



INTERACTIVE MAP ROUTES FOR PUBLIC TRANSPORTATION IN SURABAYA RUNNING ON SMARTPHONES AND TABLETS

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ABSTRACT

The public transportation in Surabaya is quite varied, whether bus or minibus (called bemo). But that mass transportation is not interesting for Surabaya citizens to use. One problem is that the information about public transportation is not available completely. Department of Transportation of Surabaya already has a website, but not yet contain complete information on maps and public transportation routes. This study was conducted to address the lack of route information of public transportation in Surabaya by creating an online guide that can be accessed by passengers to get complete information on maps and travel routes for public transportation which is made interactive, simple, accessible and appropriate transport adapted to the conditions in the city of Surabaya. This research will develop the responsive websites that can be used on various types of smartphones and tablets using Android operating systems. Maps and routes are obtained from Department of Transportation of Surabaya. Survey was done by distributing questionnaires to determine the needs of the passengers of public transportation. Maps and route are developed using OpenStreetMap, Ajax, Javascript, XML, OpenLayer, PostgreSQL, PostGIS, Apache and PHP programming language. Passengers simply entering the destination of his journey could be the name of the street or landmarks and public places. The system will automatically choose the alternative route of bemo they should take, including the routes to reach the destination. The information includes the connecting route of bemo if the routes need to be connected by more than one route of bemo. Also the information regarding the price to be paid. From the test results, responsive website can adapt to a wide range of smartphones with a variety of screen sizes, from 3.5 inch to 5 inch smartphones and 7 inch tablets. However, there is a little difficulties for 3.5 inch smartphones to touch the button on the screen because the screen size is too small.

Keywords: routes, maps, public transportation, bemo, responsive website, open street maps, smartphone, tablet, android.

INTRODUCTION

Currently one of the mass public transportation in the city of Surabaya is the type of small and medium 1000cc car commonly called bemo with a maximum carrying capacity of 10 persons [1]. Watkins et al in the studies of open source development of mobile transit traveller OneBusAway information systems for King County Metro (KCM) in Seattle suggest that the provision of good information systems for public transport passengers, will increase passenger satisfaction and increase the interest using public transport. [2]. It would be useful to encourage people to switch from the use of private transportation to the public transportation.

Furthermore, based on the observation of the initial research, there are some Android applications of TransJakarta Busway public transportation in Jakarta. Among them is Komutta which has the highest rating is 4.6 out of 1, 263 voters and has been downloaded by more than 50,000 times in the Google Play Store (<http://play.google.com>). But all the applications that have been created can only be running on one operating system, for example that can be used on Android can not be used in iOS, Blackberry and Windows Mobile. Conversely the one that running on Blackberry, can not be used in the others operating system.

As a result, not all smartphone users can take advantage of software applications that have been created. This is because initially all of the applications has been developed using native app and not with the hybrid app

[3]. As a result, if an application is already developed as an Android native app, then to make it available as BlackBerry native app, the developer must re-develop the app from the beginning, because of the different programming languages that are used to develop native apps for different operating systems. If initially the applications are developed using hybrid technology to produce cross-platform app, for example for Android, then developed for Blackberry, only very minor and simple changes need to be done. The idea of implementing hybrid app could be seen in the diagram at Figure-1.

Head of IDC Operations of Indonesia, Sudev Bangah argued that many smartphones with varying price will be affordable for smartphone users who are on the middle class customers [4].

Setiabudi, Rostianingsih and Tjahyana [5] have conducted research for creating tourism guide web based application for Malang Tourism Department, Indonesia. The research was focused on providing tourism map that developed using Google Map API version 3. Thus, the map functionalities depend entirely on Google Map API functions in that version, whereas Google Map API could be altered or upgraded to the latest version in the future without compromising with the previous versions. In result, major changes should be made to adjust with the latest version of Google Map API. Moreover, the web application was only compatible for desktop users, because the layout was not created using responsive web design template. Therefore, it was not usable for mobile viewers.



Based on the fact that market share is issued by IDC Indonesia, to increase the satisfaction of bemo passengers in Surabaya, this research will develop a responsive website that can be used from browser of various operating systems (iOS, Android, BlackBerry, and Windows Mobile) for trip planning using bemo in Surabaya using OpenStreetMaps.

Those websites and applications will help the passengers planning their trips based on routes, timetables, and costs. The website created will use a responsive layout that can accommodate all types of browsers and screen sizes ranging from desktops to smartphones [6].

As shown in Figure-1 the time can be shortened and costs can be saved, because after developing a web based application in the form of responsive website, furthermore it become native apps using phonegap which can then be distributed through the app store for each mobile operating system.



Figure-1. Block diagram of the system.

The responsive website will provide information about route guide and timetable of public transportation in Surabaya. The information will be equipped with a search feature and a trip planning using public transportation simply by entering the origin and destination specified by the passengers. Both the origin and destination can be either a street name or landmark name and public place such as bemo stations, parks, rivers, shops, schools, and others.

The planning features will use a multimodal transport network that takes into account some factors such as multimodal routes, timetables, and costs to provide recommendations for the route optimized. This feature will guide the passengers to the nearest public transportation station, by giving the order of public transportation they should take, to arrive at the nearest public transport to the destination. This feature will also be equipped with an estimation of their costs for the service. Furthermore, in this paper will be discussed the steps of this research, which starts from the survey to Department of Transportation of Surabaya to get information about all of the routes of bemo in Surabaya, then distribute the

questionnaires to passengers of bemo, followed by the design of the algorithm to create the route from the current position of the passenger to destination and ending with the testing of the software that was developed to find out the results.

RESEARCH METHODOLOGY

The method used in this research can be seen in Figure 2. First step includes a survey of the timetables of public transportation, the cost of travel, location of public places.

The second step is a survey to determine the needs of passengers on public transportation includes information about features (maps, routes, cost, etc.), operating systems, smartphone brand. The third step is the design of application, by making flowcharts, interface and database design. The fourth step as seen in Figure 2 includes designing of journey planner module that consists of a multimodal factor, determining the adoptive node passed by bemo, the integration of these points by using the OpenStreetMaps API [7][8] and creating a journey planner.

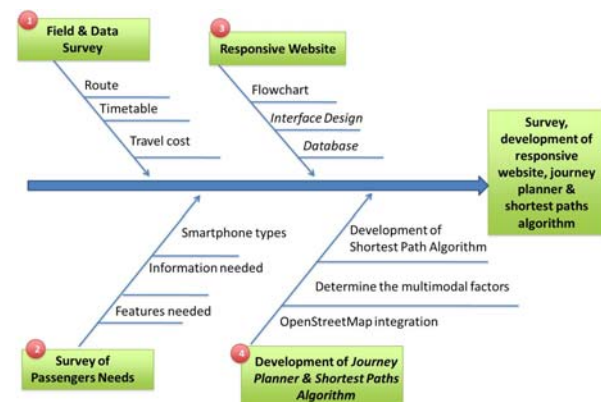


Figure-2. Fishbone diagram of research methodology.

Determination factor for designing of multimodal transport network will consist of the route, timetable, travel expenses, as well as landmarks and known public places. The points passed by public transportation, can be the name of the street or landmarks and places known by passengers. The integration of points on the database and OpenStreetMap API, be accompanied by the calculation of the distance between the point and the line of the route. On the second step, the purpose of the survey is to find out the needs of the passengers. It has been collected samples from 100 respondents. Respondents stated that the route information is not enough and seen less satisfying.

Currently the route information is obtained directly from the driver of bemo (by 46%). The information of bemo transport routes is rarely available from a website. This makes the basis of this research that is the required accessible route information through information technology devices such as website or smartphones. From a range of different communication



tools used by the respondents as seen on Table-1, 98% had a smartphone and tablet while only 2% using regular phones.

Table-1. Communication devices.

Phone Type	Frequency	Percent	Valid Percent	Cumulative Percent
HP biasa	2	2.0	2.0	2.0
Smartphone	75	75.0	75.0	77.0
tablet	12	12.0	12.0	89.0
iphone	5	5.0	5.0	94.0
iPad	6	6.0	6.0	100.0
Total	100	100.0	100.0	

It strongly supported the plan to provide the route information through a smartphone. Brand communication tools commonly used by respondents is Samsung of 30% and Android-based operations systems of 77%.

The screen types on a smartphone mostly is touchscreen (73%) compared with the keypad is only 27%. The screen size of the smartphone mostly is 4 inch by 55%, the 5-6 inch size by as much as 24% and 21% of tablets. It shown on Table-2.

Table-2. Screen size.

Screen Size	Frequency	Percent	Valid Percent	Cumulative Percent
3"	26	26.0	26.0	26.0
4"	29	29.0	29.0	55.0
5"	15	15.0	15.0	70.0
6"	9	9.0	9.0	79.0
7"	14	14.0	14.0	93.0
8"	7	7.0	7.0	100.0
Total	100	100.0	100.0	

The needs to get the expected route information exists on the smartphone application is very high, amounting to 92%.

From a wide range of features that are desired by the respondents, the most demand feature is the route as much as 63%. Followed by feature of landmark or public facilities amounting to 61%, features of the estimate costs by 50%, and features of alternative route by 48%.

From the samples data, respondents have devices with various screen size. In order that the application can works on devices with various screen, some library codes are available. But that library codes may lower the performance for low class of devices.

The majority of respondents are using smartphone having the size mostly 4 inch, and in general the smartphones in that size have low performance specification. Mostly the specifications are only suitable for chat, communications, email, and low requirement games. For that reason, the application have to be modified so it can also opened on all device with low specification. Because of the library codes could not be used for the application, it has to be replaced by using

basic JavaScript, html, css, and php codes. In addition, mostly the people who will using this application is not a person who has knowledge of a computer system, so that a simple design is the best.

The design of the client system shown in flowchart on Figure-3. Firstly, the users must choose what they want to do, whether want to look all ROUTE routes or directly get the direction. If they choose see all ROUTE routes, it will be shown all list of route of bemo nearby their current position. Furthermore they have to pick one from the list to see the route on the map. After the user selects one of the routes (LYN) to watch on the map then the server will process the street name passed in the route which would then be converted into OpenStreetMap and the end result will appear as a map that shows the path through all the way from LYN selected.

But if they want to get the direction to their destination, then they must choose one point of interest available in the server database. Another screen will be shown to the user where the user is required to enter the name of a place you want to target. After that name will be used as a keyword to display a list of points of interest that exist on the server. After that, the user must select one of the points of interest to be used as a destination point to go.

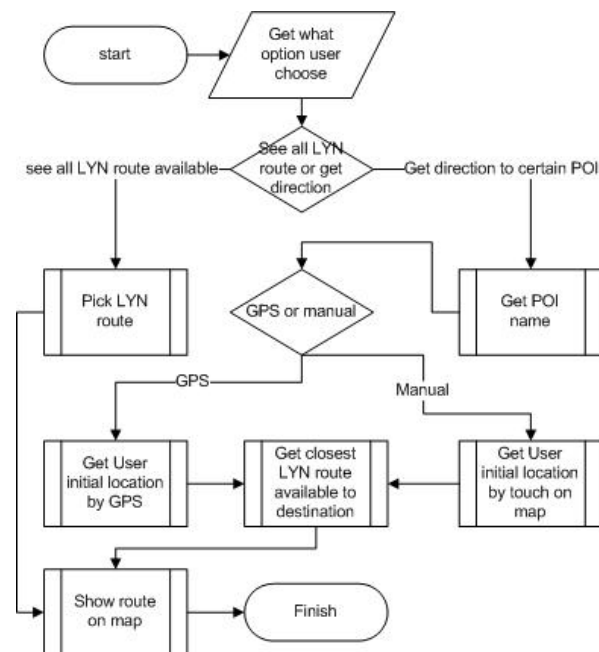


Figure-3. Flowchart of the client system.

Once the user has selected the place to go then the application will search for the user's position now. To search for the current user position using the application in two ways, namely by GPS or selecting a starting location in the map view. If the user's mobile phone has the ability to use GPS then the application will use GPS to set the current user location, but if the phone user does not have



GPS capability, the user can directly specify the location on the map, simply displayed.

Once the application has a current user position and the position the user's destination, the applications have had a two-point that can be connected. So both positions will be sent to the server. For the first calculation, the server will look the routes closest to the user's position. Now the route will then be included as the first track to the next route connected with another route that would eventually get to the point of interest.

The closest route found by comparing the distance between user initial location and all route available using haversine formula. In this research, the haversine formula is used to calculate the shortest distance from the initial position of the passenger of bemo to reach the final destination of the passenger.

Haversine formula is used to calculate the shortest distance between two points on the spherical surface of the latitude and longitude of the points. Although the earth ellipsoid-shaped and not round like a ball completely, haversine formula can still be used [9].

$$\begin{aligned} \Delta lon &= longitude2 - longitude1 \\ \Delta lat &= latitude2 - latitude1 \\ a &= (\sin(\Delta lat/2))^2 + \cos(lat2) \times \cos(lat1) \\ &\quad \times (\sin(\Delta lon/2))^2 \\ c &= 2 \times \tan^{-1}(\sqrt{a/\sqrt{1-a}}) \\ d &= R \times c \end{aligned}$$

Where:

d= distance in kilometers

R=6371 (earth radius in kilometers)

Since the target users of this research using a variety of screen sizes and devices, the design concept using Responsive Web Design[6], by using a measurement of the percentage instead of using pixels, so the size of the components can both adapt to a wide range of screens and devices types. For digital maps is used data from OpenStreetMaps [10] placed on the server itself, so it is easier to modify if there is a street name that is considered not true, while the retrieval of data from the server by the client supported by OpenLayers javascript library that can be displayed on the user's screen. The OpenStreetMaps system architecture is based on a distributed model consisting of a PostgreSQL database backend with a middle tier, called API 0.6, developed in Ruby on Rails. Large data imports and exports can be accomplished via a direct load with a tool called osmosis [11].

EXPERIMENTAL RESULTS

From the survey that has been done, there are 68 routes of bemo in Surabaya which are coded with letters for example: C, D, BM. The number of bemo terminals in Surabaya is 4 main terminals, and several sub-terminals. For example the route of BM is: the depart route: Terminal Bratang - Jl. Nginden Kota - Jl. Manyar - Jl. Raya Nginden - Jl. Prapen - Jl. Raya Jemur Sari - Jl.

Tenggilis Tengah - Jl. Raya Tenggilis - Jl. Tenggilis Mulya - Jl. Kendangsari Gg. Lebar - Jl. Raya Kendangsari Industri - Jl. Rungkut Industri - Jl. Raya Kutisari - Jl. Kutisari Utara - Jl. Kutisari Selatan - Jl. Siwalan Kerto Timur - Jl. Siwalan Kerto - Jl. Jend. A. Yani - Jl. Gayungan PTT - Jl. Gayung Sari - Jl. Gayung Sari Barat - Jl. Wisma Pagesangan - Jl. Menanggal Utara - Terminal Perumnas Menanggal (Final destination). The distance is 17, 7 km. The return route: Terminal Perumnas Menanggal - Jl. Menanggal Utara - Jl. Wisma Pagesangan - Jl. Gayungsari Barat - Jl. Gayungsari - Jl. Gayungan PTT - Jl. Jend. A. Yani - Jl. Siwalan Kerto - Jl. Siwalan Kerto Timur - Jl. Kutisari Selatan - Jl. Kutisari Utara - Jl. Kendangsari Industri - Jl. Kendangsari Gg. Lebar - Jl. Tenggilis Mulya - Jl. Raya Tenggilis - Jl. Tenggilis Tengah - Jl. Raya Jemur Sari - Jl. Raya Prapen - Jl. Barata Jaya - Jl. Manyar - Jl. Nginden Kota - Terminal Bratang (Final destination). The distance is 17, 6 km.

The testing of the responsive website was done using two devices, those are 3.5 inch smartphone and 7 inch tablet. At first time the website was accessed, it will display the screen like in Figure-4. There are two options to choose, there are 'Search bemo routes to destination' and 'See all existing route of bemo'.



Figure-4. Two options to choose.

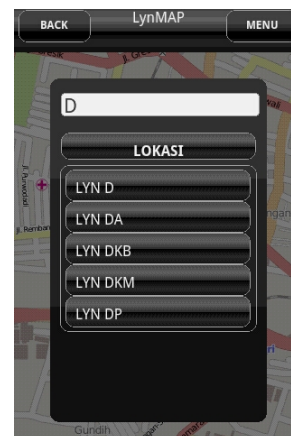


Figure-5. Alternative of bemo routes.

If the user selects the option 'See all the existing route of bemo', then the screen shows as in Figure-5. If the



user enters a particular letter or word and press the 'ok' then it will display a maximum of 5 routes containing these words or letters entered by the user. If user press one of the available button from the options then the application will bring up a page with a map of the selected route route like in Figure-6.



Figure-6. Maproute of one Route of Bemo.



Figure-7. 5 Point of interest.

If on the Figure-4 the user selects option 'Find route to the destination' screen will display as shown in Figure-7. If the user enters a particular word (i.e. MALL) and pressing the 'ok' button then it will display a maximum of 5 points interest containing a word entered by the user. Once the user selects one of the existing points of interest, then it will be displayed as in Figure-8.



Figure-8. Options automatically or manual.

Here the user is prompted to choose whether he want to select the starting location by GPS or selecting the starting location on the map using touchscreen. Once the initial location has been determined it will appear the route to be passed and the estimated costs to be paid as in Figure-9.



Figure-9. Information of routes.

On Figure-9 it was shown that the user originally was on the Nyamplungan Street and the user wants to travel to Ambengan Street. The first time the user is asked to go by Route A bemo. On the way he should go down from the Route A bemo on Tambaksari Street and walk to Kapasari Street to ride on Route B bemo. Next he has to go down of Route B on Tambaksari Street and walking to the destination on Ambengan Street.

When users want to see the resulting route they can press on the 'view map' button then it will appear the display as of Figure-10 on smartphone and Figure-11 on tablet.

CONCLUSIONS

Based on the experimental result, it proofs that the website of this research can be used to give the information of routes, maps, varying type of route of bemo using any size of smartphones and tablets without any difficulties. The display always be adjusted to the screen size of the browser. For 3.5 inch smartphones, there is a



little difficulties to touch the button because the screen size is too small.



Figure-10. The routes generated on the map (on smartphone).

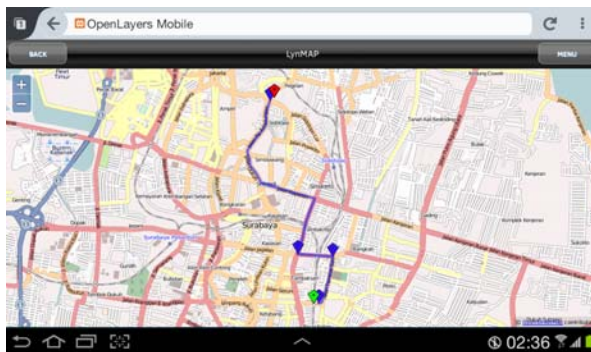


Figure-11. The routes generated on the map (On tablet).

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