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Changing methods of location planning for retail companies

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Abstract

Academic research has made an enormous contribution to applied problem solving in the areas of retail planning and marketing. The aim of this paper is to review the changing methodologies used in store location research beginning with the work on simple checklist and analogue techniques in the 1960s. The arrival of geographical information systems (GIS) heralded the start of a second phase of work which eventually saw GIS established in many retail organisations. However, the main argument of this paper is the need to consider more sophisticated modelling procedures if the different types of corporate growth strategy are to be adequately investigated. This third phase of research development focuses on these models and illustrates the business potential of such approaches through a number of case studies.

Introduction

The aim of this paper is to review the changing methodologies used by retail companies to aid the process of site location. The evidence has been constructed from the experience of the Leeds School of Geography and its sister consultancy group – GMAP (now a private company earning $5 million per annum from spatial analysis associated with site location). Although it is thus largely a story based on evidence from UK companies it is believed that the picture is mirrored in many other European countries, and certainly in the US. The paper is organised around three development cycles. The first refers to a pre-GIS era in the 1970s and early 1980s when location analysis was largely based on gut feelings, checklist and analogue techniques. The GIS revolution came much later to the business world than many other areas of applied geography (see Longley and Clarke 1995), hence the second phase can be dated from around the mid-late 1980s when GIS became widespread in many retail organisations. This period also saw the resurrection of applied spatial modelling, particularly within companies which saw the limitations of GIS technology. Phase III is underway as this article is written. There are a number of issues emerging in this era of development. First there is a need to counter the argument continually made that saturation will inevitably reduce the need for site location analysis. Then, it is possible to speculate on the type of analysis that will become more commonplace in phase III – in particular, data mining methods (inductive) and optimisation methods (building on deductive spatial modelling techniques). Before reviewing phase I it is useful to emphasise that store location research is not simply about appraising sites for new store openings. Moore and Attewell (1991) summarise the UK's leading grocery retailer Tesco and its philosophy:

> "From the relatively narrow confines of site location analysis the company now calls upon the Site Research Unit to perform the broader function of Market Analysis whenever a locational element is involved. By this we mean the ability to advise not only on new store potential but on the past and future performance of existing branches, the purchasing behaviour and preferences of their catchments and the trading strength of other retailer's branches." (p. 21)

Another important caveat is that most organisations will not use any one methodology in isolation. Examples of organisations using more than one methodology will be apparent in the discussion which follows.

Phase I – the development of store location research

Whenever the history of site location research is attempted most authors begin with the work of Applebaum (1965) in the US. He reviews a variety of techniques within the overall framework of spatial analysis for retail location. Similar works then appeared in Europe (Cox, 1968; Davies, 1977; Davies and Rogers, 1984). Although each of these texts reviews a variety of techniques it seems clear that in the 1960s and 1970s most retailers relied on 'gut feeling', 'checklist' or 'analogue' techniques. We shall consider each of these in this section. Gut feeling is usually thought of as the simplest in terms of spatial analysis. It normally involves the on-site decision of a senior member of staff who obtains a 'gut feeling' for a location through a site visit. As Davies (1977) points out this should not be berated since these individuals will usually have the ability to offer very good instinctive judgements. However, there are a number of obvious drawbacks with such an approach. First, it will remain highly subjective and depends entirely on the experience of those making such decisions (there are a number of boardroom anecdotes of senior staff each having to write their own estimates of a new store's potential to see how much agreement on a site exists – then the Chairperson goes along with his/her opinion anyway!). Second, it is a very time consuming and expensive exercise. For those organisations with large-scale planned expansion programmes it may be logistically unfeasible to visit all possible sites in the time allowed. In the US for example, the fast food retailer Taco Bell plans 3000 new stores over the next five years (however it is interesting to note the use of a plane by Ray Krok to speed up the process when he was masterminding the diffusion of McDonald outlets in the US in the 1950s and 1960s!).

Even though many senior retailers will openly declare they have never made an unprofitable decision through such gut feelings the market is littered with failed examples and store closures. Even profitable sites are open to investigation – could greater profits have been made elsewhere? Second, the increasing complexity of the retail scene makes it harder to make such simple predictions. It is difficult even for the most experienced senior executive to stand on a green-field site and predict the drawing power and revenues which might accrue to a new store.

A second common methodology in the early years has been the 'checklist approach'. This is a broad set of procedures aimed to measure more objectively the size of existing centres (and hence their potential) and to understand the breakdown of their catchment areas in terms of population structure. The size or importance of a centre can be measured relatively easily by standard floorspace statistics available from local authorities or private sector organisations. Such aggregate statistics can be broken down by type of retailer present in order to gauge the 'quality' of that centre. In effect, the procedure is concerned with compiling as much information as possible concerning the centre and its neighbourhood. Thus, the retailer may make a list of all the positive attributes of a potential new store location (perhaps comparing this with other stores in his/her portfolio – see below). Consideration of the neighbourhood of a store would include basic population counts based on (often arbitrary) catchment areas drawn around such centres. These population counts could then be broken down by age, sex or social class. Thus a key question might be: 'how many 45–60 year old persons live within 5 minutes drive from a major shopping centre?'. Comparisons of different sites would then allow the retailer to rank the possible alternatives.

Simkin (1990) emphasises how important gut-feeling and the checklist approach were even by the late 1980s in the UK amongst a variety of retailers (see Table 1).

Table 1. Survey of UK retailer's assessment techniques (cf. Simkin, 1990)

Company type	Most common technique
Department stores	Checklist
Variety stores	Checklist and analogue
Out-of-town warehouses	Analogue
Grocery superstores	Analogue and regression
High street multiples	Gut feeling/Analogue
Small multiples	Gut feeling
Financial outlets	Gut feeling

Analogue techniques were (and still are) also very common procedures for site location in the UK and US (also shown in Table 1). The basic approach involves attempts to forecast the potential sales of a new (or existing) store by drawing comparisons (or analogies) with other stores in the corporate chain that are alike in physical, locational and trade area circumstances. This may be done 'manually' or through regression techniques (see below). Hence, if you are evaluating a new store site in say Cambridge can you find an existing store location around the UK that has the same (or similar) population and trading characteristics of Cambridge? If so, you can attempt to draw analogies with the trading performance of the store in that other town. Alternatively, the procedure may work by trying to find sites which are analogous with the top performing stores within the company. That is, if Oxford is performing very strongly, can the analyst find sites elsewhere in the country which match the characteristics of the Oxford site?

The success of this approach depends on whether or not you can find similar sites across the country and whether you believe you can successfully transfer the trading characteristics across geographical locations. This again depends on the experience of the location analyst and his/her team. According to Moore and Attewell (1991) 'Tesco' are improving in this area;

> "(The) greater understanding of the way in which existing stores trade has been fed back into the sales-forecasting process through an increased appreciation of analogue store performance." (p. 24)

Apart from the required experience, a second problem remains the variable performance of stores across similar geographical markets. In reality, a wide variation in performance is frequently found between outlets in a retail chain. If a similar geographical catchment is found to the new store what happens if the analogous store is currently over or under performing? Thirdly, it is extremely difficult to evaluate green-field sites in this way. These may have catchment areas greatly distorted by local transport networks and it would prove impossible to import revenue predictions from other towns or cities.

A similar approach to the analogue method has been to follow the behaviour of other (larger) retailers and base store location decisions on whatever decisions they make. This has been labelled the *parasitic approach*. In the early days of the British high street many new multiple groups would simply follow Marks and Spencer, Woolworth and Boots to new locations. The practise is still common today, especially for smaller retailers. In the US for example Mason and Meyer (1981) quote the (then) strategy of County Seat:

> "If a Penney, Sears, Wards or local department store is going to go there then they have already done de-

mographic studies. It almost sounds too simple but that really is our strategy."

The multiple regression model builds on the philosophy of the analogue procedure (see Rogers and Green 1979). Regression analysis works by defining a dependent variable such as store turnover and attempting to correlate this with a set of independent or explanatory variables. Coefficients are calculated to weight the importance of each independent variable in explaining the variation in the set of dependent variables. The model can be written as:

$$Y_i = a + b_1 X_{1i} + b_2 X_{2i} + b_3 X_{3i} + \ldots + b_m X_{mi}, \quad (1)$$

where Y_i is turnover (the dependent variable) of store i, X_{mi} are independent variables, b_m are regression coefficients estimated by calibrating against existing stores, a is the intercept term.

Fenwick (1978) gives an example of these variables for a building society. Keeping the above terminology: X_{1i} = average age of persons in catchment area of branch *i*, X_{2i} = average socio-economic status in catchment area of branch *i*, X_{3i} = number of years branch *i* has been established, X_{4i} = number of new houses under construction in catchment area of branch *i*, X_{5i} = total number of building societies in the catchment area of branch *i*.

Although these models allow greater sophistication and objectivity than more manual analogue techniques there does remain a number of problems. The primary weakness of such models is that they evaluate sites in isolation, without considering the full impacts of the competition or the company's own global network. As the above building society example shows the level of competition is typically incorporated by the simple absence or presence of stores. A second major weakness is the problem of 'heterogeneity of sample stores'. This was also seen as a problem with analogue techniques. That is, how easy is it to find a sample of stores which have similar trading characteristics and catchment areas (see Ghosh and McLafferty, 1987)?

A third problem relates to the basic feature of regression analysis which assumes that the explanatory variables in the models (X_{mi}) be independent of each other and uncorrelated. In many retail applications this is not the case – independent variables such as floorspace and car parking spaces may be strongly correlated. This can lead to unreliable parameter estimates and severe problems of interpretation. The so-called multicollinearity problem has received much attention in the literature (Lord and Lynds, 1981; Ghosh and McLafferty, 1987). However, through careful analysis and interpretation many of these problems can be overcome. Most poor applications of multiple regression in retail analysis have shown statistical naiveté and limited understanding of retail process.

Fourthly, and from our point of view the most important limitation, is that regression models fail to handle adequately *spatial interactions or customer flows.* That is, they do not model the processes (spatial interactions) that generate the flows of revenue between residential or workplace areas and retail outlets. Although regression models may sometimes demonstrate impressive descriptive powers (through their ability to reproduce the variation in sales across a network) the absence of any process modelling leaves us sceptical as to their ability to undertake *impact analysis* with any confidence.

Phase II - GIS and spatial modelling

Reviews of store location methodologies used in the 1980s and early 1990s begin to show an important shift towards the use of more sophisticated techniques. Clarkson et al. (1996) present the findings of their survey of major grocery retailers in the UK. It is clear that there is a movement towards 'models' of various types. However, the checklist approach is still deemed to be fundamental. This is partly because the ease of undertaking such checklists has been increased through the availability of geographical information systems (GIS). Information relating to shopping centres and their catchment areas could be *geocoded* (that is placed on the computer with a spatial referencing point) and visually *displayed* through maps and graphs. The standard approach using a computerised checklist procedure would be also to set up the required database of populations within cities or regions. These too could be mapped. A new site could then be analysed by first exploring the population types which surrounded that site and then by using the GIS to calculate likely revenues for the new store. Once the information is stored in the GIS the user can *buffer* travel times around the new store and then calculate the population within each time band using the standard *overlay* procedure available in most GIS packages. This is illustrated well by Beaumont (1991a, b), Howe (1991), Elliot (1991) and Ireland (1994) and shown graphically in Figure 1. Once an estimate has been made concerning the demand within the likely catchment areas (normally used in conjunction with a market survey to see how far people typically travel to a similar store elsewhere in the corporate chain) then a variety of methods may be used to translate population totals into branch sales. The most likely method is the so-called 'fair share' approach (Beaumont, 1991b). Hence, if there are three other competing stores in the buffered catchment area of the new store then the new store may be expected to obtain 25% of the revenue generated in that catchment area. This simple fair-share allocation could be weighted by store size or by retail brand to increase realism. The alternative is to assume the consumer will travel to the nearest store within the catchment area (*dominant store analysis*: see Ireland 1994).

Elliot (1991) illustrates this well. She notes how a GIS can be used to calculate the population within a 20 minute drive time for any new or existing Debenhams store (a large UK department or variety store group). The great difficulty with this procedure however is that it does not allow for the complex set of real interactions between residential areas and retail locations which are distorted by intervening opportunities. As Elliot herself acknowledges, the presence of competing centres will restrict the catchment boundary of a new store in certain directions. Her response is to 'override the drive time where it seems appropriate' (p. 171). Such

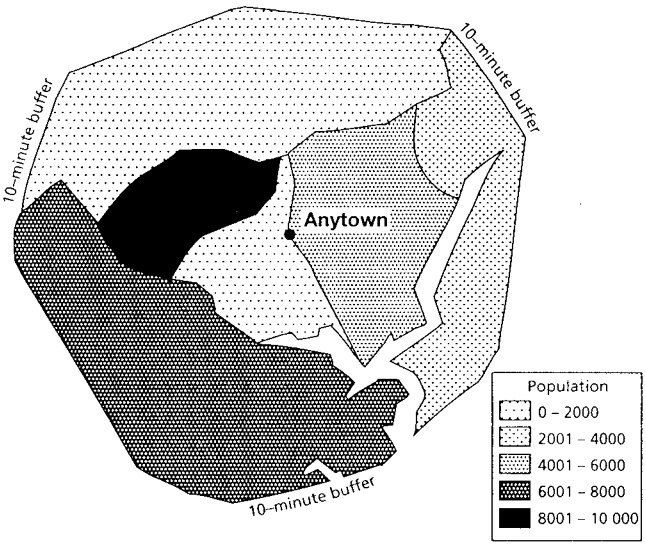

Figure 1. Combining overlay and buffer procedures in GIS to calculate catchment area populations.

subjectivity is the precise reason why such methods are not as accurate as alternate methods discussed below

Many retailers now use GIS for marketing and site appraisal. In the UK these include most of the major grocery retailers as well as large international groups such as Marks and Spencer and Kingfisher (see Ireland, 1994).

The usefulness of GIS technology has been increased with the arrival of geodemographic packages which ultimately became linked in many GIS packages. Geodemographic systems attempt to profile catchment areas into customer segment types. This is especially useful for those retailers whose customers are concentrated in certain geodemographic segments and are keen to find localities of the 'right type' for their products. Although geodemographic systems in the UK have been available since the late 1970s (CACI's ACORN system being the earliest commercial application in the UK.) they proliferated after the publication of the 1981 Census and following their availability through GIS packages. These small area profiles are based on a multivariate analysis of a large number of variables associated with small areas. This produces a limited number of single-dimensional classifications of neighbourhoods such as enumeration districts. Small areas that fall within the same cluster classification can be considered alike and to contain similar types of households. Figure 2 shows the ACORN classification mapped by Hirschfield et al. (1993) in St.Helens, near Liverpool in the UK. For a detailed history and review of these techniques see Beaumont (1991a, b), and Batey and Brown (1995).

The importance of geodemographic systems should not be underestimated. As companies increasingly target their stores at different members of society so these methods will remain popular. Sears for example owned many different shoe shops in the UK in the 1980s which traded under a variety of names targeted at different consumer groups. Dawson and Broadbridge (1988) list some of these outlets and the specific market they are aimed at. This is shown in Table 2. Clearly, an important planning task is to work out which stores should be in which locations to maximise corporate returns on investment. This can be achieved, at least partially, by profiling the catchments of centres in such a way as to optimise the brand offering.

A good example of a linked GIS/geodemographic system in the UK is CACI's 'Insite System' which has been specifically targeted at retail businesses wishing to match catchment area profiles (based on Census and geodemographics) with those obtained from their customer data bases. They are working with a number of UK high street retailers including Norweb, Britdoc, Budgens, Woolworth and Yorkshire Building Society (CACI 1993). Such customised geodemographic systems are also increasingly available within general GIS packages for other regions of Europe (Hinton and Wheeler, 1992; Reynolds, 1993). Indeed, CCN have recently launched a pan-European version of their popular MOSAIC system (Webber, 1993; Birkin, 1995).

As retailers have identified their customer base more narrowly (niche marketing) so more information has been required on *lifestyles.* From the late 1980s geodemographic systems have thus become increasingly more sophisticated by linking population demographics with lifestyle information obtained from companies such as NDLI and CMT (Openshaw, 1995; Birkin, 1995). Lifestyle data is information collected about individual households, through the use of self-completed questionnaires. Since the data is collected at this micro-level it avoids the problem encountered by using Census data, namely the fact that data is only available at an aggregate level. Using lifestyle data it is possible to identify the number of households who have specific combinations of characteristics such as 'Volvo owning golfers with an interest in fine wine'. An early example of such a package is 'SHOPPiN', an amalgamation of 'Pinpoints' geodemographic 'PiN' system and Nielsen's 'Homescan' lifestyle consumer panel which detailed the shopping habits of 100 000 households (Ody, 1989). A second example is 'Equifax' and its geodemographic system based on census and lifestyle information (Sleight, 1993). A good example of the use of lifestyles comes from the UK wine merchants known as 'Bottoms-up'. They have identified their main target group not as a single age or social-class group but as persons with a special type of lifestyle. They call these persons 'serious piss artists' – a crude terminology for persons 25–40 of higher incomes who spend most of their drinking time now at home (so usually married with young families which prevents visits to the pub) (see Belchamber, 1997).

It is probably true that lifestyle data offers a more precise way of targeting particular customer groups, as well as being a powerful tool for direct marketing. Its main drawback, however, is that it is not a complete Census of the UK population and has under and over-representation of certain groups. However, the largest lifestyle data base (collated by NDLI) contains over 10 million households, nearly 50% of the UK total. These systems are set to have a large impact on geodemographic marketing tools in the 1990s.

Although the GIS/geodemographic approach is popular with retailers there are two principal drawbacks. First, there is the problem of how to define the catchment area and sec-

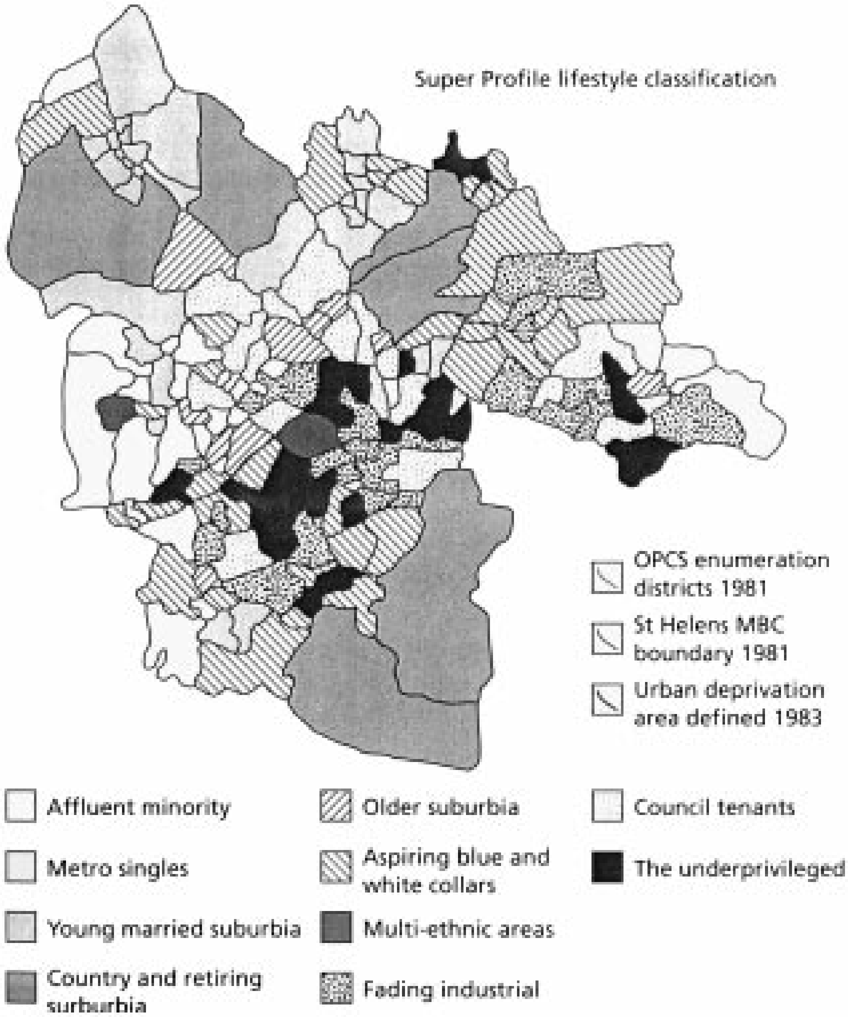

Figure 2. Mapping 'Superprofiles' in St. Helens (cf. Hirschfield et al., 1993).

ond, how to adequately treat the competition. The former is normally represented by distance or drive time bands and it is often assumed that the store will capture trade uniformly in all directions. Even when drive time bands are drawn in relation to transport networks (Reynolds, 1991) there is still the assumption of equal drawing power in all directions. These methods also give equal weight of importance to all households within a buffer. If a five mile buffer is drawn around a new store as the primary catchment area then households close to the site are given the same weight (or probability of patronage) as those 4.9 miles away. In addition, the treatment of the competition is wholly inadequate. The presence of competitor stores will mean the real geographical catchment area of a new store will be highly skewed in certain directions. This can normally be shown in all appraisals of existing store catchment areas. Similarly, there is no effective way in most GIS of estimating the new store revenue in light of the level of competition. As Beaumont (1991b) suggests the method most often used is 'fair share' with the potential revenue of the catchment area being simply divided between all retailers on some ad-hoc basis (type of retailer, level of floorspace, etc.). Hence, this methodology whilst offering a useful overview of potential catchment area revenue is fundamentally flawed due to the inadequate treatment of spatial interactions and the inadequate treatment of competitor impacts. (for more details see Benoit and Clarke, 1997).

It should be noted that in more manual catchment area analysis some of these problems have been solved quite effectively (see Davies and Rogers, 1984). However, little of this work has so far appeared in GIS packages to sophisticate the level of analysis.

For these reasons, a number of retailers have looked at the potential of spatial modelling techniques, such as *spatial interaction models.* These are a feature of the latter stages of phase II. Indeed, Simkin (1990) observes:

> "While mathematical models have been created, there is a dearth of operationally predictive models capable of reproducing meaningful and useable information for a company's management." (p. 33)

The situation however changed rapidly in the early 1990s. To illustrate the power of these models we first need to briefly explain their structure.

Let us label any residential zone such as a postal sector or enumeration district (i) and any facility location such as a centre or supermarket (j). Then the number of people travel-

Table 2. 'Sears' target markets in the late 1980s (cf. Dawson and Broadbridge, 1988)

Operation	Sector	Target/position
Fosters	Menswear	Middle market, 15–30
Your Price	Menswear	Keen-priced fashion
Bradleys	Menswear	30–50, traditionalist
Hornes	Menswear	25–40, up-market
Zy/Jargon	Menswear	Younger men
Wallis	Womenswear	25–35 professional
Miss Selfridge	Womenswear	Young fashion
Curtess	Footwear	High-volume, low-price
Freeman Hardy and Willis/Trueform	Footwear	Family
Dolcis/Tiptoe/Bertie	Footwear	Fashion
Saxone/Manfield/ Lilley and Skinner	Footwear	Quality/high price

ling between i and j can be labelled S_{ij}, and modelled using a spatial interaction approach:

$$S_{ij} = A_i \times O_i \times W_j \times f(c_{ij}), \qquad (2)$$

where, S_{ij} is the flow of people or money from residential area *i* to shopping centre *j*, O_i is a measure of demand in area *i*; W_j is a measure of the attractiveness of centre *j*; c_{ij} is a measure of the cost of travel or distance between *i* and *j*; A_i is a balancing factor which takes account of the competition and ensures that all demand is allocated to centres in the region. Formally it is written as:

$$A_i = 1/\sum_j W_j \times c_{ij}. \qquad (3)$$

The model allocates flows of expenditure between origin and destination zones on the basis of two main hypotheses:
(i) Flows between an origin and destination will be proportional to the relative attractiveness of that destination viz. a viz. all other competing destinations.
(ii) Flows between an origin and destination will be proportional to the relative accessibility of that destination viz a viz all other competing destinations.

The model works on the assumption that in general, when choosing between centres which are equally accessible, shoppers will show a preference for the more attractive centre (which can be measured by size or other attributes such as car parking availability, price, etc). When centres are equally attractive, shoppers will show a preference for the more accessible centre. Note, however, that these preferences are not deterministic. Thus when choosing between equally accessible centres, shoppers will not always choose the most attractive. The models are therefore able to represent the stochastic nature of consumer behaviour. Neighbouring households would not be expected to behave in exactly the same way, even though their characteristics are similar. Equally, particular individuals and households will not always use the same retail centres.

These models can be *disaggregated* in a number of ways. First, recognition of different types of consumer such as car owners and non car owners is important in most real world applications. Second, as mentioned above, the destination attractiveness term can be disaggregated to include all sorts of centre or store attributes (Pacione, 1974; Spencer, 1978; Timmermans, 1981; Wilson, 1983). Thirdly, various forms of the distance deterrence term may be used and different transport modes introduced. Wilson (1983) provides a useful summary of the degree to which retail models can be disaggregated, whilst other authors have looked at new formulations of spatial interaction models which incorporate additional behavioural variables. Fotheringham (1986) has argued that the models need to be modified to allow stores in close proximity to other stores to have greater attractiveness to consumers. These competing-destination models measure relative accessibility of stores to one another to measure the degree to which stores located close to each other have a locational advantage over isolated outlets. This may be particularly important in comparison shopping.

The calibration procedures of mathematical models (that is, the procedure to set the model parameters to reproduce real world interactions) are not problematic when good interaction data is available and when the models are not highly disaggregated. Many organisations are becoming 'data-rich' and many will have at least some information on customer flows. If not, this is increasingly available from commercial agents or can be obtained using some kind of questionnaire or sample procedure. Once organisations realise the benefits of having such information they are normally happy to spend resources to rectify their data deficiencies.

So how would a retailer typically use such models? First the model is calibrated to reproduce existing interaction patterns between populations (either at home or at work) and shopping centres. This facilitates the estimation of store turnovers (which may not be available from published sources: few retailers have turnover estimates for their competitors for example). Having allocated expenditures between all retailers in this way then the most obvious new geographical indicator is that of local market penetration. Such indicators show that market share can vary enormously within regions. In addition to new information such as local market shares the models can also be used to compare actual turnovers to model predictions – that is given a certain population size and type and the nature of the distribution of all competitor outlets what would the model expect a

Table 3. Impacts of opening a new car dealership in Blackpool on the retailer's own outlets

	Previous sales	New sales ($000 per week)
New outlet in Blackpool	0	310
Chorley	448	445
Preston	805	796
St. Annes	412	391

certain outlet to be achieving in sales terms? This helps to provide a more objective picture of store potential. Is a store which turns over $3 million per annum doing well or badly in relative rather than absolute terms?

The models are most often used in what-if? fashion. Having identified the variations in market penetration the retailer may be keen to improve its performance by opening new outlets in the areas which currently have a low market share. The models can then be used to test the impact of a new store opening. The results for a new car dealership in Blackpool, Lancashire UK are shown in Table 3. Note here that the retailer is not only interested in the total sales predicted: the impact on the rest of his/her network is also crucial. In this case, the new Blackpool dealer generates $300 000 of new business which is mostly taken from the competition.

The use of spatial interaction modelling (still often referred to as gravity modelling in the literature) has increased since the late 1980s. Some organisations now develop these models in-house. Marks and Spencer is a good example of a recent convert to this methodology, especially as they search for sites outside the UK (see Bond, 1997). Elsewhere, such modelling is carried out by consultancy groups such as GMAP at the University of Leeds. By using such consultancy groups retailers can tap into years of university research into the development and calibration of these models. GMAP's client list in 1996 included a number of blue-chip clients working in many countries of Europe, America and Australasia (including Ford, Toyota, Mazda, Halifax, Barclays, Asda, Smith Klein Beecham).

What are the drawbacks with spatial interaction models? It has been argued that they are more powerful predictors of store turnovers and spatial interactions than any of the other methods so far introduced. They are however difficult to calibrate (data intensive) and it is likely that they must be disaggregated to fit the case-study under investigation. Given the complexities of consumer behaviour for different types of goods and services it is unlikely that a model which fits the car market, for example, can be taken off the shelf to operate in the bingo market. Thus the user needs to be a skilful spatial modeller. For these reasons, the availability of off-the-shelf- models in some GIS packages now might actually be a rather dangerous development (see Benoit and Clarke, 1997, for more details).

Phase III Increasing sophistication

It is interesting to speculate on the future of store location research. Some authors are convinced that the increasing saturation of many retail markets (in theory meaning no more new constructions are possible or feasible) means that store location research will become more redundant. Clarkson et al. (1996) suggest:

> "As the UK grocery market becomes increasingly saturated, the development of new stores on new sites would diminish in importance. The need for more sophisticated location assessment procedures would then become significantly less important to retailers in their pursuit of growth strategies (p. 31)."

However there are two major responses to such an argument. First, in many markets the notion of saturation can be challenged even in the sophisticated markets of the grocery sector in the late 1990s (see Langston et al., 1997, 1998,; Guy, 1996). Second, it could be argued that the increasing sophistication of retailing may result in a greater need for store location research rather than less need. Clarkeson et al claim that the response of retailers to home saturation will either be internationalisation or store refurbishments. However they miss the point concerning alternative distribution systems. In the UK grocery market for example, we have witnessed the search for sites for a new wave of medium-smaller-sized supermarkets thus making their store location teams even more busy (Wrigley, 1998). In addition, retailers are looking for ways of analysing the impacts of new trends which threaten the traditional nature of distribution. These include a new wave of large corporate mergers and acquisitions, advances in information technology, and the process of disintermediation (this refers to the elimination of layers of added cost from the distribution network by companies which have previously relied on other organisations to sell their products: for example British Airways). These trends cast increasing doubts over branch viability and the threat of rationalisation is very real in many retail sectors. The simple removal of select branch outlets may not however be the optimal strategy. What branch closures does create is a network which may be at odds with the existing spatial demands of consumers. The lack of consideration as to the link between supply and demand remains a major drawback in business development strategies. What will be required is more flexible, local responses to these trends. That will require greater and more subtle store location research not less (see Clarke and Clarke, 1998, for more detail on this argument).

It is likely that store location research will itself develop over the next decade or so. The power of spatial interaction modelling is already being increased for example through optimisation procedures. In the long term a company may be interested to know what the optimal locations for their local network should be, given the objectives of either maximising total sales or market shares, and how this compares to the existing distribution network. Formally, the spatial interaction model can be rewritten as a mathematical programming

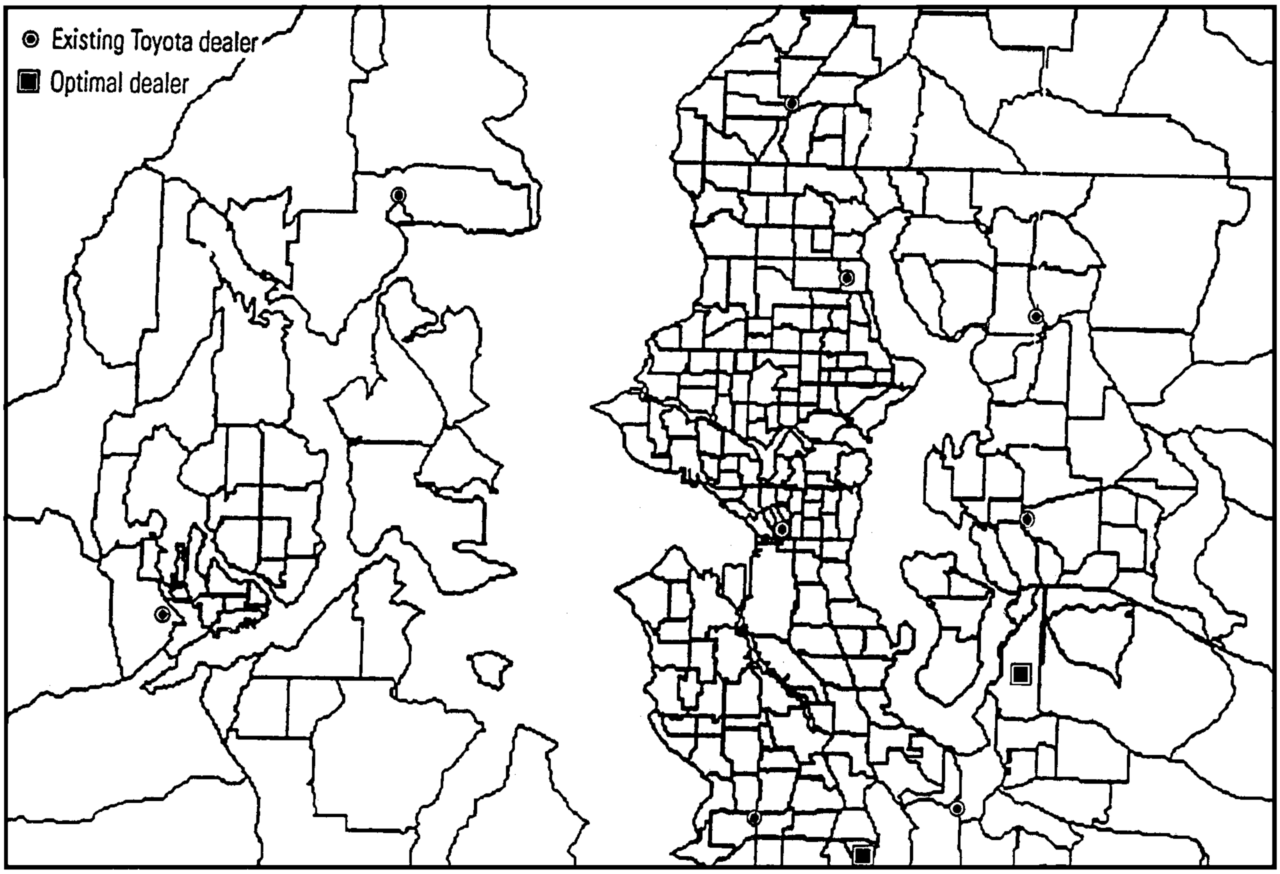

Figure 3. Optimal location of two new Toyota dealerships in Seattle, USA.

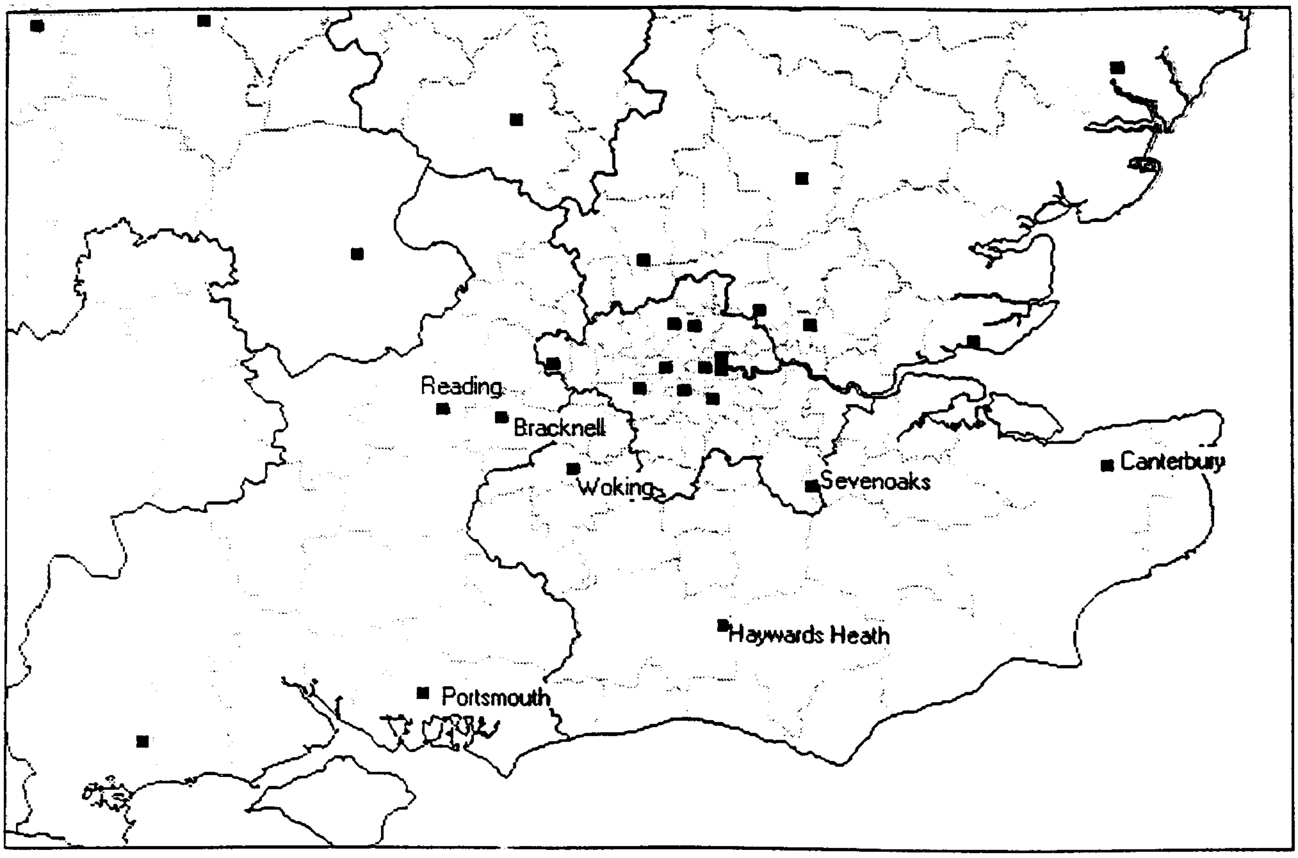

Figure 4. Optimal locations for an expensive new Toyota model in SE England.

formulation. The following may be a typical objective and set of constraints:

Maximise: Market share in region X for organisation Y.
Subject to: Maximum number of outlets,
Minimum number of outlets,
Minimum outlet sales of $Y,
Minimum inter-outlet drive time of T minutes,
No consumer to be more than M minutes drive-time from an outlet.

Either the problem can be solved with existing outlets in situ or with all outlets free to relocate (at least theoretically). A heuristic algorithm has been developed that solves this complex problem on a PC (for a full description of the detail see Birkin, Clarke and George, 1995).

To illustrate the results from this approach we can use a case study from the motor industry. The first example relates to Toyota's distribution network in Seattle, Tacoma US. Toyota have a current representation pattern in Seattle as shown in Figure 3 (note that the circles refer to current dealers). The task was to use the model above to ascertain whether any new opportunities for Toyota dealerships existed within the Seattle market. The criteria used for the optimisation model were as follows: there must be a minimum and a maximum of two dealers in the region, with no new dealer allowed within 13 minutes drive time of an existing Toyota dealer; each new dealer to have a minimum of 300 new car sales per year and no potential customer should be more than 25 minutes away from a Toyota dealer. The results of this analysis are also presented in Figure 3 which highlights the location of the two new dealers: one in the downtown area and an additional dealer in the prosperous eastern suburbs (here the squares identify the two new dealer locations). In total this scenario of openings generated 1068 volume sales with 850 incremental sales for Toyota (as some of the sales generated at the new locations are deflections of sales from existing dealers).

Simple arithmetic suggests that if this type of incremental improvement could be obtained in each of the 90 metropolitan markets in the USA then Toyota could generate over 75 000 additional retail sales per annum. The impact on profitability would thus be significant (see also Birkin et al., 1996; Clarke and Clarke, 1995).

A final example of the use of this optimisation procedure examines a 'clean sheet' scenario. Suppose we could develop our dealer network in a market from scratch: where would our dealers be compared to the current situation? To illustrate this we use the example of the launch of a new expensive car by Toyota in the UK. If they wish to sell 200 cars then where should these appear in the salesroom? Figure 4 shows the optimal locations for such an expensive car in the South East of the UK.

Alongside optimisation techniques it is likely that we will see more research on data mining to produce new models inductively. These models are often referred to as 'genetic algorithms' (GAs). This line of research is strongly advocated by Openshaw (1995). GAs begin with a (often simple) representation of the phenomenon to be modelled. This is termed the parent. Variations (or mutations) are then introduced to the main parameters of variables of the algorithm to see if it now reproduces the existing phenomenon more accurately. If there is an improvement in fit then the mutation becomes the parent! This continues until no improvement is made with new mutations. It should be apparent that there are many millions of possible mutations given the original parent. Experience on setting convergence criteria are thus important. It does however mean there may be many solutions which fit real-world data better then our existing models for clustering or site location. However, how good these 'mutations' are for prediction is a major unknown, since this type of inductive route may produce models which fit existing data well but which have no deductive theoretical base for making predictions. A fuller discussion of these methods would take us beyond the scope of this paper (see Openshaw, 1995, for more details).

There are few working examples in the retail world to date. One exception is the modelling technique proposed by Integral Solutions Ltd (1997). They have worked with Halfords (retailer of toys and bicycles) to produce a more accurate model of store success. They show the impacts of a new GA model (Clementine) fitted to a company data set in comparison with a normal regression model.

Conclusions

Whatever the past situation, retailing in the 1990s is evermore characterised by increasing competitiveness, falling margins and the exploitation of niche segments. Any competitive edge which a retailer can obtain in such an environment may prove to be precious. The pursuit of an optimal location strategy has the potential to provide such an edge. This paper has hoped to show the range of techniques currently on offer and how these can be used in actual applications. The case study element is naturally selective, with many companies keeping their store location methodologies close to their chests. It is though an undeniable fact that more organisations are committed to store location research than ever before and that the added complexity of the retail environment makes traditional methods of site assessment, especially those based on gut feel or intuition, progressively less effective. This is creating good job opportunities for geographers, whether within organisations themselves or through consultancy groups such as GMAP.

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