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Influence of infrastructural compatibility factors on walking and cycling route choices

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This paper uses a two-pronged approach to assess which infrastructural compatibility factors affect people's willingness to select the desired route for walking or cycling. An intercept perception survey and walkability/bikeability audits were carried out to assess various factors. From the perception survey, rain shelter supplants distance as the most important factor for walking whereas security is the most important factor for cycling. A user-rated weighted point system is then utilised to establish the Safety and Accessibility Index (SAI) as metric for auditing of walkability and bikeability. Comparing segments between actual and shortest routes, comfort, shops and scenery showed up as significantly important factors for choosing favoured walking routes; comfort, stairs, accident risk and crowdedness are important considerations when choosing cycling routes.

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1. Introduction

Route choice of pedestrians or cyclists is complex; it is not purely the quickest route, unlike motorists' route choice. The determinants for a pedestrian or cyclist choosing a particular route range from whether the route is safe to the level of comfort. Schlossberg, Agrawal, Irvin, and Bekkouche (2007) found that a pedestrian's primary goal in choosing a route is to minimise distance and time, but safety and aesthetic conditions are also important to them. Furthermore, he or she tends to follow that particular route everyday unless due to temporal change such as increment weather or short term activity (Grable & Kretz, 2010).

Understanding what a pedestrian or cyclist considers as an attractive route can allow planners to build cities that are considered attractive by the residents, resulting in more active transport (walking and cycling) activities, and in a long term creating a more liveable city. At a secondary level, a shop owner can also assess the value of the shop location and the possible number of walk-in customers.

Research work on route choice models revolved around two main methods namely, stated preference or revealed preference methods (Dill & Gliebe, 2008). The first method typically presents respondents with two options, usually trading offs a perceived higher quality facility with a longer travel time. Revealed preference studies attempt to associate actual route choices with the presence of specific infrastructure, against the shortest distance route. The extra time the user chooses to spend on the longer route demonstrates the value of the facility for that person.

Before improvement plans could be established, it is crucial to first measure the existing condition, that is, how walkable/bikeable the current situation is. Past literature on walkability and bikeability mainly utlised area-based analysis (Cervero & Duncan, 2003; Cervero, Sarmiento, Jacoby, Gomez, & Neiman, 2008; Forsyth, Hearst, Oakes, & Schmitz, 2008; Frank, Devlin, Johnstone, & Loon, 2010; Lin & Chang, 2010; Jacobs, 2011; Martincigh, 2011; Sundquist et al., 2011), and they seldom covered the detailed characteristics of routes or segments (Borst, Miedema, Vries, Graham, & Dongen, 2008; Millington et al., 2009). Even so, those audit techniques developed for fine grain attributes of the physical environment typically only covered sidewalks (those parallel to roadway). The local walking environment differs greatly from the above overseas studies, given the unique layout of local public housing. The ground level of public housing (known as void decks) are vacant spaces specially allocated for community gatherings and events and the blocks are usually not fenced, to allow high 'permeability' of residents in the local context (see Fig. 1). The presence of the void decks may affect a person's decision to 'cut through' these spaces instead of using the footpaths which are usually located alongside the roads. To the best knowledge of the authors, there has not been research into such environment.

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Fig. 1. Unique layout of public housing.

Werner, Brown, and Gallimore (2010) measured micro-level environmental features of the block (both sides of a street between intersections) where the resident lives and matched to surveyed response on whether he or she walked to a transit stop. However, the whole walking journey was not measured. Also, there are some studies that are purely based on subjective rating and not systematical quantification, leading to lack of consistency and transferability (Sarkar, 2003). In contrast, this paper focuses on pedestrians' and cyclists' experience of local, micro-scale aspects of the physical environment through which they walk or cycle.

The purpose of this paper is to assess which infrastructural compatibility factors affect people's willingness to select the desired walking/cycling route for the last mile trips (emanating from the transit station to the onward destination) and to establish a walkability/bikeability index for evaluating the environment.

2. Relationship between human behaviour and the environment

The multi-disciplinary relationship between the environment and the human behaviour is typically known as environment psychology (Rartin et al., 2011). Human behaviour is the outcome of human's interpretation of the environment that matches his current need(s)/objective(s). People tend to seek out places where they feel competent and confident, where they can make sense of the environment while also being engaged with it. Therefore, by understanding what constitute a preferred environment (e.g. shade, scenery, shops) can effectively help planners to preserve, restore or create an environment that invites more users who gain better behavioural effectiveness. On the other hand, environmental stressors (e.g. noises, overly crowded area) are failures of preference. They possess prolonged uncertainty, unpredictability and overloading stimulus that human needs to adapt in order to cope. Malhotra (2007) viewed environmental psychology as the following equation: perception/cognition = f(functional properties). That is, how the user perceives the environment is a function of properties of the environment that matter to the user.

Theories of user decision making process normally take into account three different levels of behaviour that is, Strategic level, Tactical level and Operational level (Methorst et al., 2010). At the Strategic level, an individual makes a general plan on what he/she is going to do (activity), where he/she is going (destination) and the order of performance (modes of transport). This is the pre-trip decision. At Tactical level, the individual starts to gather information about the network and makes short term decision about the optimal route to take. The decision is mainly based on obstacles and macroscopic features of pedestrian flow (e.g. velocities, densities and flows). At the Operational level, the individual involves in the actual walking and how he/she adjusts the direction/speed to achieve the goals set at previous levels. The focus of this study is on the tactical level.

The list of infrastructural compatibility or environmental factors that affects walkability/bikeability from past literature include intersection safety, street design, land use, perceived safety, traffic (volume and speed), sidewalk completeness, security, greenery, shops, building height and number of people (Ewing, Handy, Brownson, Clemente, & Winston, 2006; Evans, 2009; Joo, Kim, & Kim, 2011; Duncan, Aldstadt, Whalen, & Melly, 2012). After reviewing the past literature and considering local operating conditions, this led to the selection of 11 infrastructural compatibility factors for the study (Koh & Wong, 2012b). They include security, detour, delays at road crossings, directional signs, comfort, weather protection, steps/slopes, accident risk, crowdedness, shops along routes and good scenery.

3. Methodology

The experimental design can be divided into three main parts namely, Part I – Gathering route details via perception survey, Part II – Auditing the routes and Part III – Establishing the Safety and Accessibility Index. Part II utilised some of the results from Part I survey.

3.1. Part I – gathering route details

Face to face interviews were conducted at exits of five selected rail transit stations in the residential areas in Singapore during evening peak hours. The selected rail transit stations represent a good geographical spread (see Fig. 2). The targeted respondents were those exiting from the transit stations and making their last mile trips to their destinations (typically home). Random transit passengers (without bias) were approached and interviewed at all exits of the stations. For those who were in a hurry and refused to do a face-to-face interview, they were distributed a mail-back envelope for them to self-fill at home and mail it out after completion. The intention was to increase the sample size. At each station, the target number of respondents (walk, cycle, take bus or other private transport after exiting the station) was set at 100. During the pilot survey, it was found that the proportion of cyclists was too low for meaningful interpretation of data. Hence, it was decided to intentionally 'capture' about additional 50 cyclists while they were unlocking their bicycles at each station. This led to a final sample size of 1146, collected over a two-month period at the five locations.

In the survey, the respondents were asked to rate the level of importance (1 – Not important, 2 – Somewhat important, 3 – Important, 4 – Very important) of the 11 pre-determined

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