TrainYarn: Probing Perceptions of Social Space in Urban Commuter Trains

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ABSTRACT
We studied the ways that urban commuter train passengers experience their journeys. We present the design process and in-situ evaluation of *TrainYarn*, a mobile app prototype designed to facilitate social interaction between co-located urban train passengers. Through the deployment of the prototype, we sought to probe perceptions of social space with a view to positively impact the assessment of public transport. Our results support that our target users saw value in the use of TrainYarn, perceiving it as emancipatory, in alignment with their communicative needs, and having the ability to transform their perceptions of social space. To further inform future research and practice, we put forward a series of design recommendations.

Author Keywords
Public Transport; Design Research; Qualitative Research; Activity Theory; In-Vehicle Activities; Social Norms; User Experience; UX Laddering; AttrakDiff

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The role of public transport to address issues of congestion and pollution is widely recognised (TTF, 2011). Within the modes of public transport, trains play a particularly relevant role due to both the number of passengers they transport, as well as their centrality in multi-modal journeys (TTF, 2011). Improving the quality of service in public transport is a valuable goal, given the relationship between the attractiveness of the transit service and patronage levels (Eboli et al., 2011). Hence, we constantly strive to improve the core factors of the service, such as availability, efficacy, efficiency, and safety (Eboli et al., 2011). Despite the necessity of focusing on such pillars, there are other factors that contribute on how public transport is assessed by passengers (Cairns et al., 2004). Whilst these "soft" factors (e.g., campaigns, personalised services) are considered peripheral to the service, they are nevertheless impactful from the point of view of passengers and how they *experience the service* (Lyons et al., 2007; Olsson et al., 2012). Together, both the core and "soft" factors shape how passengers see public transport and how they assess it, both at a functional and at an emotional level (Lyons et al., 2007; Ettema et al., 2012). Still, from a passenger-centric perspective little has been done to further our understanding on how non-traditional operational interventions throughout the myriad touch points of the service can lead to a service that is better appreciated by passengers.

One of the most central stages of any public transport journey is the *in-vehicle stage*. Both from a private as well as public transport perspective, individuals will associate a series of experiential factors to the method of transport based on their experiences of the in-vehicle stage (Jared, 2009). For public transport, there is value in exploring new opportunities in bringing more meaningful ways for passengers to experience their journeys, adding to the emotional appeal of the method of transport (Steg, 2005). Hypothetically, technological solutions can lead to the facilitation of new spatially bounded experiences to emerge in public transport vehicles (Paulos et al., 2004; Line et al., 2011). Technology can enable passengers to inhabit public transport vehicles in different ways, making traveling spaces places of leisure where passengers disassociate themselves from their surroundings. But whilst such disassociation comes about due to the lack of perceived interest of such spaces (Ettema et al., 2012), what could change if we enable passengers to experience such travelling spaces in ways that are better aligned with their needs and motivations? How could that impact their perceptions of public transport?

In this work, we seek to understand how a tool to support social interaction can lead to changes in how social space is perceived and experienced by passengers (Lefebvre, 1991). For this purpose, we present the design and in-situ evaluation of *TrainYarn*, a mobile application prototype that provides contextually tailored features aimed at public transport journeys, such as randomized, co-located, and anonymous interactions. Furthermore, this work seeks to understand the relationship between experiences of social space and perceptions of public transport as a service. We hypothesise that, when

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purposefully designed and tailored to specific segments of passengers, there is value in crafting tools that are supportive for an activity such as social interaction. To support this claim, our results demonstrate how such a tool can be connected to underlying motivations.

RELATED WORK

Opportunities and The In-Vehicle Stage

Public transport as a service is assessed both functionally as well as emotionally (Ettema et al., 2012; Carreira et al., 2014). Existing evidence stresses that passengers assess the service holistically, and that what happens at a micro-level (e.g., how a carriage looks and smells, how comfortable a seat is) contributes to shape their experience of the service (Olsson et al., 2012; Carreira et al., 2014). Hence, supporting passengers throughout their different touch points with the service is crucial in devising a public transport service that is able to be attractive both functionally as well as emotionally (Steg, 2005). To this extent, we need to look beyond the service as a means of moving passengers from one point to another (Watts et al., 2008). Instead, we should further focus on the "soft" factors that shape public transport (Cairns et al., 2004).

These factors extend beyond the traditional core characteristics of the service (e.g., availability, safety), instead emphasising more peripheral aspects of public transport, such as the use of personalised services. While secondary, these factors are less risky, less costly, and further enable for interventions that can be targeted at particular segments of passengers, bringing new levels of personalization that can foster emotional connection (Cairns et al., 2004). In seeking ways to tap into this potential, we need to understand how to better potentiate the unique characteristics of public transport. This exploration of the *opportunity space* in public transport becomes ever more accessible due to the ubiquity of technology (Line et al., 2011), paving the way for new experience to unfold (Foth et al., 2012; Royal College of Art, 2012). The *Tesco* virtual grocery system exemplifies the value of technology in transforming perceptions of waiting time, making use of the opportunity to enable passengers to buy groceries and get them delivered home.

From the myriad service touch points that shape public transport, the *in-vehicle stage* is particularly central (Camacho et al., 2013). Both from a private and a public transport perspective, existing research posits that individuals carry certain predispositions on how they assess a method of transport based on their activities and experiences during the in-vehicle stage (Lyons et al., 2005; Ohmori et al., 2008). While car manufacturers increasingly realise this and promote differentiation by offering drivers new means to shape their in-vehicle activities, the same does not happen in public transport. Consequently, there is a lack of evidence, both in quantity and academic rigour (Stradling et al., 2007; Ettema et al., 2012), to support the value of potentiating the in-vehicle stage in public transport. Questions remain unanswered about how perceptions of the in-vehicle stage could be

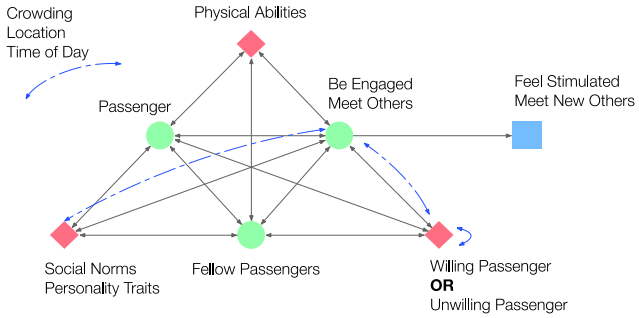

Figure 1. Activity modelling of in-vehicle social interaction. Relationships between primary elements (green circles) are mediated by secondary elements (red diamonds). Tensions (blue dashed lines) exist within, between elements, or even between activities (e.g., crowding). From the perspective of the subject (i.e., the passenger) tensions impact the intended outcome of the activity.

impacted and transformed if purposefully designed tools existed to support passengers and their underlying needs.

The Social Space and Mediating Tools

Passengers are influenced by how well the social space is experienced in public transport (Lefebvre, 1991; Dourish et al., 1996), which reflects on their assessment of the service (Jared, 2009). Theoretically, the social environment in public transport vehicles can be used to nurture social capital and produce a more conducive environment for those passengers interested in socialising with others (Currie et al., 2008; Hult et al., 2011). The *Love Seats* campaign exemplified this: a Danish public transport service provider set up a campaign where a set of dedicated "interaction seats" would be used to signal the willingness of those wanting to socially interact (Nordahl, 2012, p. 20). The results showed interest from specific segments of passengers, with patronage levels reportedly increasing throughout the campaign.

Sociality has also been explored in the aviation industry, with KLM's *Meet & Seat* program (KLM, 2014) and Virgin America's efforts to implement a fully fledged social networking system (Ghee, 2014). Despite the perceived value for enabling certain segments of passengers to interact with each other, public transport vehicles are not particularly conducive to social interaction and neither do passengers usually look positively at face-to-face interactions with unknown others (Jared, 2009).

Nevertheless, face-to-face communicative behaviour is not necessarily an appropriate baseline to draw inferences about all forms of communication (Dourish et al., 1996). Particularly, in public spaces, e.g., trains and buses, societal and cultural norms such as *civil inattention* constrain how interactions unfold and how social spaces are explored and experienced (Watts et al., 2008; Jared, 2009). Technology as a facilitator may allows us to move beyond the simple privatisation or escapism observed in the public space (Crawford, 2008; Camacho et al., 2013); instead it can empower individuals to overcome restrictions related to the free-form exploration and

creation of social spaces which are deemed more interesting (de Souza e Silva et al., 2010).

Paulos's work on "familiar strangers" demonstrates how technology might provide added control about how we bring meaning to public spaces, and how such social richness may be exploited in new ways (Paulos et al., 2004). Related work has also hinted at how location-awareness can be fostered to support social awareness and interaction between individuals (Licoppe et al., 2012), and on how individuals can attach added meaning to physical spaces through the use of digital tools (de Souza e Silva et al., 2010). Work on computer-mediated communication has further emphasised the usefulness of technology in addressing issues relating to interaction between individuals (e.g., "ice-breaking", social awareness) (Brignull et al., 2003). Nevertheless, and with exceptions (Bassoli et al., 2007; Royal College of Art, 2012), studies are lacking to support the usefulness of technology in positively impacting how passengers feel about public transport vehicles or the overarching service.

While location-based and locative media studies emphasise the emancipatory role of technology in the shaping of space (Licoppe et al., 2012), such insights usually look at the mapping of online social networks to physical spaces, and are not easily transferable to the exploration of the dynamic social space inside public transport vehicles. Furthermore, such studies do not answer questions relating to how such solutions can shape perceptions towards not only the social space, but also towards public transport as a whole.

This study looks to understand how and in which ways perceptions of social space inside urban commuter trains can be transformed through the deployment of technology that is designed to facilitate social interaction. This study further looks to gain insights into how such purposefully designed tools could impact overall perceptions of public transport as a service. The research questions are:

- **RQ1** – How can existing perceptions of the social space inside urban commuter trains be transformed through the introduction of tools designed to facilitate social interaction between passengers?
- **RQ2** – How can such tools impact how passengers assess public transport as a service?

DESIGN PROCESS AND RESEARCH METHODS

Throughout this study we followed a *design-oriented research* approach (Zimmerman et al., 2007; Fallman, 2009). TrainYarn can be described as a design intervention, where our goal was to move beyond studying current technology usage scenarios. Instead, we were interested in assessing responses and reactions of passengers when their ability to explore and experience the social space inside urban commuter trains was modified – i.e., what could change if the appropriate tools were made available? For the sake of brevity, we solely discuss the *research* and *evaluation* activities of the overarching iterative design process.

Research and Design

From a theoretical standpoint, TrainYarn was underpinned by activity theory, which was used as an *explanatory framework*. This was justified given the focus that activity theory gives to not only the capacities and motivations of individuals, but also to the role that other contextual elements have in influencing the outcome of an activity (Kaptelinin et al., 2012). Furthermore, the use of activity theory was considered useful due to its ability to promote *consistency* throughout research, design and evaluation. The framework offered the researchers a well-established theoretical lens in which to analyse, synthesise, design, and evaluate. Therefore the framework was instrumental in bridging the different phases of the design process (Kaptelinin, 2013).

In relation to our target audience, we focused on creating a design that we identified as being attractive to those passengers willing to interact with other unknown fellow passengers during their travelling time. The intent was not to aim at all passengers, neither was it to indicate that the facilitation of social interaction would be of interest to *all passengers*. Instead, throughout our research we screened for passengers who reported interest in communicating with fellow passengers, but that for some reason experienced difficulties in doing so. We further screened participants according to their age group (i.e., between 18 and 44 years old), based on existing nationwide survey data that indicated a higher predisposition for this age group to be both tech-savvy as well as daily users of public transport.

Our research activities included unobtrusive field observations and focus groups. Observations were done before focus groups and used to inform (along other existing secondary data) the overarching topic of social interaction between passengers in trains. Due to the inability of performing contextual research, we decided to perform focus groups due their ability to enable rich discussions between participants.

Approximately 7 hours of observations and 6 focus groups, involving 24 participants, were undertaken. Of the 24 participants, 50% were male, the majority travelled regularly (58.4%), and 83.3% were between 18 and 34 years old. Observations followed a synthesising framework, where a series of concepts (e.g., activities, behaviours, device usage) was used to guide data collection. Focus groups lasted 90 minutes and were divided into two parts. The first part consisted of a normal focus group session, while in the second part we presented a TrainYarn prototype (of increasingly fidelity and functionality over time) to participants and asked them to utilise it at will. Follow up open-ended questions were used to gather insights for formative evaluation and to guide the iterative refinement of the prototype.

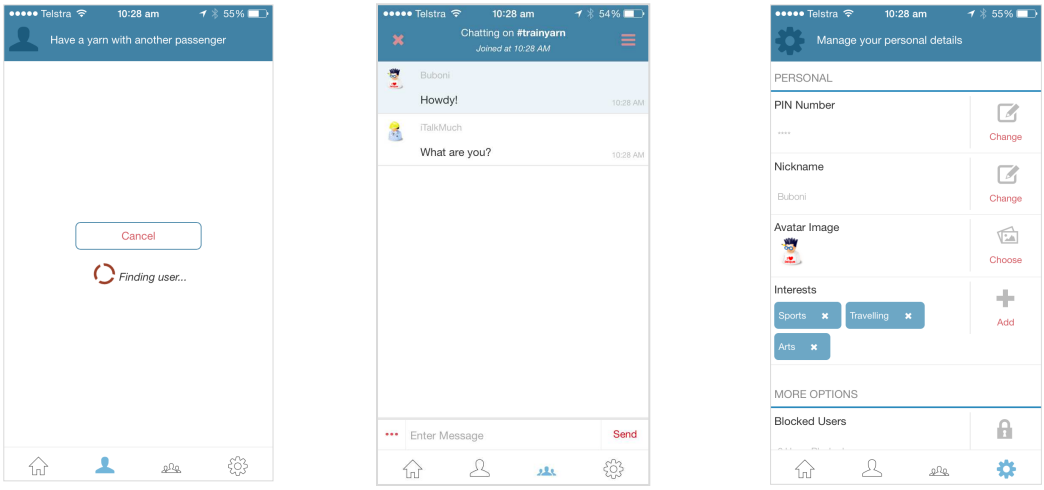

Figure 2. Final prototype showing (1) single chat, (2) group chat, and (3) settings screen

Conceptual design involved both domain and solution models, with *activity system modelling* used to define the elements of the domain space and how social interaction was being undertaken (Figure 1). Activity system modelling enabled us to synthesise the research insights into a cohesive model that could be referred back to when moving towards the design of the system. Aspects such as cultural and social norms, personality traits, the inability to recognise cues for interaction, and the negative impact of being rejected, were all identified as "pain points" for passengers when trying to explore the journey's social space and were used. These "tensions" (as defined by activity theory) were used to inform the design direction of our prototype. Figure 2 shows three major functions provided by the TrainYarn prototype: (a) single chat, (b) group chat, and (c) personalisation of profile.

Afforded Functionality and Design Rationale

TrainYarn was designed for use during train commuting, and as such we implemented a geo-fencing mechanism to restrict its operational radius and ensure that users were actual train passengers. The single chat mode was designed to try and match co-located users. The purpose of such feature was to exploit the sense of locality and that of engagement. Single chat further promoted serendipitous connections with passengers, working in a similar manner to *ChatRoulette*, where users would be randomly connected to others and not allowed to choose with whom to talk. The purpose of this strategy was to promote social awareness and add to the excitement of talking to unknown but co-located others. Group chat worked as a normal chat room, where users would congregate and interact by broadcasting their messages. Group chat was mostly a way of addressing issues of enticing participation, creating a sense of group belonging, and further promoting social awareness by exposing the presence of users to others in a transparent manner.

Personal settings were designed to add personalisation and control over the prototype. The prototype exposed only non-sensitive information (e.g., nickname), hence ensuring anonymity. Anonymity has been associated with higher stimulation levels, as well as facilitating face-to-face interactions (Burak et al., 2004). Users could further define a series of interests, which allowed for establishing common ground (Farnham et al., 2009), as well as promoting a higher sense of control. Further relating to control, users could arbitrarily block any user, resulting in all messages from this user being blocked.

Evaluation

Three distinct types of evaluation were performed: formative, assessment, and validation. Formative evaluation was done using open-ended questions and used to identify issues and define the direction in the early stages of the process. Assessment evaluation was used to assess user experience and consisted of 6 participants performing 13 representative tasks and filling a User Experience Questionnaire.

The validation evaluation tested the prototype in the "real-world". The prototype was uploaded to both App Store and Google Play, and a media release was used to make users aware of a two-week field trial. Participants taking part in the field trial had to use TrainYarn once each day during their weekday commute. Participants that registered for the trial would receive AUD150 if they adhered to the conditions, but the majority of the users did not in effect register, and hence their participation was *not* renumerated. The reward was used to ensure that a minimum number of users would populate the system. Additionally, a chat bot was installed to entice more users to communicate by always have at least 1 user always present. The bot was removed once more than 2 users were in the system. TrainYarn was fully functional for approximately 3 weeks, in which over 60 users engaged in repeated sessions (i.e., 2 sessions at least).

After the three-week period of operation, we contacted participants for a follow up interview and made an online version of the *AttrakDiff* questionnaire available (Hassenzahl et al., 2010). In total, we performed 10 follow up laddering interviews, and gathered data from 12 AttrakDiff questionnaires. We also analysed the raw log content of the conversations between users using a qualitative approach. AttrakDiff was used to assess UX based on the hedonic/pragmatic model (Hassenzahl, 2010). UX Laddering was used to connect afforded functionality with intrinsic needs and values of users (Vanden Abeele et al., 2012). Content analysis was used for both UX Laddering and the raw log content. In relation to the UX Laddering, qualitative analysis was

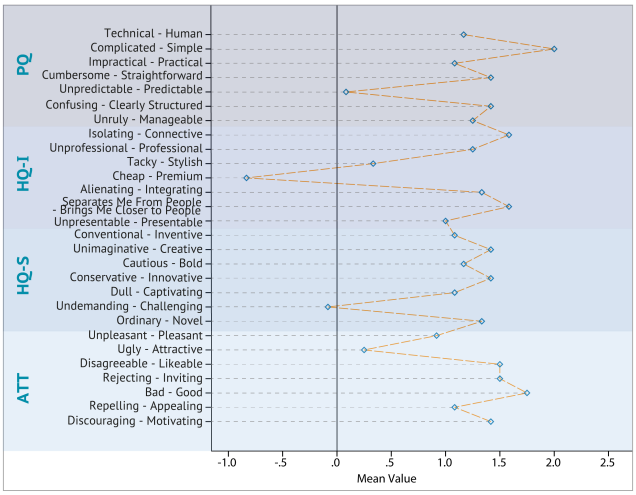

Figure 3. AttrakDiff questionnaire showing measures for Pragmatic Quality (PQ), Hedonic-Identity (HQ-I), Hedonic Stimulation (HQ-S), and Attractiveness (ATT)

first used for the concept identification phase, after which quantitative analysis was used to test the relationships between such concepts. Due to resource availability restrictions, only one coder performed the content analysis. To address reliability concerns though, several test-retest iterations were performed. UX Laddering validation concerns were addressed by adjusting the "cut-off" levels according to existing recommendations (Vanden Abeele et al., 2012). The qualitative analysis of the raw log content was used to corroborate insights gained by both the AttrakDiff and laddering analysis (i.e., a deductive approach).

RESULTS

Our results consisted of the AttrakDiff questionnaires, the semi-structured interviews with participants, and the raw log content of TrainYarn. The raw log content consisted of *2083 messages* that were exchanged between users, including individual and group chats, but excluding content sent by the chat bot. The results of the AttrakDiff questionnaires (Figure 3) indicate the overall perceptions of the participants towards the prototype. The prototype was indicated as being likeable and easy to use, and that connectedness and social integration were among the main characteristics associated with the prototype.

On the other hand, results show issues regarding predictability, aesthetics, and the lack of challenge afforded by TrainYarn. Performing the UX Laddering (Figure 4), we elicited 28 distinct concepts that were arranged according to a hierarchy of 5 different levels (i.e., *concrete attributes*, *abstract attributes*, *functional consequences*, *psycho-social consequences*, and *values)*. We defined the levels as follows: after the establishment of the codes/concepts using NVivo, we transferred them onto the LadderUX tool. As a result, 260 distinct data points were defined, which translated into 77 distinct ladders with an average of 3.43 elements per ladder. The construction of the hierarchy was based on questions to try and identify any potential value that participants would associate with the function afforded by the prototype. We adjusted the cut-off values for the quantitative analysis part, removing weak links from the data. We defined the cut-off values as 2, 3, 3, 3, 4 for the values, psycho-social consequences, functional consequences, abstract attributes, and concrete attributes respectively, which resulted in the retainment of 2/3 of links which is in accordance with existing recommendations (Vanden Abeele et al., 2012).

Engagement and Journey Perceptions

Looking at Figure 4, we can observe that there is a connection between single chat and the promotion of social awareness, which in turn was linked to the attainment of stimulation and relatedness:

> *P2 – "It was a little exciting, I guess. Yeah. It was a feeling of curiosity in your mind: 'Who is this person? Where are they? Where might they be?'"*

Hence, providing means to communicate with others within the train environment has sparked feelings of excitement and of curiosity. Additionally, a link between real-time interaction, reduced perceived journey length, and a sense of feeling captivated was identified:

> *P9 – "It would definitely help me to, you know, get by the time in a sense. With this application, I can just spend some time chatting with random people that I don't even know and spend some time. It helps time go by faster.*

> *P2 – "When I looked up I was almost at my stop. So yeah, more absorbent than Facebook or than listening to music. Because you are actively engaged in what you're doing, where the others are more passive."*

> *P4 – "(…) If they think public transport is boring maybe they can, with this application, have a better look and have another perception that public transport used to be boring but now, you have this to help you to interact."*

We further identified the theme of perceived journey length through our analysis of the raw log content:

> *Jelly: I like it too. I just want more people!*
> *Scooter22: I think it'll catch on...*
> *SexyPuppy: Yes Jelly let's give it some time*
> *SexyPuppy: In the beginning it can be hard*
> *Scooter22: makes the trip go faster...lol.*

Hence, it seems that the exploration of the social space can lead to greater sense of engagement and have a positive impact on how the journey is perceived by passengers. We further found that certain passengers retained particular interesting moments:

> *P2 – "Yeah going home on the train at 9:30 at night. And…I assume it was a female I was talking to and a younger one or maybe a university student or something (….) like…I can't remember some of the remarks but there was something about blood sacrifices… and I was like 'How do I respond to this?'"*

Localised Interaction

When it comes to localised interaction, we note that this was linked to feelings of belonging and perceived as a facilitating mechanism for interaction:

P5 – "My preference may be to share you know…people may share experiences based on locality. Just being close. Having something in common, but in common on the same train. It might have been an issue on the train or even on the same line that might be interesting."

P9 – "I think that interacting in that way was quite effective. Hmmm…there were a few people that were obviously on the train on the same time each day as I was. So I could sort of keep a bit of a conversation – a bit of a relationship with those people."

The relevance of localised interaction was also identified in the raw log content:

Jelly: That would be great
John81: Better than mx
Android: should we all move to 1 four seated and talk directly? lol
Jelly: hehe. mX is funny also
Jelly: But I get that crappy paper ink on my fingers
Android: yeah…and better than killing time going to random web pages.

Here we note the potential for localised interaction to spur face-to-face social encounters, countering the argument that technology within public transport serves the sole purpose of leading to social alienation.

Anonymity

Another insight relates to anonymity. As seen in Figure 4, anonymous interaction was linked to freedom to engage in a conversation, which was related to a heightened sense of relatedness. Additionally, anonymity was a central attribute in ensuring participants felt safe whilst engaging with others:

P7 – "Because I'm guessing people, and my experience behind the PC chatting – like not a train but anywhere in the world – is that anonymity gives greater freedom in your speech and liberates you to a certain extent. People might say things that they might not say if they knew "Hey I'm talking to you on the train". And if that cloak unveils then it does not work well."

P3 – "(...) So the avatar allows you to hide your identity. And also it helps me create a sense of security. So then when I used the application I would know that people wouldn't be stalking me or something because I was using the avatar."

Therefore, ensuring anonymity seems paramount in ensuring the future adoption of such systems. Another interesting aspect about the use of anonymity is how it catered for participants with different personality traits:

P6 – "(...) So I actually meet people that would be like…and go through like…hmmm…my name is and this is who I am, instead of doing what I usually do on trains which is walking up to random people and be going 'Hi. Do you want have a chat?' Which tends to creep people out."

P8 – "(...) I'm not very good at conversations, so I thought it might be a good way for me to develop on that and try and meet new people, try and start conversations, try and work on that side of things for me."

Here we note that despite the stated personality differences, both participants saw value in using TrainYarn to connect with others without the need to engage in face-to-face interaction straightaway.

Limitations

There were several limitations identified. Participants felt that, even though anonymity was essential in the current context, options for personalisation were limited. This led to a lack of perceived control and the inability to define oneself expressively to others. Also, the ability to define more interests and connect to others who share similar interests was seen as something that would enable participants to have a more refined level of connectedness with fellow passengers:

P7 – "(...) So…but there was a bit of a…like some constraints. Like there's no gender, so how do I get around like…if I do want to portray myself as a bloke, I've got to put that in the name as opposed to an…in a describable thing."

P7 – "(...) the inability of having a broader range that people might want to say "Well, this is me". And might present more conversation topics for people to meet and talk."

The limitations of the prototype were further identified on our raw log analysis:

(...) Scooter22: nah...freaking disconnected again...quiet joint this morning...must be too cold...lol
skinny: Gender id. Avatar import
LightMe: what do u mean gender id?
skinny: M or F
LightMe: oh ok
Spooky: yes you could add that, but people might just lie about it, i guess
LightMe: That's true. Perhaps you could make it optional

Here we note several interesting aspects. The first is the perceived lack of users. This stemmed mainly from the chosen synchronous iteration model, which supported only real-time interaction. Furthermore, this excerpt reinforces the limitations around the ability to personalise TrainYarn and to create more rich representations of their digital personas.

DISCUSSION

Designing Supportive Tools

One insight that stems from our analysis is that several existing assumptions need to be revised. The first is the role that technology has in the context of public transport vehicles; its potential to create more interesting and meaningful journeys for passengers; and how service providers should reappraise the relevance of what happens during the in-vehicle stage. While research suggests that the use of technology fails to make public transport journeys any more attractive to passengers (Ettema et al., 2012), we argue that this is related to the lack of designs to support such moments altogether.

Nevertheless, as participants explored the prototype and were allowed to communicate with fellow passengers and explore the social space in new ways, they associated a series of factors that redefined their journey experience. Passengers hinted at the need to become more active agents in their journeys, having higher levels of control on shaping the in-vehicle environment. In this regard, participants saw TrainYarn as an empowering mechanism that would renew their ability to connect with fellow passengers.

Hence, it follows that when appropriate tools are in place to support passengers in activities that are of value to them, then such activities can have a transformative power and influence assumptions of what a public transport journey is (Jared, 2009). Consequently, we have, from a service perspective, to consider the role that such tools can play in how passengers assess the service as a whole. While focusing on core factors of public transport is paramount it becomes evident that passenger-centricity plays an increasing relevant role in shaping experiences (Camacho et al., 2013).

Exploring and Shaping the Social Space

In relation to how passengers are allowed to explore the social space inside urban commuter trains, we note several aspects. First, our results show that anonymous interaction is associated with a propensity to engage with others and further with a sense of safety that enables passengers to communicate more freely with others. We argue that anonymous interaction is central when considering designing for social interactions in the current context. This argument aligns with evidence from computer-mediated communication, where mediation through technology is known to facilitate trustworthiness and contribute to higher levels of self-disclosure (Walther, 1996). To further corroborate this, we note that details shared by individuals included personal information about current personal affective states and moods, boarding and alighting train stations, current train lines and direction of travelling, location of work, and living suburb. Whilst this can raise safety concerns, participants noted their preference for having control on whether they wanted their true identities exposed to others or not. Hence, having tight safety constraints but allowing for control of these seems appropriate in this context.

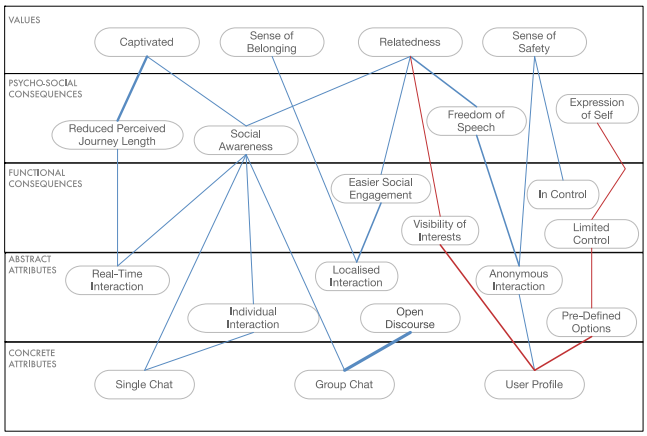

Figure 4. The UX Laddering result showing the five-level hierarchy going from attributes to values

Another aspect that drew our attention was that of social awareness. We note that TrainYarn worked to promote a reduction of "social distance," emphasising the role that technology can have other than privatising the public space (Crawford, 2008). We argue that localised interaction in particular brings to the forefront the intrinsic curiosity and willingness of certain passengers to find out more about other passengers, adding to the level of meaningfulness that is associated with public transport vehicles (Licoppe et al., 2012). Hence, anonymity and localised interaction seem valuable strategies in enhancing the exploration and transformation of the social space inside public transport vehicles.

The Value of Tailored Tools

A variety of participants associated interest and value with the TrainYarn prototype. An example for this consensus can be seen in the previous comments from two participants who demonstrated opposite personality traits. Despite one being described as extroverted and the other introverted, both of them saw value in the TrainYarn prototype. This indicates that personality traits can be surpassed by existing normative rules that govern the social space inside transit vehicles (Goffman, 1969).

Hence, we argue that providing mechanisms to enable safe and socially accepted means to interact with others is a valuable approach in supporting the needs and motivations of specific segments of individuals. In alignment with activity theory, a deeper reason propels individuals to seek to communicate with others (Kaptelinin et al., 2012). Hence, tools that are tailored for such an environment have the ability to create an environment that becomes more appropriate for sociality. We furthermore note that certain mechanisms, such as real-time interactivity, contributed to how engage and stimulated passengers felt whilst conversing with others. Real-time functionality allowed passengers to go from passive observers to active agents having a say on the dynamics of the journey. Finally, we note that social interaction has the ability to promote positive experiences that extend beyond the moment and linger over time (Roto et al., 2011), something that can have a noticeable effect on perceptions of the service over time (Friman, 2004).

Overall Insights and Recommendations

To summarise, we consider the research questions that motivated this research. In relation to **RQ1,** how can existing perceptions of the social space inside urban commuter trains be transformed through the introduction of tools designed to facilitate social interaction between passengers? We argue that existing perceptions can be transformed at a deep level, effectively addressing not only momentary aspects that might influence social interaction; instead, such tools have the ability to reconfigure how social space is perceived altogether, transfiguring fellow passengers from uncertain to willing individuals to communicate with (Figure. 1).

We further argue that the reconfiguration of the social space occurs naturally and follows from intrinsic interests and values. We argue that at its core TrainYarn emphasized that, while not all results were positive and even issues of a novelty effect might be raised due the relatively short period of evaluation. Participants saw in the prototype a vehicle to address what they saw valuable to them. With this in mind, we recommend that the following guidelines should be considered when designing future solutions that aim to facilitate the exploration of the social space in public transport vehicles:

1. Variable anonymity levels. Allow users to personalise their information, but make the visibility of any personal information an opt-in; (self-expression, sense control, sense of safety);
2. Allow users to describe themselves by means of interests, occupation, and other kinds of information which are not excessively personal (self-expression, relatedness, sense of safety, and sense of belonging);
3. Prefer synchronous communication (i.e., real-time) but enhance it with asynchronous communication to promote higher levels of engagement (stimulation, social awareness);
4. Promote localised interaction, preferably inside the same transit vehicle (sense of curiosity, relatedness, sense of belonging);
5. Randomised interaction can be considered, but only in relation to localised interaction (sense of control, stimulation);
6. Promote diversity of interaction by allowing individual and group interactions (sense of control, diversity).

In relation to **RQ2**, and how can such tools impact how passengers assess public transport as a service, we note two aspects. The first aspect is that offering the means for certain passengers to connect with others is of value to them. It provides these passengers a better means to support their journeys and to foster what they see valuable to them. This in turn has the ability to impact their perceptions and experiences of the service. Whilst we focused on social interaction, we argue that many other opportunities exist to take the service to new heights. Nevertheless, this will require a commitment from service providers to continuously gain a more in-depth understanding of passengers and their needs beyond sole transportation.

The second aspect is that, while these interventions are secondary from a service provision perspective, we argue that such efforts are essential in adding emotional attractiveness to public transport as a whole. Hence, designing tools that connect individuals and service providers beyond the sole functional dimension are essential in the betterment of the service.

LIMITATIONS AND CONCLUSION

We start by stating that a higher number of participants are likely to have provided more grounded insights. Nevertheless, we note the qualitative nature of the research and the depth of the gathered insights, which we see as being of sufficient strength to support our conclusions. Furthermore, despite limitations of the in-situ evaluation, we argue that the richness and the added reality of such a type of evaluation exceed its limitations. Participants went from imagining or trying a prototype in a controlled environment to actually experiencing it in context of use. We judge the contribution of this work in its ability to show that there is value in designing tools to support public transport passengers. In particular, we believe that there is value in designing for social interaction, as our empirical data suggests. Furthermore, this works provides insights on what to look for when designing such tools.

To finalise, we argue that this work is a step forward in showing the value of supporting passengers in activities of their interest as they travel. We have provided evidence to support the role that technology and design can have in shaping a future for public transport where passengers see the service as functionally as well as emotionally appealing.

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