A method for measuring bus patronage to address the needs of the 90s

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Abstract:

Transit operators in all parts of the world seek accurate measures of patronage on their systems to aid in management strategies. These measures have been obtained by methods ranging from kerbside estimates to the use of electronic information from automated fare boxes.

This paper briefly reviews previous methods and proposes a simple new method of accurately finding ridership. A matrix of trip origin destination stops is obtained, by an on-bus survey procedure which links them with boarding-alighting times. The journeys are also related to trip purpose, ticket and socio-economic characteristics of passengers. This is the type of information needed by operators to meet the challenges of the 90's.

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Introduction

Transit operators in all parts of the world seek accurate measures of patronage to aid in management strategies. Passenger kilometres, the distance actually ridden by passengers on the system, has been widely adopted as an appropriate measure. Since 1977 the Urban Mass Transit Administration in the U.S.A. has required American transit systems, receiving federal operating assistance, to provide passenger miles as one of three required measures of service consumption (U.S. Department of Transportation, Urban Mass Transportation Administration 1977). A variety of methods has been devised to obtain this measure and a considerable body of literature has been built up.

Almost all methods are applied to a representative sample of bus journeys, by route, type of service, time of day and perhaps season of the year and expanded up to the total population of bus travellers for the year. Even if data is available from automatic devices, it is usual to analyse selected data not the whole body of data. Thus in all cases correct sampling strategies and sensible stratification of the sample must be applied for accurate results to be obtained. Conversely good techniques may allow results from relatively small samples. It is not necessary to intercept every bus traveller on every day (Stopher,1983).

The primary concern of this paper, however, is with the initial task of finding answers for the representative sample. It will be suggested that simple aggregates of passenger kilometres are insufficient. Patronage measures should also address the questions of who the patrons are and exactly where they are travelling on the system, if they are to provide the information needed for transport planning in the future.

Current methods for measuring bus patronage

How many riders

Bus passenger kilometres have been calculated using a variety of methods (Attanuci et al,1982)

* kerbside load checks at points on the side of the road

* counters attached to the fare box with which the driver is required to log boarding passengers
* ride checkers on board the bus who note boarding and alighting passengers
* automatic passenger counting devices such as light beams and pressure pads
* direct use of fare box receipts and automatic ticketing machine information
* on board passenger surveys

There are some deficiencies in each of the methods and choice of method is often dictated by the opportunity to simultaneously obtain other information of value to the company.

Kerbside counts : Kerbside counts or point counts taken as the bus passes a fixed location can be, at best, only estimates of loads and often can't distinguish between even adult and child passengers However the checkers can also monitor running to schedule, and give a quick response to the need for another bus to satisfy unexpected demand, and so are widely used.

Fare box counters : Counting devices attached to the fare box save money as the information is collected by the driver so no extra staff are needed. They have the additional advantage of allowing the counts to make fine distinctions amongst passengers by fare type and / or age. Up to ten buttons can be used by the driver to register boarding passengers in categories such as travel pass, school pass, cash fare In practice, however, these devices result in an undercounting of passengers, as most drivers quite properly see their primary task as driving the bus and serving the passengers rather than counting them (Koffman & Nygaard,1989).

Ride checkers : Staff riding the bus with the dedicated task of counting passengers will miss fewer passengers but will have greater difficulty distinguishing fare types. The effectiveness of ride checks is also diminished in crowded buses with frequent boardings. The ride checks will be carried out less frequently than point checks but may be economically updated with point check data (Furth,1988).

Automatic counting devices : Light beams or pressure pads to register boarding and alighting passengers give complete loadings at all points on the bus route and work equally well on a crowded bus, within the limits of machine tolerances. If boarding behaviour can be controlled sufficiently to prevent passengers boarding exactly at the same time accurate passenger kilometres can be obtained.

Who are the riders

There would be no need to look for any other method if bus passengers could be viewed as equivalent interchangeable units. However this is not true, different passengers have different revenue implications, in the simplest example children are usually carried at half fare and infants are carried free. For marketing purposes, as advertising strategies move towards targeting specific groups, companies want to distinguish between passengers. Moreover governments in the future will require information on specific groups, such as elderly passengers, for social costs estimation in considering subsidies.

Similarly specific journey information may be required. One passengers alights, did he board at the previous stop or at the beginning of the trip? The relationship between fare and journey length is often not linear, lower per section fares may be charged in the final parts of long journeys. It may also be useful to understand common origin destination choices for proper transit planning Perhaps the crowding on one section of a route might be alleviated by diverting a bus to cover that section, but that solution would only work if a significant number of passengers had journeys confined to that section

Fare box and Automatic ticket machine information : If every one either bought a cash fare or used a form of ticket which was registered in some way on boarding, such as the Metro Ten used on the State Transit Authority buses in Sydney, which are valid for set journey sections and must be stamped in a ticketing machine, this information could be obtained from the fare box and ticketing machines. However many people use various forms of travel pass such as weekly tickets, combined train/bus/ferry passes, pensioner passes and school passes. In this case, the only way to collect this level of information is via an on-board survey. In fact the spread of pre-paid(off-bus) ticketing has increased the need for survey work (Savage, 1989).

On-board bus surveys

There are two possible alternative mechanisms, either an on-board interview or a self administered survey form. Interviews are difficult on crowded buses so self administered forms are more often used. The form is either completed on the bus or mailed back or in some cases both. Two part forms combine a short on bus form with a longer form for reply by prepaid mail. Obviously the amount of information which can be obtained during a short bus ride will be limited. However a two sided A4 card can provide a wealth of data if clear questions are combined with careful form design. For instance it is easier for the passenger to tick boxes than write answers.

The advantage of the form being completed during the journey is that it is more easily retrieved giving a better response rate. This is important because one of the major criticisms of surveys as a means of collecting transit information is that they produce biased estimates due to non-response. Brog and Meyburg(1981) have shown that response rates as high as 90% can still result in biased estimates. To more easily measure non-response it is better that all passengers on any surveyed trip are offered forms, this also saves the practical problems of keeping mental counts to sample each fifth passenger or needing to answer the complaints of "why me , not him?"(Stopher,1983).

Obviously surveys have been used to obtain a wide variety of information of interest to the bus companies but this paper concentrates on obtaining passenger origin and destination data, and relating this information to ticket type and the passengers socio-economic status. The terms origin and destination are used to describe two different concepts. In one definition they can describe the place where the traveller's trip begins, the production site and the place where the trip purpose is satisfied, the attraction site. If this information is required in detail the only way to get it via a survey which asks the passenger.

However very often such detail is not really needed. To know that the passenger is going to work in the CBD of a city may be sufficient description of his attractor. Or the transit operator may be more interested in the finding the bus stops, where passengers board and alight, rather than their initial origin and final destination In theory this bus stop information might be obtained by ride checkers monitoring each passengers boarding and alighting but in practice this is impossible on busy bus routes.

Seeking origin-destination information from passengers is difficult. Bus stops do not have unique identities like train stations. Even if we exclude the type of passenger who gets on "near home" and gets off "near Aunty's", those who do their best to name

nearest cross streets often choose a different one to that marked on the transit operators bus stop location sheet. Perhaps for the simple reason that they walk east from the stop and name the next street east, whereas the list quotes the nearest street to the west. Thus to translate this information into a form suitable for computer analysis considerable hand editing of survey forms using maps is needed.

Another approach uses numbered survey forms handed out in sequence order. The survey officer, distributing forms to passengers boarding, is asked to note on a log form the sequence number of the first survey form handed out at each stop and a stop identifier location or number, on a log sheet. This method works well when the bus is not crowded and the stops are well defined and infrequent. However in a bus stopping every 200 metres, with passengers boarding frequently, the logistics of the exercise requires the survey officer to combine wonderful concentration with the skills of a juggler, writing sequence numbers whilst simultaneously handing out forms and pens. This obviously increases the chance of mistakes being made. If you wish to apply a similar logging system to alighting passengers a second survey officer is needed stationed near the back exit of the bus to collect alighters survey forms and bundle them in some manner, according to stop. The second officers task is far simpler than that of his colleague at the front, especially on Sydney buses where passengers are permitted to alight from both back and front doors.

A new survey design

The setting requiring a new method

The Transport Research Centre was asked by the New South Wales State Transit Authority's South & West region to undertake a study of passenger travel on the routes in the region. STA South &West operates 410 buses, out of 3 larger and 2 smaller depots, over 52 routes, in 24 route clusters, where a cluster is defined as a set of very similar routes, often identical except for minor diversions. We were required to specifically sample all routes in the system rather than choose a subsample, and the routes were to be surveyed from terminus to terminus, to monitor travel behaviour in all parts of the route. The sampling unit of interest here was the bus passenger rather than the individual bus

ride. That is we wanted to discover the passengers' overall pattern of bus travel on that route. If we found the passenger made this journey ten times per week to and from work we were able to obtain ten observations of weekly travel on the route rather than one.

The character of both the buses routes and the population in the region prompted the search for a new survey method.

Frequent stops and crowded buses : In parts of the region bus stops are located only 100 metres apart and the peak buses are frequently crowded with standees making filling in log forms difficult.

Limited English : In addition the region has a significant concentration of bus travellers with limited English, but as they come from diverse countries providing each with a form in their own language is impractical.

Elderly : There is also a greater number of elderly people compared with Sydney as a whole. These passengers often have eye sight difficulty in reading the printed form.

High passenger turnover : Many routes in the area carry passengers on short trips and there is a high incidence of complete load renewal on the buses, as the bus fills with passengers to alight at the first railway station on the route and then refills with passengers for a second station. This makes survey conditions far more difficult than on commuter buses bringing passengers from outlying suburbs to the city centre.

The classic dilemma facing all on board bus surveys, of trading off the need to obtain as much information as possible against the passengers ability to fill in the form during the bus journey is exacerbated. A design was sought which addressed all these difficulties. It uses the *times* that the passengers get on and off the bus.

The survey method

We used two survey officers for each run but aimed to simplify the tasks required by the survey officer handing forms to boarding passengers so they would be able to concentrate on sympathetically encouraging response. We limited the task to handing out survey forms and pencils. The forms are sequence numbered but instead of writing down the sequence of the first form given out at each stop the number on the form is circled for noting at data entry. The sequence number of the first form handed out at the stop was then retrieved in the analysis stage. The officer is also required to immediately set aside any forms refused in keeping with proper sampling practice.

In contrast the second survey officer's tasks are made more complex. At each stop he collects the forms as the people get of the bus. They are put into a snuggly fitting box. After the last form from that stop is collected, including any handed in at the front, he drops in a divider form on which he has filled in the time, section and where the bus stop is, cross street or landmark. Back at the office the time and section can then be coded onto the survey forms which follow them. The very first question on the survey form is "what time did you get on this bus?" Since we know the time the bus was at each bus stops from the divider sheets we can tell *where* each passenger got on from *when* they got on.

This method is very successful if carried out by intelligent people who care about the job. It is not that the survey officers have a difficult things to do just that they have to understand what they are doing and why. The two key requirements are

* that the forms must be collected at the stop where the passenger gets off. This sounds simple but in practice many passengers need to be cajoled into retaining their completed forms until they alight. If they cannot be deterred from handing the form back early, their destination data is lost.

* that they are handed out in sequence order so that if the passenger with form number 1429 doesn't say what time he boarded the bus but the people with forms 1428 and 1430 both said they got on the bus at 8.25am we can assume he did too. This second requirement means that the officer must be extremely careful, when taking extra forms from his supply, that they are added to the bottom not the top of the bundle in his hand.

A by-product of the method is a set of stop arrival times which can also be used as an indicator of service reliability.

Conduct of the survey

The fieldwork was carried out over 4 weeks in May / June 1990, and approximately 11,000 passengers were surveyed on 50 routes in the region. STA South & West intend to build up the capability of performing their service monitoring "in-house", thus the survey was administered by STA officers with supervision from National Survey Research Pty. Ltd. The officers chosen were newly appointed revenue inspectors, who volunteered for the task. Their training consisted of a thorough explanation of theory behind the method as well as instruction and practice in the physical requirements. They

understood they were linking time to place in the survey and carried their task out very diligently, despite finding the work demanding. They worked in a similar shift pattern to their normal duties, either in 7 hour straight shifts with a meal break, or in split morning / evening shifts, riding buses on selected routes terminus to terminus. We surveyed services ranging from 6am in the morning to late in the evening on weekdays and a selection of Saturday and Sunday services.

A combination of the authority carried by an inspectors badge, as the officers handed out the surveys, and their efforts to encourage respondents, resulted in an amazing 100% response on some routes. Those unable to fill in the form due to language difficulties, were either helped to provide the most vital information or minimally asked to hold the form until they alighted, so that their origin destination information could be obtained.

This paper was written just as the field work was completed so that only preliminary analysis of the responses has been made, although it is quite clear that the method is a successful means for obtaining accurate origin destination data under difficult conditions. The information needs minimal hand preparation for data entry and an accurate matrix of trip origin destination stops is obtained, meaning that the viability of options, such as express services and interchanges, can be examined. This level of information is obtained for nearly 100% of passengers.

In addition there was a high level of response to questions of type of fare, adult, concession or child and type of ticket or travel pass. Information about gender, age, journey purpose, work pattern and home postcode allow us to build up a picture of who goes where on the buses in the region.

Conclusions

Technology for automatically counting passengers is now widely available and it can be expected to decrease in price and spread throughout the bus industry in the 90's. However a corresponding rise in off-bus ticketing can be expected. Operators will seek to attract passengers with travel pass discounts. Moreover, the use of travel passes limits the boarding delays which result in buses running behind schedule. Together with frequency of service, reliability has an important influence on passengers satisfaction with a bus service. Thus on-board surveys will still be required to estimate patronage.

It is fortunate that surveys will continue for calculating passenger kilometres because they can be used to link the passenger with the journey. This gives a much more useful description of patronage, which will allow companies in the future to consider market segments, in line with new management practice. The information will also allow governments to address questions of social needs.

The new design for obtaining passenger origin-destination data proposed here is eminently suited to the conditions on buses in Australian cities in the near future, at least. We can expect a multi-cultural population with difficulties with the English language. The percentage of elderly people is expected to increase. And, as the cities grow, crowding on peak bus services can be expected. The growing desire for information to be obtained without delay can be satisfied, as the simple method eliminates time consuming coding of origin-destination data on each survey form.

On all public transport modes in the 90's we can expect to see a greater recognition of the needs of individual passengers, or groups of passengers, in response to market demands. The survey method presented here can provide the disaggregate bus patronage data that will be required.

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