**Public Transport Comfort - An inclusive taxonomy of attributes**

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Abstract

A taxonomy of what constitutes comfort in public transport is presented, based on the research literature in public transportation and ergonomics. A critical review of the public transport research literature is provided, enabling the reader to differentiate between empirical works and those that are themselves compiled from the literature. A key outcome of the taxonomy is the comparison between knowledge in public transport and that in ergonomics, with the former being far broader and more practical for the public transport professional, and the latter grounded in scientific experimentation and observation. The taxonomy provides the reader with a broad ranging, inclusive set of comfort attributes that have been discovered in this review to have some impact on the comfort of passengers in public transport.

Four categories of comfort have been determined; environmental, organisational, social and personal. The environmental category for example contains three families and 10 types of attributes borne of characteristics pertaining to the way in which a transport service is carried out. The three families of dynamic, static and physical pertain to the nature of those sensations, which are then further categorised under types to make the attributes more accessible.

In order that the taxonomy may be of practical use, a framework for understanding comfort is presented, as a summary of existing literature. This framework determines how the attributes of comfort may contribute to the perception of public transport and how these may be perceived when compared to other known factors in transit such as frequency of service.

1. Introduction

Comfort sits at the intersection between a transport system and the human user. The provision of comfort, the elements of which comfort is comprised, and the memories and perceptions of comfort before and after transport use are all important considerations in the creation and provision of public transport. This paper presents a practical taxonomy of comfort in order that its determining factors may be addressed and improved in the development of public transport systems. Conceptualised as a checklist for designers and engineers, the taxonomy should also inform policy and decisions and provide a framework for how comfort can be viewed in relation to more conventional performance measures in public transport such as service frequency.

This paper has three aims: first, to communicate the first stage development of a public transport comfort taxonomy. To this end a literature review has been undertaken and comfort attributes mined from research papers, technical handbooks, and standards in the fields of public transport and ergonomics. The second aim is to provide a theoretical framework useful to practitioners when considering comfort as an objective alongside more conventional quantitative measures. The third aim is to provide a starting point for deeper understanding of the elements that comprise a total *Public Transport User Experience.* As such, while every effort has been invested to ensure the quality of this first generation taxonomy, refinement is expected.

In making this taxonomy a broad study, the context of the journey is considered in entirety. Mayr (1959) states that a journey experience is comprised of more than a vehicle experience, and as such the view of comfort taken in this taxonomy entertains Mayr’s approach. Indeed, many of the literature sources employed in this taxonomy implicitly consider the “whole journey” as contributing to comfort. The taxonomy, therefore, considers the range of interactions that people have with the public transport system, from planning a journey, intermediate trips such as from house to bus stop, as well as the oft-cited “last mile” of the journey in total. The identification of a plausible start point creates the opportunity for a broad view of transport comfort, with Mayr identifying two candidates as firstly, “*the need to go somewhere”*, and secondly, *a physical phenomenon for example stepping out the door* (Mayr, 1959).

Following this introduction, section two provides an overview and critical review of the literature, section three listing the factors discovered and providing the taxonomy of comfort in public transport. Section four synthesises views of transport psychology and ergonomic theory to provide a theoretical framework for applying the taxonomy. A discussion is made in section five with conclusions and an indication of future work.

2. Passenger comfort in public transport

“*Unfortunately, it is not clear what constitutes a good quality*.”(Richter, Friman, & Gärling, 2011)

Quality is a broad target for public transport. As an element of quality, studies of comfort are reassuringly commonplace. It is observed however that the majority of these studies do not aim to be exhaustive, and as such tend to deal with short lists of comfort attributes. In aiming to provide a broad ranging context to many shorter lists of comfort attributes, the taxonomy responds to a general paucity of dedicated resources in this area.

A singular, unified concept and definition of comfort continues to elude precise, agreed definition in the literature and practice. Nevertheless, useful directions and frameworks can be found. One major distinction is drawn between comfort and discomfort, and the concept that the two are states of being which do not, in theory, overlap (Vink & Hallbeck, 2012 pp271). Oborne (1978) neatly summarised some views on comfort in a more linear fashion as “*an optimal state in which the person takes no further steps to avoid discomfort*” with Branton (1969) adding that the user “*loses all awareness of his* [sic] *environment*” and going on to set out a useful description in that the absence of discomfort does not, necessarily, imply that comfort has been achieved, but perhaps merely the presence of no feeling at all. This brings us to the debate as to whether comfort is an active, or passive state. Comfort is itself comprised of many dimensions as this review will show, but another useful distinction is between the physical and psychological drawn by Mayr (1959) and many since. For example one may be physically accommodated but under some stress, and therefore not comfortable, or perhaps distracted from mild discomfort by excellent psychological comfort, as described in a study of airline travel (Vink, Bazley, Kamp, & Blok, 2012). An absence of discomfort is necessary, but not sufficient, to achieve a pleasurable state of comfort. It is speculated that an active state of pleasure may only be achieved through psychological comfort factors in addition the physical.

Comfort has also eluded precise measurement and definition because of its nature as a personal and relative phenomenon. Comfort is also temporally affected by exposure time to particular stimuli, and may also be viewed as a cumulative phenomenon, with regard to both physical exposure and psychologically derived views and experiences (Edvardsson, 1998; Friman, Edvardsson, & Gärling, 2001; Friman & Gärling, 2001). With a view to taxonomy of comfort attributes in public transport, two main fields of literature have been investigated. The public transport literature concerning comfort, and the ergonomic literature.

2.1 The public transport literature

A tendency is observed in the earlier literature to focus on tangible elements of public transport as those most important to comfort. A more contemporary view (Friman et al., 2001) identifies that while the tangibles and system properties are an obvious part of the passenger experience, it is also observed that many stimuli located across time and space - identified in the taxonomy – bring intangible factors to bear on comfort. This aims to include both tangible and intangible determinants of comfort.

Comfort then, can be seen as a cumulative sensation of many affective avenues. Research efforts in the public transport field have dealt with comfort in several ways, the dominant direction of research being efforts to quantify, rank and thereby inform policy and practice with a view to public transport improvement and ridership growth. The public transport literature provides many and varied insights into what may influence comfort, and in particular is most useful in identifying attributes that are disproportionately important when compared to the broader ergonomic literature.

Other research foci concerning public transport comfort are its relationship to customer satisfaction and the supply, or level of, service. The terms “level of service” and “quality of service” are often confounded. The present work aims to disentangle the two hidden meanings and as such will treat the term “level of service” to concern the *quantity* of public transport supplied – attributes such as service frequency, vehicle capacity, and speed. The term “quality of service” is used herein to describe the *manner* in which the quantity is delivered, and is a much broader umbrella including for example, on-time running and the central theme of this paper, comfort.

The terms, and concepts above were not always viewed interchangeably. Davis and Levine (1967) discuss the nature of any particular “ride” on transport, showing that the elements comprising the ride may be categorised as either instrumental or affective. Instrumental elements of the ride are those contributing directly to the utility, for example the route or time at which the destination is reached. These factors may of course contribute to comfort by limiting exposure to certain stimuli, such as a crowded vehicle. Such a crowded vehicle would be considered an affective part of the ride, since the instrumental goal of transport is still achieved. The important distinction in the affective elements of the ride is the manner in which the ride is carried out. Is it done pleasantly? What are the characteristics of the visual or olfactory environment as compared to what might be physiologically tolerable?

Why then, should the present study and taxonomy be inclusive? A study of Voluntary Travel Behaviour Change (VTBC) (Stopher, Clifford, Swann, & Zhang, 2009) provides a viewpoint. While not identifying specific factors, the VTBC studies are observed in this review to be inclusive, as they often deal with the choice between public transport and the private car. Comparing public transport to the private car (Bunting, 2004 p74), especially in the Australian context, offers us a view into an affective mode of transport that can drive consumer choice by means of meeting desires, far over and above the mere provision of transport (Coxon, Napper, & Allen, 2007). An inclusive study may be larger, but is hopefully more useful in being more complete.

The practical use of comfort to a transport professional should be resolved. Aside from many anecdotal sources, there exist some studies showing a basis for comfort as an attractive element of public transport. A study in Winchester, UK, has shown that comfort along with other affective elements of transport viewed through the proxy of newness (new buses) has positive impact on ridership (Wall & McDonald, 2007). In this Winchester example, but also as a result of common practice, the means by which affective elements of public transport are delivered are often associated with the contemporary, new, or novel. It remains unknown to what extent newness may elicit emotions of comfort or pleasure, however a contemporary environment tends to be associated with the mechanical realities of cleanliness, technological advancement, mechanical refinement, and even speed or dynamism. The above factors, among others are included in the taxonomy, however observations of the phenomenon are difficult to quantify, and are at best shown to correlate with, rather than cause, comfort (Wall & McDonald, 2007 p173).

Instrumental and affective elements have been respectively described as tangible and perceptual (Currie & Wallis, 2008). Coming to a similar conclusion as Davis and Levine (1967) and citing other sources for factors, this study distinguishes between more traditional performance measures such as frequency of service and fares, compared with the role of the perceptual features to “substantially affect travel decisions”. Identifying similar results to studies of VTBC the Currie and Wallis review describes the ability of “*perceptions of quality*” to influence the travel behaviour of individuals in the same way as more operational elements such as timing.

Further discussion of the difference between the quality of public transport and the quantity in which it is provided is observed (Friman & Fellesson, 2009). While calling for a “*richer set of quality attributes*” some of which this taxonomy hopes to provide, the study shows that while the provision of more services does have a positive impact on ridership, it is not the sole determinant of public transport attraction. More transport may attract more riders, but it will not cause riders, either new or existing, to be more satisfied or comfortable. Observing a similarity with research in service quality the authors describe a situation whereby the perception of service quality is determined by what the consumer gets, but also how they get it. The paper also suggests investigation of a “richer set” of what constitutes quality.

The Transit Capacity and Quality of Service Manual (Transportation Research Board, 2013) is a major North American-centric work in the area of public transport interface, and contributes many factors to this review of comfort. In dealing with quality of public transport, the manual draws a distinction between the availability of the transport, and then the comfort and convenience of the trip that may attract a passenger – if indeed the passenger has a choice of mode. The manual asks an important set of questions, repeated here: Is transit service an option for a given trip? If transit service is an option, how attractive is it to potential passengers?

Determinants of comfort are mainly to be found in the discussion of the latter – comfort and convenience – the manual identifying such factors as lighting and wayfinding (or wayshowing (Mollerup, 2005)) information. The manual also identifies “reassurance” as a factor in what passengers need, and factors such as this offer a good insight into how broadly comfort can be construed. The provision of information about a route is a factor of availability, since if a potential passenger is unaware of a service they will not deem it an available option. Once engaged in the act of transit use however, this passenger may find it useful and reassuring to know where they are headed, the stops prior to their own, and interchange information. The taxonomy aims to distinguish between measures of comfort and convenience, and the observation is made that for a true understanding of both these categories, that comfort and convenience may in time be better served by being separated.

This review determines that while the TCQSM offers one of the richest resource lists on comfort, it is still not complete. “Completeness” may indeed be an unattainable goal in a context of great variation and constant change, such as public transport is. The reader is reminded of observations made in the introduction, in that the nature of comfort is still a matter of some debate and research, supporting the observation of this review that no one resource can be reasonably expected to cover all ground. This review aims to offer an inclusive view of comfort and therefore integrates different viewpoints in order to create the taxonomy.

Of eight categories for comfort identified in EN13816 (European Committee for Standardization, 2002), the sixth is comfort, within which are identified a further six sub-categories; usability of passenger facilities, seating and personal space, ride comfort, ambient conditions, complementary facilities and ergonomy. While each of these sub-categories is also broad, it shows that the standard takes a largely physical, rather than psychological, view of comfort. Interestingly, of the eight overall categories seven may be considered to have some impact on comfort – for example customer care (Vink et al., 2012) and organisational comfort as shown by Mayr (1959).

Evidence of this review, and tracing references with regard to comfort attributes shows that little empirical research effort has been expended in the identification of comfort attributes in the public transport literature. In setting out methods to measure the relative importance of attributes, a tendency in the literature is to provide truncated, if useful and illuminating, lists of comfort attributes before getting on to a task of measurement, ranking or determining relative importance to other public transport aspects. The resulting analyses provide insightful knowledge into public transport passenger behaviours and motivation, however if they are founded on small, incomplete lists of factors then all we can glean from the results is the relative importance of those factors to one another. One role of this taxonomy is to provide a broader context in which to place these smaller lists of useful factors, such that their relationship to the public transport field in general is better understood.

The majority of research concerning comfort and public transport is that which sets out to rank and quantify attributes of the journey experience. These studies tend to apply a stated-preference methodology to the analysis of attributes, and provide useful insights into passenger attitudes, preference for one attribute over another, and guidance to policy (D. Hensher, 1990; D. A. Hensher, Stopher, & Bullock, 2003; Prioni & Hensher, 2000). Commonly ranked attributes include seat availability, information at bus stop, temperature on bus and general cleanliness on board. These are undoubtedly useful, especially when ranked. As this paper seeks to create a nuanced, more complete taxonomy of comfort, it is observed that several of these comfort attributes are themselves categories that may be further disaggregated.

The means by which comfort attributes are identified varies. The vast majority of research works cite previous studies and add a few of their own attributes. Ultimately, two means of empirical identification dominate the literature: asking bus passengers, and relying on industry experience and expertise to generate lists of attributes.

Asking passengers is a logical, simple, and accessible means of identifying comfort attributes. General reasoning for this method is that the passengers themselves, having experienced public transport, are well placed to identify pleasing and displeasing aspects of their journey. A sample bias in this method is observed however – if passengers are surveyed with a view to improving ridership figures, then it stands to reason that asking non-passengers or passengers familiar with public transport but who choose not to use it would identify more specific weaknesses. Collecting the views of non-users, especially those who choose not to be users is regarded as a more thorough path to understanding what attributes in a product may be wanting (Norman, 1998). It is the information, and perhaps perception, of a product from those non-users that may identify attributes most ripe for improvement.

Some comfort attributes in this review have been empirically “identified” by expertise and experience. While no specific method of identification is made clear, it is observed that the authors of such lists are experienced public transport professionals and researchers (Brewer, 1997). This is highly valuable to a broad ranging review such as this one, and importantly, many of those empirically identified attributes have been verified by survey to be important. The research cannot prove that such lists are exhaustive, however the attributes have withstood a test of attempted refutation by survey.

The public transport literature has provided a rich understanding of organisational comfort, first identified in it’s own right by Mayr (1959). Organisational comfort is a distinctively transit-focussed category when comparing the public transport literature with the more general ergonomic field. Characteristics such as the provision of information, the accessibility of that information, and operational adherence to such schedules and maps are all cited as possible determinants of quality, and psychological comfort. In parallel to the identification of organisational comfort, work in the service quality field (Parasuraman, Berry, & Zeithaml, 1991) has pointed towards a fine-grained understanding of organisational comfort, for example responsiveness, communication and competence. These and other attributes under this category are perhaps some of the most ripe for improvement because of their specificity, but also that many of the attributes, for example the provision of good information, do not foreshadow major infrastructure spending.

Stress is identified as a source of discomfort. The stress associated with meeting a particular service before departure, and also the stress of uncertainty (Bates, Polak, Jones, & Cook, 2001) are important factors in public transport interactions. Passengers can feel a certain level of anxiety no matter what mode may be chosen, for example traffic afflicts cars and buses alike, however there appears to be a larger range of potential stressors in the public transport environment that in the private equivalent. Someone else is in control of your vehicle, and adherence to the schedule, making a connection, timely arrival at destination and route followed may also be factors in comfort.

2.2 The ergonomic literature

The International Ergonomics Association defines ergonomics (or human factors) as the “*scientific discipline concerned with the understanding of the interactions among humans and other elements of a system”* (IEA, 2013). To this end, the human factors and ergonomic (HF/E) literature on comfort is rich, given that feelings of comfort are drawn from such interactions – physical, psychological, immediate and cumulative over time of exposure and repeated exposures.

The HF/E literature is reviewed in order to mine further comfort attributes, and also as a means of cross-checking those discovered in the review of public transport above. This literature offers two fields of insight – the attributes presented in the taxonomy, and the theoretical framework for comfort set out and discussed in section four.

HF/E research has yielded models of how comfort and discomfort relate to one another (de Looze, Kuijt-Evers, & Van Dieën, 2003) as well as how stimuli can act on human subjects to create a feeling of one or the other. Further contributing to the breadth of this present study, Wichansky identifies (in Everett & Watson, 1991) that comfort is a sum reaction to a number of components and that research should go beyond immediately apparent elements such as motion, seating and lighting.

The first observation made from the HF/E literature is the role of expectations in deriving any kind of score or measure for comfort, with expectations being as much a determinant of comfort as a physical stimuli (de Looze et al., 2003). This phenomenon is illustrated in a trial showing comfort scores of a business class airline seat being the same as an economy one (Vink et al., 2012). Expectations provide the explanation for this phenomenon as the business class passenger has higher expectations of comfort, somewhat understandably when considering fare. This study also observed the role that “*aesthetic design*”, presumably meaning visual appeal as opposed appeal to other senses, had an impact on comfort, but not discomfort.

The concept of comfort and discomfort as a continuum is generally reflected in the HF/E literature. In particular, Everett and Watson (1991) observe that studies of passenger ride quality perception are normally used to identify factors contributing to discomfort, rather than comfort. This is true of much literature in the field, and as such a rich vein of comfort factors are found in the physical sense, for example the yaw rate, shocks, jolts, ascents, descents and changes in speed (Richards, 1980).

When considering the ability of public transport to move people en masse, it is easy to see how an aggregate view of passengers is pervasive. When considering the comfort of a mass of passengers, it follows that physical factors and those related to the group, such as proxemics, may take precedent over smaller details such as access to and characteristics of seating. Observation of the market shows that the car succeeds by entertaining the opposite view. Cars appeal to the comfort of the individual, and while this is representative of a fundamental difference in product type, it shows that research in the area of public transport comfort would do well to observe the car. Although physical attributes may not be bettered by public transport they remain an ideal target (Bunting, 2004). In considering the car as competitor to public transport the reader is reminded that non-physical elements such as expectations or stress may be opportunities for public transport to better its private transport counterpart.

Identification of physical comfort attributes is rich, and it is observed that the HF/E field identified many of these factors in the decades prior to 1980. With those serving as something of a base, the field has since brought psychological factors into focus as an addition to dealing with the physical. This aligns with the intent of the taxonomy to be broad and inclusive.

Several resources in the HF/E field provided particularly rich sets of comfort attributes. The method by which these attributes were identified was unclear however, as they were mined from handbooks (Pheasant, 1988; Salvendy, 2012; Tillman & Tillman, 1991). They do however survive any theoretical attempt at refutation and as such are included in the taxonomy.

At the conclusion of the review 64 direct references were reviewed to create the taxonomy of comfort attributes. Starting from a physical sense of comfort, and discomfort, the study followed the tendency in the literature of both public transport and HF/E to include matters of a psychological nature. In that vein, the public transport literature provides the valuable perspective that comfort may be viewed as an individual and group phenomenon, as well as something experienced in the moment, over a period of exposure, and as a cumulative experience of many exposures – good and bad. The public transport literature also identifies many attributes in the psychological sense relating to organisational comfort, in which a considerable number of attributes are found. The HF/E literature provided some context to the results, showing expectations as a major consideration in how a passenger may experience comfort. It is to the task of arranging a suitable taxonomy of these attributes that the paper now turns.

3. A taxonomy of public transport comfort

The taxonomy was generated by mining sources in the scholarly literature of public transport and ergonomic research and is summarised in Figure 1. As expected, the number of secondary studies was greater than empirical. Of the 65 individual sources only eight were entirely empirical, with the majority of others citing particular works, or generating lists of comfort factors from what might be deemed common sense and first-hand, albeit untested, experience. While none of those factors have been identified as erroneous, it is the use of such incomplete lists in public transport research motivating the generation of this taxonomy.

Figure 1: Steps taken to generate the taxonomy

|  |
| --- |
| Method |
| **1. Collection of attributes** |
| **2. Generate Taxa (23)** |
| **3. Move attributes into taxa.** |
| **4. Generate Families (9)** |
| **5. Generate Categories (4)** |
| **6. Eliminate duplicates** |

The method for collection of factors was carried out as a desktop exercise, with attributes identified and collated as raw data. The raw data were then copied into a preliminary set of taxa suggested by the literature. The taxa were then grouped into a higher order rank of families, with these families then placed in one of four categories. This collation was then categorised, with categories being drawn from the literature itself in many cases. The Organisational category is taken directly from found resources (Mayr, 1959), whereas the Social category was suggested by the small list of attributes which formed a logical group. The last step in creating the taxonomy was the elimination of duplicate factors reducing the initial collection from 520. The taxonomy of comfort attributes is divided into 4 categories, 9 families, 25 taxa and contains 203 individual attributes presented below.

What follows is a first generation taxonomy from the literature. The attributes are provided with a provision to update by adding, removing and moving attributes within this taxonomy as necessitated by application, experience and the acquisition of new knowledge.

Table 1: Category 1 - Environmental Comfort

|  |  |  |  |
| --- | --- | --- | --- |
| ENVIRONMENTAL |  | |  |
| **DYNAMIC** | **STATIC** | | **PHYSICAL** |
| **DYNAMIC RIDING COMFORT** | **SEAT CHARACTERISTICS** | | **FUNCTIONAL AMENITY** |
| roll rate | design and arrangements inside car | | consideration of consumer's property |
| pitch rate | seat shape | | design of luggage area |
| yaw rate | seat padding | | seating configuration |
| vertical acceleration | opportunity to adapt ergonomic features | | mode convenience |
| lateral acceleration | upholstery friction | | reservation for special needs |
| longitudinal acceleration |  | | latest technology |
| shocks, jolts | **ACCESS & EGRESS** | |  |
| ascents, descents | stopping position of bus | | **VEHICLE CLIMATE** |
| change in speed | step height | | air pressure |
| smoothness of ride | access task | | humidity |
| pressure | egress task | | ventilation |
| touch | number and location of doors | | air quality |
| sway | nature of departure | | thermal conditions |
| deceleration and impact | effort for access-egress | | air flow rate |
| second impact | time to board a bus | | type of ventilation |
| kinaesthetic disturbances | gamespersonship in access-egress | | passenger control of micro-climate |
| orientation (personal) / disorientation e.g. vertigo | |  | |
| demands on stamina |  | | **VEHICLE OLFACTORY** |
| vibration | **LOCAL ENVIRONMENTAL** | | emissions from fuel |
| work (physical) required to ride | attractive | | odours |
|  | well lit | |  |
| **PHYSICAL SAFETY** | accessible | | **VEHICLE CLEANLINESS** |
| operated safely | exposure to elements | | clean seats |
| safety (physical) | pavement ergonomics | | dust |
| provision of hand/grab rails | type of shelter | | graffiti |
| safe traffic | type of seat | | garbage |
| vehicle reliability | state of repair | | cleanliness of vehicle |
| perceived risk | amenity | | interior cleanliness |
| perceived safety | available toilet facilities | |  |
| driver competence |  | | **MUSCULO-SKELETAL** |
|  | **AESTHETIC - CUMULATIVE** | | leg room |
|  | quality of material | | knee room |
|  | condition of material | | seat orientation relative to forces |
|  | physical representations of the service, (myki card) | | posture |
|  | modernity | | seat layout/configuration |
|  | consistency of form with culture | | spatial |
|  |  | | position of media screens |
|  |  | | freedom of movement |
|  |  | | ability to move in seat |
|  |  | | travelling in a seat Y/N |
|  |  | |  |
|  |  | | **AUDITORY** |
|  |  | | audible irritants |
|  |  | | noise |
|  |  | |  |
|  |  | | **OPTICAL** |
|  |  | | shadows |
|  |  | | illumination |
|  |  | | adequate task lighting |
|  |  | | adequate security lighting |
|  |  | | panoramic windows |
|  |  | | view/visual input |
|  |  | | disorientation (vertigo) |
|  |  | | visual illusion |
|  |  | | level of visibility to outside from vehicle |
|  |  | | natural light |

Table 2: Category 2 - Organisational Comfort

|  |  |  |
| --- | --- | --- |
| ORGANISATIONAL | |  |
| **TRANSPORT SERVICE** | **CUSTOMER SERVICE** | |
| **TRANSPORT SERVICE** | **CUSTOMER SERVICE** | |
| compulsory or request stop | prompt service | |
| frequency | company name | |
| punctuality | company reputation | |
| service span | financial security (e.g. of stored credit) | |
| reliability | confidentiality | |
| perceived variations in waiting time | employee handling of customers | |
| recognisability (permanence) | record keeping | |
| availability of $ change | responsiveness to enquiry | |
| value for money |  | |
| recovery (after something goes wrong) | **STAFF BEHAVIOUR** | |
| distance to stop | ability to answer questions | |
| availability (possibility of refusal) | general behaviour of staff | |
| recovery from disruption | complaint administration | |
| speed of service | knowledge and skill of personnel | |
| waiting at transfers | learning customer requirements | |
| travel time spent in seat | providing individualised attention | |
| express/all stations service | recognising the regular customer | |
| long queue | treatment by employees | |
| assurance of a seat | clean and neat appearance | |
|  | customer assurance | |
| **TRANSPORT SERVICE INFORMATION** | | |
| convenience of information source | **DRIVER BEHAVIOUR** | |
| information about changes | driver appearance | |
| real time info | driver helpfulness | |
| simplicity of information | driver identification | |
| legibility of information | |  |
| location of information | |  |
| information at stops | |  |
| information prior to travel | |  |
| information en route | |  |
| information post travel | |  |
| comprehensiveness of information | |  |
| ease of remembering information | |  |
| accuracy of information | |  |
| wayfinding, wayshowing | |  |
| timetable certainty | |  |
| timetable disruption | |  |
| explaining the service itself | |  |
| explaining cost | |  |
| explaining cost-service trade-offs | |  |
| temporal journey stage distinction | |  |
| destination signs (presence of) | |  |
| information during traffic interruptions | |  |
| resulting reassurance from information | |  |
| ease of identifying correct vehicle | |  |
| intervisibility with other systems | |  |

Table 3: Category 3 - Social Comfort

|  |  |
| --- | --- |
| SOCIAL |  |
| **SOCIAL DYNAMIC** | **SOCIETAL** |
| **PASSENGER LOADING** | **SOCIAL FACTORS** |
| crowdedness | guilt of using mode |
| moving to your seat | self esteem needs |
| vistas | social impact of mode |
| social crowding, distance | social attraction and self image |
|  | suit social arrangement |
| **SPATIAL ACTIVATION** | modify to suit social arrangement |
| other customers in the service facility |  |
| imposition of journey monitoring |  |
| services (e.g. newsstand, refreshment) |  |
|  |  |
| **SOCIAL SAFETY** |  |
| conditions for sleep |  |
| insecure (feeling) |  |
| security from crime |  |
| proxemics |  |
| perceived risk |  |
| security irritants |  |
| social surveillance |  |
| situation |  |
| safety at stations and stops |  |
| evidence of past crime (e.g. vandalism) |  |
| unfamiliar environments |  |
| dangerous environments |  |

Table 4: Category 4 - Psychological Comfort

|  |  |
| --- | --- |
| PSYCHOLOGICAL |  |
| **PSYCHOLOGICAL** | **ACTIVATION** |
| **EXTERNAL PSYCHOLOGICAL** | **TASK ACTIVATION** |
| perception | ability to use transit time |
| history | vehicle adaptability to aid amenity / task |
| mood | task performance under dynamic cond |
| our state | control over situation |
|  |  |
|  | **PERSONAL ACTIVATION** |
|  | (over)stimulation |
|  | interpersonal overload |
|  | pleasant activation |
|  | ability to choose activated/deactivated |

4. Towards application – a synthesised framework

With the attributes of comfort in public transport in mind, a model of application is required. Five compatible but distinct models were discovered in the literature search and review, and offer an insight into how the taxonomy may be translated into application. First, the instrumental and affective sides of public transport (Currie & Wallis, 2008; Davis & Levine, 1967). Second, the notion that a whole origin-destination journey is comprised of stages (Mayr, 1959; Transportation Research Board, 2013). Third, from HF/E literature, that comfort exists as an area on a continuum from discomfort to comfort, and that these states may be actively or passively construed (de Looze et al., 2003; Vink, 2005). Fourth, that perception and cumulative experience affect comfort (Friman, 2004; Friman et al., 2001). Fifth and finally the notion that comfort can be provided as part of a quality loop (European Committee for Standardization, 2002) engaging humans with the service provider’s capabilities. Each model provides a functional understanding of the subject area in isolation. The contribution of this section is to synthesise these views into a practical framework for the public transport professional, such that a focus on any attribute from the taxonomy may be improved in context.

The framework is presented as a set of linear steps, in which an attribute of comfort in public transport may be viewed. The linear process is summarised in Figure 2 and an example is worked through below choosing the “simplicity of information” attribute from the taxonomy. For purposes of brevity the resources drawn on in the framework are not repeated here and the reader is referred to those specific references above.

Figure 2, framework for considering comfort attributes.

|  |
| --- |
| Framework |
| *1. To what extent is the attribute* |
| **Instrumental - affective?** |
| *2. Where does it arise on the many* |
| **Journey Stages?** |
| *3. For each and every stage what's the impact of* |
| **Cumulative and Multiple Exposures?** |
| *4. How does the attribute fit into the* |
| **Quality Loop?** |
| *5. Seek understanding of what impacts the attribute through a* |
| **Contemporary Comfort Model.** |

4.1 A working example

The extent to which an attribute is associated with instrumental and/or affective sides of public transport is considered first. Information for the passenger on service, and the simplicity thereof (abbreviated to “information” for the purposes of this example work-through) is instrumental in that without it there would be no service, and affective because the extent to which the information is, or can be simplified will have some bearing on the effort of the user. This distinction is important when we consider familiar trips such as commutes where the information becomes less important, and more affective. Consider the counter example of an unfamiliar journey, where information is more instrumental, since without it there is less chance of the journey being executed at all.

The second consideration is for which journey stages the attribute is required. Information is required across most stages of a journey, but is of heightened importance when providing the means to choose the correct railway station platform, or the desired locale in which to disembark from a bus. The practitioner is encouraged at this point to assess each journey stage as of importance in its own right. For example, desire to travel, planning, walking, embarking and so on.

For each of these individual stages, the cumulative and multiple exposure to the attribute should be considered next. As already noted, multiple exposures to the same journey stage will engender familiarity with information and thus make it less important. Until, that is, the information changes, in which case familiarity is often the path to ignorance and journey stage disruption in the case of timetable updates. Consider also that even on an unfamiliar journey, exposure to information communicated in a particular way will be viewed by the user as part of their overall experience of public transport. In this way the regular commuter may encounter a difficult journey, becoming part of an otherwise satisfactory cumulative experience.

In applying the notion of the quality loop next, the practitioner is encouraged to determine how the comfort attribute may be targeted and delivered. What practical undertaking could improve information? Enhanced legibility, timeliness, and removal of superfluous material may all assist in the current example.

Within the quality loop, applying the known model of comfort comes next. In using a contemporary model of comfort as reviewed in this research, the practitioner is able to consider the spectrum of discomfort-comfort, how expectations come into play, with the outcome of a comfort model being some human perception of whether the user themselves is comfortable in the view of the attribute at hand. Has the passenger been provided with information in such a way as to alleviate anxiety or burdensome effort for example.

5. Discussion and conclusion

This first-generation taxonomy of comfort on public transport hopes to facilitate improvement in public transport by offering specific attributes for doing so. The interplay of elements comprising the total public transport offering, and indeed the even more complex perceptions of such elements are discussed below.

Comfort is but one part of the public transport offering. The relative importance of comfort is difficult to gauge, but naturally it is insignificant when compared to the basic provision – or not – of service. It is when a service is provided, and furthermore when passengers are “choice” riders, that comfort and the affective side of public transport comes into focus. If the intent is to move more journeys from private cars to public transport then perhaps even more so.

With the taxonomy and framework in mind, the question arises as to what constitutes success in the delivery of comfort. How important are attributes relative to one another? Fulfilment of minimum requirements – nominal and subjective as they may be – will only lead to a level of benign satisfaction (Brandt, 1988). This may be reasonable if the intent with which the public transport service is provided is for a social safety net, or basic mobility. Cars are providing a range of value enhancing attributes, the attainment of which users are willing to sacrifice large sums of money and even time of day to achieve.

More broadly than the discussion in public transport, we return to the idea of expectations. It remains a topic of research to determine more completely what a passenger’s expectations may be. Taking an instrumental view of public transport will show that expectations can be met if services are frequent, reliable and provide the transport commodity required with a minimum of transfers. The problem with the instrumental view is that if these requirements are met, then a passenger will be satisfied. When considering the affective elements of the transport system, and those of comfort in particular, it is observed that these may be the means to provide enhancement, and perhaps even approach the joy used as the foundation of automotive emotion. The impact of such thinking has on the taxonomy of comfort, and further work in public transport user experience, is that a useful distinction should be made between those factors which will only lead to satisfaction, and those leading to pleasure.

Repeated exposure to public transport results in a cumulative view of factors, and we are reminded that adding more services can lead to a decrease in satisfaction (Friman, 2004). Comfort is no exception to this cumulative phenomenon, with musculo-skeletal implications for a particular journey exposure, and implications on overall mode perception for the cumulative effect of many journeys.

Future work will challenge the current taxonomy’s entries. Aside from individual attributes, the proposed hierarchy may be further refined to be more useful and offer the user a more Linean structure. Techniques of measurement for attributes should be ascertained and, where appropriate, ranges of comfort for particular attributes may be determined. Modal performance of attributes could be field tested. Most importantly a ranked taxonomy would offer practitioners and research potential foci in application.

A further ambition of the taxonomy has been to disentangle many factors often viewed as a whole, by offering a more complete range of attributes for study. Such drawing out of details is related to the complete journey being made of smaller parts (Mayr, 1959; Transportation Research Board, 2013) with the emphasis being made that no one stage is really more important than the next – or indeed that the lowest quality stage of a complete journey may be perceived as *the* overall journey quality.

The taxonomy of comfort as presented in this paper is something of an answer to calls for better understanding of the nuanced human interactions in public transport. It is also a starting out point for research and practice to determine how the individual attributes contribute to a service, and to provide a means for improving how attributes are delivered to users. Comfort is one area contributing to an overall *Public Transport User Experience*, and as such the taxonomy is hoped to form part of a larger study into what discrete elements combine to form public transport services in total. Although this research has endeavoured to make the taxonomy as accurate, exhaustive and broad as possible it is likely to be improved by the discovery of more attributes and refinement of models in which they may be applied.

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