

Title Page

Measuring the Performance of Transit Passenger Information Web Sites

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Abstract

Almost all transit authorities worldwide now operate centralised transit passenger information web sites (TPIWS). While a range of research has demonstrated good practices in design and operation of TPIWS there has been no consolidated measurement tool developed to date which can objectively assess the performance of these sites. This paper summarises the results of a research project aimed at developing an objective multi-criteria report card for assessing TPIWS based on the findings of previous research on good practice. The score card is structured around a series of general website accessibility, usability and consistency tests and also a review of static information and journey planner evaluations.

The paper reviews the research literature, describes the methodology and reports on its application to assess the performance of 9 worldwide TPIWS systems. The approach is low cost and can quickly review sites in an objective assessment of the performance evidence.

The findings of the application described rates the TPIWS systems in Melbourne, London and Portland (Oregon) with the highest scores out of the 9 cities assessed. Although Melbourne achieves the highest overall score the application of the score card has provided a basis for identifying areas for improvement. Many city systems are shown to demonstrate high scores in selected areas. Brussels has high scores for site usability, Portland for static information provision and Melbourne for journey planner facilities.

The paper discusses how the report card system might be improved including areas for new research in its further development.

Abstract = 244 words (limit = 250 words)

INTRODUCTION

Almost all transit authorities worldwide now operate centralised transit passenger information web sites (TPIWS). Increasingly these systems have been seen as an effective means of communicating with customers [1]. They have also been shown to act as a means of changing the perception of users and potential users of transit. Research shows that an effective TPIWS can counteract negative perceptions that transit travel is more difficult than auto travel while an ineffective site can act to reinforce negative perceptions [2]. Critical questions for transit authorities are therefore:

- what are the critical features of an effective TPIWS? ; and
- how can the performance of existing sites be measured against these?

This paper summarises the findings of a research project aimed at defining best practice features of transit passenger information web sites (TPIWS) and developing and applying simple and objective measures of performance for a series of worldwide sites to understand relative performance.

The paper starts with a review of previous research literature in this field. This is followed by a discussion of approach to measurement of TPIWS performance. Results of the field application of the measurement systems are then described followed by a discussion of the key findings. The paper concludes with a summary of key findings and a discussion of how the approach might be improved and developed.

RESEARCH CONTEXT

There has been a significant amount of research examining the requirements and presentation of web based passenger information. Three particular areas have been identified as critical including:

- General web system functional requirements such as accessibility, usability and consistency
- Access to static information such as timetables and route maps; and
- The performance of journey planners which can evaluate specific user trip needs from the options available on the transit network.

General Web Site Performance

Table 1 presents a summary of good practices for general website performance requirements based on the literature discussed below. In general the literature suggests that TPIWS should have a user-friendly interface that is accessible, consistent, and current [3].

In terms of **accessibility** the homepage must be quick to load, easy to navigate, and visually attractive [4]. Important information should be located at the top of the page, frequently accessed information should be easily found, and related information grouped together. The homepage should also provide information about timetable changes, service disruptions and other news alerts that may affect travel [4]. Several sources suggest that websites should have text available in HTML and plain text format, that JavaScript should be unobstructive, that usage of frames should be minimal, and that images should have alternative text [3, 5].

Usability is also said to be influenced by aesthetic qualities such as font size, style and colour as well as background style and colour [3]. The text should contrast background colour, red and green should not be used together as colour-blind users cannot differentiate between the two, and wallpaper backgrounds should be plain and undisruptive. “The ability to print is particularly important to traveller information websites” [3] so a light background with dark text provides an all round colour solution. Coloured lines denoting public transport routes on maps are accessible to a great number of users [5]. Similarly usability can be achieved by choosing words, graphics, and layouts that do not confuse and that strike a familiar chord with the user [6]. Usability is also a function of the number of clicks used to get between pages and the average time per visit of the website [7, 8]. A simple rule of thumb is that the site should provide the “three clicks and you’re there” measure of usability [3, 8].

Graphics are a useful tool in representing information and can be useful to non-English speaking users or those with reading difficulties. Image maps and portable document format (PDF) are useful for the same reasons, one source advises that provisions must be made should the users equipment not be able to support this type of interface[3]. Another recommends that all information should be available in PDF as well as in HTML format due to the inaccessibility of Adobe Acrobat Reader to some users and that PDF files sizes should be restricted to keep download times less than ten seconds [4].

Consistency within the website and with established web conventions also promotes ease of use [3]. The convention that hyperlinks be blue and underlined with previously visited sites in purple increases

speed of use and user comfort as this is a familiar Internet tool. Another useful convention is to locate the website navigation tools on the left of the page as users tend to read left to right.

TABLE 1 : Good Practices for General Website Performance

Key Requirements	Considerations		
Website Accessibility Considerations			
<ul style="list-style-type: none"> • Good homepage load speed • Text available in HTML and plain text format • JavaScript is unobtrusive • Minimal usage of frames • Images, graphics and PDF have alternate text • Use of coloured lines to denote routes on map 	<ul style="list-style-type: none"> • PDF accessibility (PDF maps, timetables or other information should download within ten seconds for a 56k modem). • Coloured lines to denote routes • Language selection available 		
Website Usability Considerations			
<ul style="list-style-type: none"> • Information located on left side of homepage • Most frequently accessed information should appear at the top of the page. Grouped information should be located at the left with the most frequently accessed information at the top. • Appropriate font size - Font size should be appropriate for the amount of information presented on the screen and the text function. If the text is a heading the font should be larger, while body text should be smaller. Font should not overlap when the font size is increased within the browser settings. • Appropriate font style • Appropriate font colour - Dark coloured fonts are the easiest to read. Red and green should not be used together as colour blind users cannot differentiate between the two. The text colour should contrast the background colour. • Appropriate background and/or wallpaper colour - Background should be a light, neutral colour without an image which can distract from the text. The background colour should contrast the text colour. • Print quality - The ability to print the information presented is particularly important to passenger information websites. Some browsers will print a blank page when the background is dark and the text is light. • Number of clicks to find desired information - The number of clicks and time spent visiting a website can be used to evaluate its usability. Three clicks to find the desired information is considered ideal. • Current location within site shown clearly - The current page should be identified at the top of the page • Homepage link available on all pages • Information currency - The currency of information is particularly important to public transport users who rely on this source of information for timetable and service frequency information. A clear statement of information currency should be viewable on the homepage and on each page where specific time or route information is displayed. <table border="0" style="width: 100%; margin-top: 10px;"> <tr> <td style="vertical-align: top;"> <ul style="list-style-type: none"> • Sitemap • Search function • Frequently asked questions </td> <td style="vertical-align: top;"> <ul style="list-style-type: none"> • Site description • Feedback form • Contact details </td> </tr> </table>		<ul style="list-style-type: none"> • Sitemap • Search function • Frequently asked questions 	<ul style="list-style-type: none"> • Site description • Feedback form • Contact details
<ul style="list-style-type: none"> • Sitemap • Search function • Frequently asked questions 	<ul style="list-style-type: none"> • Site description • Feedback form • Contact details 		
Website Consistency			
<ul style="list-style-type: none"> • Hyperlink identification - Conventionally underlined and displayed in blue with previously visited sites in purple increases speed of use and user comfort, as this is a familiar Internet tool. • Navigation tools - Website navigation tools are conventionally located on the left of the page as users read left to right. • Colours and fonts - Colours used to denote menu areas and specific functions should remain consistent through the website. The use of colours to identify different parameters is a conventional and effective mechanism in website design. • Wording - The same words or phrases should be used consistently to describe an item or function. • Links - Links reflect the title of the page to which it refers. 			

A number of sources [2, 3, 9] indicate that the currency or degree to which the site is kept up to date is an important characteristic of a quality website. A clear and prominent statement of information currency on the homepage can give an immediate message about the quality of the information within the site [3]. One source suggests that undated factual information is no better than anonymous information [9].

The currency of information is particularly important to public transport users who rely on this source of information for timetable and service frequency information.

Static Information

When static information, such as timetables, is presented on the Internet, interactive media can be incorporated to allow the user to select a timetable from a route map, and may provide real time information about delays [10]. Conventional website information such as site description, frequently asked questions, feedback forms, site map and contact details are also considered important in quality web based PTI [3]. Research suggest the following about static transit information presented on web sites[3]:

- Overall network information - The PTI website should provide an overview of the modes of services available for a particular area. This should incorporate an overall network map with either all modes shown or a map per mode depending on the complexity and amount of information to be displayed.
- Route information and selection - A quality PTI website provides clear instructions on the method by which a user can select the appropriate route. This may be by inputting the road name, area (suburb), landmark, or service number. A pyramidal style organisation can assist the user in identifying the correct route by progressively narrowing down the journey options from a general area to specific location. The use of service numbers as a selection tool for routes is useful only to those who already know the public transport network. This should not be the only way by which a user selects a route.
- Timetable information and selection - A quality PTI website provides clear instructions on the method by which a user can select the appropriate timetable. Having selected the route, the user must be able to readily locate the appropriate timetable. A link should be made available from the route information page. Timetables should be selected via route number or name, or directly from the route information page. Timetables provided on the web should be designed in accordance with guideline principles [6, 8, 10] including that the use standard reference codes with a key, use the 24 hour clock, include the providers contact details, make a clear distinction between services running on different days of the week, indicate the currency, indicate the route number on each page, and include a concise route map. This can be in the form of a PDF which is a direct copy of printed material, however in addition to accessibility issues discussed previously; the direct transfer of general timetables to the web can produce usability problems. The PDF documents should incorporate more horizontal lines, columnar shading and larger font than general printed timetables. The user should be alerted to viewing requirements and the web page should include a link to download Adobe Acrobat Reader [3]. Information about how to read the timetable should also be available.
- Fares and other ticketing information, online booking facilities and information about service interruptions and maintenance delays should also be provided.

Journey Planners

Journey planners have the potential to provide a huge amount of information to the user in a way that reduces the need to consult multiple sources of information to plan a journey[10]. Journey planners combine timetable and route information to provide a solution to a trip based on user inputs. The user specifies the origin and destination locations, date and time of travel, and the trip generator, using a comprehensive geographic information system (GIS), provides an itinerary based on available modes of public transport. The form of origin and destination inputs options can vary between PTI websites[3]. The Montreal Transit Commission (MTC) website, for example, allows the input of address, intersection, clicking on a map or selecting a stop from a list [7] while the Electronic Timetable for Germany, Austria and Switzerland (EFA) allows the input of address, stop, and locations of interest and should the address or stop be misspelt, uses a phonetic search to replace unknown names with a valid but similar sounding one [10]. The type of input should be clear to the user [3]. Some sources suggest that the trip planner should use a confirmation or verification screen which presents a number of near matches from which the user can choose their location [3, 11]. This provides confirmation to the user that their desired input has been correctly interpreted. One source suggests that 'drop down lists' instead of data input are only useful for journey planners covering a small geographical area as the number of items that can be included in the list is restricted [3].

Having selected the origin, destination, date and time (arrival or departure), the user has the option of applying penalties on certain transit modes [7], shortest travel time, least transfers [11], and lowest cost and walking distance or time [10]. From this information, the system calculates and presents one or more optimal itineraries [10]. The search results should be logically presented with departure time presented to the left of arrival time to ensure the natural flow of information as the user reads [3]. The same source also suggests that the presentation of alternative journey plans can eliminate the need for further enquiries. In general the user is often presented with three journey options: the journey that best matches the user's

enquiry and an earlier and later journey option, with links to greater levels of depth for each option. Some sites provide greater options; output itineraries for the WMATA website incorporate walking time and fare information, and Ventura County Transportation Commission provides the direction of travel in a map format [10]. The introduction of real time information to journey planners is another innovation. Examples include Virginia Rail Express, Denver's Regional Transportation District and Portland's Tri-Met's Transit Tracker website's which display the real time location of the vehicle on a journey planner map, and Bavaria's Elektronische Fahrplanauskunft (EFA) which provides an itinerary which takes temporary traffic restrictions into account [10].

The above observations from the research literature were used as the basis for developing a framework for WTPIS assessment.

METHODOLOGY DEVELOPMENT

A weighted multi-criteria score card approach was developed to assess the performance of TPIWS based on the findings of the research literature presented above. The score card was divided into three sections; General Website Performance, Static Information Provision and Journey Planning Information as shows in Table 2. Table 2 shows the maximum possible scores under each of the section headings. A maximum possible score is 1,000 points per website. The following discussion describes how scoring was undertaken.

TABLE 2 : TPIWS Report Card Score Structure

Section		Maximum Possible Score
General Website Performance		
a.	Accessibility	120
b.	Usability	120
c.	Consistency	55
Sub-Total		295
Static Information Performance		300
Sub Total		300
Journey Planner Performance		
a.	Input	180
b.	Preliminary Solution Output	75
c.	Detailed Solution Output	150
Sub Total		405
Grand Total		1,000

General Web Site Performance

Table 3 shows the scoring system adopted for the General website evaluation. This includes the components of each score set and the relative significance weightings applied to each. Each score set is a number between 0 (lowest and poorest score) and five (highest and best score). Significance weightings enable some factors to be given more or less prominence in the final scores based on the researchers view of importance. The higher the weighting used implies a higher and better score.

A major factor in developing the general website **accessibility** measure is use of a free on line tool developed by a company called Etre (available at <http://www.etre.com/>). Etre is a London based web site design specialist company who assist organisations in web site development. They provide a free on line assessment tool to check web site performance. This evaluates the accessibility of web pages using the Web Accessibility Initiative (WAI) guidelines[12]. The website and the guidelines are a tool developed to assist organisations in developing strategies, guidelines, and resources to help make the internet accessible to people with disabilities. This website can be used by web providers to evaluate and improve their website's accessibility. Etre's webpage accessibility evaluation provides the user with information about the number of problems within the following categories:

- Priority 1 – must be fixed to provide the most basic level of accessibility
- Priority 2 – should be fixed to provide the minimum level of accessibility recommended by the EU
- Priority 3 – may be fixed to maximise accessibility

**TABLE 3 : TPIWS Report Card – Individual Score Criteria, Methods and Weights
– General Website Performance**

Criteria		Score Method		Significance Weighting	Notes	
No	Type					
Website Accessibility						
1	TPIWS Home Page	Priority 1 Error	1 - 10 or more errors	4 - 1 to 3 errors	3	Based on Etre online web site evaluation tool
		Priority 2 Error	2 - 7 to 9	5 - No errors	2	
		Priority 3 Error	3 - 4 to 6 errors		1	
2	Journey Planner Input Page	Priority 1 Error	1 - 10 or more errors	4 - 1 to 3 errors	3	Based on Etre online web site evaluation tool
		Priority 2 Error	2 - 7 to 9	5 - No errors	2	
		Priority 3 Error	3 - 4 to 6 errors		1	
3/ 5	Home Page Load and PDF Download Speed (average of 3)	1 - more than 25s 2 - 20-25s 3 - 15-20s	4 - 10-15s 5 - less than 10s	3	Self assessment using a consistent hardware/software system	
4	Use of coloured lines to denote routes on map	0 - not used, through to 5 - effectively used"		3	Self assessment using a consistent hardware/software system	
6	Language Selection	0 - no English available 1 - 1 language to 5 - five or more		3		
Website Usability						
7	Key Info Location on Homepage (timetables, routes, fares)	0 - not displayed 1 - displayed randomly, through to 5 - all top/left		3	Self assessment using a consistent hardware/software system	
8	Font Size – change to browser size settings	1- poor quality, through to 5 - good quality all sizes		2		
9	Font Style	1- difficult to read, through to 5 - easy to read: bold headings		2		
10	Home Page Colour Check	Brightness	1 - Score less than 50 2 - Score 50 - 74 3 - Score 75 – 99	4 - Score 100 - 124 5 - Score greater than 125 or tick	1	Based on Etre online web site evaluation tool
		Contrast	1 - Score < 200 2 - Score 200 - 299 3 - Score 300 – 399	4 - Score 400 - 499 5 - Score > 500 or tick	1	
11	No. clicks home page to bus route by direction and stop	1 - 10-11 clicks 2 - 8 - 9 click 3 - 6 - 7 clicks	4 - 4 - 5 clicks 5 - 3 or less clicks	3	Self assessment using a consistent hardware/software system	
12	Print quality (black and & white, colour) – timetable (from 11), route map (from 5)	0 - blank page 1 - poor quality 5 - good quality		2		
13	Current website location at top of page – test 5 pages/ site or all	0 - Not Shown, or 5 – Shown		2		
15	Site map availability	0 - Not Available		1		
17	Frequently asked questions	or 5 – Available		1		
18	Site description			1		
19	Feedback form			1		
20	Contact details			1		
Website Consistency						
21	Hyperlink Identification	1 - non-conventional 2 - underline only 3 - blue only 4 - blue & underline	5 - blue and underlined, previously viewed links purple	3	Self assessment using a consistent hardware/software system	
22	Navigation Tools	0 - no tools 1 - no organisation 2 - grouped 3 - located centrally	4 - located at top of page 5 - located on left of page	3		
23	Consistent colour for info.	0 - no organisation, through to 5 - effective colour use"		2		
24	Wording	1 – inconsistent through to 5 – consistent		1		
25	Links	1 - poor link content to 5 - clear		1		
26	Currency Statement	0 - not available, or 5 - available		1		

The report card incorporates the outputs of the testing of each TPIWS homepage and journey planner input page to evaluate general accessibility. In addition scoring of accessibility was assessed based on :

- Homepage Load Speed – with timing of the seconds required to load the home page as a performance measure. While this clearly depends on the users own internet infrastructure it is a reasonable way of comparing performance between systems as long as the same system is used for each performance assessment.
- Use of coloured lines to denote routes on maps – systems with lines are given preference
- PDF Download speed – an average of the speed taken to load three documents is used
- Language Selection – the number of languages available acts to generate a higher score.

Web site **usability** is assessed based on a number of separate features of the site. Firstly key information should be provided on the homepage (timetable, route and fare information with the highest score (5) if this provided in a prominent location to the top left). Font size should be adjustable using the browser to different sizes but the quality of the page on the screen should remain the same at all sizes (this gets the highest score of 5). For font size a high score (5) is available for easier to read fonts with bold headings and body text normal types. The influence of colour and contrast on usability is evaluated by utilising Etre's free on line Colour Check function. This tool uses the WAI guidelines regarding the effect of colour contrast and brightness on usability. This tool checks the foreground (text) colour against the background colour and rates its brightness and contrast. The evaluation requires the user to input the two colours. These can be typed or selected from a colour chart containing 216 colours which is available on line. The Etre website evaluation gives a score for both brightness and contrast. The desired brightness score is 125 or greater and the desired contrast score is 500 or greater. Scores are allotted based on performance relative to these measures as indicated in Table 3.

Usability is also assessed through a number of other tests devised from the research literature. The number of mouse clicks required to locate the timetable of a bus route in a particular direction from the homepage is one measure used. Print quality of hardcopy outputs from the system are also assessed for both colour and black and white outputs. Sites are also assessed with regard to the provision of 'current location' information within the system. This can assist in guiding users through the TPIWS system. Other key usability information considered includes the availability of a site map, frequently asked questions, site description, feedback form and contact details pages.

Website consistency information is assessed firstly by examining the hyperlink identification and colour criteria adopted with higher scores for those adopting the best practice measures discussed earlier. Navigation tools, colour, wording consistency, link conventions and the availability of a currency statement are also considered and valued in the assessment. Higher weights are applied to hyperlink and navigation tools in the proposed framework.

Static Information Performance

Table 4 shows the scoring system adopted for the static information evaluation. The components and scoring principles are relatively simple to understand from the Table information presented. Again all components and their scoring principles are based on the findings of the previous research as identified earlier.

Journey Planner Performance

Table 4 also shows the scoring system adopted for the evaluation of available journey planners. Here the assessment is based on the format and options available for input of requests to the system and also from an assessment of a preliminary and a detailed output solution. The preliminary solution concerns the initial result set provided whilst the detailed solution concerns the form of the final detailed journey data provided for a given selected journey from the options provided by the systems.

**TABLE 4 : TPIWS Report Card – Individual Score Criteria, Methods and Weights
– Static Information and Journey Planner Performance**

Criteria		Score Method		Significance Weighting	
No	Type				
STATIC INFORMATION PERFORMANCE					
1	Overall System Information	Network Description	0 - No network info 1 - No description 2 - basic 3 – intermediate	4 - incl. Modes or area covered only 5 - incl. modes, area covered	5
		Network map	0 - No overall map 1-2 - Basic maps 3 - Intermediate map/s	4 - Map/s without route no 5 - Clear map/s with route no	5
2	Route Information and Selection		1 - No instructions 2 - =>2 selection methods 3 - At least 3 methods	4 - Pyramid approach - no instructions 5 - Pyramid approach + clear selection method	5
3	Timetable Information				5
4	General Info about modes		0 - not available, through to 5 - detailed information available		5
5	Timetable Presentation	Where PDF used	0 - PDF not readable, through to 5 - PDF readable with shading		5
		Link to PDF reader	0 - not available 3 - available at other location	5 - Available in view of timetable link	5
6	Passenger Info for Persons with Impairments		0 - not available, through to 5 - detailed information available		5
7	Luggage Storage & Station facilities		0 - not available, through to 5 - detailed information available		5
8	Fare Information				5
9	Online Booking/ Ticket Purchase				5
10	Service Interruptions				5
JOURNEY PLANNER PERFORMANCE - Input					
1	Origin-destination inputs		1 - no choice of input 2 - drop down list only 3 - 2 input options	4 - 3 input options 5 - more than 3 input options	3
2	Input date and time available		0 - no selection available, or 5 - selection available"		2
3	Selection of departure/ arrival time		0 - not on same page/not available, or 5 - on same page"		2
4	Confirmation/ Verification	Matches provided to verify search option	0 - no confirmation 1 - 1 match provided 2 - 2 matches provided 3 - 3 matches provided	4 - 4 matches provided 5 - more than 4 matches provided, or input correctly interpreted	1
		Back or refine option	0 - not available or 5 - available		1
5	Penalty application		0 - no option 1 - 1 penalty available, through to 5 – 5 or more penalties available		3
Preliminary Solution Output					
6	Number of Solutions Presented		0 - no solution 1 - 1 solution to 5 – 5 or more		3
7	Solution Presentation – info provided		1 - unclear presentation, through to 5 - clear presentation reads left to right		2
Detailed Solution Output					
8	Presentation		0 - no detailed solution 1 - unclear presentation or same as preliminary	through to 5 - logical presentation of information	2
9	Info provided (platform & access, direction of travel, time spent on each mode, where to get off, how to find connecting service)		0 - no detailed description 1 - 1 criteria met Through to 5 - all criteria met"		2
10	Maps		0 - no map 1 - map of journey available	through to 5 - detailed maps of each leg and overall journey	2
11	Printed Material		1 - poor print quality, through to 5 - high quality		1
12/ 13	Fare Information / Real Time Information		0 - no facilities or 5 - facilities available		1
14	No. Mouse Clicks from input to detailed info		0 - 14 or more clicks 1 - 12-13 clicks 2 - 10-11 clicks	3 - 8-9 clicks 4 - 6-7 clicks 5 - 5 or less clicks	1

METHODOLOGY APPLICATION

The methodology was applied to assess 9 city TPIWS as detailed in Table 5. Melbourne, Australia was the first selection since this was the city where the authors are located. The other cities were selected on the basis that they should have at least two transit modes (Melbourne has three) and that they should be large major cities broadly comparable to Melbourne.

The assessment of each TPIWS involved the application of assessment rules identified in Tables 3 and 4. Each assessment was carried out in a single set of tests rather than splitting assessment into groups over time. This avoided the problem of varying system performance over time and also potential upgrades of sites during an assessment. In general assessment took around an hour per site.

The Journey Planner evaluation also required some selection of example planned trips to test the system. This required some careful consideration since selection of unusually difficult trips in one city may bias the score card results due to trip selection bias rather than Journey Planner performance. Table 5 also shows the origin and destination locations selected for each city. In each case two trip origin addresses are selected outside the city centre but in diametrically different geographic locations from the city centre. Two destinations are selected within the city centre but in geographically different parts of the city centre. The three trip pairs tested involved three combinations of trips to these four trip ends. In addition trip end selection was based on mapping which did not show the transit network.

TABLE 5 : TPIWS Report Card Selected City TPIWS and Planned Trips

City/Company	TPIWS URL	Journey Planner Test Trips		
		No	Trip Origin	Trip Destination
Berlin, Germany Berliner Verkehrsbetriebe (BVG) Translation: Berlin Transport Services	http://www.bvg.de/	1	Herzbergstr. 55,10365	TV Tower, near Alexanderplatz
		2	Brandenburger Gate near Unter den Linden	Berliner Str. 46, 10713
		3	Herzbergstr. 55,10365	Berliner Str. 46, 10713
Brussels Société des Transports Intercommunaux de Bruxelles (STIB)	http://www.stib.be/	1	24 Rue Auguste Beernaert	Royal Palace (Domaine Royal)
		2	Manneken Pis - cnr Rue de l'Étuve & Rue du Chêne	64 Rue Adolphe Marbotin
		3	24 Rue Auguste Beernaert	64 Rue Adolphe Marbotin
London Transport for London	http://www.tfl.gov.uk/	1	8 Atney Road, Wandsworth	St Pauls Cathedral
		2	Tower of London	7 Rookfield Close, Haringey
		3	8 Atney Road, Wandsworth	7 Rookfield Close, Haringey
Madrid Consortio Transportes Madrid	http://www.ctm-madrid.es/	1	(Calle de) Pradillo	Museo Nacional del Prado
		2	Plaza de la Puerta del Sol	(Calle del) Sorbe
		3	(Calle de) Pradillo	(Calle del) Sorbe
Melbourne Metlink	http://www.metlinkmelbourne.com.au/	1	8 Cabal Crt, Mulgrave	Federation Square
		2	Queen Victoria Market	18 Cudmore Street, Essendon
		3	8 Cabal Crt, Mulgrave	18 Cudmore Street, Essendon
Paris Régie Autonome des Transports Parisiens (RATP)	http://www.ratp.info/	1	22 Rue Michelet, Montreuil	Sacre Coeur Basilica
		2	Eiffel Tower	12 Avenue Amelie, Chatillion
		3	22 Rue Michelet, Montreuil	12 Avenue Amelie, Chatillion
Portland (Oregon) Tri-Met	http://www.trimet.org/	1	8130 Ne Fremont St	Saturday Market
		2	100 SW Salmon St	1800 SW Elm St
		3	8130 Ne Fremont St	1800 SW Elm St
Rome Azienda Tramvie e Autobus del Comune Di Roma (ATAC)	http://www.atac.roma.it/	1	Via Sestio Calvino, 66	Musei Vaticani
		2	Piazza di Spagna	Via Simone De Saint Bon, 5
		3	Via Sestio Calvino, 66	Via Simone De Saint Bon, 5
Washington Metropolitan Area Transit Authority (WMATA)	http://www.wmata.com/	1	1612 U St NW	White House
		2	National Air and Space Museum	315 G St Se
		3	1612 U St NW	315 G St Se

RESULTS

Figure 1 and Table 6 illustrates the results of the assessment with a full detailing of the component scores presented in the tables in attachment A.

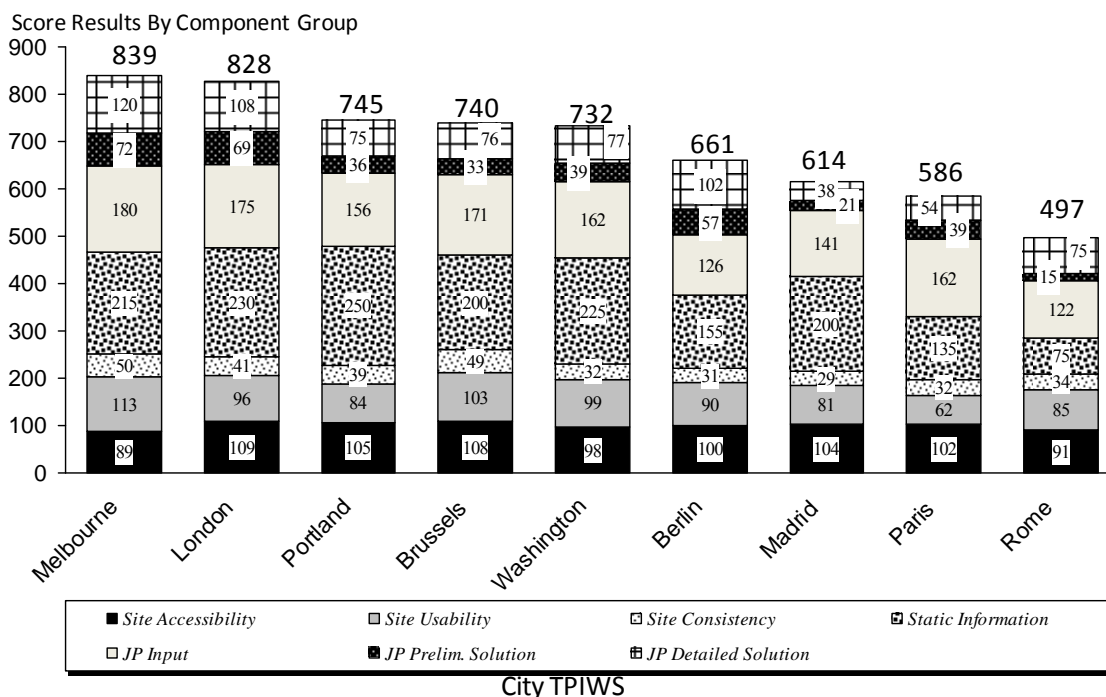


FIGURE 1 : TPIWS Report Card – Summary Results by Component Group Results
– Nine Example Cities

The range of results available and the analysis undertaken to compile these is large. A summary of key findings is therefore provided and focuses on firstly a broad overview followed by a specific discussion of the findings in relation to the Melbourne TPIWS.

Overall the Melbourne TPIWS had the highest weighted overall score closely followed by London and Portland. Rome had the lowest score at about 50% of the highest possible score. However Melbourne did not lead scoring in all category groups:

- Brussels had the highest overall score for general website performance. Within this group the Brussels Accessibility rating was the second highest after London of those assessed. This was due to a low number of errors identified in the Etre website test and a high rating for the number of languages available (but not the highest overall). Load speeds were also the highest rating possible although this was shared amongst several of the higher rated sites including Melbourne.
- Portland had the highest score for static information provision. This was due to high ratings for online booking/ticket purchase, provision of ancillary information on stations etc on the site, a good rating for the use of columnar shading in the PDF timetables used and high scores in other static information tests (which was shared with other leading sites e.g. London, Washington and Melbourne)
- Melbourne did achieve the highest score for journey planner performance.

Although Melbourne achieved the highest overall score a number of performance areas were identified where improvements could be made:

- Website accessibility – Only 1 language was available compared to 5 in London.
- Website Usability – Five clicks are required to locate detailed bus timetable information from the home page. This was achieved in three in Brussels. Print quality of timetables and route maps was not as good as is achieved in London which achieved the highest possible score. There was no currency statement on either the web site or the journey planner in Melbourne.
- Static Information – Melbourne's web site provided only a very basic network description. The network maps were also considered basic and substantially below the quality of those provided in Portland, London and Washington. Only 2 selection methods were available to select timetables and their presentation was considered of variable and low quality compared to others.

TABLE 6 : TPIWS Report Card – Summary Results –Nine Example Cities

	Max	MELBOURNE	LONDON	PORTLAND	BRUSSELS	WASHINGTON	BERLIN	MADRID	PARIS	ROME
1 WEBSITE										
i) Accessibility	120	89	109	105	108	98	100	104	102	91
ii) Usability	120	113	96	84	103	99	90	81	62	85
iii) Consistency	55	50	41	39	49	32	31	29	32	34
Sub Total	295	252	246	228	260	229	221	214	196	210
	%	85%	83%	77%	88%	78%	75%	73%	66%	71%
2 STATIC INFORMATION	300	215	230	250	200	225	155	200	135	75
	%	72%	77%	83%	67%	75%	52%	67%	45%	25%
3 JOURNEY PLANNER										
i) Input	180	180	175	156	171	162	126	141	162	122
ii) Preliminary Solution Output	75	72	69	36	33	39	57	21	39	15
iii) Detailed Solution Output	150	120	108	75	76	77	102	38	54	75
Sub Total	405	372	352	267	280	278	285	200	255	212
	%	92%	87%	66%	69%	69%	70%	49%	63%	52%
TOTAL	1000	839	828	745	740	732	661	614	586	497
	%	83.9%	82.8%	74.5%	74.0%	73.2%	66.1%	61.4%	58.6%	50%

Even though the Melbourne Journey Planner achieved the highest score of the systems tested a number of areas for improvement were noted:

- The number of preliminary solutions presented was generally high (over 4) but in the three tests undertaken on one occasions only 3 were provided. The London planner provided over 4 in each case.
- Again the printed outputs of the planner were rated high but not of the quality of the London journey planner output
- No real time information was provided.

DISCUSSION AND CONCLUSION

Almost all transit authorities worldwide now operate centralised transit passenger information web sites (TPIWS). While a range of research has demonstrated good practices in design and operation of TPIWS, there has been no consolidated measurement tool developed to date which can objectively assess the performance of these sites. This paper summarises the results of a research project aimed at developing a multi-criteria report card for assessing TPIWS based on findings from previous research on good practice. The score card is structured around a series of general website accessibility, usability and consistency tests and also a review of static information and journey planner evaluations. The paper has reviewed the research literature, described the proposed methodology and reports on its application to 9 worldwide TPIWS systems. The findings rate the systems in Melbourne, London and Portland with the highest scores out of the 9 cities assessed. Although Melbourne achieves the highest overall score the application of the score card has provided a basis for identifying areas for improvement.

Although an objective approach to TPIWS performance assessment was sought in this research many elements of website design remain subjective. Hence performance assessment approaches will remain an issue of debate. Some of the individual score sets require subjective judgement from the researcher and it is likely that different results will emerge from different researchers. In addition the significance weightings applied in this research have been developed in a subjective manner based on the authors views and interpretations of what the research literature suggests. In practice there are varying views on what good performance is and also probably alternative viewpoints regarding the weights applied. Nevertheless the methodology suggested in this paper is a good starting point for anyone wishing to understand TPIWS performance. Researchers and practitioners have the option of adjusting the methodology and the weightings suggested as they wish.

There may be a good reason to maintain a flexible approach to performance assessment of TPIWS systems. The last two decades have seen substantial changes in system quality and much innovation in information access and delivery. Any performance assessment tool will have to keep pace with such developments as innovations act to change what and how performance is measured.

A potential weakness of the methodology suggested is the reliance on the Etre web site for assessment of a subset of the general web site accessibility and usability performance measures. The approach adopted has the benefit of being free to implement but does rely on the integrity of the Etre online assessment system. The authors are unable to comment either way on this issue although the Etre website refers to what appears to be a substantial experience base in this field which includes TPIWS development. In addition their approach is based on a reputable set of accessibility guidelines which are widely adopted [12]. It would be fair to say that use of the Etre website as suggested is probably a rather superficial way to assess the technical performance of web sites. The Etre website recommends website owners seek more in depth technical assessment. This seems a reasonable approach for more in depth technical development of TPIWS but this research is more focussed on a strategic first pass relative performance assessment. It would be wise to develop a wider range of more technical assessment tools for inclusion in the score card if this is achievable at modest cost.

A new concept which would be greatly enhanced with the development of the methodology suggested in this paper is an independent periodic review of worldwide TPIWS systems. This would be an informative means of highlighting good and bad performance to the transit industry as well as a means of tracking innovations. In effect a periodic ranking of worldwide TPIWS systems could be undertaken including the independent identification and highlighting of world leading sites. A review of this kind could be published on a website or through print media. A major problem in implementing such a scheme is methodology development and financing. Financing is particularly problematic when multiple worldwide transit agencies are involved. Individual agencies might be particularly concerned when paying for a review which is unfavourable. Similar benchmarking initiatives in transit have been based on subscriptions including private/confidential rather than public sharing of results (e.g. the CoMET and Nova

rail benchmarking initiative at Imperial College London [13]). The authors would welcome support to develop such a review from any agencies interested in financing its development.

As an initial development of the score card there are clearly a range of areas for improvement. A particularly fruitful task would be to research users views and opinions relative to the weightings applied in the score card. In this way assessment might be better related to the opinions of those who use TPIWS systems. Developing a more objective set of rules for the application of individual score sets might also remove subjective judgement from a range of the tests. An interesting development of the methodology would be to develop a web based assessment tool. This might better automate the assessment task, also acting to reduce subjective judgement into the process.

As technology and communications systems continue to develop and play a bigger role in modern society it is likely that TPIWS systems will increasingly act as the public interface of transit agencies worldwide. Improving the performance of these systems is therefore an important objective for transit system planning. The development and application of objective, low cost TPIWS assessment tools as suggested in this paper will therefore be a worthwhile aim for future transit system planning.

ACKNOWLEDGEMENTS

The authors would like to thank Etre for providing useful free online web assessment tools used in this paper and also for Mr Dan Griffin of Etre for providing permission to refer to their site in this paper. Any omission or errors are the responsibility of the author.

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TABLE 5 : TPIWS Report Card Selected City TPIWS and Planned Trips

TABLE 6 : TPIWS Report Card – Summary Results –Nine Example Cities

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ATTACHMENT A – INDIVIDUAL SYSTEM SCORE CARD RESULTS

		BERLIN		BRUSSELS		LONDON		MADRID		MELBOURNE		PARIS		PORTLAND		ROME		WASHINGTON		
PART 1. WEBSITE EVALUATION		Significance 1-5	Score 0-5	Total	Score 0-5	Total	Score 0-5	Total	Score 0-5	Total	Score 0-5	Total	Score 0-5	Total	Score 0-5	Total	Score 0-5	Total		
i) Website Accessibility																				
Etre Accessibility Evaluation: homepage																				
i)	Priority 1																			
		3	5	15	5	15	5	15	5	15	5	15	4	12	5	15	4	12	5	15
ii)	Priority 2																			
		2	3	6	3	6	5	10	4	8	1	2	1	2	2	4	4	8	1	2
iii)	Priority 3																			
		1	4	4	5	5	3	3	5	5	3	3	5	5	5	5	5	5	4	4
Etre Accessibility Evaluation: Journey Planner Input Page																				
i)	Priority 1																			
		3	5	15	5	15	5	15	5	15	5	15	4	12	5	15	5	15	5	15
ii)	Priority 2																			
		2	2	4	4	8	1	2	4	8	1	2	3	6	1	2	1	2	1	2
iii)	Priority 3																			
		1	5	5	5	5	4	4	5	5	4	4	5	5	4	4	4	4	3	3
3	Homepage Load Speed																			
		3	5	15	5	15	5	15	5	15	5	15	5	15	5	15	5	15	4	12
4	Use of coloured lines to denote routes on map																			
		3	5	15	5	15	5	15	5	15	5	15	5	15	5	15	5	15	5	15
5	PDF Download Speed - average of three																			
		3	5	15	5	15	5	15	4	12	5	15	5	15	5	15	4	12	4	12
6	Language Selection																			
		3	2	6	3	9	5	15	2	6	1	3	5	15	5	15	2	6	5	15
		Sub Total:		100	108		109		104		89		102		105		91		98	
ii) Website Usability																				
7	Key Information Location on Homepage - timetables, routes & fares																			
		3	5	15	5	15	4	12	2	6	5	15	3	9	5	15	4	12	5	15
8	Font Size - change browser settings from medium to large and check readability of homepage																			
		2	5	10	5	10	4	8	1	2	5	10	0	0	3	6	5	10	5	10
9	Font Style																			
		2	5	10	5	10	5	10	4	8	5	10	3	6	4	8	5	10	4	8
10	Font and Background Colour: Etre colour check - homepage																			
i)	Brightness																			
		1	5	5	5	5	5	5	5	5	5	5	4	4	5	5	4	4	4	4
ii)	Contrast																			
		1	5	5	4	4	4	4	5	5	5	5	3	3	4	4	4	4	4	4
11	Number of clicks to desired information																			
		3	0	0	5	15	3	9	5	15	4	12	0	0	5	15	0	0	4	12
12	Print Quality (black & white, colour) - timetable from 11 route map from 5																			
		2	5	10	2	4	5	10	5	10	3	6	5	10	3	6	5	10	3	6
13	Current Location shown at top of page - test 5 pages per website																			
		2	5	10	5	10	5	10	5	10	5	10	5	10	0	0	5	10	5	10
14	Homepage link available on all pages - test 5 pages per website																			
		2	5	10	5	10	5	10	5	10	5	10	5	10	0	0	5	10	5	10
15	Sitemap																			
		1	5	5	0	0	5	5	5	5	5	5	0	0	5	5	0	0	0	0
16	Search Function																			
		1	5	5	5	5	5	5	0	0	5	5	0	0	5	5	5	5	5	5
17	Frequently Asked Questions																			
		1	0	0	0	0	3	3	0	0	5	5	0	0	0	0	0	0	5	5
18	Site Description																			
		1	0	0	5	5	0	0	0	0	5	5	0	0	5	5	5	5	0	0
19	Feedback Form																			
		1	0	0	5	5	0	0	0	0	5	5	5	5	5	5	0	0	5	5
20	Contact Details																			
		1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
		Sub Total:		90	103		96		81		113		62		84		85		99	
iii) Website Consistency																				
21	Hyperlink Identification																			
		3	1	3	4	12	3	9	1	3	5	15	3	9	2	6	1	3	2	6
22	Navigation Tools																			
		3	5	15	5	15	4	12	4	12	5	15	4	12	5	15	5	15	5	15
23	Colours used to denote specific information																			
		2	2	4	5	10	5	10	3	6	5	10	1	2	4	8	4	8	2	4
24	Wordings																			
		1	4	4	5	5	5	5	3	3	5	5	4	4	5	5	4	4	2	2
25	Links																			
		1	3	3	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5
26	Currency Statement - homepage - journey planner																			
		1	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub Total:		31	49		41		29		50		32		39		34		32	
WEBSITE EVALUATION TOTAL:		221	260		246		214		252		196		228		210		229			

		BERLIN		BRUSSELS		LONDON		MADRID		MELBOURNE		PARIS		PORTLAND		ROME		WASHINGTON								
PART 2. STATIC INFORMATION		Significance 1 - 5	Score 0 - 5	Total	Score 0 - 5	Total	Score 0 - 5	Total	Score 0 - 5	Total	Score 0 - 5	Total	Score 0 - 5	Total	Score 0 - 5	Total	Score 0 - 5	Total								
1	Overall Network Information:																									
i)	Network Description																									
	0 - No overall network info available 1 - No Description 2 - basic 3 - intermediate 4 - incl. Modes or area covered only 5 - incl. modes, area covered etc	5	5	25	5	25	1	5	1	5	2	10	4	20	3	15	1	5	0	0						
ii)	Network Map																									
	0 - No overall map 2 - Basic maps 3 - Intermediate map/s 4 - Maps without route numbers 5 - Clear map/s with route numbers	5	5	25	5	25	5	25	5	25	3	15	5	25	5	25	5	25	5	25						
2	Route Information and Selection																									
	1 - No instructions 2 - At least 2 selection methods 3 - At least 3 selection methods 4 - Pyramid approach - no instructions 5 - Pyramid approach + clear instructions about selection method	5	2	10	2	10	5	25	4	20	4	20	2	10	4	20	1	5	1	5						
3	Timetable Information and Selection																									
	1 - No instructions 2 - At least 2 selection methods 3 - At least 3 selection methods 4 - Pyramid approach - no instructions 5 - Pyramid approach + clear instructions about selection method	5	0	0	1	5	5	25	4	20	2	10	0	0	4	20	1	5	2	10						
4	General Information about each mode of transport available																									
	0 - not available through 5 - detailed information available	5	5	25	5	25	3	15	1	5	4	20	5	25	2	10	0	0	4	20						
5	Timetable Presentation:																									
i)	Where PDF timetables used, document is readable and uses columnar shading																									
	0 - PDF not readable through 5 - PDF readable with shading	5	0	0	5	25	3	15	5	25	0	0	0	0	4	20	0	0	3	15						
ii)	Link to Adobe Acrobat Reader Download																									
	0 - not available 3 - available at different location 5 - Available in view of timetable link	5	0	0	3	15	3	15	5	25	3	15	5	25	3	15	0	0	5	25						
6	Passenger Information for Persons with Impairments																									
	0 - not available through 5 - detailed information available	5	4	20	3	15	5	25	0	0	5	25	5	25	5	25	2	10	5	25						
7	Luggage Storage and Other Station Facilities																									
	0 - not available through 5 - detailed information available	5	0	0	0	0	3	15	0	0	5	25	0	0	5	25	0	0	5	25						
8	Fare Information																									
	0 - not available through 5 - detailed information available	5	5	25	5	25	5	25	5	25	5	25	0	0	5	25	5	25	5	25						
9	Online Booking and/or Ticket Purchase Facilities																									
	0 - not available through 5 - facilities available	5	0	0	1	5	3	15	5	25	5	25	0	0	5	25	0	0	5	25						
10	Service Interruptions																									
	0 - not available through 5 - disruptions published on homepage	5	5	25	5	25	5	25	5	25	5	25	1	5	5	25	0	0	5	25						
STATIC INFORMATION EVALUATION TOTAL:		155			200			230			200			215			135			250			75			225

PART 3. JOURNEY PLANNER		Significance 1 - 5	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total					
i)	Input																		
	1 - no choice of input 2 - drop down list only 3 - 2 input options 4 - 3 input options 5 - more than 3 input options	3	27	45	45	45	45	45	45	36	45	27	45						
2	Origin/Destination Input																		
	0 - no selection available or 5 - selection available	2	30	30	30	30	30	30	30	30	30	30	30						
3	Input Date and Time Available																		
	0 - not on same page/not available or 5 - on same page	2	30	30	30	30	0	30	30	30	30	0	30						
4	Confirmation/Verification Screen (If score for 1 is greater than 2)																		
i)	Matches provided to verify search																		
	0 - no confirmation 1 - 1 match provided 2 - 2 matches provided 3 - 3 matches provided 4 - 4 matches provided 5 - more than 4 matches provided, or input correctly interpreted	1	15	15	15	15	15	15	15	15	15	15	15						
ii)	Back or refine search option available																		
	0 - not available or 5 - available	1	15	15	10	15	15	15	15	15	0	5	15						
	Penalty application																		
	0 - no option 1 - 1 penalty available 2 - penalties available 3 - 3 penalties available 4 - 4 penalties available 5 - more than 4 penalties available	3	9	36	45	36	45	36	45	36	36	45	27						
Sub Total:			126	171	175	141	180	162	156	122			162						
ii)	Preliminary Solution Output																		
6	Number of Solutions Presented																		
	0 - no solution 1 - 1 solution 2 - 2 solutions 3 - 3 solutions 4 - 4 solutions 5 - more than 4 solutions	3	33	9	45	9	42	9	18	9	27								
7	Solution Presentation - departure time, arrival time, travel time, number of transfers, modes, walking dist/time																		
	1 - unclear presentation through 5 - clear presentation reads left to right	2	24	24	24	12	30	30	18	6	12								
Sub Total:			57	33	69	21	72	39	36	15	39								
iii)	Detailed Solution Output																		
8	Detailed solution presentation																		
	0 - no detailed description 1 - unclear presentation or same as preliminary through 5 - logical presentation of information	2	30	30	30	6	30	6	6	6	6	18							
	Detailed solution information - platforms & access, direction of travel, time spent on each mode where to get off, how to find connecting service																		
	0 - no detailed description 1 - 1 criteria met 2 - 2 criteria met 3 - 3 criteria met 4 - 4 criteria met 5 - all criteria met	2	30	24	24	12	30	18	18	12	12								
10	Maps																		
	1 - map of journey available through 5 - detailed maps of each leg and overall journey available 5 - poor print quality	2	12	6	24	6	30	0	6	30	2								
11	Printed Material																		
	0 - no facilities through 5 - high quality printing	1	12	9	15	3	12	12	15	12	15								
12	Fare Information																		
	0 - no facilities or 5 - facilities available	1	3	0	0	0	3	3	15	0	15								
13	Real time information																		
	0 - no facilities or 5 - facilities available	1	0	0	0	0	0	0	0	0	0								
14	Number of clicks from origin/destination input to detailed solution																		
	0 - 14 or more clicks 1 - 12-13 clicks 2 - 10-11 clicks 3 - 8-9 clicks 4 - 6-7 clicks 5 - 5 or less clicks	1	15	7	15	11	15	15	15	15	15								
Sub Total:			102	76	108	38	120	54	75	75	77								
JOURNEY PLANNER EVALUATION TOTAL:		285		280		352		200		372		255		267		212			278