TOWARDS A USER-ORIENTED APPROACH IN THE DESIGN AND PLANNING OF PUBLIC TRANSPORT INTERCHANGES

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ABSTRACT

This paper discusses the process and findings of case studies of the user experience during transfers between public transport modes at public transport interchanges. The research analysed the links between existing policy, institutional fragmentation and the quality of the actual public transport user experience during transfers. In order to test the impact of policy and fragmentation on the transfer process, an assessment framework was developed that analysed the factors influencing the continuity and ease of user transfer trip chains between the mode of origin and the onward mode at interchanges. The assessment framework was applied at nine interchange sites in Cape Town in South Africa, and Curitiba and Sao Paulo in Brazil. The findings of a comparative evaluation between sites and cities led to the formulation of recommendations regarding institutional integration and the provision of more effective design and planning guidelines for public transport interchange facilities. It is argued that a fundamental shift from a vehicle- to a user-oriented approach to interchange design and planning is required, and that this shift in mindset should be accompanied by a comprehensive revision of existing, and in some instances significantly outdated, interchange design guidelines.

1. INTRODUCTION

It is commonly accepted that the so-called ‘model’ transport cities in South America (including Curitiba and Bogota) have managed to create relatively successful public transport solutions in their particular contexts. The apparent success of the public transport systems in South American cities is in part attributed to the presence of unified local transport provision authorities, the introduction of some or all of the features of bus rapid transit (BRT) systems, and the structuring of public transport services along integrated trunk and feeder routes. South African transport policy has taken this to heart. Public transport policy documents, at all levels of government, indicate that it is the intention to replicate elements of the South American model in our cities in the hope of improving generally poor public transport services. From the latest policy documents governing the planning and implementation of public transport services it is clear that regulatory agencies wish to move from a modally based mindset to a model based on the needs of the public transport user, or customer. This approach necessitates the integration of modes and facilities, which are currently individually managed and implemented, into a fully functional, integrated system managed by a single authority operating at the local government level. The envisaged system would rely on high-volume trunk routes, from which feeder and distribution services radiate. The nodes where these services meet would cater for large numbers of users and the activities related to their presence. Transfer at these points of

Proceedings of the 27th Southern African Transport Conference (SATC 2008) 7 - 11 July 2008
ISBN Number: 978-1-920017-34-7 Pretoria, South Africa
Produced by: Document Transformation Technologies cc Conference organised by: Conference Planners

interchange would be seamless. This would be achieved by a single fare management and collection system that speeds up transfer and increases user-friendliness, and the removal of physical obstacles that would allow all users, regardless of their level of personal mobility, to successfully utilise public transport services and the facilities that provide access to such services (RSA-DT 2006, RSA-DT 2007, PGWC-DTPW 2005, CCT 2006a).

Since the integration of public transport services depends on successful transfer facilities, what then is the required configuration of interchanges between trunk and feeder public transport services? Planning and design guidelines for public transport facilities and interchanges should provide direction on how the desired seamless transfers should be facilitated. Documents commonly referred to in current interchange design practices include *Bus Terminals and Bus Stations: Planning and Design Guidelines* (RSA-DT 1985) and *Guidelines for the Design of Combi Taxi Facilities* (RSA-DT 1990), as well as some of the most recent documents, e.g. *Planning and Design Guidelines for Public Transport Interchanges in Gauteng* (GPG-DPTRW 2002) and *Design Guidelines for Public Transport Facilities* (CCT 2005b).

A critical question therefore is: do the guidelines, and policy in general, translate into a better experience for the public transport user at interchanges? This paper addresses this question. Firstly, it provides an overview of interchange case studies in Cape Town, and Curitiba and Sao Paulo in Brazil. The case studies analysed user transfers at interchanges according to a qualitative analysis of the transfer process between different modes. Secondly, a comparative evaluation of the case study findings highlight whether the Brazilian facilities do, in fact, perform better than their counterparts in Cape Town, and what lessons can be learnt from such facilities. The evaluation also illustrates the extent to which the foci of policy and guidelines are reflected in the actual experiences of users at interchanges in Cape Town. Finally, the paper concludes with recommendations based on the case study findings and evaluation. The analytical framework, literature, case studies and comparative findings presented in this paper are based on a more detailed analysis of user transfers at interchanges than that presented here, and is documented in Schalekamp (2007).

2. CASE STUDIES

The effectiveness of an interchange can be measured by the ease with which a user can transfer between modes. In order to evaluate such a transfer, the tasks which a user would perform during a transfer have to be identified. These tasks, when seen sequentially, describe the user's 'transfer trip chain' through a number of adjacent spaces, or interchange 'components'. Various obstacles might be encountered during the transfer trip, affecting the efficiency of the transfer and ultimately the ability of the user to transfer successfully. The tasks, components and obstacles allowed a structured assessment framework to be developed (

Table 1) that analyses the user's transfer experience from one public transport service (*Service A*) to another (*Service B*). When applying the framework, the researcher adopted the role of marginal participant observer (Robson 2002: 310, 318) at each site to form a detailed understanding of the components of, and obstacles to, user transfers. The case studies presented in this paper were situated at trunk-feeder nodes with a similar order of user volumes in all cases. This enabled a comparative analysis to be made of the quality and efficiency of user transfers at the various interchanges, but more critically, to identify in which manner, if any, the design and planning practices at the Brazilian interchanges led to improved user experiences during transfers.

Table 1 User transfer evaluation framework

TRANSFER TASK	COMPONENT	POTENTIAL OBSTACLE	CRITERIA
Disembark Service A	Platform	Access control type	Fare collection at vehicle exit causes time delay to disembark Excludes some users due to complexity of operation
		Access control dimensions	Number of exits from vehicle cause time delay to disembark Height difference between vehicle and platform excludes some users Aperture dimensions excludes some users or causes physical discomfort
		Platform dimensions	Platform cannot accommodate number of users disembarking from vehicle
		Platform type	Disembarkation is subject to climatic discomfort Surface quality or slope excludes some users
Confirm location	Platform	Location information	Name of interchange is not apparent upon disembarking
		Locality information	Names of and ways to notable destinations that can be reached from this interchange are not apparent
Find information for Service B	Platform	Service information	User cannot obtain schedule, route and platform layout information for Service B
		Location information	Information on spatial layout of interchange is not available Directions to Service B are not available
Utilise amenities	Platform	Amenities	Amenities obstruct travel path to platform exit Absence leads to user discomfort or inconvenience Location and types of available amenities are not apparent
Access platform exit	Platform	Location information	Information on spatial layout of interchange is not available User cannot establish way to other interchange components Exits from platform are not apparent
		Vertical displacement	Physical discomfort to negotiate Vertical displacement excludes some users Device causes queuing
Pass access control	Platform - Concourse	Access control type	Fare collection before concourse access causes time delay Excludes some users due to complexity of operation
		Access control dimensions	Queuing before access control Excludes some users Physical discomfort to negotiate access control or fare collection device
Utilise amenities	Concourse	Amenities	Amenities obstruct travel path across concourse Absence leads to user discomfort or inconvenience Location and types of available amenities are not apparent
Access service B	Concourse	Location information	Information on spatial layout of interchange is not available Directions to Service B are not available
		Concourse dimensions	Distance between services causes physical discomfort Distance between services excludes some users Concourse cannot accommodate number of users transferring
		Concourse type	Transferring is subject to climatic discomfort Surface quality or slope excludes some users
		Vertical displacement	Physical discomfort to negotiate displacement device Vertical displacement excludes some users Device cannot accommodate number of users
Pass access control	Concourse – Platform	Access control type	Fare collection before platform access causes time delay Excludes some users due to complexity of operation
		Access control dimensions	Queuing before access control Excludes some users Physical discomfort to negotiate access control or fare collection device
Utilise amenities	Platform	Amenities	Amenities obstruct travel path across platform Absence leads to user discomfort or inconvenience Location and types of available amenities are not apparent
Ascertain Service B arrival	Platform	Service information	User cannot confirm schedule and route information for desired service
Await Service B vehicle arrival	Platform	Platform dimensions	Platform cannot accommodate number of users waiting for vehicle Platform dimensions exclude some users
		Platform type	Waiting is subjects users to climatic discomfort Surface quality or slope excludes some users
		Amenities	Lack of seating leads to user discomfort
Embark Service B	Platform	Service information	User cannot confirm vehicle's route and destination before embarking
		Access control type	Fare collection at vehicle entrance causes time delay to embark Excludes some users due to complexity of operation
		Access control dimensions	Number of entrances to vehicle cause time delay to embark

			Height difference between platform and vehicle excludes some users Aperture dimensions excludes some users or causes physical discomfort

The evaluation framework was applied at the interchanges outlined below. The platforms, concourses and interchange extents are indicated diagrammatically to a consistent scale.

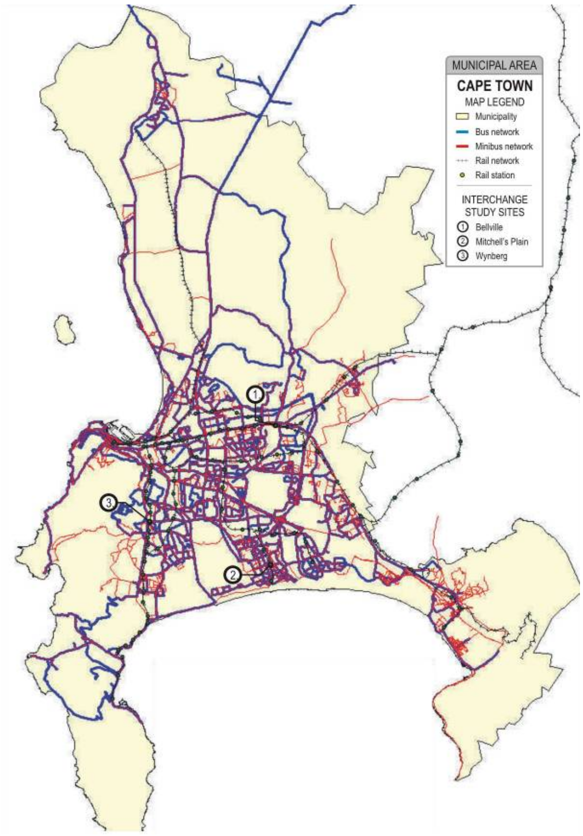

Figure 1 Cape Town study sites

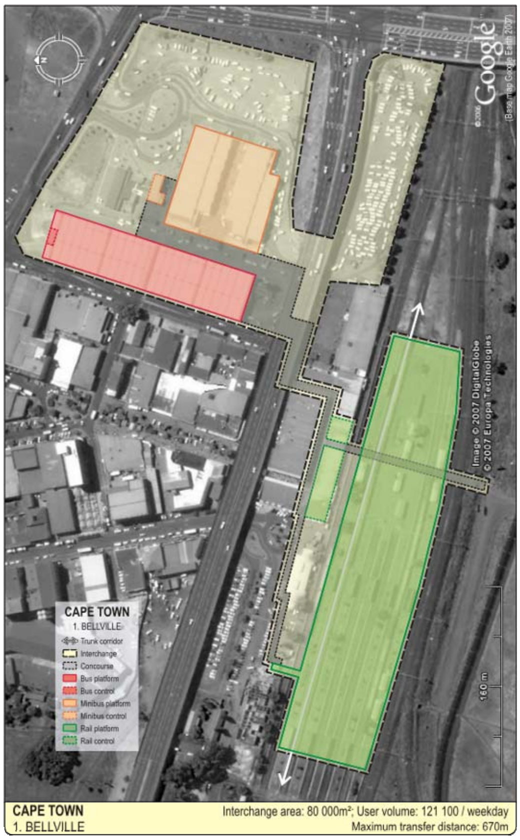

Figure 2 Bellville interchange

Figure 3 Mitchell's Plain interchange

Figure 4 Wynberg interchange

2.1 Cape Town interchange study sites

It was found that the public transport network that served the Cape Town interchanges (Figure 1 to Figure 4) consisted of three main services. These services were scheduled bus, unscheduled minibus (or minibus taxis) and scheduled over-ground rail. Bus routes were predominantly long distance and widely distributed throughout the city. Minibuses performed a wide range of services that often competed with those offered by buses and rail, while also offering feeder services to rail. Rail was a highly commuter oriented service, with certain lines extending beyond the municipal boundary. Except for the trunk rail service, it was difficult to classify bus and minibus services as either trunk or feeder as they were hybrid services that had not been planned to perform a specific structural function (CCT 2006b: 7-8; CCT 2007a: 34-43). Fares were charged individually per mode according to the trip length, and started at minimum of ZAR2.90, ZAR3.50 and ZAR 2.50 for bus, minibus and rail respectively.

2.2 Sao Paulo interchange study sites

The interchange sites in Sao Paulo (Figure 5 to Figure 8) were served by three scheduled public transport services: buses, over-ground rail and underground rail. The bus service comprised 588 trunk routes and 395 feeder routes (SPTrans 2007, data for March 2007), managed according to nine regions. The other public transport services in Sao Paulo were rail based. Underground rail routes were more concentrated in the inner core of the city, while over-ground rail services ran further away from the central area connecting more of the outlying municipalities. These services offered free transfers between them at a number of points. The Sao Paulo public transport network used a single flat fare system. Fares were BR$2.30 (or ZAR7.65 at March 2007 rates) across all modes.

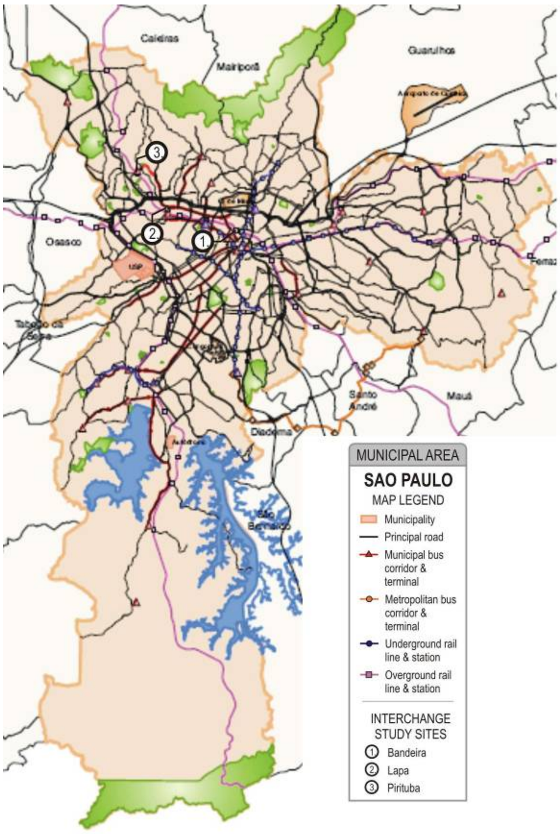

Figure 5 Sao Paulo study sites

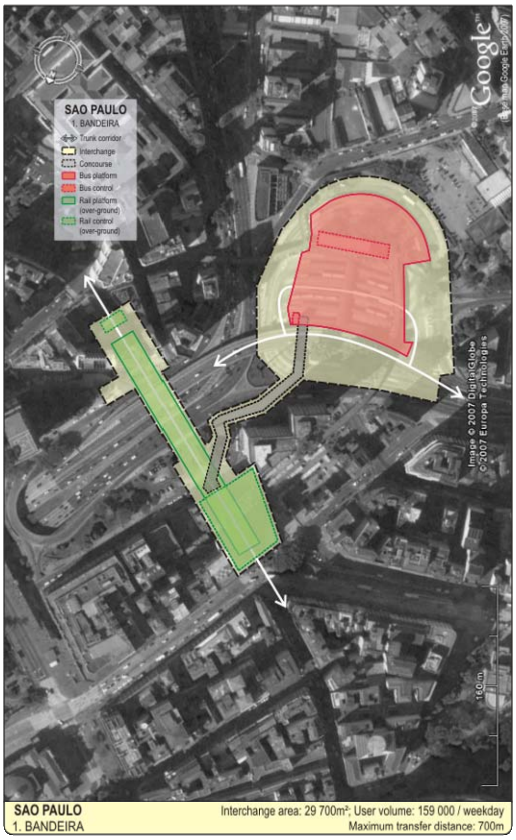

Figure 6 Bandeira interchange

Figure 7 Lapa interchange

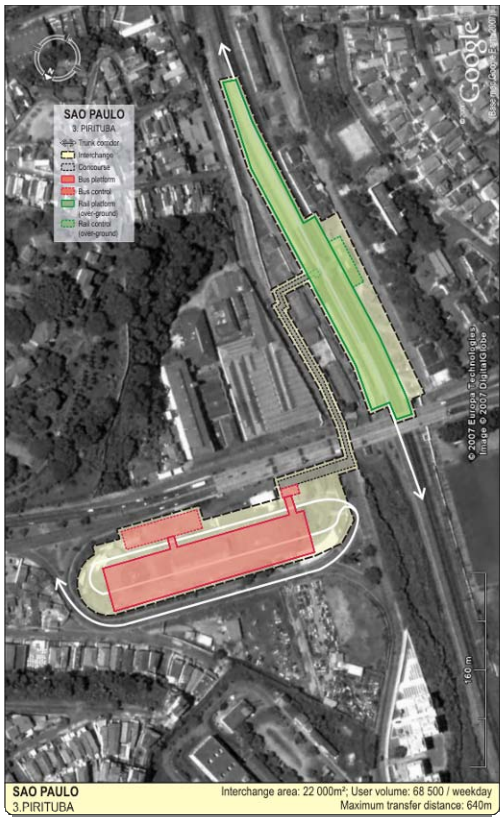

Figure 8 Pirituba interchange

2.3 Curitiba interchange study sites

The public transport services in Curitiba (Figure 9 to Figure 12) were all bus-based and scheduled. Integrated services offered free transfers at interchanges, while conventional

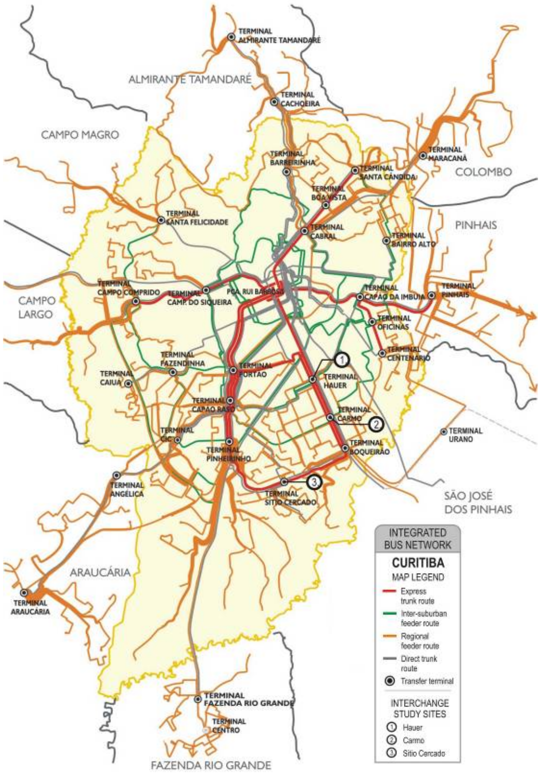

Figure 9 Curitiba study sites

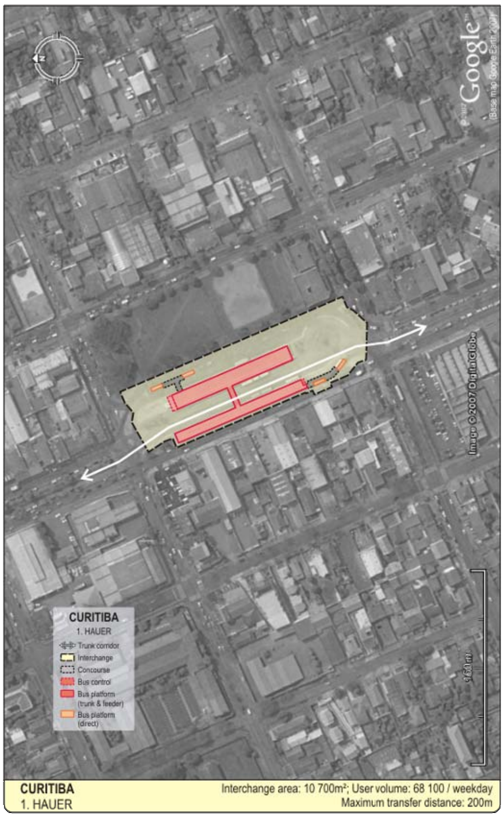

Figure 10 Hauer interchange

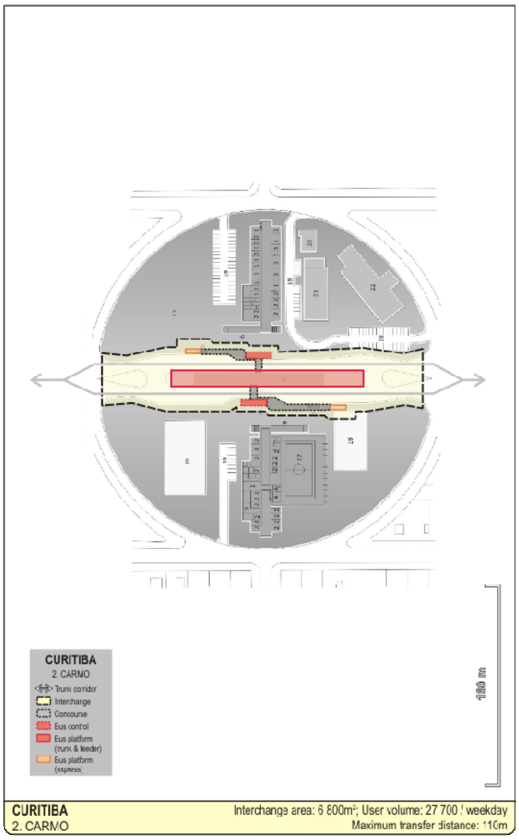

Figure 11 Carmo interchange

Figure 12 Sitio Cercado interchange

services offered un-integrated coverage. Of the integrated services, express (red) and direct (silver-grey) lines were trunk services, while inter-municipal (orange) and intra-municipal (green) lines provided a distributive function (URBS 2003). These services charged a single flat fare of BR$1.00 on Sundays, and BR$1.80 on all other days, equating to ZAR3.33 and ZAR6.00 at March 2007 levels.

3. COMPARATIVE EVALUATION

This section presents a comparative evaluation based on the complete case study findings at the various sites. The evaluation provides insight into the link between the level of integration of transport provision institutions and the continuity and efficiency of the user transfer between modes. The measured characteristics were the physical extents of interchanges, effective accessibility provision, and effective wayfinding provision.

3.1 User volume, surface area and transfer distance

Table 2 (below) presents a summary of weekday user volumes, interchange surface areas and transfer distances at the documented interchanges. The user volumes were the average number of passengers boarding and alighting at each interchange per weekday, rounded to the nearest 100 (CCT 2005a; CPTM 2007; IPPUC 2007a; Metro 2007; SPTrans 2007). The total interchange surface area was calculated by adding together the surface areas of the platforms, concourses, amenities, management facilities and vehicle holding areas, rounded off to the nearest 100m² (Google Earth 2007; Socicam 2007; URBS 2007). The maximum transfer distance is the longest possible distance that a user would have to travel within the boundaries of the interchange from the point of alighting from the vehicle of arrival to the point at which the user would access the onward vehicle, regardless of mode or platform.

Table 2 Comparison of user volumes, surface areas and transfer distances

DIMENSIONS	CAPE TOWN			SAO PAULO			CURITIBA		
MODE	BUS	MINIBUS	RAIL	BUS	UNDERGR. RAIL	OVERGR. RAIL	TRUNK BUS	FEEDER BUS	DIRECT. BUS
INSTITUTION	CCT	CCT	Metrorail	SPTrans	Metro	CPTM	URBS	URBS	URBS
GOVT LEVEL	Local	Local	National	Local	Regional	Regional	Local	Local	Local
USER VOLUME	TOTAL			TOTAL			TOTAL		
SITE 1	121 100 / weekday			159 000 / weekday			68 100 / weekday		
SITE 2	101 200 / weekday			76 500 / weekday			27 700 / weekday		
SITE 3	79 400 / weekday			68 500 / weekday			47 000 / weekday		
INTERCHANGE AREA	TOTAL			TOTAL			TOTAL		
SITE 1	80 000m²			29 700m²			10 700m²		
SITE 2	76 100m²			18 300m²			6 800m²		
SITE 3	15 000m²			22 000m²			5 900m²		
AREA PER USER	TOTAL			TOTAL			TOTAL		
SITE 1	0,66m² / user			0,19m² / user			0,16m² / user		
SITE 2	0,75m² / user			0,24m² / user			0,25m² / user		
SITE 3	0,19m² / user			0,32m² / user			0,13m² / user		
MAX. TRANSFER DIST.	FROM		TO	FROM		TO	FROM		TO
SITE 1	Bus >>	670m	<< Rail	Bus >>	700m	<< Undergr.	Direct >>	200m	<< Direct
SITE 2	Bus >>	595m	<< Rail	Bus >>	310m	<< Overgr.	Direct >>	110m	<< Direct
SITE 3	Minibus >>	380m	<< Bus	Bus >>	640m	<< Overgr.	Direct >>	165m	<< Direct

Even though some user volumes at the sites in Curitiba were not all of the same order as Cape Town or Sao Paulo, the ratios of interchange surface area to user volume allow for a comparative evaluation of the spatial efficiency at all the interchanges. These ratios were the highest in Cape Town, and much lower in Sao Paulo and Curitiba. This means that interchanges in Cape Town use larger plots of urban land to move the same number of users as in the other two cities, and consequently do so less efficiently. This was largely due to substantial provision for on site vehicle holding, i.e. temporary parking space for vehicles waiting to load passengers, in particular for unscheduled minibuses. Secondly, the table illustrates that due to the physical extent of interchanges and separate facilities for different modes in Cape Town (and to a lesser degree in Sao Paulo) the maximum transfer distance that a user had to negotiate between getting off the trunk service vehicle in which he or she arrived and boarding the onward feeder service vehicle, and vice versa, was substantial.

3.2 Accessibility

The data in Table 3, below, indicate the findings of interchange accessibility per city. The terms used in the table refer to an aggregate level of accessibility that a user experiences between components or across components. Good accessibility would comprise an uninterrupted trip chain, thus a trip chain with no stepped level changes, no conflict with vehicles and good surfaces, for example. Fair accessibility implies a complete trip chain, but obstacles such as gates, steps or guardrails might force some users to use a detour. Lastly, if only able bodied, adult users could complete a transfer, it is regarded as poor accessibility. (For a detailed description of obstacles and criteria refer to

Table 1.)

Table 3 Comparison of accessibility during user transfer

ACCESSIBILITY	CAPE TOWN			SAO PAULO			CURITIBA		
MODE	BUS	MINIBUS	RAIL	BUS	UNDERGR. RAIL	OVERGR. RAIL	TRUNK BUS	FEEDER BUS	DIRECT. BUS
INSTITUTION	CCT	CCT	Metrorail	SPTrans	Metro	CPTM	URBS	URBS	URBS
LEVEL OF GOVERNMENT	Local	Local	National	Local	Regional	Regional	Local	Local	Local
VEHICLE – PLATFORM	Poor	Poor	Poor	Fair	Good	Poor	Good	Poor	Good
CROSS-PLATFORM	Fair	Fair	Poor	Fair	Good	Poor	Fair	Good	Good
PLATFORM – CONCOURSE	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
CROSS-CONCOURSE	Poor			Poor			Fair		

The table illustrates the poor standard of accessibility in all three cities. Even in Curitiba, which in relative terms offers the best transfer accessibility of all three cities, interchange accessibility is only fair. Across sites, common causes of poor accessibility were a lack of at-grade vehicle boarding, poor management of surfacing and level changes, and at grade crossings across vehicle travel paths. Facilities in general were designed primarily around able-bodied adults. The implication of this is that most people with disabilities (including children, pregnant women and the elderly) would struggle to transfer successfully.

3.3 Wayfinding

In order to complete a transfer efficiently, a user should be able to find his or her way through an interchange from one transport service to the next without having to resort to consulting fellow passengers or interchange staff. The aggregate quality of wayfinding provision at the studied interchanges is presented in Table 4. A good rating in the table means that all users would have been able to find their way during transfers without assistance. This is achieved only if comprehensive location, locality and service information, as detailed in

Table 1, was available to all types of users. A fair rating signifies that some wayfinding measures were provided, but that these were not continuous along the transfer path, or they did not address all user ability levels in equal measure. Such limited measures might include signage that only caters to the literate, or signage that is too small or offers. Lastly, poor wayfinding is indicated when very little information was provided, and the user thus had to be familiar with the interchange layout, or would have had to resort to consulting other users, or staff, to assist in completing the transfer trip.

Table 4 Comparison of wayfinding during user transfer

WAYFINDING	CAPE TOWN			SAO PAULO			CURITIBA		
MODE	BUS	MINIBUS	RAIL	BUS	UNDERGR. RAIL	OVERGR. RAIL	TRUNK BUS	FEEDER BUS	DIRECT. BUS
INSTITUTION	CCT	CCT	Metrorail	SPTrans	Metro	CPTM	URBS	URBS	URBS
LEVEL OF GOVERNMENT	Local	Local	National	Local	Regional	Regional	Local	Local	Local
VEHICLE – PLATFORM	Poor	Poor	Poor	Fair	Fair	Fair	Poor	Fair	Poor
CROSS-PLATFORM	Poor	Poor	Poor	Poor	Fair	Poor	Poor	Poor	Poor
PLATFORM – CONCOURSE	Poor	Fair	Poor	Fair	Fair	Fair	Poor	Poor	Poor
CROSS-CONCOURSE	Poor			Poor			Poor		

There are two general observations on wayfinding concerning all cities. The first is that, since all text on signage in Sao Paulo and Curitiba was in Portuguese, wayfinding for an English-speaking person, for instance, would be near impossible. However, in Brazil the only official language is Portuguese and thus most users of local transport could be expected to have a sufficient grasp of the language. This still does not overcome the problem of literacy, although it should be noted that all municipal buses in Sao Paulo are colour-coded according to the region of origin, thus simplifying identification of the correct vehicle, especially in large interchanges. In contrast, the colour-coding of buses in Curitiba by service type (i.e. trunk or feeder) do not offer the same level of wayfinding assistance. The second observation is that, on the whole, wayfinding in all cities required a user to be literate, visually able and familiar with the transport system and individual routes. There was not much scope for users deviating from this limited norm, and textures, colours, symbols and announcements were seldom, if ever, utilised as wayfinding aids to these users. Wayfinding consequently was of a poor standard across the board.

4. CONCLUSION & RECOMMENDATIONS

Based on the evidence of the case studies and the comparative evaluation, it was apparent that there was little coordinated management of the transfer process between modes at any of the interchange sites. Even though there appeared to be a link between the level of integration between transport provision institutions and integration between transport services at interchanges, such integration only had a demonstrable effect on more efficient land use (as shown in Table 2). Institutional integration did not seem to be directly linked to accessibility and wayfinding (Table 3 and Table 4). Rather, these aspects were influenced by the design of the interfaces between transport services, platforms and concourses. It is reasonable to assume that this level of detail should have been addressed by design guidelines.

In this regard, a key conclusion of this research with respect to the South African context was that commonly used guidelines are oriented towards the needs of public transport vehicles, and offer little input regarding the quality of the user experience during transfer.

Even the latest design and planning guidelines (RSA-DT 1990, GPG-DPTRW 2002) still carry over vehicle-focussed operational guidelines from the original mode-based documents (RSA-DT 1985, RSA-DT 1990). Furthermore, multiple conflict points between vehicles and users at boarding areas appeared to be inherent in the layout of interchange platforms. A clear discrepancy exists between the prescriptions of policy, on the one hand, which aim to improve the poor user transfer experience illustrated in this paper, and, on the other hand, the bias towards designing interchanges around the needs of vehicles and the associated lack of attention to the needs of users during transfers. A further key conclusion was that, based on the aggregate poor quality of user transfers in the documented interchanges in Curitiba and Sao Paulo, the solutions to the challenges faced in the design and planning of interchanges in South Africa may not necessarily be found in those cities.

A first recommendation in view of the above findings is that the establishment of an overarching transport authority in isolation will not result in improved service to the user. This is not to say that this step should not be taken: the site investigations indicated that institutional integration appears to be a prerequisite for the planning of more integrated public transport services, and consequently for the planning of more space-efficient and integrated interchanges. However, the other prerequisite for more effective user transfers has been shown to lie in the design of the interfaces between, and the physical and wayfinding characteristics of, the components of interchanges. In order to address the problems of the current bias towards vehicle-oriented design, and the poor quality of user transfers at interchanges, there needs to be a fundamental shift in the interchange design and planning mindset. Since interchange planning and design guidelines are the implementing tool of official policy, and as such influence the mindset behind the provision of interchanges, these guidelines must reflect a user-oriented approach. The guidelines must ensure that all the parties involved in the provision of interchange facilities are clear on what it means to prioritise the user, right from the outset. The assessment framework presented in this paper provides the basis for such an approach, but does not, and cannot, claim to be a substitute for design and planning guidelines that prioritise the needs of the interchange user. Therefore, a second recommendation of this paper is that new guidelines for the planning and design of interchanges have to be developed that, in addition to addressing technical and socio-economic considerations, view interchange first and foremost from the user's perspective.

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