USE OF PUBLIC TRANSPORT IN TOWNS AND CITIES OF BRITAIN AND IRELAND

By Peter R. White

It is well known that there has been an overall decline in trips made by public transport in urban areas. Municipal operators in the United Kingdom carried the following numbers of passengers:

<table>
<thead>
<tr>
<th>Year</th>
<th>Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1937–38</td>
<td>4,700 million</td>
</tr>
<tr>
<td>1950–51</td>
<td>7,000 million</td>
</tr>
<tr>
<td>1959–60</td>
<td>5,700 million</td>
</tr>
<tr>
<td>1968–69</td>
<td>4,200 million</td>
</tr>
</tbody>
</table>

Data on trip lengths is not available, but average trip length has probably increased. For example, successive annual returns for some municipal operators have shown a decline in trips made, but an increase in revenue, although fare scales were unchanged. In London, where annual estimates are made of passenger miles, these have shown a slower rate of decline than numbers of trips. The causes are not hard to seek: very short trips have been discouraged by lower frequencies, irregular running, and high fares for short distances. In many smaller towns new estates produce a substantial demand for longer-than-average trips, even if frequency of trip-making declines.

This overall trend correlates closely with rises in car ownership and fare levels. For a sample of ten operators, either car ownership or average fare paid gives a correlation of about −0.9. Using both as independent variables in a regression equation, we can obtain values of the multiple correlation coefficient ($R^2$) of up to 0.99. Details are given in appendix A. Car ownership is the more satisfactory explanation, since the main decline is known to be in evening/weekend travel. It is noteworthy that similar high correlations can be obtained for the city of Göteborg, Sweden, where public transport has maintained a strong position despite very high car ownership levels. Thus, we can speak not only of the correlation between public transport trips and car ownership, but of different degrees of response in different areas to increases in car ownership, dependent upon managerial and planning policies for public transport.

Attitudes toward public transport in urban areas have changed markedly in the

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*Polytechnic of Central London. This paper is based on one read at the annual conference in January 1972 of the Universities Transport Study Group.

Land use-transport studies and similar surveys from which data has been extracted are listed in Appendix B. The annual municipal trading results published in the Bus and Coach supplement of Motor Transport have proved of great value. Thanks are due to my colleagues Alan Jessop and Steven Lowe for assistance in computing, and to Alan Moran for permission to quote results of regression analyses.

1At Lancaster, for example. See Lambden, W.: "Things are looking up at Lancaster". Bus and Coach, Sept 1969, pp. 236–329.
past two years. From its role as a residual mode for those unable to own or drive cars, public transport has come to be accepted as essential if present patterns of city life, especially journeys to work in town centres, are to be maintained. Congestion is most acute in the largest cities, where public transport remains at a high level. Its essential role for the work journey is accepted even in the USA; but, stemming from this approach, there has been a tendency in Britain to understate implicitly the role of public transport both for non-work journeys and in smaller urban areas. Since it is largely the off-peak journeys that are profitable, this planning approach could be unfortunate for the viability of public transport (and hence its ability to meet without extensive subsidy the peak travel needs implicit in many transport plans). It would also be unfortunate if the role of public transport in smaller towns and cities were to be ignored simply because in them it carries a smaller share of work journeys,2 and in other countries (particularly the USA) is known to have a smaller share of total traffic, than in the conurbations. It is my intention in this paper to show that public transport has in some respects (notably profitability) been more successful in the smaller towns and cities.

It would be reasonable to deduce from the dependence of large city centres upon public transport, and their apparent high rates of usage, that total passenger trips on public transport should show a slower rate of decline in larger cities. However, this has not happened (see Tables 1 and 2).

There is very little variation by size of urban area, save for the distinctly better performance in Table 2 by the 100,000 to 149,000 group. Table 2 excludes the Isle of Man and Ireland; it excludes also operators who ceased or were taken over by companies during this period, operators taken over by Passenger Transport Executives, and operators whose catchment areas are not defined by local authority boundaries. All data refer to municipal operators: where a municipal operator serves the areas of local authorities other than its own, the total population served has been calculated. The use by some operators of ticket sales as a measure of total passenger trips can result in some bias: it would be desirable to regard the figures in Tables 1 and 2 as subject to a range of error of about ±10%.

The lowest values are generally in the range of 130–150 trips per head, typified by isolated towns such as Lincoln. The most recent trends3 (for the largest operators) indicate a stable level of use in Leeds and Edinburgh but rapid decline in Glasgow. The Passenger Transport Executives have recorded a poor performance in general: SELNEC, Merseyside and West Midlands suffered a decline in passenger trips over the period 1970 to 1972 inclusive of about 15%. Tyneside PTE, which carries fewer passengers than Leeds or Edinburgh municipal fleets, has regained a small traffic loss made in 1970–71. The remaining municipal operators have averaged a decline

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2Data for modal split of work journeys from the 1966 census, by size of urban areas over 200,000, is given by D. Elyes and C. J. Spiller [1].

3Full details for municipal statistics for 1970/1 and 1971/2 with a commentary by the author of this paper appear under the title “Expenditure increased but deficits reduced” in Motor Transport (Bus and Coach supplement), 2 March 1973, pp. 20/21. Data for PTEs is similarly reviewed in “Are the PTAs a success?” Omnibus Magazine, July-August 1973. Projections for the period to 1981, based on assumptions about the effect of car ownership (a secular decline of 1% per annum), fare increases (elasticity of 0.3) and vehicle mileage reductions (elasticity of 0.7), are given in Public Transport in Urban Areas, published by the Society of County Borough Treasurers, 1973.
of about 3 to 5% per annum over this period. For 1972/73 some operators, such as
Southport, report a negligible passenger loss or even an increase over the previous
year. This is largely due to a stable labour situation and national price restraint: the
latter, however, has resulted in some financial deficits. The National Bus Company
recorded a 10% traffic decline in 1970, but reduced this to 2% in 1972. Its best
performance so far is little better than average trend for municipal operators.

The highest levels of usage are to be found in Tyneside, Edinburgh, Leeds and
Glasgow, at around 330 trips per head per annum including an estimate for local
rail travel. If BR trips are included, public transport trips per head in London were
about 460 in 1960–61, and 350 in 1971. This rate is slightly higher than for the other
cities just mentioned, but it must be remembered that many more trips in London

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consist of linked bus and rail, or BR and LT rail, trips. The latter may be covered by through seasons, but the former will appear as separate trips in the annual total. In a large provincial city a typical passenger takes a through bus service to the centre, but a substantial proportion of London passengers use bus feeder services and then rail to reach the central area. An exaggerated estimate is thus likely to result, and within the limits of accuracy of the data it is reasonable to assume that the effective trip generation rate for London is no higher than for Edinburgh, Leeds or Glasgow. However, London is exceptional in that the average public transport trip is longer than the average car trip (this is due to the rail feeder element and to high use of cars for intra-suburban trips): the reverse applies in other cities. In terms of passenger-miles, therefore, public transport may account for a higher share of all motorised travel (i.e. travel by rail, bus, car, taxi and motorcycle) in London than in other large cities. The annual trip rate in PTA areas is difficult to determine, because of the continued importance of company operation. However, for SELNEC, Merseyside and West Midlands a figure of about 250 would be a fair approximation.

These absolute levels of public transport usage in Britain are the highest in Western Europe and North America. East Europe (an extreme case, with very low car ownership and high population densities) reaches 900 trips per head in some cities. A level of 70 is typical for bus travel in major U.S. and French cities [3] and even those cities where public transport is “successful” use display trip rates well below those in Britain: Toronto, for example, has a current trip rate of 150 per head per annum [4]. The absolute rate of usage is higher in larger towns and cities within Britain, although the variation—from an average of 225 in the under 100,000 group to 330 in the largest—is not as great as one might expect. When one recalls that a higher proportion of total trips in smaller towns is made by cycle and on foot (as shown in the 1966 work journey sample census), it is reasonable to suggest that the public transport proportion of motorised trips may be just as high in smaller towns and cities. The availability of land use-transport studies and similar surveys for the 1960s permits examination of this hypothesis: see Table 3.

Most surveys were carried out in the period 1964–67, and are thus broadly comparable with results from the 1966 census for work trips. The data for Northampton refers to 1962, and hence the role of public transport is slightly overstated. Areas are ranked in approximate size order, but definitions of some trip purposes (notably “business” and “social/recreational”) are apt to vary greatly between surveys. The 1971 Department of the Environment rural transport study for Devon has also been shown for comparison. Graph 1 shows the proportion of total motorised trips made by public transport—apart from areas above one million population, rail trips form an insignificant part of the total. This proportion has been adjusted to a common base year (1966), assuming a 5% per annum decline in public transport trips. Thus for a town with 50:50 public:private split in 1964 a figure of 45 is shown, total trips (i.e. including car) being assumed to remain constant within this short period.

A broad trend of greater use of public transport with size of urban area could be

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4Data on London modal split is conveniently summarised by A. C. N. Brown [2].
FIGURE ONE: PROPORTION OF MOTORIZED INTERNAL TRIPS BY PUBLIC TRANSPORT BY SIZE OF URBAN AREA, ADJUSTED TO A COMMON BASE YEAR OF 1966 ASSUMING 5% P.A. DECLINE IN PUBLIC TRANSPORT TRIPS WITHIN A CONSTANT TOTAL.

- Observed value (adjusted)
- Predicted value from regression
- Average company and municipal values for 150 per 1000 car ownership
- Average values for areas in four size groups derived by Vickerman from the 1965 National Travel Survey, adjusted to 1966 values.
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Table 3

Public Transport share (percentage) of Motorised (including Rail) trips, by purpose

<table>
<thead>
<tr>
<th>Area</th>
<th>All</th>
<th>Work</th>
<th>Shop</th>
<th>Business</th>
<th>Social-recreation</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devon</td>
<td>23</td>
<td>16</td>
<td>15</td>
<td>6</td>
<td>9</td>
<td>79</td>
</tr>
<tr>
<td>Worcester</td>
<td>32</td>
<td>31</td>
<td>46a</td>
<td>—</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>Cambridge</td>
<td>23</td>
<td>16</td>
<td>36</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Exeter</td>
<td>47</td>
<td>—</td>
<td>67</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Norwich</td>
<td>29</td>
<td>35</td>
<td>65</td>
<td>—</td>
<td>36</td>
<td>65</td>
</tr>
<tr>
<td>Northampton</td>
<td>57</td>
<td>48</td>
<td>82</td>
<td>52</td>
<td>61</td>
<td>80</td>
</tr>
<tr>
<td>Plymouth</td>
<td>53</td>
<td>58</td>
<td>75</td>
<td>37b</td>
<td>—</td>
<td>82</td>
</tr>
<tr>
<td>Coventry</td>
<td>39</td>
<td>44</td>
<td>70</td>
<td>19</td>
<td>33</td>
<td>77</td>
</tr>
<tr>
<td>Brighton</td>
<td>49</td>
<td>51</td>
<td>70</td>
<td>25</td>
<td>56</td>
<td>79</td>
</tr>
<tr>
<td>Belfast</td>
<td>45</td>
<td>58</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>Merseyside</td>
<td>54</td>
<td>59</td>
<td>62</td>
<td>47</td>
<td>46</td>
<td>76</td>
</tr>
<tr>
<td>Glasgow</td>
<td>72</td>
<td>73</td>
<td>87</td>
<td>57</td>
<td>67</td>
<td>91</td>
</tr>
<tr>
<td>London</td>
<td>60</td>
<td>65</td>
<td>62</td>
<td>25</td>
<td>42</td>
<td>74</td>
</tr>
</tbody>
</table>

* Including education.

b Including social-recreation.

derived from this data—a correlation of 0.6 is obtained when areas below one million population are examined—but other interpretations may be more realistic. The observations can be split into three bands: the lowest consisting of small towns in rural areas with company rather than municipal services; the highest of one city (Glasgow) with very low car ownership and high population density; and the numerous class of municipally-served towns and cities with a public transport share of 36 to 55 per cent. Within this centre band, very little evidence is apparent of a trend by size of urban area.

Car ownership levels for 1966 are shown on graph 2. It is clear that the sample of towns subjected to detailed land use-transport studies tends to have above-average car ownership, especially in the smaller range of population figures. This is not surprising—large cities have been the subject of extensive studies because of the acute problems and high investment involved in new road systems. In the smaller range, only towns with high car ownership would feel the need for major highway planning at an early stage.

Company bus services in towns have often been used to cross-subsidise rural bus services; they have therefore developed lower quality and higher fares than municipal transport, which is normally operated on a breakeven basis within each town. The comparative remoteness of company management from the needs of a small town within a large operating area may also have an effect. As smaller towns are less likely to have their own municipal undertakings, the result may be less favourable to public transport; but this is not due to size per se. The sample of towns for which detailed survey results are available unfortunately excludes small industrial towns with municipal services and also provincial cities (Bristol, Swansea, Stoke) with
FIGURE TWO: CAR OWNERSHIP BY SIZE OF URBAN AREA, ADJUSTED TO 1966 ASSUMING 8% p.a. INCREASE

* Survey data

X From 1966 census (average household size of 3.3 persons assumed)
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c company services. Passenger trips per head in Bristol for 1971 were about 145, a
figure which compares unfavourably with municipal data shown above, and,
assuming that a similar proportion of all trips are motorised, gives a correspondingly
poor modal split: about 35% for 1966. Its position on graph 1 (population 425,000)
would thus support the hypothesis that company operation is associated with a
lower market share for public transport. Car ownership in Bristol in 1966 was
quite high (graph 2), but was exceeded in Coventry and Leicester, comparable
towns with municipal services, also shown on graph 1.

A regression analysis was performed, with the following result:

\[ P = 50.6 + 0.000009 \cdot C + 14.4 \cdot D - 0.12 \cdot T \]

\[
\begin{align*}
(5.25) & \quad (0.000006) & \quad (2.71) & \quad (0.03) & \quad \text{standard error} \\
(9.64) & \quad (1.44) & \quad (5.32) & \quad (-4.1) & \quad \text{T-ratio}
\end{align*}
\]

where

- \( P \) = percentage of motorised trips by public transport (graph 1)
- \( C \) = population of the area (1971)
- \( D \) = dummy variable, taking value 0 if company bus service, 1 if municipal
- \( T \) = cars owned per 1000 population (1966).

A multiple correlation coefficient (\( R^2 \)) of 0.80 was obtained, all terms being
significant at the 95% level apart from \( C \) (population); this indicates its marginal
effect. It will be seen from graph 1 that the values predicted from this equation were
all very close to those actually observed, apart from Leicester (observed 54%,
predicted 45%) and Glasgow (observed 67%, predicted 56%).

The exceptionally low fares and high service quality in Leicester and the high
population density in Glasgow may be held accountable for these results. After
calibration of this simple model, data for the SELNEC area became available. The
model predicted a value of 45-5%, which corresponds closely with the actual value
of 48%. Similarly for Edinburgh 48-5% was predicted; the observed figure (adjusted
to 1966) was 51%.

With the same independent variables, an equation for trips per head of population
per annum (\( H \)) can be formulated:

\[ H = 402 + 0.000024 \cdot C - 1.5 \cdot T \]

\[
\begin{align*}
(76.2) & \quad (0.000007) & \quad (0.56) & \quad \text{standard error} \\
(5.3) & \quad (3.4) & \quad (-2.6) & \quad \text{T-ratio}
\end{align*}
\]

This is based on a sample of eighteen municipal operators only. After the calibration,
data from another operator gave an observed figure of 160 trips per annum (to the
nearest five units). The value predicted by the model was the same.

As one would expect, population is significant at the 95% level. This equation
relates only to a sample of municipal operators, because it is difficult to calculate a
“trips per head” figure for company services.

Thus it has been established that the rate of decline in trips per head is not higher
in the smaller urban areas, and that overall modal split can be predicted very closely
without use of population as a parameter.

The prediction that public transport trips may remain at a stable level for work
journeys (because of private car congestion) but decline for other trips at other times
of day would appear to be a reasonable one; and it is certainly true that weekend
and evening trips, mostly social/recreational, have declined. The same is not necessarily true of shopping trips. A survey carried out by Manchester City Transport showed that the percentage of peak travellers within the bus passenger total for a typical weekday was no higher in 1969 than in 1959; but the proportion within shopping hours increased, while in the evening it decreased.

<table>
<thead>
<tr>
<th>Hours commencing</th>
<th>Oct. 1959</th>
<th>Oct. 1969</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>0500 to 0700 incl.</td>
<td>12.9</td>
<td>11.0</td>
</tr>
<tr>
<td>0800</td>
<td>15.2</td>
<td>13.2</td>
</tr>
<tr>
<td>0900 to 1600 incl.</td>
<td>32.5</td>
<td>40.5</td>
</tr>
<tr>
<td>1700</td>
<td>14.0</td>
<td>13.8</td>
</tr>
<tr>
<td>1800 to 2300 incl.</td>
<td>25.5</td>
<td>19.5</td>
</tr>
<tr>
<td>Total Passengers</td>
<td>1,157,000</td>
<td>746,500</td>
</tr>
</tbody>
</table>

A survey on the city services of City of Oxford Motor Services carried out in 1971 indicated that, compared with 1970, traffic in the a.m. peak was down by 3%, in the p.m. peak by 1%, and in the evening by 7%. The “between peaks” period, however, showed an increase.

Some land use-transport studies also provide sufficient data for an estimate of the composition of total public transport trips (see Table 4).

Graph 3 shows the work and shop trips ratio by public transport. The

### Table 4

<table>
<thead>
<tr>
<th>Area</th>
<th>Work %</th>
<th>Shop %</th>
<th>Social %</th>
<th>Business %</th>
<th>Other %</th>
<th>Education %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devon</td>
<td>15</td>
<td>9</td>
<td>9</td>
<td>3</td>
<td>—</td>
<td>64</td>
<td>100</td>
</tr>
<tr>
<td>Exeter</td>
<td>28</td>
<td>35</td>
<td>21</td>
<td>14</td>
<td>2</td>
<td>a</td>
<td>100</td>
</tr>
<tr>
<td>Worcester</td>
<td>37</td>
<td>46</td>
<td>8</td>
<td>—</td>
<td>8</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Cambridge</td>
<td>24</td>
<td>24</td>
<td>17</td>
<td>16</td>
<td>—</td>
<td>19</td>
<td>100</td>
</tr>
<tr>
<td>Norwich</td>
<td>40</td>
<td>23</td>
<td>6</td>
<td>20</td>
<td>—</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Northampton</td>
<td>34</td>
<td>38</td>
<td>26c</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Brighton</td>
<td>38</td>
<td>18</td>
<td>14</td>
<td>8</td>
<td>8</td>
<td>14</td>
<td>100</td>
</tr>
<tr>
<td>Coventry</td>
<td>42</td>
<td>16</td>
<td>10</td>
<td>8</td>
<td>—</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>Plymouth</td>
<td>40</td>
<td>20</td>
<td>27e</td>
<td>—</td>
<td>—</td>
<td>13</td>
<td>100</td>
</tr>
<tr>
<td>Leicester</td>
<td>38</td>
<td>25</td>
<td>—</td>
<td>37</td>
<td>—</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>Belfast</td>
<td>45</td>
<td>10</td>
<td>20</td>
<td>6</td>
<td>12</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>London</td>
<td>72</td>
<td>34</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>100</td>
</tr>
</tbody>
</table>

* Very small proportion of total trips. Data refers to central area only.

* Including education.

* Including personal business.

* This figure relates to the Underground. For LT bus 53%; BR services in London 82%.
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validity of this measure as a proxy for "peaking" is shown by a similar trend for the ratio work and education:shop and business trips. The ratio has the value of about 1·0 for towns of 100,000 to 150,000 population, increasing to about 3·0-4·0 for major conurbations. For London it becomes as high as 7·5 for rail trips.

The vehicle utilisation ratio (vehicles in service at morning peak:mid-morning off-peak) is similar, though less marked as peak traffic is catered for at higher load factors. This peaking has an effect on operating costs: staff are required for "split shift" work, vehicle utilisation is lowered, and much mileage is operated under bad road conditions. A recent study by W. J. Tyson [5] of a municipal operator near Manchester indicated that neither the weekday peak traffic nor Sunday traffic is profitable, but a surplus was shown for weekday off-peak and Saturday operation, in which shopping trips predominate. A study by Lee and Steedman [6] has established that economies of scale in British municipal operation are not significant.

The relationship between size and profitability may thus be examined, on the hypothesis that smaller operators, with less of a peak effect, are more profitable. Increases in passengers (rare but not unknown) were also examined. Table 5 excludes operators taken over by the Passenger Transport Executives, and, for traffic increases, Widnes and Colchester (where population growth was exceptionally rapid).

### Table 5

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 500,000</td>
<td>3</td>
<td>---</td>
<td>1 (33%)</td>
<td>1 (33)%</td>
<td>1 (33)%</td>
</tr>
<tr>
<td>300,000 to 499,000</td>
<td>3</td>
<td>---</td>
<td>1 (33%)</td>
<td>1 (33)%</td>
<td>1 (33)%</td>
</tr>
<tr>
<td>150,000 to 299,000</td>
<td>14</td>
<td>2 (14%)</td>
<td>5 (35%)</td>
<td>5 (35)%</td>
<td>5 (35)%</td>
</tr>
<tr>
<td>100,000 to 149,000</td>
<td>9</td>
<td>2 (12%)</td>
<td>6 (66%)</td>
<td>2 (22)%</td>
<td></td>
</tr>
<tr>
<td>Under 100,000</td>
<td>34</td>
<td>9 (27%)</td>
<td>16 (46%)</td>
<td>14 (40)%</td>
<td></td>
</tr>
</tbody>
</table>

$^a$ After allowing for depreciation on a 15-year life basis.

$^b$ Compared with 1968/69.

$^c$ Compared with 1969/70.

A similar distribution emerged for 1968/69, the smaller groups being most favourably placed. Owing to the small number of large operators, it is difficult to determine whether differences are significant. However, it is noteworthy that the smaller groups also emerge most favourably in the peaking ratio (graph 3) and in the rate of decline in passenger trips per head, and have a surprisingly high rate of passenger trips per head per annum.
CONCLUSIONS

Emphasis on transport planning problems in larger cities has led to implicit understatement of the importance of both off-peak traffic and the role of public transport in smaller towns. Viability of traffic on a network is associated with the balance of peak/off-peak trips on that network rather than with the highest absolute level of use (subject to a minimum trip generation rate of about 100–130 trips per head per annum). Hence public transport in smaller towns may have at least as secure a future as in major cities. It is of interest that many of the most encouraging innovations at present—the Runcorn busway, the Stevenage “Superbus” service and Reading’s bus lanes—are in the smaller urban areas. The importance of shopping traffic, of which public transport often has a higher share than of work trips, has been emphasised. The effect of drive-in shopping centres on this profitable traffic should be borne in mind in urban planning, especially where public transport is called upon to cater for a substantial peak demand for work trips.

For comparable levels of car ownership, towns with municipal operation display a substantially higher market share for public transport than those in which company operation applies. It would be naive to suggest that large-scale direct takeovers of company services by local authorities, particularly those with no public transport operating experience, would automatically improve the position of public transport: the present pattern is based on a longstanding trend toward relatively low fares and high service frequencies which results from “break-even” rather than profit-oriented operation. However, where the future of a small municipal fleet is in doubt, perhaps as a result of local government reorganisation, retention would appear preferable to company takeover. Where it is possible to expand an existing municipal fleet by voluntary acquisition of adjacent company services, this could be beneficial.

APPENDIX A

Regression equations calculated by A. J. Moran, Research Fellow in the School of Business Studies, University of Liverpool:

- $X_1$—Passenger trips (million per annum)
- $X_2$—Average fare paid, in pence (Göteborg-Ore)
- $X_3$—Number of cars registered in the area.

Relationships shown are mostly significant at the 95% level, but subject to a high degree of autocorrelation, being time series based on annual data for 1960 to 1969 inclusive.

<table>
<thead>
<tr>
<th>Location</th>
<th>Equation</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leicester</td>
<td>$X_1 = 110.16 - 3.061X_2 - 3.249X_3$</td>
<td>0.98</td>
</tr>
<tr>
<td>Reading</td>
<td>$X_1 = 53.97 - 3.673X_2 - 0.0435X_3$</td>
<td>0.96</td>
</tr>
<tr>
<td>Aberdeen</td>
<td>$X_1 = 110.84 - 0.814X_2 - 1.028X_3$</td>
<td>0.97</td>
</tr>
<tr>
<td>Wigan</td>
<td>$X_1 = 67.16 + 0.422X_2 - 2.664X_3$</td>
<td>0.97</td>
</tr>
<tr>
<td>Nottingham</td>
<td>$X_1 = 198.9 + 0.479X_2 - 2.227X_3$</td>
<td>0.97</td>
</tr>
<tr>
<td>Leeds</td>
<td>$X_1 = 260 - 13.215X_2 + 0.2168X_3$</td>
<td>0.98</td>
</tr>
<tr>
<td>Bradford</td>
<td>$X_1 = 157.7 - 4.046X_2 - 0.464X_3$</td>
<td>0.95</td>
</tr>
</tbody>
</table>
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\[
\begin{align*}
\text{Blackburn} & \quad X_1 = 35.8 + 0.872X_2 - 0.793X_3 & 0.97 \\
\text{Derby} & \quad X_1 = 72.5 - 2.58X_2 - 0.77X_3 & 0.99 \\
\text{Göteborg} & \quad X_1 = 108 - 0.297X_2 + 0.042X_3 & 0.98
\end{align*}
\]

APPENDIX B

The following land use-transportation studies and similar surveys provided data from which tables and graphs in this study were compiled:

*Travel in Belfast.* Belfast Corporation/Travers Morgan 1968.

*Travel in Cambridge.* Travers Morgan April 1969.

*Cardiff Development and Transportation Study.* Cardiff City Council/Atkins & Partners/


*Studies of Travel in Gloucester, Northampton and Reading.* M. A. Taylor. Road Research Laboratory report LR141, 1968.


*West Midlands Transport Study (3 Volumes).* Freeman Fox Wilbur Smith, 1968.


Note: The extent to which studies are formally published (as distinct from being printed for the use of local authority members only) appears to vary widely. A number of studies are known to the author to have been undertaken, but are not available in published form. Standard publication of all studies would cause little inconvenience and would greatly assist research.

REFERENCES


38
USE OF PUBLIC TRANSPORT IN TOWNS AND CITIES

Peter R. White


