INTERNATIONAL COMPARISONS OF BUS AND COACH SAFETY

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INTRODUCTION

This paper examines a number of issues in the sector of bus and coach accidents. As in other modes, deregulation is a major issue. Has it resulted in a significant change in casualty rates? The composition of casualties helps to indicate where improvements may be obtained. The incidence of casualties to other road users arising from accidents involving buses and coaches is another important aspect.

Much of the analysis in this paper is based on British data, which is generally of consistent quality, and enables the effect of deregulation to be assessed. Comparisons are made with other European countries, although differences in definition limit the degree of accuracy in this process.

It can be argued that bus and coach accidents are a very minor problem. In Britain, for example, fatalities to bus and coach passengers have averaged only 15 to 20 per year in recent years compared with total road user facilities of around 5,000 per year (1). However, public transport accidents often attract far more attention than such objective data suggests, either because of individual accidents in which many casualties occur (such as major coach crashes), or the feeling that a greater responsibility applies to the operator of a public service than to individuals using the roads at their own risk. The cost of insurance claims against operators, reflected in premiums charged, provides a direct incentive to reduce accident rates.

1. DEFINITIONS

Definitions employed follow those used in conventional British practice, based on the 'STATS 19' data collected through local police forces by the

Department of Transport. For each accident, data are obtained on all casualties, vehicle type, time of day, road type, etc. which may be cross-tabulated. In this paper we make use both of published data, and special tabulations purchased for this purpose.

An 'Accident'is an event in which one or more persons is killed or injured. Damage-only accidents are not considered in our work. An 'accident' could thus range from a major event such as a high-speed coach crash on a motorway, in which many people are killed or injured, to a single passenger being slightly injured in an event not involving any other people. In Section 3 we are concerned only with bus and coach occupants, but enlarge the scope to cover other road users in Section 4. 'Fatal', 'Serious injury' and 'Slight injury' are as defined in 'Road Accidents Great Britain (1). In addition, 'Killed and Seriously Injured' (KSI) is combined category, used in safety analysis to give a more robust trend than that based on fatalities alone, which varies markedly from year to year (2).

'Buses and Coaches' are vehicles defined as such by their appearance and construction - usually of 16 seats upwards, and including all types of service (local, express, tour, contract, etc.). The definition is similar to, but not identical with, the legal term 'public service vehicle' (psv) being a vehicle used for public hire or reward, either as a whole or at separate fares, licensed to carry over 8 passengers.

'Bus and coach occupants' are people in a bus or coach at the time of an accident, including passengers, drivers and conductors.

2. RECENT TRENDS IN BRITAIN

We have examined trends in bus and coach occupant casualties from 1966 to 1990 inclusive. Data for casualties by type; bus and coach vehicle-kilometres, and bus and coach passenger-kilometres, are shown in table 1, highlighting trends at five year intervals.

During this period the absolute total of casualties has dropped very substantially. Fatalities ranged between 50 and 106 per year during the 1970s, but only 14 and 35 during the 1980s. Certain years were influenced by major coach crashes in which many casualties occurred - notably in 1975, and crash on the M6 motorway in 1985, in which a coach hit a queue of slow-moving vehicles delayed by roadworks causing a total of 13 deaths and 42 injuries.

'KSI' casualties have likewise declined from over

1,600 per year in the mid-1970s to under 1,000 in the late 1980s and total casualties from about 14,000 per year in the early 1970s to around 10,000 per year.

These reductions are of course influenced by the decline in use of bus and coach services, from 62,000 million passenger-kilometres in 1966 to 41,000 in 1990. Vehicle-kilometres, however, rose in the 1980s to give a very similar figure in 1990 (3,838 million) to 1966 (3,708 million). This was a result of growth in long-distance services in the early 1980s, following express coach deregulation for October 1980, and a rapid growth in local bus service kilometres from deregulation of that sector in October 1986. However, total passenger trips (for all types of service) fell by 50% between 1966 and 1990. Despite a rising average trip length, average occupancy levels have fallen substantially, from around 17 passengers in 1966, and to around 11 passengers in 1990. Local bus passenger trips in particular, have fallen sharply since deregulation - by 14% between 1985/6 and 1990/1 (3), despite the growth in service kilometres: this issue is discussed elsewhere by White (4).

Table 1 Five-year trends in bus and coach casualties, and volume of service

Year	Fatalities	KSI	Vehicle Km (Million)	Passenger Km (Million)	Passenger Trips (Million)
1966	76	2,161	3,708	62,000	11,028
1970	74	1,924	3,461	56,000	9,154
1975	115	1,650	3,550	54,000	8,168
1980	29	1,952	3,338	45,000	6,783
1985	32	1,036	3,323	42,000	6,178
1990	19	826	3,838*	41,000	5,470*

*Provisional Figures, 1990/1 data.
'KSI' denotes 'Killed and Seriously Injured'.
Casualties include all bus and coach occupants (drivers and passengers).
Sources: RAGB (casualties); Transport Statistics Great Britain (volume measures to 1985 inclusive); Bus & Coach Statistics Great Britain 1990/91 (1990/1 data).

The method of estimating the national total passenger-kilometres is a rather crude one, and data are estimated to only the nearest 1,000 million units. The apparent stability of this figure since 1986 may seem

surprising in view of the marked decline in local bus traffic. The method used consists of multiplying the number of 'local' and 'other' bus and coach passenger trips by appropriate average lengths derived from the National Travel Survey and similar sources (5).

In estimating overall occupant casualties, total passenger-kilometres is probably the most valid indication of exposure to risk. However, the substantial element of 'boarding and alighting' casualties (see Section 3.3) is clearly a function of trips as such. The incidence of collisions with other road users (Section 3.7) is a function of the total kilometres ran by buses and coaches, and traffic density on roads over which they are operated.

The most realistic method of representing the casualty rate is probably that of 'killed and seriously injured per 1,000 million passenger-kilometres' (subject to the qualifications expressed above), as shown in Figure 1. The model was calibrated on data for 1966 to 1985. It can be seen that the observed rate since deregulation lies close to the trend line, and well within the 95% confidence interval. A similar conclusion, that no significant change has occurred in accident rates since local bus deregulation, is also supported in a recent TRRL study (6) and data from the West Midlands conurbation (7).

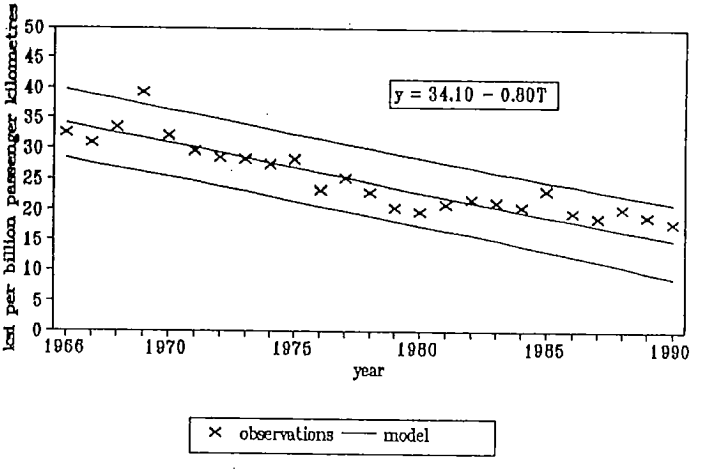

Figure 1: Observations and a simple linear model describing the trend of passenger casualties carrying vehicles (killed and seriously injured) from 1966 to 1990.

The model for the trend shown is:

KSI per 1,000m pax-km = 34.10 - 0.80t

in which 't' represents the years from 1966. The coefficient of determination (r^2) is 0.52. It should be noted, however, that there is only one independent variable in the model. Extrapolated over a long period, this model would be unrealistic, as the same absolute reduction in the casualty rate per year is implied.

A more complete model was therefore calibrated on data from 1966 to 1985, as illustrated in Figure 2.

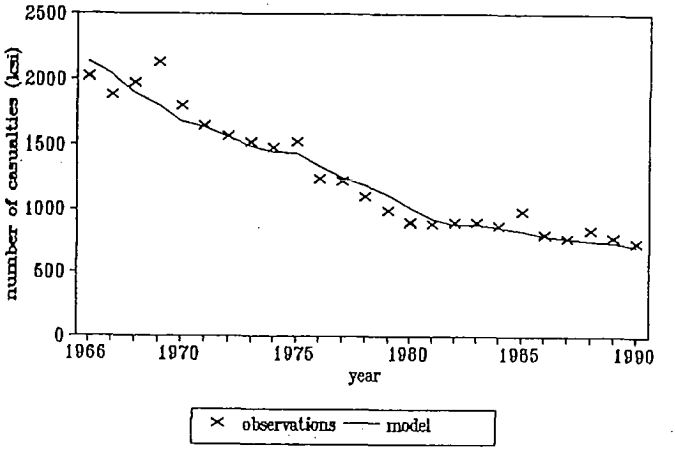

Figure 2: Killed and seriously injured passenger casualties as a function of time and passenger-kms.

KSI = exp (5.865 + 0.0285k - 0.0168t)

in which 't' is defined as above and 'k' represents passenger kilometres per year (thousand million).

This produces a much better fit, with a coefficient of determination (r^2) of 0.94. The apparent stability in passenger-kilometres from 1986 to 1990, however, produces some bias (see comments above).

3. SPECIFIC ASPECTS OF BRITISH TRENDS

3.1. Local and Long-Distance Operations

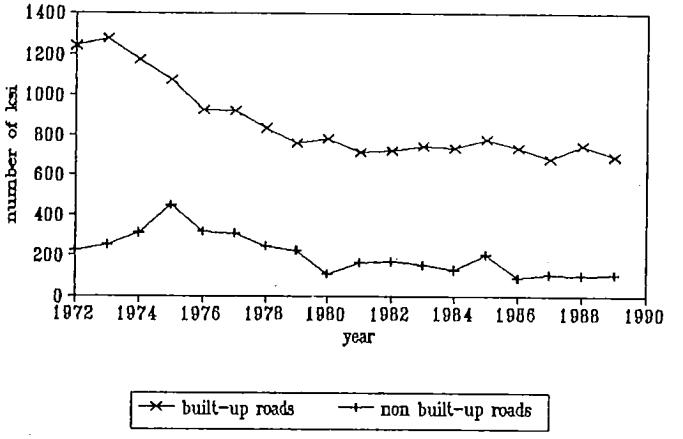

Figure 3: Killed and seriously injured bus and coach occupant casualties by road type.

The numbers of killed and seriously injured casualties for each year are also shown in Figure 3, where the location of the accident is divided between 'built-up' areas and 'non-built' up areas. It is reasonable to assume that the former category is mainly concerned with local bus operation, and that the latter includes express coach operation together with other types of coach operation, such as private hire: it is unfortunately not possible to distinguish between the various categories of operation from the published statistics. Figure 3 shows that the number of killed and seriously injured casualties in the non-built-up category has generally declined, but with significant peaks in 1975 and 1985, associated with specific major accidents. The casualties on built-up roads have shown a more consistent decline, although the absolute average per year is much higher than for the other type of service - a result of the difference in the number of kilometres travelled by local services in comparison with that for express and other interurban services, and the high incidence of boarding and alighting casualties in local services.

3.2. Boarding and Alighting Casualties

About half of the killed and serious injury casualties in built-up areas are a result of passenger boarding and alighting accidents. As Figure 3 shows, they have declined in absolute terms since 1980, which matches the drop in total passenger trips, but still accounted for 40% of the total in 1990 as shown in Fig 4.

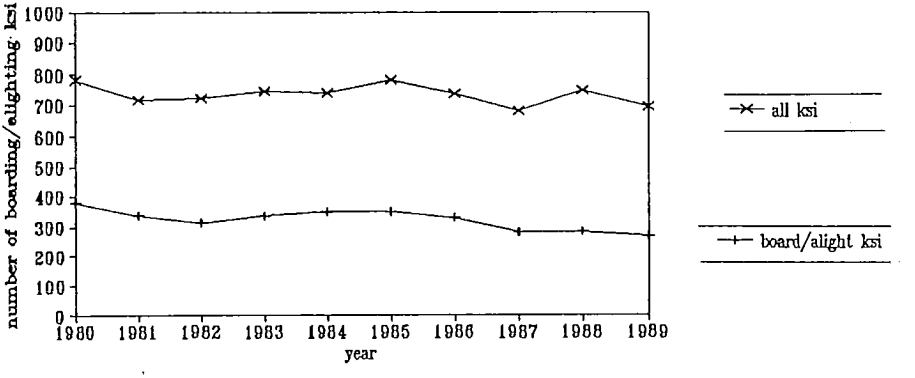

Figure 4: Killed and seriously injured casualties boarding and alighting, and all KSI injuries on passenger services in built-up areas from 1980 to 1989.

3.3. Accidents by Time of Day

The 'Stats 19' data record time at which accidents occurred. Taking 1990 data, Colski (8) has shown that a profile similar to the typical passenger loadings by time of day is produced, albeit with a peak around 1600. A fairly high accident rate between the peaks is probably a result of the high proportion of elderly people travelling at such times, and the higher accident rate they display (see Section 3.5).

3.4. Casualty Rates and Age of Passenger

This was examined in detail in earlier work at PCL (9), estimating casualty rates (all severities) by number of trips made, for the period 1980 to 1984 inclusive. For the age group 30-59 the casualty rate was very close to the mean for all passengers but that for those over 60 was some 56% higher, while for the 15-19 group the rate was only 30% of the average. In terms of absolute casualty

numbers, Colski (8) shows that in 1990, 40% of passenger casualties were aged 60 or over. Of these, 36% were standing at the time of the accident, and 23% boarding or alighting. This appears to support recent vehicle design policy initiatives by the Disabled Persons Transport Advisory Committee (DPTAC), which emphasise means such as improved positioning and design of handrails, reduced step heights, and clearer marking of step edges.

3.5 The Effect of Vehicle Design and Layout

An unusual feature of bus design in Britain, is the continued use of the open rear-platform double-decker, without any doors to regulate passenger movement, and with fares collected by a roving conductor. Most such remaining vehicles are of the 'Routemaster' type operated in central London.

Police records in London and Greater Manchester were used to compare accident characteristics in greater detail than permitted by 'Stats 19' data (9). Over the period 1985-1986, the average bus occupant casualty rate in London (KSI) was found to be up to ten times that found in Manchester whether measured on a basis of vehicle-km, or passenger trips. A much higher proportion of bus passenger casualties in London (62%) was associated with boarding or alighting, than in Manchester (28%).

It was clearly associated with the major role of the 'Routemaster' in London, which represented 64% of all boarding and alighting casualties, but only about 30% of bus-kilometres run. Many other London buses at that time were of the type with driver controlled centre exit doors, as well as an entrance directly adjacent to the driver. In contrast, most of the Manchester fleet were of a single (front) doorway design only. As a result of increased public concern about passengers trapped in centre-exit doors, new regulations now require that a more sensitive mechanism is fitted to detect such following some fatalities following such accidents in London. Ironically, no equivalent public concern is evident about continued use of the much more dangerous 'Routemaster' layout, which is accepted as a customary feature of the London transport system.

3.6 Accident Involvement Rates with Other Road Users

Most buses operate in urban areas with high densities of other road traffic (including pedestrians and cyclists) sharing the same road space. They are usually the largest

and heaviest vehicles (along with lorries) in such areas. Hence in the event of a collision, much greater harm may come to other road users as a result.

As Gordge has shown (10), for each bus or coach occupant fatality, an average of 6.7 fatalities occurred to other road users arising from accidents involving buses and coaches, over the period 1981 to 1985. In 1990, this ratio reached 10.8 (8), some 47% of the other road users killed being pedestrians. This increase in the ratio appears to result from the absolute reduction in bus and coach occupant casualties (itself partly a consequence of falling ridership), but also of the increase in bus and coach vehicle-km (which would increase the probability of collision with other road users, ceteris paribus). Nonetheless, the increase is a worrying one, and represents a significant risk to pedestrians, as identified by Jones (12). It is not clear which remedial measures may be most appropriate.

Note that these accident involvement rates do not imply that the bus or coach was the cause of casualties to other road users, or that its driver was at fault, but simply show a statistical relationship.

3.7 Extent to Which Casualties are Associated

An analysis was carried out, using special tabulations of 'Stats19' data from 1984 to 1989, to show the extent to which accidents involving a particular level of severity are associated.

The great majority (95%) of the serious injuries occurred in accidents not involving fatalities, and 91% of the slight injuries occurred in accidents not involving any other degree of casualty. It can thus be seen that many casualties do not result from serious major accidents but are likely to involve individual passengers. Typically, these would include boarding and alighting casualties and those arising from the passenger being thrown off balance within the vehicle.

The reported proportion of slight injury casualties for the bus and coach users vis-a-vis more serious casualties is higher than for other modes of passenger transport. This may reflect not only the good (occupant) safety record of bus and coach travel, but also a tendency to report minor injuries that would not be reported for other modes, as a result of the liability of the carrier, rather than the user, being perceived and the resultant tendency to make insurance claims. The total casualty rate for all types of severity may also be somewhat

exaggerated as a result.

4. COMPARISONS BETWEEN BRITAIN AND OTHER EUROPEAN COUNTRIES

As indicated in our earlier work (9) such comparisons are more difficult than may at first appear, since although detailed records are kept by other West European countries, definitions are not consistent with or as comprehensive as, the British 'Stats 19' form. Significant variations may occur even within the same country (e.g. the use of different report forms by the Police Nationale and the Gendarmerie in France). In particular, bus and coach occupant casualties tend to be recorded in relation to collisions involving the vehicle as such, and do not necessarily include individual boarding and alighting casualties, or those involving standing passengers. This has the effect of reducing the apparent number of occupant casualties in built-up areas.

The differences have been examined by Gordge (10) also examining differences in the fatal accident involvement rate (see Section 3.7). The Netherlands and Britain displayed a similar fatality rate for the other road users involved in accidents with buses and coach in the period 1981-85, but a lower rate was found in Western Germany, despite the overall higher accident rate for road transport found in that country in comparison with Britain. The composition of such accidents also differs: in Britain the most frequent victims are pedestrians, whereas in West Germany and the Netherlands car occupants and pedal cyclists respectively were the largest categories. This may reflect the mix of traffic in such countries, and the typical accident problem - for example, Germany has a higher rate of accidents involving cars on non-built-up roads while Britain, despite its generally good road safety record in comparison with France or Germany, does have a bad pedestrian accident rate, especially that for children which is some 31% above the EC average (11). These differences in accident characteristics among the West European countries may well be reflected in the priorities they place on different types of accident remedial measures, both at domestic and international levels.

5. CONCLUSIONS FOR POLICY

The British experience suggests that quantity and price deregulation need not result in any statistically

significant change in casualty rates for bus and coach occupants, provided that strict 'quality control' is retained. This is achieved through the operator licensing system in which vehicle maintenance and safety standards are probably the most important criteria in the award and duration of the licence, and numbers of vehicles (discs) an operator is permitted to run.

The major problem in Britain relates to the continued operation of open-platform 'Routemaster' buses in London, with a much higher accident rate for occupants than other types. The accident involvement rate with other road access is also a cause for concern. Occupant casualties result mostly from numerous accidents involving individual passengers, rather than major collisions involving the bus or coach itself. Elderly passengers have much higher accident rates, especially for boarding and alighting. This suggests that measures, to improve vehicle design in terms of entry/exit layouts, interior layouts and in driving standards, may be more important than politically fashionable measures, such as fitting seat belts or increased 'roll-over' strength, which result from a small number of spectacular coach crashes.

Within Europe as a whole, one may question whether the standard 100 kmh speed limit to be imposed on coaches is necessarily based on firm statistical evidence, or represents the most urgent priority. Within Britain, it will hamper the role of a successful long-distance express coach network. Current European proposed standard specifications for urban buses will encourage multiple entry/exit doorways. While speeding-up total boarding and alighting movements, these may well increase overall accident rates. However, only the British data at present seems to fully include such passenger casualties.

Greater consistency in recording of data is thus desirable to inform policy debates especially when common international standards are proposed.

ACKNOWLEDGEMENTS

Earlier work in this field was carried out at PCL by Catherine Rogers, under the supervision of Peter White, between 1986 and 1988 with the support of a grant from the Science and Engineering Research Council (SERC). Further analysis was carried out by Dr Nigel Dennis of PCL. Some issues, especially of international comparisons, were examined further in Richard Gordge's MSc project at PCL in 1982. Updating of overall trends was carried out by Nick Tyler, working as a visiting researcher at PCL, in 1991.

NOTES

1. Except where otherwise indicated, statistics and definitions for British data are taken from 'Road Accidents Great Britain: the casualty report', published annually by HMSO, London and shown as 'RAGB'.
2. However, this measure is dependent upon the somewhat subjective division of casualties into 'Serious' and 'Slight': see Adams, John 'Evaluating the effectiveness of road safety measures', Traffic Engineering and Control, (London), June 1988, pp344-352.
3. Derived from 'Bus and Coach Statistics Great Britain 1990/1' (HMSO, 1991), Table 2.
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