Understanding Transport & Development

TRICS Research Report 95/2

Pass-by & Diverted

A RESUMÉ

1 Introduction

1.1 This report reviews recent literature looking into the traffic implications of "pass-by" and "diverted" trips to retail developments. It is hoped that the document will provide a useful synopsis of the current state of research. Most of the research that has been undertaken relates to major food retailers. It is certain that similar principles will also apply to non-food retailing and to other land uses such as leisure, restaurants, etc, however insufficient research exists to enable any quantification to be undertaken.

1.2 It has become common practise in the preparation of Traffic Impact Assessments (TIA), for developers and highway authorities to separate the total traffic generation estimate for a new retail development into discrete "trip types". This acknowledges the fact that the number of trips to the store may not be comprised entirely of new trips. Many of the trips may occur anyway, albeit to another location, or where a visit to the store will be incorporated into an existing pattern of travel behaviour.

1.3 For many years, practitioners accepted the simple logic that projected development traffic plus the opening year network traffic would be equal to the final flows. It has since been demonstrated that this is rarely the case. Allowances need to be made for "pass-by" and "diverted" trips so that a more realistic appraisal of traffic impact can be made.

1.4 As will be seen from the data incorporated into this report, there is significant variability in the relative proportions of the various trip types. This makes it difficult to arrive at a representative split and means that each site should be considered on an individual basis.

2 Trip Type Definitions

2.1 There has been much classification and re-classification of trip types by researchers looking into the question of the distribution and assignment of traffic to retail developments. Most of these classifications are similar to one another in principle but in order to keep an account of all the terminology that may from time to time be used, a fairly comprehensive review is set out below.

2.2 Based on information derived from questionnaire surveys, Kamali and Crow [1] in 1988 categorized trips to superstores as follows:

- **Primary Shopping Trips**: Trips from home to the retail centre and back directly to home.
- **Newly Generated Trips**: a primary shopping trip which would not have been made at all if the centre had not existed.
- **Diverted Linked Trips**: these trips, as the name suggests, are diverted from other roads to the centre. They are 'stopping off' trips, included as part of another journey but involving a diversion from the normal route.
- **Non-Diverted Linked Trips**: these trips are those that already exist on the roads adjacent to the retail centre and do not bring any extra load to the impact area (*Pass-by Trips* in latter terminology).

2.3 Kamali [2] later made the distinction between primary trips from home and primary trips made to and from the workplace. This distinction is not normally required as long as the origin and destination of the journeys are the same.

2.4 Dickinson and MacIver [3] condensed the classifications of 5 previous studies into two broad classifications:

(1) **Primary Trips**: Primary trips have the same origin prior to visiting the site as destination on leaving the site. Primary trips are, however, broken down into:

- newly generated trips - these are new trips on the network that would not have been made if the new development did not exist; and
- redistributed trips - these are trips which were previously made to another shopping centre but have transferred to the new development (sometimes referred to as *transferred trips*).

(2) **Linked Trips**: All linked trips are part of a chain of trips in which the visit to the store forms an intermediate point between two trip ends. Linked trips may be broken down into:

- pass-by trips - these are undiverted linked trips via the retail centre which is an intermediate stop on the normal route taken; and
- diverted trips - these are similar to pass-by trips but involve a diversion from the route that would otherwise be followed.

2.5 A further elaboration of the trip type classifications is included in the paper by Hazel and MacIver [4]. This categorizes the trips as follows:

- **Primary New**: a single purpose trip which did not exist previously on the network.
- **Primary Transfer**: a single purpose trip which previously used another centre and has transferred to the new retail centre.
- **Pass-by**: a multi-purpose trip from a given origin and destination that passes the new retail centre without making a significant network diversion.
- **Diverted**: a multi-purpose trip from a given origin and destination that passes the new retail centre making a significant network diversion.
- **Diverted Transfer**: a multi-purpose trip from a given origin and destination that has transferred from another retail centre and has made a significant network diversion in order to use the new retail centre.

2.6 Hazel and MacIver [4] were aware that, for practical purposes (i.e. the preparation of Traffic Impact Assessments), the above level of classification was probably not necessary. Their table, reproduced below, draws our attention to the local and wider network effects of the various trip types:

Table 2.1 Effect of Trip Types on the Network

Trip Type	New Trips on the Local Network?	New Trips on the Wider Network?
Primary New	Yes	Yes
Primary Transfer	Yes	No
Pass-by	No	No
Diverted	Yes	No
Diverted Transfer	Yes	No

2.7 MacIver and Dickinson [5] point out the difficulties in determining the split between trips which are pass-by and which trips are diverted when the actual store entrance is fed by a side street or secondary route. In such a situation, the normal procedures would be to include pass-by trips that come from the major route, despite the creation of additional trips on the side street. As the paper points out *'...in practise Traffic Impact Analysis must be carefully considered in the light of local network and land-use patterns.'*

2.8 Shaw [6] assumes both pass-by and diverted trips would generally be on the local network and prefers to merge the two values. There is therefore some contention over what constitutes a diverted trip and how it differs from pass-by. Obviously, each local network configuration merits a different approach. If the site feeds directly onto a major arterial road then pass-by will be the major component. Similarly if the site feeds off a minor road then diverted trips from the nearest local through route will be more important. However, any trips diverted from further afield will enter local roads as new trips and they can therefore not be thought of as existing traffic. Clearly care and common sense is required in applying any percentages to traffic figures.

2.9 If primary transfer trips (i.e., trips transferring to the new store from other stores) have a significant effect on local roads which service the new store, then it may be that these trips need to be plotted on the local network as well. If the store is located on the edge of town, for example, it may intercept a large number of trips which would previously have gone on to the town centre. Similarly, the outbound trips from the town centre will no longer be present. In this case, a redistribution of trips might be required.

2.10 The American Institute of Transportation Engineers [7] define only three categories of trip: *Primary Trips, Pass-by Trips* and *Diverted Link Trips*. An alternative estimation theory relating to traffic flows on surrounding links is suggested without being expounded in the manual. The following equations are suggested

$$N_{Pb} = p(VOL_{Pb})$$

$$N_{D} = p(VOL_{D})$$

Where:
N_{Pb} = Primary Trips
N_{D} = Diverted Link Trips
p = Probability of driver, already in the traffic stream, stopping at the generator, $0 \leq p \leq 1$.
VOL_{Pb} = Passing traffic stream volume available to produce pass-by trips.
VOL_{D} = Traffic volume on other streets available to produce diverted linked trips.

2.11 Clearly, one might expect pass-by trips to be some function of traffic flow. However, the total number of pass-by trips calculated from the flow on the adjacent network must relate to the number of trips calculated for the site from trip generation assessments. In most cases, practitioners would have to rely on engineering judgement in order to determine the allocation of these trips to the network.

IHT Standard Definitions

2.12 The IHT Guidelines on Traffic Impact Assessments [9] seek to provide a refined categorization of trip types based on much of the previous work and experience. It is hoped that this will emerge as the standard for trip type definition and should also provide a consistent framework for future data collection. The fundamental breakdown is between two trip types , ***new*** and ***transferred*** (sometimes called redistributed).

- ***NEW*** are trips that did not occur anywhere on the network before the development was provided, or that used alternative modes i.e. modal split changes. For many land uses this proportion of the trip attraction may be relatively small although for residential uses it is conventional to assume that all trips are new.

- ***TRANSFERRED***are trips that used to travel to one opportunity but now travel to the new site. These are normally the predominant element of the trip attraction.

2.13 The guidelines also point out a further categorization between ***Primary*** and ***Non-Primary*** trip types:

- ***PRIMARY*** are defined here to be *single purpose* trips for example, home - development - home.

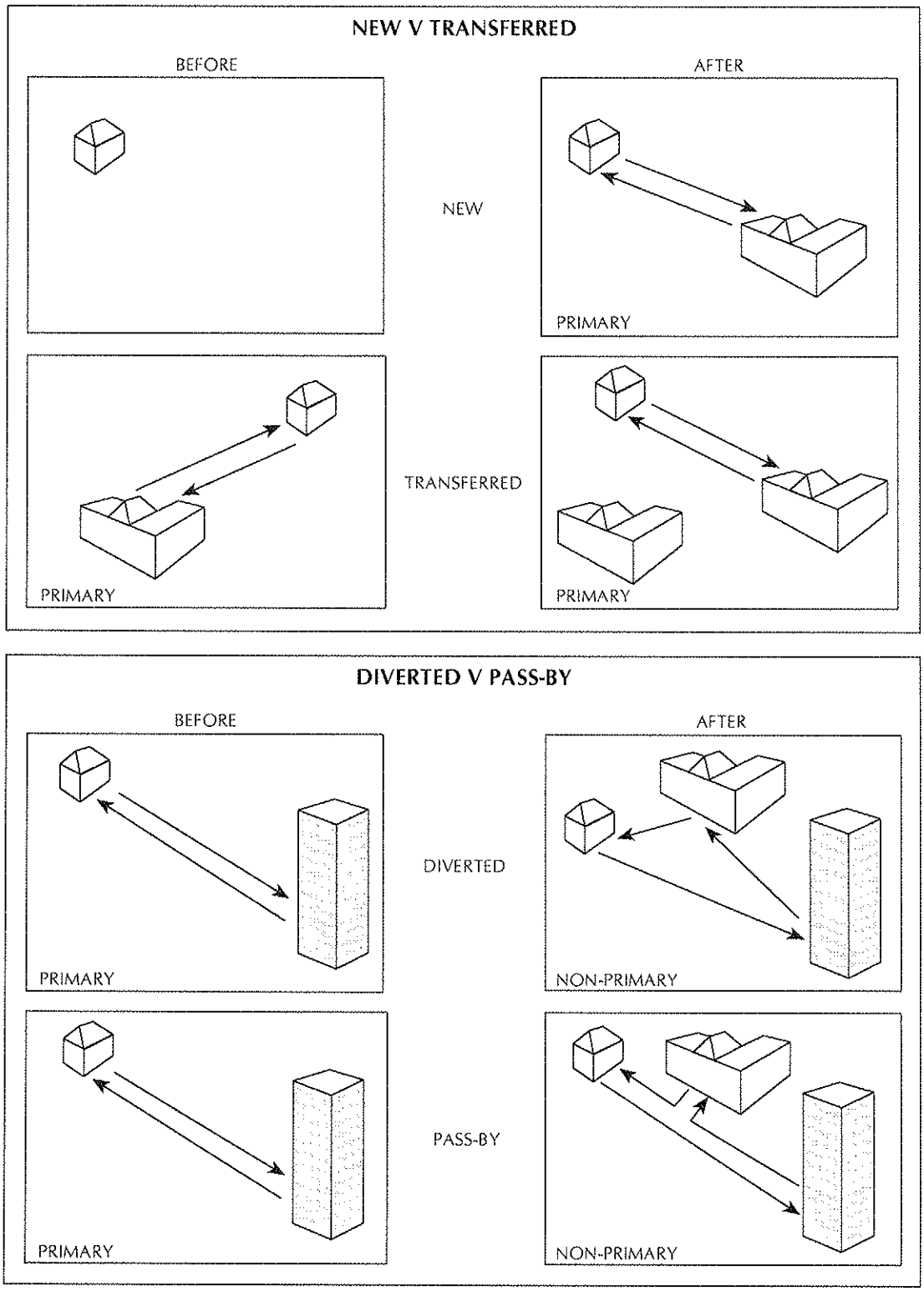
- ***NON-PRIMARY*** are defined to be *multi-purpose* trips which call into the development en-route to another destination. Frequently this is a work-shop-home trip. Non-primary trips can be further sub-divided into ***diverted*** and ***pass-by*** trips. Diverted trips are those non-primary trips that deviate off their normal route to visit the new development. Pass-by trips are those non-primary trips that visit the new development without having to make any significant diversion from their existing route.

2.14 The difference between "diverted" and "pass-by" is a function of network configuration which varies from site to site. It is, therefore, recommended that these two classifications should be considered as a single category.

2.15 Figure 2.1 is based on the definition set out in the IHT Guidelines and explains the categorisation of trip types in pictorial format.

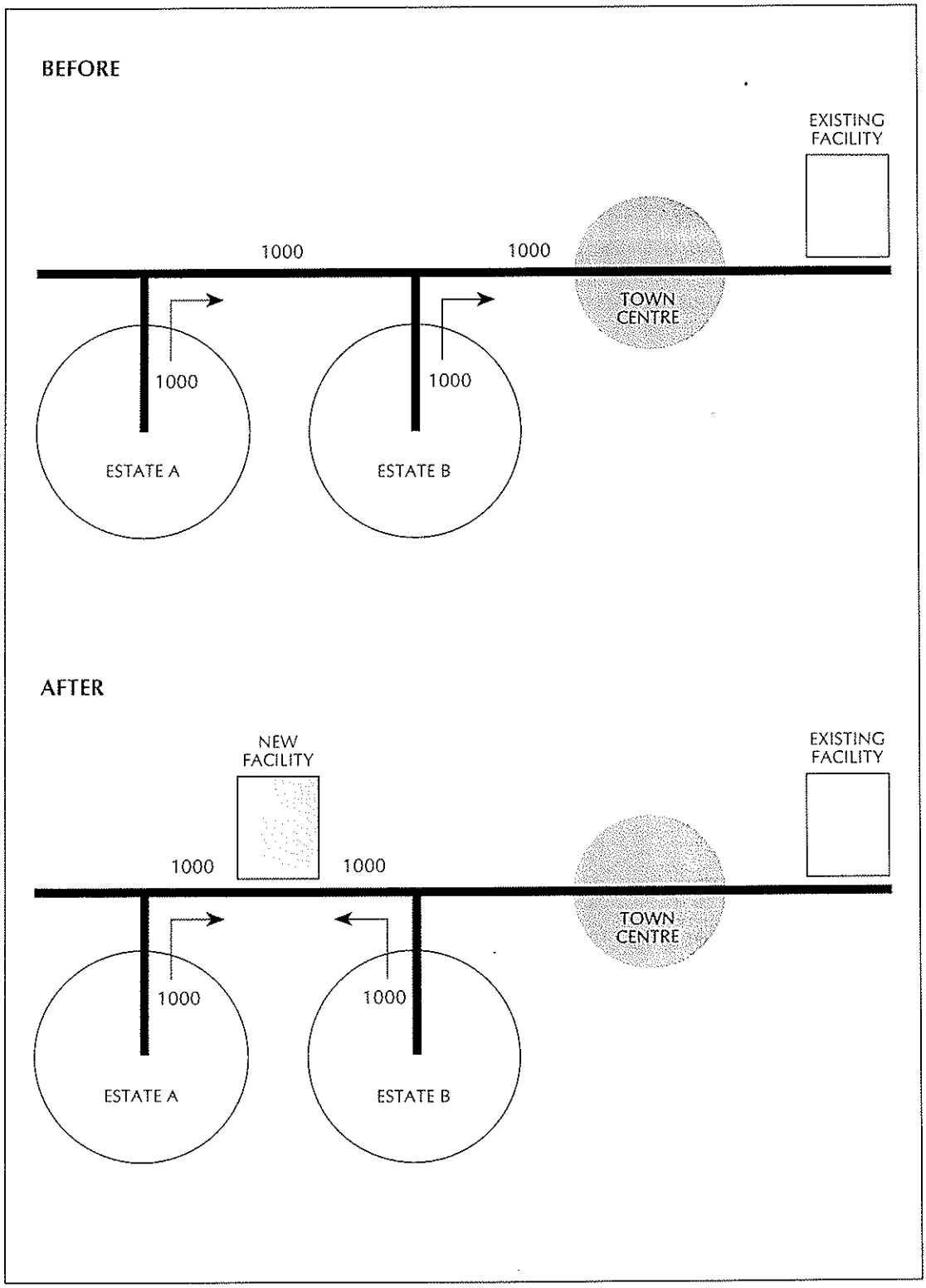
2.16 As most of the trips to a new site are transfer (redistributed) trips it is important in any Traffic Impact Assessment to understand where those trips were before the new opportunity was provided. Even if the alternative attraction was on the other side of town, some distance from the new site, it is likely that some of the home-based generations would be in the locality of the new facility and would therefore be on the local network.

2.17 To illustrate how a new development may affect traffic flows on the highway network, consider the example below. Assume a new retailer is to be established close to the edge of town with one residential estate of 1,000 households on the rural side of the new facility (Estate A) and another identical size estate on the town side (Estate B) (See Figure 2.2). Assuming one car trip per household per week, each estate would generate 1,000 weekly trips. In both estates, the local estate roads would carry that level of traffic. In the case before the new facility opened the 1,000 trips from the outer estate would have to pass the new site to get to the existing facility. Once the new facility is open those trips would stop at the new site. The trips from the other estate would turn in the opposite direction on the road. In both cases the traffic on the local estate roads would be unchanged. This example highlights some of the complexities and the careful way that traffic assessments need to be considered.



TRIP TYPES

Figure 2.1



AN EXAMPLE OF TRANSFERRED TRIPS

Figure 2.2

3 Studies of Trip Types

3.1 There have been a number of questionnaire studies analysing the relative proportions of the various trip types to retail sites. These demonstrate a high level of variability between sites which lead to questions about factors affecting the proportional split. The results of these various studies are discussed below.

3.2 A summary of the main research findings prior to 1990 is included in Dickinson and MacIver [3]. This information is presented in Table 3.1. All these studies would suggest that new retail developments do not result in a large number of new trips on the area-wide network, but do involve a transfer of existing trips.

Table 3.1 Review of Trip Type Studies

Study	Time Period	Primary Trips (%)		Non-Primary (%)	
		New	Transferred	Pass-by	Diverted
Slade & Gorove Regional Centre Washington DC					
1.2M ft² (111500 m²)	1630-1800h	-	35	25	40
JHK & Associates Shopping Centres Maryland					
< 100000 ft² (9290 m²)	1600-1800h			60	
100 - 400000 ft²	1600-1800h			49	
> 400000 ft² (37160 m²)	1600-1800h			38	
Lalani, Colorado					
Regional Centre	pm peak			9	24
Supermarkets	pm peak			28	34
Convenience Stores	pm peak			16	28
Kittelson & Lawton					
Retail Centre Portland	0900-2100h	6	37	57	
150000 ft² (13935 m²)	pm peak	7	28	65	
Hooper: Suburban Centres					
17800 ft² (1650 m²) - 92000 ft² (8550 m²)				21 - 51	
Toth *et al*, Calgary Regional Centres					
440000 - 1.2M ft²	0900-2100h		56	14	30
40890 - 111500 m²	pm peak		39	20	41
Hazel & MacIver					
Safeway, Edinburgh (3600 m²)	1600-1800h	0	27	29	44
Asda, Kirkcaldy (6500 m²)	1600-1800h	2	36	22	40

Source: Dickinson and MacIver [3]
Note: Gross Floor Area is shown for all Studies.

3.3 TIA studies for retail stores, as reviewed by Shaw [6], currently assume that 30% of the traffic generated will be non-primary. Different assumptions regarding trip type proportions may hold for certain developments and some TIA's have attempted to trace and redistribute all transferred primary trips.

3.4 Table 3.2 details the trip type percentages, yielded from questionnaire surveys, for four J S Sainsbury stores in the South of England. This research is described in MacIver & Dickinson [5]. The study compares stores which were broadly similar in size and character (see Table 3.3). All four stores were opened between September and December 1990. The questionnaire surveys were all conducted approximately 2-3 months after the store opening, giving them a chance to settle down into normal trading patterns before the surveys took place.

Table 3.2 Trip Type Proportions to Four Sainsbury Stores 1990-1991

Store	Time	Primary Transferred (%)	Diverted (%)	Passed-by (%)
Christchurch [1]	Thursday 1600-1800h	63	22	15
	Friday off-peak	73	14	13
	Friday 1600-1800h	60	21	19
	Saturday	77	15	8
Poole	Thursday 1600-1800h	66	22	12
	Friday off-peak	77	15	8
	Friday 1600-1800h	60	29	11
	Saturday	76	16	8
Swindon	Thursday 1600-1800h	55	35	10
	Friday off-peak	68	26	6
	Friday 1600-1800h	59	27	14
	Saturday	75	17	8
Thanet	Thursday 1600-1800h	57	34	9
	Friday off-peak	65	28	7
	Friday 1600-1800h	61	33	6
	Saturday	54	37	9

Source: After MacIver and Dickinson [5]

[1] See paragraph 3.5

Table 3.3 Details of Four J Sainsbury Stores

Store	Christchurch	Poole	Swindon	Thanet
Date of Opening	18 Sept. 1990	27 Nov. 1990	25 Nov. 1990	11 Dec. 1990
Gross Floor Area	5720 m^2	6251 m^2	6410 m^2	6132 m^2
Sales Area	2973 m^2	3437 m^2	3437 m^2	2973 m^2
Parking Spaces	535	560	535	665

3.5 As can be seen from Table 3.2, there is still significant variation between the proportions of the various trip types by location and time. However, the research confirms the emerging consensus that only a small proportion of trips to new stores are newly generated trips. There is also, broadly speaking, some similarity between the trip type proportions although, as the authors themselves conclude, the results do not immediately suggest a general 'rule of thumb' which could be applied with confidence to all sites. It will be noted that the proportion of "pass-by" traffic at Christchurch is higher than at other stores. However, these figures should be used with caution. A close analysis of the data identifies that the pass-by point was located not at the roundabout junction built as part of the Sainsbury application, but at Somerford roundabout junction some way down a county distributor route which itself was connected to a pass-by corridor. Therefore, the definition of "pass-by" was based on this junction some 200 metres from the roundabout junction closest to the store. If the road directly in front of the store had been used as the basis for defining pass-by the rate would have been very small.

3.6 In addition, the study by MacIver and Dickinson [5] analyses the shopping behaviour of respondents before and after store opening. This gives an indication of where trips are being redistributed from. However, there is no before and after comparison of shopping trip frequency which might have been relevant.

3.7 Table 3.4 details more trip type research, this time including non-food retail sites. Primary new trips are again demonstrated to account for only a small proportion of the traffic generated, in this case between 0 and 8% of the total trips, across the sample of sites. The other trip type proportions vary quite considerably, again making it fairly difficult to arrive at a generally applicable proportional split.

3.8 The very low proportion of newly generated trips on the network, suggested by all of the above research, is not entirely surprising. People are unlikely to go shopping for food on a more frequent basis simply because a new store opens. It has even been suggested that new store openings can result in a decrease in total vehicle mileage on the network if a new store brings a shopping opportunity nearer to where an existing market is situated. Such a situation was examined by Stokes[10] in Swindon before and after the opening of a Sainsbury store in Bridgemead and a Tesco store in Ocotal Way. Travel diary surveys recorded shopping behaviour during these periods for a sample of households. Detailed analysis of the results demonstrated a small increase in the number of trips but a total vehicle mileage decrease of 6%.

Table 3.4 Trip Type Proportions for Four Scottish Food and Non-Food Retail Centres

Retail Centre	Date & Day of Survey	Time of Survey	Trip Type (%)			
			Primary New	Primary Transfer	Non-Primary Pass-by	Non-Primary Diverted
Safeway, Edinburgh	06/4/89 Thurs.	1330-1530h	2.5	54.2	19.2	24.1
	17/2/89 Fri.	1330-1530h	4.9	52.0	23.6	19.5
	06/4/89 Thurs	1600-1800h	-	26.9	29.4	43.7
	17/2/89 Fri.	1600-1800h	-	44.4	23.8	31.7
Asda, Kirkcaldy	16/3/89 Thurs.	1330-1530h	0.8	57.3	16.9	25.0
	17/3/89 Fri.	1330-1530h	1.0	47.5	16.2	35.3
	16/3/89 Thurs.	1600-1800h	1.7	35.5	22.3	40.5
	17/3/89 Fri.	1600-1800h	0.8	46.6	17.8	34.8
Great Mills, Edinburgh	25/5/89 Thurs.	1330-1530h	5.4	48.2	21.4	25.0
	26/5/89 Fri.	1330-1530h	-	31.8	16.7	51.5
	25/5/89 Thurs.	1600-1800h	1.9	36.5	32.7	28.0
	26/5/89 Fri.	1600-1800h	1.6	31.7	28.6	38.1
Texas, Glenrothes	08/6/89 Thurs.	1330-1530h	3.8	52.8	7.5	35.9
	09/6/89 Fri.	1330-1530h	7.8	54.9	11.8	25.5
	08/6/89 Thurs.	1600-1800h	-	46.0	8.0	46.0
	09/6/89 Fri.	1600-1800h	2.9	37.7	11.6	47.8

Source: Hazel & MacIver [4]

3.9 Shaw [6] also documents a study by JMP for a new store in North London which found that only 10% of the total vehicle mileage associated with traffic visiting the store was new mileage. The remaining 90% was already on the network. However, the traffic impact in the vicinity of the new site is still likely to be highly significant and it is the local network issues which need to be addressed in depth by any TIA.

3.10 In addition, JMP Consultants[6] looked at the proportions of diverted and pass-by travel to three London stores, the results of which are tabulated in Table 3.5.

Table 3.5 Trips by Type - London Retail Foodstore Sites

Trip Type, by Day of Week and Time Period	Store A	Store B	Store C
	Out-of-Town	Suburban	Town Centre
Weekday Off-Peak			
Primary	68%	88%	65%
Non-primary Pass-by	24%	12%	6%
Non-primary Diverted	8%	-	29%
Friday Evening Peak			
Primary	65%	47%	50%
Non-Primary Pass-by	10%	37%	14%
Non-primary Diverted	25%	16%	36%
Saturday			
Primary	67%	78%	71%
Non-primary Pass-by	10%	11%	6%
Non-primary Diverted	23%	11%	23%

Source: Shaw [6]

Store A was in a typical out-of-town location whereas store B was in a suburban location and store C was in a town centre location. The general conclusion made by Shaw, from the figures, is that the disaggregation of non-primary trips into diverted and pass-by categories is very dependant upon network configuration.

3.11 A study, into the trip types at two J Sainsbury urban superstores during the Friday pm peak (1630-1830 hours), was undertaken by Harris and McCoy [11]. The results of these two stores, located at Hampton and Croydon, along with the results of the MacIver & Dickinson research [5], are given in Table 3.6.

Table 3.6 Trip Type Proportions, Friday pm

Site	Primary (%)	Non-Primary Diverted (%)	Non-Primary Pass-By (%)
Christchurch	59.6	21.3	19.1
Poole	59.8	28.7	11.5
Swindon	58.5	27.1	14.4
Thanet	60.7	33.3	6.0
Hampton	51.5	18.5	30.0
Croydon	40.3	31.5	28.2

Source: Harris and McCoy [11]

3.12 Compared to the MacIver and Dickinson study [5] the results indicate that peak hour pass-by rates on commuter routes are high and suggest that in conurbations pass-by rates of 30% could be applicable although the rate would be dependant on other factors such as competing stores/centres and catchment area. However, again the location of the traffic diversion must be considered: at Hampton the principal commuter route was a little removed from the store entrance. Furthermore, the Harris and McCoy study shows significantly less primary trips compared to the MacIver and Dickinson research [5].

3.13 The results of recent surveys at 9 Safeway food superstores, undertaken by Safeway and TRICS, are given in Table 3.7. Surveys were carried out at town centre and out-of-centre stores on various days of week and time of day. The results suggest that there is a wide variation in the proportion of primary trips according to the site location, day of week and time of day. The percentage of non-primary trips is highest on the weekdays, particularly during the Friday peak period. Primary trips are also predominant at town centre sites where the opportunity to combine such trips with school, work, etc., seems to be less.

Table 3.7 Percentage of Primary/Non-Primary Trips

Site Location and Trip type	Friday	Friday peak	Saturday	Sunday
Town Centre				
Primary	80	64	92	92
Non-Primary	20	36	8	8
Out-of-Centre				
Primary	73	62	79	82
Non-Primary	27	38	21	18

Source: After JMP Consultants(12)

3.14 The same research compared total travel distance before and after each store opened by asking respondents where they had previously shopped. Whilst recognising the limitations of this approach the results are quite clear cut as set out below:

- Reigate (Surrey) 42% reduction
- Southport (Lancashire) 2% increase
- Harwood (Bolton) 54% reduction
- Teweksbury 43% reduction
- Malvern 29% reduction
- Reading 33% reduction

The Southport store differed from all the others as it was the only location where the new store was a replacement for an existing store and was in close proximity to an alternative facility.

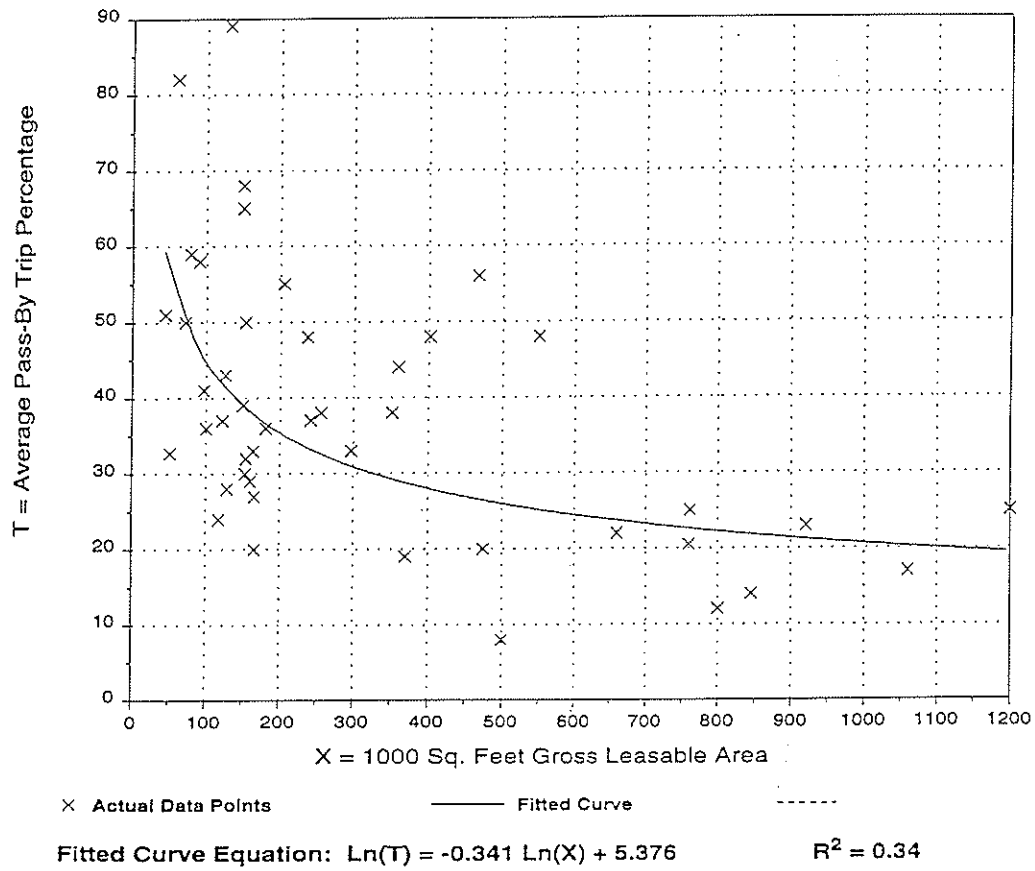
3.15 Another factor which is thought to affect the proportion of pass-by trips to a site is the Gross Floor Area. This is hinted at by the findings of JHK & Associates, documented by Dickinson and MacIver [3] (see Table 3.1). As the shopping centres increase in size there is a corresponding drop in the proportion of pass-by trips. However, the authors criticise the questionnaire design for this particular piece of research and feel that it may have influenced the very high pass-by percentages obtained.

3.16 The Institute of Transportation Engineers [7] also investigates the relationship between Gross Floor Area and the percentage of pass-by trips (including our definition of diverted; hence the figure corresponds to non-primary). The result of their accumulated data is a fitted curve equation (see Figure 3.1). This would again suggest that the smaller shopping centres will generate a higher proportion of pass-by trips. The relationship between the independent and the dependant variable, in this case, is not very strong, only giving a level of explanation of $R^2 = 0.34$. It should also be emphasised that while this relationship may loosely hold for U.S. shopping centres, it has yet to be demonstrated in the UK.

3.17 Further factors affecting pass-by, suggested by Dickinson and MacIver[3] and American work includes the proportion of commuter traffic in the traffic stream passing the site and whether or not the site is located on the left-hand side of a commuting route.

3.18 It would appear from the accumulated research that there are a variety of factors, many of which are as yet unquantified, which are likely to have an effect on the proportion of pass-by or diverted trips to a site. At this stage practitioners must suffice to make use of engineering judgement backed up with examples of research work to produce the best estimate.

Number of studies = 45
Average 1000 sq. feet GLA = 326
(For a weekday pm peak hour)



RELATIONSHIP BETWEEN THE AVERAGE PERCENTAGE PASS-BY AND GROSS LEASABLE FLOOR AREA DERIVED BY THE ITE [7]

Figure 3.1

4 Conclusions

4.1 The IHT Guidelines on Traffic Impact Assessment divide all trips into two broad classes; *new* trips and *transferred* (or 'redistributed') trips. The trips can also be subdivided into *primary* and *non-primary* trips, that is single purpose or linked trips. The non-primary element can also be subdivided into *diverted* or *pass-by* trips.

4.2 The distinction between diverted and pass-by trips can sometimes be difficult to make in practise, particularly as it is not clear what constitutes significant diversion or insignificant diversion (in the case of pass-by). All research which uses these definitions should be treated with care unless one is sure of the definitions used. In general it is probably more robust to combine the two values into a single term; non-primary. All research confirms the view that very little new traffic is generated by new store developments. Figures compiled in this document suggest that in most circumstances 10% or less of the total trips are completely new and in practice the value is so small it can be discounted.

4.3 The proportion of trips generally accepted to be non-primary is 30%. Most of the non-primary trips tend to be home-work-site-home and hence values are generally lower than this at weekend when there is less home commuting but could be higher on a Friday evening but would not expect to exceed 40%..

4.4 Obviously, the manner in which these values are applied to flows on the ground depends upon ones interpretation of the pass-by and diverted trip types in a local context. There is evidence to suggest that factors such as GFA, base-link flows and percentage of commuter traffic will all have an effect on the amount of pass-by to retail sites but there is insufficient documented evidence to support this at present.

4.5 There is frequently a need to consider the effect of redistributing the existing pattern of trips as some of these will already be on the network adjacent to the new site. The "generation" end of the trip, i.e. the number of trips generated from the home end, will not change significantly just because a new facility is opened. Hence, in general the introduction of a new store will not increase the traffic levels within a residential area unless that area is to be subjected to increased through movements.

4.6 There is a body of evidence that supports the view that new stores may often reduce the total value of vehicle mileage.

5 References

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