence toward women are an endemic issue, with heightened concerns particularly linked to night hours, transport culture, security and system design that enables feelings of fear, isolation and/or vulnerability. Gekoski et al. (2015); Easton and Smith (2003). We evaluate women's perception of personal safety, factors influencing travel behaviours and the physiological approaches to using PT.

2. Women and Transport

A gender-blind PT system defaults to a defacto homogenous and normative service provision. Disparities are present in both the acquired and required PT demand of men and women. TII (2020).

Women's desired quality of PT is faltered in the absence of services that feel safe/comfortable. Women's transit decisions and behaviours are influenced by these responsibilities. Women's mobility on PT is multimodal with shorter, more intricate journeys than male counterparts who more typically partake of linear travel. Hail & McQuaid (2021); TII (2020); Alyavina et al. (2020). Measures women use to safely navigate daily travel reduces economic, spatial and temporal resources resultants from typically increased care-giving responsibilities than men (European Institute for Gender Equality (2017), while simultaneously impinging on the right of appropriation and participation in society. Lefebvre (1996).

Engagement with essential social and economic opportunities becomes easier with an increased right to and delivery of safer mobility options. Shah (2018). Access to such opportunities is cast under a political light by Levy who argues that travel is more than a logistical exercise but rather a holistic reflection

of movement, safety, social and economic agency and independence in addition to appropriation of public environment and infrastructure. Levy (2013). Unbiased, equal access to these elements is a consequence of overcoming distributional issues ingrained in transport fairness and access and recognising the fear-based barriers women experience. Where transport planning fails to recognise "…*the different social positions and multiple identities of transport users; the social construction of space, public and private; and the politics of transport in the context of social relations*", implementation of policy would *defacto* address and provide a "*Right to the City*" (RTTC). Levy (2013). It does not; this research and references here-in highlight continuing gender-based distributional inequities in PT. "*The right to the city is far more than the individual liberty to access urban resources: it is a right to change ourselves by changing the city*." Harvey (2008).

Unqualified access to equitable PT and the RTTC challenges social and political stresses exerted on women. In denying personal agency granted by complete access, restrictions are set in place to inhibit both mobility freedoms and the ability to engender change in PT.Lefebvre (1996).

3. Safety for Women in Transport

Recent decades are bookended by reactions to well publicized world events concerning women's safety; The "*Reclaim the Night*" movement's origin influenced by the Sutcliffe murders in 1970's England were reignited in 2004 and again came into focus in 2021 following the murder of Sarah Everard. Bindel (2006) and Petter (2021). The global #MeToo campaign emphasis issues faced by women, issues which have been historically marginalized. Mendes et al. (2018).

Concerns for personal safety manifest as behavioural changes in the way women interact with PT. Stanko (1993). Fear-driven precautionary travel-behaviours and/or change in conduct or mode (i.e., to a private vehicle) is not a characteristic exclusively linked to women who have experienced criminal activities, harassment or antisocial behaviour. Stanko (1993); Easton and Smith (2003); Reid and Konrad (2004); Smith and Clarke (2000); Dhillon and Bakaya (2014); Gekoski et al. (2015); Stark (2018). Mitigation techniques manifest as passive – service avoidance, travel time restriction, destination avoidance (Easton and Smith (2003) and active – group travel, separation to others with obstacles, i.e. luggage (Dhillon and Bakaya (2014), personal or private vehicle use (Smith and Clarke, 2000), self-defence (Stark, 2018) or technological security. Gekoski, et al. (2015).

Social network and community-led awareness campaigns amplify women's voices proclaiming fear of crimes. The outcries are a direct and accurate reflection of the experiences: "*Researchers exposing men's violence to women explain women's fear of crime as a realistic appraisal of endemic abuse*". Stanko (1993). Women's concerns for personal safety go beyond that of crime: "*Women do not only suffer crime...but also an undertow of incivilities and harassment which men do not experience*". Young (1988).

Harassment experienced by women while using PT is quantified by different forms of sexual violation. Sexual comments, groping, touching, staring, invasion of personal space or other forms of harassment elicit a wide range of reactions from victims. Kebede et al. (2020) and Stanko (1993). "*...there is also a great deal of variability in the ways in which women are affected by experiences of sexual assault and a great deal more variation in the ways in which the emotional and psychological impacts of the violence are expressed*". Randall (2010). The magnitude of the impact of harassment and violence toward women on PT is obfuscated by "*hidden figures*" of under-reporting. Transport for London (2018); Loukaito-Siders (2014); Gekoski et al. (2015). Under-reporting has a direct impact on decision-makers motivation to implement tangible safety measures (Stanko, 1992).

4. Methodology

4.1. Research Design

The methodology in this study is as per Figure 1, expanding on that of previous DIAMOND Project works to compare key determinants of safety from mixed method approach. Ari et al. (2022)

Fig. 1. Method Map for establishment of safety determinants via parallel quantitative and quantitative data analysis.

4.2. Quantitative design and sampling

Data were primarily collected in April 2020, primarily from users of major train line connections in Ireland and Dublin-area surface transport at both peak and off-peak hours with approval from the service providers. Further responses came via online questionnaires distributed on the DIAMOND project consortia websites. Prior to distribution, survey material was tested on a small sample to examine clarity, understanding and validity and response time. Passengers scored questions on a 1-7 Likert scale (strongly disagree to strongly agree) with some 336 of respondents meeting the core criterium for analysis of a sufficiently completed survey.

The questions were tailored to interrogate the perceptions, expectations and needs of users in relation to a rail transport service offering. Ari et al. (2022).

4.3. Qualitative design and sampling

An online semi-structured interview of 22 participants facilitated information gathering on experiences of PT, including socio-demographic data. Interviews were transcribed verbatim, analysed and inductively coded into clusters using NVIVO software with specific regard for instances of safety concerns. Qualitative coding interrogated all macro areas, extrapolating concerns of safety from the interviews to further advice on quantitative study on rationale for user engagement. Interviews were analysed with consideration of both manifest and latent content allowing for substantive depth in the understanding of data. Elo (2008); Thomas and Magilvy (2011) and Assaroudi (2018). Emerging themes were clustered as informed by analysis to identify prominent macro-themes. Iterative interrogation of emerging themes guided by safety FC, enabled reclassification of themes in view of participants comments and perceptions relating to PT safety.

5. Results

5.1. Descriptive statistics - survey

Responses in this study were 48.5% male, 47.9% female, 0.9% non-binary with 2.7% preferring not to say. Ages ranged from 24 to over 75 years. The majority of respondents were white (87.2%), Christian (59.6%), single (39.8%), heterosexual (85.6%) with third level education (67.9%). The typical user did not have any dependents (69.8%), nor travelled with dependents on a regular (weekly) basis (87.8%) and were in paid employment (56.1%) that was full-time (70.1%). Most lived in urban and sub-urban areas, 27% residing in rural locations.

The survey examined service capability to meet the required needs of users, its accessibility and safety and security measures. Our data showed that respondents generally disagreed with the ease of sufficiently safe access, most prominently in relation to secondary modal access and complaint or seeking help.

5.2. Descriptive statistics - interview

Our population was comprised mostly of women (68%), living in sub-urban (32%) and urban areas (59%). Our interviewees were of working age with only 9.1 % over 75. The ethnic composition was 68% White Europeans with 32% minority backgrounds of Asian, Black and Mixed ethnicity. A minority had dependants (40.9%) and of this group, about 22.7% not travelling with dependents. During interviews, participants projected emerging theme (ET) relating to personal safety concerns; (i) Antisocial behaviour, 49% (ii) Safety of personal belonging, 24% (iii) Racial abuse, 13% (iv) Unwanted sexual attention, 7% (v) Social altruism, (7%).

5.3. Prevailing safety themes

We identified 3 macro-factors that prominently contributed to participants perception of safety for a PT service*:* security, environment and access. For fig. 2,3 and 4 the responses frequency for each ET are shown as a percentage of responses by the respective gender; i.e. 60% of male Access ET hierarchy responses were in relation to accessible routes and platforms.

5.3.1. Security

Security was a consideration for 91% of participants, including 100% of minorities and 72% of the female participants. More than half of participants concern are linked to '*presence of police, security and staff*' and '*discrete complaint or alert platforms'*.

The protruding frequency responses of secondary ET regarding security concerns are show in figure 2, below. We present responses by as a percentage of overall responses, by gender.

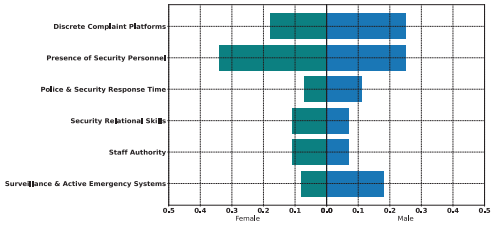

Fig. 2. Security FC as a percent of total responses.

5.3.2. *Environment*

The environmental ET response frequencies are shown in figure 3.

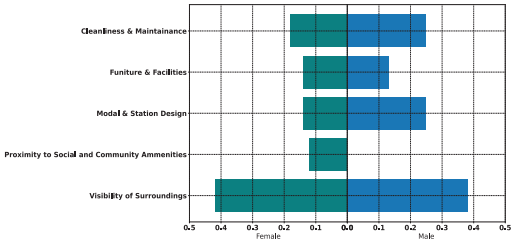

Fig.3. Environmental FC as a percent of total responses.

Environmental factors primarily concerned '*visibility of the surrounding area'* with 50% of the participants highlighting concern. This was followed by the need for '*cleanliness and maintainace*' along with '*furniture and facilities'*, both from 41% of our interviewees. The '*furniture and facilities'* ET had higher concern among women at 47% compared to men at 14%.

A little over one quarter (29%) of the male participants had environmental concerns for safety linked to '*modal and station design'* or '*furniture and facilities'*. The, '*proximity to social outlets'* ET issues was evident only with 27% of female participants.

5.3.3. *Access*

The ET frequencies of responses relating to access are shown in figure 4.

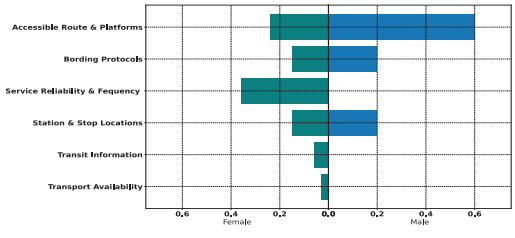

Fig. 4. Access FC as a percent of total responses.

There were over twice as many female participants than male partipants regarding '*accessble route and platform'* as a safety concern. Matters of '*frequency and reliability of service'*, '*transit information'* and '*transport availabil*ity' were highlited by only female participants, accounting jointly for 47% of female participants.

5.4. *Bayes network*

Quantitative data were modelled via a Bayesian Network (BN) with a Naive Bayes structure using a wrapper approach. The variables are sorted in terms of mutual information (MI). At each iteration, a variable is added and a score is calculated. The score of the model is based on the AUC. 10 folds stratified shuffle split cross-validation is used. The model with the best score is chosen. A second model is created based on the first one to focus on the difference between gender. The node gender is added as the parent of all the selected features. The class node, feel safe, is a parent of gender.

5.4.1. *Bayes results*

Seven variables were selected by the model as identified via Hugin in order of highest MI were: "CCTV", "get help", "evacuation", "cleanliness", "access", "lighting" and "value for money". These represent the best predictor of safety with an AUC of 81% and an accuracy of 75% as in figure 5. Bayes Factor is used to discriminate between two hypotheses given observation as described in Kjaerulff and Madsen (2008). The Bayes factor is calculated for each variable. The hypothesises are H0: is feeling not safe and H1: feeling safe. The evidence is the selected variable is less than 4.5. All values are above 1, the fact of not being satisfied for each of the 7 selected variables acts in favour of feeling not safe. The result can be seen in figure 5.

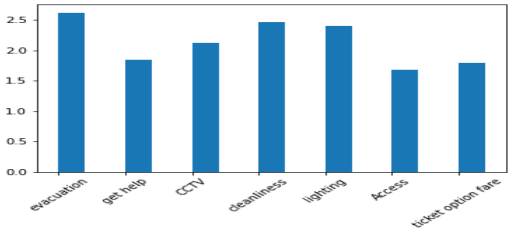

Fig 5. Bayes factor for each variable lower than 4.5 with hypothesis H0: feel not safe and H1: feel safe for the Naive Bayes model

The second model discriminates the result between men and women. The model can be seen in Figure 6. Note that gender was not selected by the algorithm. The AUC of the model is 80% and the accuracy is 74%. In order to discriminate between men and women, the evidence on gender is entered before the test.

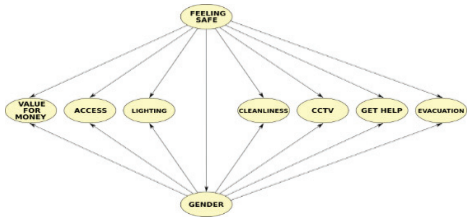

Fig. 6. Bayesian Network for the second model

This gendered model reveals variables which contributes most to passengers' sense of safety. "Cleanliness", "Lightning", "Access", "Value for money" and "Getting help" were identified as the most relevant variable for women feeling unsafe whereas men related "Evacuation" and "CCTV" with safety. "Getting help" represented the ET with the smaller disparity of importance between genders. Figure 7 shows the result of the Bayes test.

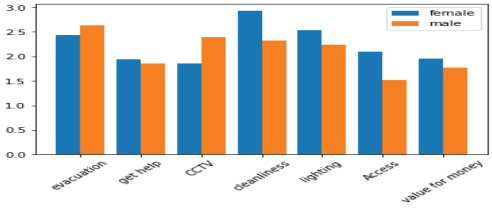

Fig. 7: Bayes factor for each variables lower than 4.5 with hypothesis H0: feel not safe and H1: feel safe for the second model.

More generally, the macro-theme (as highlighted in discussion) of security was most important for men, with those relating to Access and Environment the driving facors behind women's sense of safety.We classified variables outcome into 2 groups, A) Security, involving "CCTV", "Get help" and "Evacuation" and B) Station, consisting of all remaining variables. Table 1 shows the probability of feeling unsafe as a function variables within these groups.

Gender	Security	Station	P(feel safe<4.5) %
Female	0-4.5	4.5-7	54.10
Male	0-4.5	4.5-7	42.44
Female	4.5-7	0-4.5	**80.27**
Male	4.5-7	0-4.5	**27.49**
Female	0-4.5	0-4.5	99.65
Male	0-4.5	0-4.5	98.85
Female	4.5-7	4.5-7	1.64
Male	4.5-7	4.5-7	0.32

Table 1. Probability of not feeling safe: security and staion variable

The most significant difference is between the scores of Security > 4.5 and Station score < 4.5. The probability here of a woman feeling unsafe at 80.3% with men feeling safe with at 72.5%. With this model, the Bayes factor can also be calculated by considering gender as evidence and hypothesis of feeling safe or not. Females are more likely to feel not safe according to a Bayes factor of 1.47 and males are more likely to feel safe with a Bayes factor of 0.65.

Women's perception of safety as identified from BN models data are broadly in line with macro-themes from qualitative data which are now discussed.

5. Discussion: *Determinants of personal safety*

Safety provisions are essential to promote opportunities for societal interaction. Shah (2018) and Levy (2013). Users recognise the existing measures catering to safety but also offered resignation to the limitations of those applied.

5.1 Security

User considerations were exhibited with technological security and human-centric security.

5.2 Technological security

PT systems' technological aspects play a vital role in promoting user independence and interaction with environmental and infrastructural elements while promoting an unbiased safe access of the service. Technological limits are identified by users when considering '*active surveillance and emergency systems'* that cater in real-time to incidences of crime, antisocial behaviour and harassment. Ari et al. (2022). Female users emphasised a lack of trust with these static measures. CCTV systems were seen as fraught with uncertainty in functionality, visibility, clarity and presence. Such passive surveillance was viewed as irrelevant in relation to prevention of some and more so a platform to provide evidence. Users agreed that surveillance was not evenly distributed across the PT services and surroundings; stop, stations or interconnecting environment.

Integrating monitored surveillance throughout a transport network did not itself promote a sense

of mediation of real-time attacks for users but also required sufficient lighting and a dynamic monitor readiness of these systems to be regarded as a deterrent. In the presence of proactive safety surveillance, improved access for users to '*discrete alert systems'* could bridge the gaps between passive and active measures. Ari et al. (2022). Systems accessed reliably, efficiently, anonymously, and in a user-friendly fashion facilitate a sense of wellbeing and create a deterrent for instigators of unwanted attention, offering peace of mind that timely, in-person help is available when needed.

Alert systems to facilitate security personnel providing aid to the 3rd party, especially in cases where the driver is both victim and sole authority, were viewed as key to ensuring perpetrators may be apprehended while shielding the good Samaritan from potential victimisation. Regardless of technological safety or security support, intervention of personnel is the goal.

5.2.1 Human-centric security

Technological measures offer comfort to a passenger, but the goal remains access to security personnel or police to provide capable intervention when needed. The authority must grasp the nature and severity of a passenger's distress in order to accommodate them. A cognitive awareness of unsafe situations women experience on PT does not infer an understanding of the obstacles encountered on a journey. Neither direct observation nor first-hand accounts may suffice for a 3rd party to appreciate the often-times delicate circumstances.

A holistic understanding is essential to ensure that intervention is provided in an efficient, effective and relatable manner. Women were of the perspective that a female security operative was more likely to comprehend circumstances of which men may not even notice, let alone possess first-hand experience. Those of a minority background were also acutely aware of racial victimisations that others are shielded from.

Empathy was considered a vital characteristic for authorities to exhibit with our users. Where it was found wanting, they identified the potential for inadequate intervention or potential for an incident to be exacerbated. Coupled with these, approachability, relatability and compassion are characteristics that our passengers both desire and expect.

Security personnel may only meet a user's needs with a continuum of availability, across all platforms, inter-modal nodes and services. A consistent visible presence is seen by passengers to offer both peace of mind and act as a deterrent to potential offenders. Discrete roles among transport staff were seen to dilute this deterrence and obscure their capacity to intercede, with conductors, drivers, catering and ticketing staff not always presenting authority sufficient to enforce arbitration. Women undertaking long journeys remain disadvantaged in cases of sparse security. Our user base identified that security absence buoys an atmosphere of risk which is exacerbated at night.

5.3 Environment

The cumulative effect of external environmental parameters influences users' transport behaviours and perceptions of PT. Analysis of interviewee responses revealed factors most conducive to conditioning their outlook and those which were most directly relatable to personal need.

5.3.1 Conditioning factors

Passenger experiences may be exceedingly conditioned by how the environments of stations, stops and service vehicles are presented. The ET of '*Visibility of the surrounding areas'* is a fundamental prerequisite to instigate travel. Lighting and visibility are essential, both safety and practically, in a fit-for-purpose service offering. TII (2020) Ari et al. (2022). Sufficient lighting entices access to connecting modes and infrastructure and secondary PT amenities. Visibility encourages a holistic engagement with PT.

Darkness on the other hand, conditions users to relate a potential journey with isolation, vulnerability, fear, danger and a sense of the unknown. A user with misgivings about lighting may forego a journey, especially at remote or poorly maintained locations.

Lighting is not outright a panacea for an appealing PT environment. *'Cleanliness and maintenance'* are factors that restrict user engagement. Users consider especially poor maintenance or a disagreeable appearance repellent enough to warrant behavioural changes in service engagement. Graffiti, faulty amenities, unsanitary bins or toilets or dilapidated stops or shelters are not only unpleasantries but elements which convey a sense of neglect to the overall

offering. Many users may tolerate disagreeable upkeep but for others, the PT service conditions become issues of hygiene, well-being and access. Standards of cleanliness and maintenance were subject to scrutiny by lone female passengers, users with dependants, the elderly and those with health conditions; a broken lift can hinder or prevent access, an unsanitary washroom can be detrimental to maintaining hygiene, a defective AV information system may obstruct travel. The absence of sustained maintenance fuels an oppressive and intimidating environment.

5.3.2 Relatable factors

'Modal and Station Design', 'Furniture and Facilities' and '*Proximity to Social or Community Outlets'* are ET that encompass the components of a PT journey which have the capacity to enable or inhibit a passenger's journey experience and engagement. Involvement in the activities PT provides and the mobility and independence it enables are dependent on an aggregate of journey components; those involving aspects of design, infrastructure, convenience, space and location.

A standardized design approach of stations and PT service vehicles neglects the user with needs departing from that of the mode user. Ari et al. (2022). Our user base report barriers in traversing a station and boarding or exiting a vehicle if they travel with dependents, children, buggies, luggage, using a wheelchair or are among the old or disabled. A clear need for space management to ensure equitable access to all service amenities and modes was highlighted. The absence of measures such as dynamic seating arrangements and readily accessible platforms, carriages or storage facilities further marginalises the already disadvantaged passenger, cultivates stress and impacts on safety.

The issue of design impact on luggage storage was in focus for passengers. Ill-conceived or inadequate storage for luggage or bicycles, inaccessible in crowds or gated by physical capability i.e., overhead units, diminishes mobility independence. Schwanen and Ziegler (2011). Considerations of the *'Furniture and facilities'* ET extend to practical access. The limited provision or absence of facilities such as lifts, shelter, waiting area seating, are not questions of discomfort for passengers but rather ones of necessity. The lone female passenger precludes herself from a service that obliges exposure to substandard or prohibitive facilities which can imprint an expectation of danger or vulnerability. Hine & Scott (2000) and Berghdal (2019).

The environment surrounding and connecting to a service or station also bears weight in the mind of passengers where the '*Proximity to Social Outlets or Community'* for them is a function of service routes. The vicinity of both service routes and stops providing access to locations of interest and to the service itself is commensurate with passenger uptake. Fulfilling essential caring duties that are disproportionately undertaken by women (Tofelotti and Starr, 2016) requires access to key locations that are decidedly sensitive to route disruption. Kane and Whitehead (2018).

5.4 Accessibility

A fulfilled participation in economic and social activity requires both a means and opportunity to engage. In a PT system, the destination is moot unless the service itself is accessible.

5.4.1 Mobile routes and locations

'*Location of Station'* was a prominent ET from our user base responses. The remoteness of stations that were not readily accessible by foot, such as those situated on the outskirts areas was underlined. Isolated spaces added a layer of risk to female users or passengers with responsibility for a dependant or child that other users do not experience. Stanko (1995). Stations spatial geography was not an attractive proposition to the users and impinged on services access, especially where parking for vehicles was absent, insecure or inconvenient.

The '*Accessible Routes and Platforms'* ET revealed the existence of added barriers for carers, older or infirm passengers to safely and confidently travel to, from or within a station. Poorly functioning or absent lifts or boarding aides or locations with long walking distances to the platforms were bases for journey abstention, compromising passenger independence. Delivery of a service which offers ample, easy to navigate and frequent (inter)connections were viewed as reasonable expectations to allow minimal waiting times and reducing isolation and vulnerability while markedly expanding inclusive access.

5.4.2 Transport dependent states

The journey prospect is more directly related to issues relating to service frequency by

interviewees in discussion of mobility aspects pertaining to '*Frequency and Reliability of Service'*. (Over)crowded services were an especially unattractive proposition, though passengers are still reliant on traversing PT networks during hostile peak hours or the demands of connecting to an urban hub. Journey expectations were again in focus here with quality of service perceived as temperamental, inconsistencies adding unavoidable stresses or even dangers to those beholden to a specific service, i.e. from additional waiting at isolated stops due to unreliable services or subjection to densely packed vehicles for long periods of time, devoid of the luxury of personal space and the exposure to real and perceived crime this entails, especially for women. Valentine (1989).

The subject of service information access materialised from the *'Transit Information'* theme. These exists an interdependency of information for across all modes of the extended PT network. Accurate and timely information flow was primarily a consideration for intermodal travellers, with reliable real-time information regarded as essential for navigating even more basic modal connections. Reliable knowledge of the expected (inter)connections added a sense of security and certainty to the journey expectation, the absence of which influences user decisions, travel behaviour and involvement. Friman et al. (2020).

5.4.3 Procedural alignment to mobility needs

Passengers voiced apprehension regarding *'Boarding Measures and Protocol'* and the inhospitable experience of an aggressively operated service tailored toward the functional mobility transaction user. Ari et al. (2022). The hassles involved with (dis)embarking a service are exacerbated by each additional (inter)connected mode, and more-so for the user with mobility aids and those with dependant, i.e., a child's buggy. Convenience is not the primary consideration for these passengers. Rather it is a question of access, that which A) Includes suitable standing or seating arrangements, based on user need(s) and B) Implements boarding procedures that provide passengers with ample time and space to safely navigate crowds and doors or gates.

6 Conclusion

Tackling PT safety issues warrants a comprehensive approach by the transport network that integrates all mobility modes and policy that further abolish inequality. Safety concerns differ between men and women, an inclusive approach to promoting the use of PT involves considerations of the granular aspects of what determines personal safety and the examination of the implications of these factors. Interpretations could affirm potential solutions in promoting equal participation and opportunity in society for all.

In promoting user accessibility, service conditions, route and designs must be perceived as safe and relatable, promoting comfort and convenience irrespective of gender. Concurrently, solutions that cater to safety initiatives and real-time dynamic measures are vital to the success of safety initiatives. Considerations of safety measures in planning and design require an approach catered to the magnitude of perceived safety and user needs. It is beholden on the PT system to promote the sense of safety.

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