Towards an integrated public transport system

D Allopì

Department of Civil Engineering and Surveying
Durban Institute of Technology, South Africa

Abstract

The Government of South Africa has recognised transport as one of its five main priority areas for socio-economic development and are currently seeking strategies to optimise capacity utilization and to achieve a level of integration between modes. However, the present structures of most of the cities are not conducive to the development of efficient public transport systems. Sometimes, expensive infrastructures were constructed in certain areas without proper planning. Chatsworth, one of the major suburban areas of the city of Durban, is a typical example of such kind of planning. A substantial percentage of the commuters still rely mainly on public transport provided by privately owned buses and minibus taxis. However the main problem remains that they are reluctant to use the expensive metro rail service. This paper focuses on the development of a prototype model following the methodology based on data flow diagrams.

1 Introduction

One of the strategic objectives of the Government of South Africa as reflected in the White Paper on National Transport Policy (Department of Transport [1]), is to promote the use of public transport with the goal of achieving a ratio of 80:20 between public transport and private car usage, as a long term vision. In view of the high car ownership and usage in most of the South African cities, this is no easy task to achieve and an in depth analysis of the current transport situation is required. Major cities are scattered and the suburban areas are quite far off from the city centres with just one or two major connecting links. Chatsworth, a major suburban area of the city of Durban, is a typical example. The vehicles on Higginson Highway (M1), the only major access road from this area to the Durban CBD, operate at capacity during peak periods. Volumes in excess of 4800 vehicles per hour have
been recorded during the morning peaks (Durban Metropolitan Transport Advisory Board [2]). This has resulted in the public demanding for the construction of a second access road to the area. Chatsworth is also connected to the CBD by a surface rail system which is operated by metro rail. Since the area is inhabited by people of different income groups, a substantial percentage of the commuters still rely on public transport. Surprisingly, the patronage on the rail service is extremely low when compared with bus and minibuses and is gradually decreasing. The recent status quo report (Traffic and Transportation Department [3]) indicates a potential growth in capacity of 265% for metro rail on the Durban-Chatsworth line. This is a unique case of under-utilization of existing infrastructure when, on the one hand, there is a demand to construct a new access road and on the other hand, an expensive rail system remains almost unused.

Improper land use planning and the alignment of the rail in relation to the residential dwellings are two important reasons for the decline of the rail system in Chatsworth. It has been estimated that less than 5 percent of the residents live within 500m of a railway station, highlighting the lack of accessibility (Allopi & Sarkar [4]). Also, the parking facilities at the stations are inadequate and unsafe which discourage the commuters from “park and ride”. Moreover, bus and minibus services from the residential areas to the railway stations are inadequate.

A study was carried out to establish deficiencies in the existing transportation infrastructure and services and the response of the commuters revealed that the distance to the rail station and inadequate safety were the primary causes for the under-utilization of the metro rail system (Allopi & Sarkar [5]). The study identified the lack of access, lack of convenient ticket sales offices, restricted hours of ticket sales, inadequate and poor facilities/infrastructure and limited services as the other contributing factors. With regard to the commuter survey, it was interesting to note that 80% of the present car users indicated that they would prefer public transport if the existing conditions were improved (Allopi & Sarkar [6]). The factors that they considered most important to be improved on rail service included: security while travelling, improved frequency of rail and minibus service from their locality to the main station. It was quite evident from the analysis that the present rail users showed greater discontent with the level of service in comparison with bus and minibus commuters.

To encourage commercial and residential development along the rail corridor is one of the long term solutions to increase the accessibility. However, in the short run, the integration of the rail system with the road based modes may be the only possible solution to increase the utility of the rail service in Chatsworth. A methodology based on data flow diagrams was proposed to integrate rail with the minibus services (Powers et al [7]). It was found that the minibus association operated on the inner circle route (greater Chatsworth area) and recently allocated a small percentage of its fleet to the Durban CBD route which resulted in conflict with the bus association. Interviews conducted by the author with the Chatsworth Minibus Association with regard to the formation of a partnership with rail to provide a feeder service to the stations proved promising and positive. The South African Rail Commuter Corporation (The authority responsible for train services in
South Africa) supports an integrated public transport system. It was therefore
decided to look closely at this option and to formulate an integrated system between
the minibus association and rail services. A methodology was presented for
developing a computer simulation model for the operational analysis of minibus and
rail integration. Through a structured analysis technique called data flow diagrams
(DFD), a graphical representation of data processes throughout the organisation for
an integrated system was presented (Allopi & Sarkar [8]). This paper focuses on the
development of the prototype based on the methodology suggested.

2 Development of the prototype

2.1 Overview

The model developed provided the user with an overview of data movement through
the system, adopting a visual perspective that was unavailable in narrative data.
However, there was scope to look at a more practical solution by expanding on the
integration technique suggested.

Considering the human and financial resources available and the constraints on
time, it was not possible to go for a full scale model. It was therefore decided to
develop a prototype model following the methodology based on the data flow
diagrams. Prototyping can be classified as a modelling approach which emphasises
the creation of abstract description of a software system in order to answer questions
about the system. The emphasis is on the determination of the feasibility of a
proposed solution before investing in the large scale development of the target
system i.e. the intention is to go a step closer to the pilot program by developing a
prototype model program. The prototype system fulfils the most important
requirements of the user in an undetailed way, in a relatively short time by using
tools such as screen generators. The user will be able to determine from the input
and output screens as to whether his or her needs are being met by the software thus
avoiding expensive programming. It should be highlighted that even if the resources
were available to build the entire system, problems may arise if refinements
or changes are needed. The cost implications at this stage could be astronomical. By
building a working model of the system (prototype) as initially envisioned by the
user, the user could work with this model, suggest changes and have these changes
quickly incorporated into a revised working model. It should be further noted that
the prototype is not a toy but a functioning system or subsystem doing real
processing with which the user can interact.

2.2 Prototyping as a solution

One way of minimising any kinds of risk is to construct a prototype which can then
be tested to determine whether it is worthwhile to develop the actual system.
Prototyping can help when the user is unable to visualize how the proposed system
will work. It triggers user reaction and therefore serves to introduce an element of
communication and feedback. The purpose of the prototype is to enable the client
and the developers to agree as quickly as possible on what the product is required
to do. What is of importance is that this experimentation will help achieve user
friendliness, a vital objective of all software products. The visibility of screen flow
which is an essential feature of a prototype allows the user to follow a function
which makes the checking of function proposals so much easier. It further
encourages earlier appreciation of a proposed system and also makes it easier to see
the consequences of a proposed change. The first step in the prototyping process
model is to build a prototype and let the client and future users interact and
experiment with it. Once the client is satisfied that the prototype does most of what
is required, the developers can draw up the specification document knowing the
clients real needs.

The development of a prototype with input/output screens to final specification
will include:

i) The analysis of existing data flow diagrams in relation to screens.
ii) Structuring of input/output screens.
iii) Programming of input/output screens.
iv) Implementation and testing of screens using set test data.

2.3 Tools and procedure used in the development of the prototype

It can be summarised from the information previously covered that the main
objectives of the prototype include:

i) Minimizing risks involved in the development of the full system.
ii) Assisting the user in visualizing how the proposed system will work.
iii) Providing the means of building a trial version of a software system in a fast,
economical and effective way.
iv) Determining whether it is worthwhile to develop the actual system.
v) Determining whether the needs of the user are met by the software thus avoiding
expensive programming.

The data flow diagrams were used in the development of the prototype. However
it should be noted that the development of the prototype required the explosion of
some of the processes. The development of the complete system would require all
processes to be exploded.

In the prototype, the conventional punch card ticket was illustrated as an output
that would be used for the control of the integrated system. It was decided to go for
a single or common ticket system where the fare is paid once, regardless of vehicle
and mode changes. In this case, a common ticket was proposed in order to gain
access to the minibus taxi and rail systems. This will avoid the wastage of time in
taking separate tickets for travel to use both the modes. The punch card ticket will
have the necessary information such as the taxi boarding point, origin and
destination rail stations and whether the ticket is valid for a single, return or weekly
trip. Provision was also made on the ticket for both public transporters to verify
usage by punching the ticket in the appropriate grid or space.

Other options with regard to the type/format of the ticket include:

i) A simple plastic card that is valid for a certain period as specified/ reflected on the
card. Commuters are entitled to any number of trips for the valid date range. The assumption is that most commuters would use the ticket for an average of ten trips per week. This system would require constant monitoring and could lead to abuse by the operators and/or the commuters.

ii) Smart Cards: These are similar to telephone cards incorporating the latest technology and have a built-in chip. Each time the Smart Card is swiped at a taxi or train terminal/entrance, the available amount on the card is reduced. The control of fraud and system security are inherent in the design of the smart card system. This option would require the installation of smart card readers, a highly versatile electronic ticketing or validation system, which can be specifically designed for use on minibuses and rail systems. It is designed to reduce the need for cash handling and speed-up passenger movement. The smart card facility could also allow for the provision of a "black list" for lost or stolen cards and cards could also be retained under software control. This system, although more expensive, will offer improved efficiency and a friendly and beneficial service to commuters without detracting from operational efficiency and management planning.

The server would be based at a central position (Chatsworth Centre) with terminals located at each of the five stations in the area. The server and terminals will be connected by means of a dial up WAN (Wide Area Network). Every evening, say at 20H00, the terminals would download the daily data to the server in order to consolidate the number of tickets sold.

With the smart card option, each station would require card readers installed at access points. Commuters would be required to swipe his/her card, which would increment a counter, update the swipe card, activate the turnstile and allow commuters access onto the platform. Each taxi would also be fitted with a card reader that increments a counter and updates the smart card.

2.4 Development of the prototype

The prototype was developed around the option of using the integrated public transport system (minibus taxi and rail) since this was the main purpose or focus of the exercise. A host of ticket options ranging from a single to a yearly ticket were included in the input screen. For the purpose of demonstration, the first three options were included in the prototype (single, return and weekly ticket). The default was set on Bayview station as the origin/boarding station. The destination stations were set on Merebank, Clairwood and Durban for the single, return and weekly ticket options respectively. With regard to the taxi route, three nodes on Pelican Drive (Pelican/Turnstone, Pelican/Skylark, Pelican/Liberty) were considered as typical stops leading to Bayview Station. The system was designed on the assumption that both the taxis and trains strictly follow the time schedule. However, a buffer of 10 minutes was allowed between the arrival time of the taxis at the station and the departure time of the train. Adjustments would obviously have to be made from time to time to cater for the demand on various routes. A commuter wishing to use the system would indicate his/her choice of ticket (single, return, weekly), origin and destination of travel.
The cost of the ticket and the necessary travel information such as taxi node/stop, taxi and train departure times are given to the commuter. Upon payment, a printout of the ticket is handed to the passenger. The prototype also allows for a printout of the complete schedule reflecting the integrated timetable, if the commuter so requests for a detail schedule. It is anticipated that a detail schedule will be requested for at the initial stage or commencement of the integrated system until such time commuters become familiar with the timetable. A copy of the program was made available on disk.

The financial implications of carrying out a pilot project in the area was also investigated. The approach considered most logical and appropriate was to look at the two “extreme” options namely, the integrated ticket and smart card system. It was further agreed to estimate the cost of conducting a pilot project using one of the stations in the area as a test case and allocating a maximum of fifty taxis to the integrated system. The cost of a full scale pilot project taking into account all five stations and the full commitment from the taxi association in the area could quite easily be determined or estimated from the “base” calculation. Based on the hardware, software and implementation cost, a total of R160 000 was estimated for the ticket system and a total of R320 000 was estimated for the smart card system.

3 Conclusion

Although the smart card option appeared to be much more expensive, this highly versatile electronic system would certainly control fraud and prove to be much more cost effective over the long term. It should be noted that the prototype is to be used as a requirements analysis technique, that is, as a means of determining the client’s real need. Thereafter, written specification documents will have to be produced using the prototype as a basis. The technique adopted will make it easier to proceed with the development and refinement of the prototype until it becomes the product. This approach is therefore a viable technique that can lead to fast software development since the knowledge built into the prototype could be easily converted into the final product.

References


