Article:

Newing, A, Clarke, G and Clarke, M (2018) Applied spatial modelling for retail planning in tourist resorts. International Journal of Retail and Distribution Management, 46 (11 / 12). pp. 1117-1132. ISSN: 0959-0552

https://doi.org/10.1108/IJRDM-10-2017-0253

International Journal of Retail & Distribution Management

Applied spatial modelling for retail planning in tourist resorts

Journal:	*International Journal of Retail & Distribution Management*
Manuscript ID	IJRDM-10-2017-0253.R3
Manuscript Type:	Research Paper
Keywords:	spatial interaction modelling, service planning and evaluation, retail impact assessment, grocery retailing, tourism

Applied spatial modelling for retail planning in tourist resorts

Abstract

Purpose: Demonstrate that applied spatial modelling can inform the planning, delivery and evaluation of retail services, offering improvements over traditional Retail Impact Assessment (RIA), especially within localities which experience seasonal fluctuations in demand.

Approach: The paper first describes a new theoretically-informed tourist-based Spatial Interaction Model (SIM) which has been custom-built and calibrated to capture the dynamics of the grocery sector in Cornwall, UK. It tests the power of the model to predict store performance for stores not used in the original calibration process, using client data for a new store development. The model is operationalised for the evaluation of various retail development schemes, demonstrating its contribution across a full suite of location decision making application areas.

Findings: The paper demonstrates that this highly disaggregate modelling framework can provide considerable insight into the local economic and social impacts of new store developments, rarely addressed in the retail location modelling literature.

Originality: The ability to review the forecasting capabilities of a model (termed post-investment review) are very rare in academic research. This paper offers new evidence that SIMs can support the Retail Impact Assessment (RIA) process.

Practical Implications: Whilst SIMs have been widely used in retail location research by the private sector, the paper shows that such a model can have considerable value for public sector retail planning, a sector which seemed to have abandoned such models from the 1980s onwards, replacing them with often very limited and crude RIA.

Keywords: spatial interaction modelling, service planning and evaluation, retail impact assessment, grocery retail, tourism.

1. Retail modelling in tourist resorts

Many retailers struggle to account for visitor-driven demand fluctuations when planning, operating or evaluating retail services in tourist resorts (Newing *et al.* 2013a: 2013b). Newing *et al.* (2013a) show that it is possible to use retail loyalty card data to identify seasonal fluctuations in consumer expenditures within tourist resorts. They demonstrate that more accurate demand-side expenditure estimates can be constructed using small-area data related to tourism (Newing *et al.* 2013b). They also demonstrate that these demand estimations can be incorporated within a spatial modelling framework, enabling retailers to identify seasonal variations in store trading characteristics and revenues more accurately than typical 'static' models (Newing *et al.* 2014a). Their evaluation of modelled 'goodness-of-fit' is based entirely on comparison with historic store trading data and they acknowledge the need to further assess model performance in a predictive context. This paper addresses the requirement for further model testing and application and specifically aims to:

(1) Evaluate the predictive capacity of a spatial model - designed to incorporate seasonal sales fluctuations (driven by tourism) - using very rare 'post-investment review' data provided by a commercial partner.

(2) Demonstrate the potential applications of theis model in (a) commercial sector store-location research and (b) public sector Retail Impact Assessment (RIA).

To address these aims, this paper utilises a Spatial Interaction Model (SIM), custom built and calibrated by the authors to capture consumer dynamics within the grocery retail market in the tourist region of Cornwall, UK. Cornwall has been chosen owing to data availability and previously published research related to this context (Newing *et al.* 2013a: 2013b; 2014a). Although these models have been used widely for 'what-if?' style applications, this paper offers something new to the literature. It outlines a spatial modelling framework which can be used to evaluate the commercial viability and the economic and social impacts of new retail developments in tourist resorts.

The SIM produces a series of indicators of store performance which enable the commercial sector to make more robust investment decisions concerning both size and location. The model is used to explore store extensions by taking an existing major retail store in the town of Padstow and exploring the trading implications of adding greater floorspace (to cope for demand unplanned for when constructed). The power of the model to predict new store revenue is demonstrated using a new store in a major Cornish coastal town (location not revealed in order to preserve commercially sensitive data). Although there are many examples in the literature of using the models for new store openings it is often not possible to evaluate the accuracy of those predictions longer term. However, uniquely, this paper uses trading data provided by a partner retailer to compare model prediction to actual performance 18 months after opening. This tests the power of the model to predict store performance for stores not used in the original calibration process. This paper also demonstrates how such a model, once calibrated and built using mainly private sector data, can also be used in a public sector environment to examine the impacts of a new store development: in this case in the coastal town of Looe.

The rest of this paper is set out as follows. Section 2 introduces the challenges of modelling spatiotemporal fluctuations in retail demand, especially those driven by tourism. Section 3 outlines the addition of tourism into SIMs from both a theoretical and practical perspective, also highlighting the nature of the model used in this paper. Sections 4-6 present three case studies which demonstrate the predictive capacity of this model and its potential commercial and public sector applications. Although distinct from one another, the three case studies are based on genuine store development proposals and illustrate the range of decisions supported by these models. Some discussion and concluding comments are offered in sections 7 and 8, outlining the potential for this modelling framework to support commercial decision making and as a evidence base and viable alternative to traditional RIA approaches in the public sector.

2. Literature Review: Modelling retail interactions in tourist resorts

British residents undertook just over 100 million domestic trips (those involving an overnight stay) in England in 2015, with a total annual spend of almost £23bn (Visit Britain, 2016). Tourist populations tend to cluster spatially and temporally at a local level, with implications for the planning, provision and evaluation of retail services. Spatiotemporal clusters of tourist populations are particularly evident within seaside towns during the summer months. Influxes of these non-resident populations boost local retail activity, stimulating consumer demand whilst also placing operational pressures on local services (see Cornwall Single Issue Panel (2004) for examples). In many cases an influx of visitors can substantially improve the viability of retail services. This may be especially true in smaller seaside towns and villages where provision of these services would not be viable based solely on the demand or utilisation originating from local residential populations. Modelling visitor demand at the local level requires robust information on visitor numbers, their characteristics and their seasonal and spatial distributions. Such data are routinely collected for residential and workplace populations via the census and other household surveys (for example the annual Office for National Statistics (ONS) Living Costs and Food Survey provides insight into household expenditures). Comprehensive or reliable statistics on the volume, value or seasonal distribution of visitors are not available at the sub-district level. Consequently very little is known about visitor population distributions or expenditures at a neighbourhood or small area level, yet these represent the typical catchments for local services such as retail.

Retailers struggle to quantify and assess the trading potential of retail developments in tourist resorts (Newing *et al.* 2013a; Newing *et al.* 2013b). Whilst the rate of new store development has slowed down (and in some cases retailers are undertaking store closure programmes), location-based decision making remains important, with Rogers (2016) strongly asserting that location modelling has an important role, even in an era where new store construction is not prominent. Wood and Reynolds (2012) note that retailers are increasingly focussing on developing and enhancing their location planning tools to support the monitoring, management and refinement of their existing store networks. This is especially true given the increase in customer-level data which can support retailers in building, calibrating and evaluating increasingly disaggregate models (Birkin *et al.* 2017; Sturley *et al*. 2017). The examples presented within this paper all demonstrate refined modelling capabilities for use in retail modelling within a specific location type where tourist-driven seasonal demand fluctuations are experienced.

SIMs are important and widely used modelling tools for location-based decision making across many retail sectors, with considerable uptake amongst grocery retailers (Reynolds and Wood 2010; Birkin *et al.* 2010; Birkin *et al*. 2017). SIMs predict consumer interactions with the retail supply side, determined by the volume of demand in a given small area 'origin', the attractiveness of the retail 'destination', the 'cost' of interaction and the level of local competition (Birkin and Clarke 1991). Birkin *et al*. (2010; 2017) show many real world examples of SIMs applied as retail location models and demonstrate that, with appropriate calibration, SIMs can act as a robust and accurate tool for store revenue estimation and impact assessment, modelling the impacts of supply or demand side changes on consumer interactions. They also demonstrate a wide range of applications across many retail sectors, showing how progress has been made in disaggregating SIMs to capture the increasingly complex consumer behaviours within different retail sectors, especially the grocery market. For example, SIMs have recently been very successfully disaggregated to address particular grocery market applications including discount retailing, the convenience sector and e-commerce (see Thompson *et al*. 2012; Hood *et al*. 2015 and Birkin *et al*. 2017 respectively).

SIMs have also been disaggregated to capture specific spatiotemporal characteristics of the demand side. These include diurnally fluctuating workplace populations, longer-term demand side fluctuations associated with student populations and seasonal demand originating from tourists and leisure populations (Waddington *et al*. 2017, Berry *et al*. 2016 and Newing *et al*. 2014a). The presence of non-residential populations (such as those driven by leisure and tourism, workplaces and educational establishments) can have considerable impacts on the spatiotemporal distribution of small-area populations (Martin *et al*. 2015; Bell, 2015) and implications for modelling retail demand. Supply side data derived from store transaction records provided by a partner retailer have shown that retail services in tourist resorts experience pronounced and prolonged seasonal sales uplift.

Newing *et al.* (2013a) demonstrate that seasonal sales uplift is experienced at a selection of Cornish supermarkets between March and September. Given that comparable stores located in non-coastal resorts do not experience a commensurate sales uplift, this demand can be attributed to additional expenditure by visitors. Newing *et al*. (2014) incorporate tourist demand within a SIM and the modelling framework that they introduce - to capture seasonal fluctuations in tourist-derived expenditure - is the basis for the analysis undertaken in this paper. In section 3 we demonstrate that this SIM affords an excellent predictive capacity against historic store revenue data. Public sector Local Planning Authorities (LPAs) also struggle to account fully for the economic and social impacts of tourist-driven expenditure when assessing the impact of retail supply side changes on the trading potential of existing stores, consumer choice and consumer access. These are an important part of the RIA process mandated within planning policy for retail developments in England meeting certain criteria (primarily greater than 2,500 square metres in size and not in accordance with a current 'Local Plan') (Communities and Local Government 2012). The robust spatial modelling framework presented in this paper can offer an evidence base for public sector RIA, despite a move away from using such models at planning enquiries since the 1980s (Guy 1991, England 2000, Khawaldah *et al.* 2012), discussed fully in section 7. This paper thus addresses the paucity of robust examples, within the academic literature, of applications of spatial models which can be used to support the location planning and retail impact evaluation process in tourist resorts.

In the following section we introduce the demand and supply side representation of the grocery market and the SIM used within our case study examples.

3. Incorporating non-residential tourist populations within retail modelling

Custom-built visitor population and expenditure estimates were constructed using a two stage process summarised here and reported fully in Newing *et al.* (2013b). The first stage inferred counts of overnight visitors at any given time of the year, driven by the spatial distribution of visitor accommodation and their seasonal occupancy rates. Visitors using all forms of commercial accommodation (e.g. hotels, guest houses, camping and caravanning) were accounted for utilising geocoded databases of visitor accommodation, in addition to those staying with friends and relatives or in a second (holiday) home. There are scarce data sources which provide comprehensive information on small area accommodation stock (Scanlon *et al.* 2014; Johns and Lynch 2007; White 2010) and the effort required to compile and verify the underlying accommodation stock should not be underestimated. This process, combining the visitor accommodation stock with known occupancy rates enabled us to calculate a proxy for small-area visitor numbers, (comprising the average number of visitors staying overnight per night) at the census Output Area (OA) level (the smallest geographical unit for the reporting of population statistics in the UK, widely used for planning and evaluating service delivery and typically comprising around 125 households). They were reported on a monthly basis, accounting for seasonal fluctuations over the temporal recording period typically used within the tourist sector.

The second stage involved the estimation of (grocery) expenditures associated with these visitors, utilising local and national surveys and insight from store loyalty cards provided by a partner retailer (see Newing *et al.* 2014b for more detail on the insights derived from these loyalty card data). Expenditure estimates accounted for differences in party size, trip length and associated spend at different times of the year and by different type of accommodation (documented fully in Newing *et al.* (2013b)). Expenditure estimates relate specifically to expenditure within grocery stores and take account of leakage of food and drink expenditure to other sectors (such as restaurants and takeaways) frequented by visitors. The approach could be applied to any time period and retail sector for which suitable data are available.

The procedure summarised above generated a series of seasonal demand 'layers' representing estimated OA level visitor grocery expenditures at different times of the year. These layers were used (in conjunction with small area estimates of residential expenditures) in a custom built and calibrated SIM. All expenditure estimates were at the OA level, with OAs forming the zonal system used for model building, calibration and analysis of model outputs. Residential expenditure estimates are 'static' (no seasonal variations), but seasonal variations in residential households purchasing groceries for visiting friends and relatives are incorporated within these seasonal visitor expenditure estimates. In the SIM, modelled consumer interactions are driven by store characteristics (size and brand) and accessibility (road travel time), with the model disaggregated by retail brand and by consumer characteristics in order to generate realistic flows. We incorporate 8 consumer types (7 types of residential household based on the 7 supergroups reported in the 2001 Output Area Classification, plus visitors). The SIM used in this study (cf. Newing 2014a) is as follows:

$$S_{ij}^{k} = A_i^k O_i^k W_j^{\propto^k} exp^{-\beta^k c_{ij}}$$

Where: S_{ij}^{k} *represents the expenditure flow between demand zone i and store j, by consumer of type k.*

A_i^k *is a balancing factor which takes account of competition and ensures that all demand is allocated to stores within the modelled region. It is calculated as:*

$$A_i^k = \frac{1}{\sum_j W_j^{\propto^k} exp^{-\beta^k c_{ij}}}$$

O_i^k *represents the demand (expenditure) available in residential zone i by consumer of type k.*

$W_j^{\propto^k}$ *represents the overall attractiveness (size) of store j and the additional brand attractiveness of store j (captured by* $\propto$*) to consumers of type k*

$exp^{-\beta^k C_{ij}}$ *is the distance deterrence term, incorporating* β^k *the distance deterrence parameter for consumer of type k,* C_{ij} *the travel time between zone i and store j and an exponentially increasing 'cost' of distance.*

The development and calibration of the model is illustrated in detail in Newing *et al.* (2014a), drawing upon empirical data from a partner retailer. In summary, the SIM has been calibrated using observed consumer-level interaction data (derived from a retail partner's loyalty card database) and known store revenues for a series of stores (of varying format and location types) within the modelled region. Model parameters ($\propto^k$ and β^k) were set such that modelled flows correspond as closely as possible with observed flows, utilising indicators of 'average entropy difference' (AED) and goodness-of-fit statistics via an iterative procedure outlined fully in Newing *et al.* (2014a).

It has previously been reported that this model, calibrated with reference to known consumer flows and store sales data, is able to estimate existing store sales to a very impressive level of accuracy (Newing *et al.* 2014a). Based on a series of test stores in Cornwall the model typically estimates store sales and their seasonal variations to within +/- 10% of observed (known) sales, and often to within +/- 5%. This holds true for contexts where the test store is the only major retailer in town (limited competition) and for test stores in major Cornish coastal resorts and towns or cities where considerable competition is experienced. This level of performance is considered to be comparable with retail sector users' expectations of model accuracy of +/- 10% (as implied by Birkin *et al.* 2010). Such model performance demonstrates that this approach can handle the local complexities of the tourist sector and their impacts on the retail supply side. However, the new tourist-based model has not yet been discussed in relation to its potential for innovative what-if analysis, as demonstrated in the case studies that follow.

The following sections provide three case study application areas which demonstrate the value of this model in addressing 'live' commercial and public sector decision making at the local level.

4. Case study 1: Store Extensions - Padstow

Store extensions are rarely discussed in the literature surrounding retail location modelling, although they are a key business growth strategy. For this case study reference is made to an existing modest sized Tesco store (10,500 square feet) in the popular coastal resort of Padstow on the north Cornwall coast. Here tourists support the provision of retail facilities and services far in excess of those that would be expected for a town of its size (population around 3,500). A number of large self-catering holiday parks and other accommodation sites are located in proximity to Padstow, whilst the town itself is one of the most popular destinations in Cornwall for second home ownership. The Cornwall Retail Study (GVA Grimley 2010) notes that the Tesco store (which is located at an edge-of-town site adjacent to a key road link) is the only store in the town that is suitable for residents and visitors to undertake a main food shop. The store experiences considerable operational challenges due to the seasonal influx of visitors to the resort, overtrading during the summer months and suffering long-term congestion within the store and car park.

In its current format the store is modelled to attract average sales of around £220,000 per week and a trading intensity (also known as sales density) of £20.88 per square foot per week. These rise to sales of almost £400,000 per week during the August peak period and a trading intensity of over £35 per square foot per week (Figure 1). Tesco suggest that across their UK estate, stores achieved an average trading intensity of £24.87 per square foot for the comparable period (Tesco Plc., 2012). The modelled performance of this store thus far exceeds company and sector averages between June and August[1]. The overtrading discussed above is evident from Figure 1, with clear implications for the

[1] It is likely that company average may be skewed by the high performance of some of the smaller 'Tesco Express' and 'Tesco Metro' stores serving major urban areas, whilst the average trading intensity for stores of a similar size to Padstow may actually be slightly lower.

observed in-store congestion, stock and staffing requirements and resultant customer experience. Tesco has taken temporary steps to address the issue of overtrading by locating a temporary 'seasonal/summer store' in a 500 square foot marquee in the store car park during the summer months (April to September) to stock seasonal items and ease congestion in-store (Maguire 2010).

[**Figure 1 about here**]

It is clear that the initial sales forecasts used to construct this store (which opened in the year 2000) considerably underestimated its sales potential. The conventional retail planning process failed to estimate consumer patronage and store performance accurately, particularly in terms of seasonal sales uplift. This resulted in construction of a store which is considered to be too small to adequately serve the needs of its catchment. This SIM could be applied routinely at the planning stage (pre-store construction) of such a development in order to predict sales fluctuations driven by tourism and to support retailers in making the case for appropriately sized retail facilities to meet the needs of residents and visitors within the proposed store catchment area. However, it can also be used to model store extensions for those existing stores which are now deemed to be too small to cater for demand within their catchment.

Table 1 illustrates four alternative store development proposals for this resort, including the current 10,500 square foot store (which acts as a benchmark) and three larger stores. Within the SIM, an increase in floorspace makes these larger stores relatively more 'attractive' to residents and visitors (e.g. enabling space for increased product ranges and easing in-store congestion), thus attracting a greater proportion of local grocery expenditure (assuming all other factors remain consistent). Modelling reveals that the construction of a store of 20,500 square foot (approximately double its actual size) would be accompanied by sales rising to in excess of £500,000 per week during the peak season (Table 1). Note however that as the revenue increases the revenue per sq.ft (or sales density) declines. This shows revenue and floorspace are not linearly related. Some customers will still prefer other brands in the model and will not switch patronage simply because the store is now larger. Although the larger stores trade annually at less than £15 per sq ft. per week, they would be able to attain £25 per sq. ft per week during the summer months.

[**Table 1 about here**]

When planning retail provision, retailers need to consider the impacts of new store developments across their entire store estate. Relative to the current situation (with the existing Tesco Padstow store), a larger Tesco in Padstow would impact on sales at their Wadebridge store (Table 1). However, these losses are estimated to be modest, and the net-effect would be an overall sales increase for Tesco (under any of the three modelled scenarios presented), largely achieved by reducing local residents' and visitors' expenditure outflow to competitors' stores. This example demonstrates how the model can be used to assess potential store extensions, accounting fully for the complexities of the demand side and supply sides, including potential trade cannibalisation within a retailers' own estate. Documents submitted as part of similar new store construction in Cornwall (API, 2012) reveal that far less sophisticated modelling is typically used to inform decisions on new store construction, including the appropriate size store for a given catchment area (discussed fully in section 7). We strongly argue that the robust spatial modelling approach that we outline can support decisions regarding optimal store size at the planning stage, reducing the need for retrospective addition of sales space (either via temporary marquee style sales space or permanent store extensions). In the following two case studies we demonstrate how the model can be used to accurately forecast store trading characteristics predicted prior to new store opening, using rarely available client data.

5. Case study 2: Post-investment review using commercial data

In this section further new evidence is presented to demonstrate the predictive accuracy of the SIM using applied commercial data very rarely available for academic studies. Drawing on a large-format new store development scheme by a partner retailer, our SIM is used to predict sales volumes and their seasonal fluctuations prior to store opening. It is rare that academics have the opportunity to test the accuracy of their model estimates against actual store trading data after store opening (post-investment review). With good data it is usually possible to calibrate a model to reproduce existing store revenues. However, how good can the model perform for new stores where no data (other than say brand and floorspace) is known about that store? This should be the real acid test of the model's performance.

Our model predictions were assessed against 18 months' worth of actual store trading data. Figure 2 shows that the SIM was able to consistently predict the magnitude of store sales (which were modelled on a weekly basis and compared with observed weekly sales, but are shown here on a monthly basis) and their seasonal fluctuations for this new store. With the exception of December (during which additional expenditure is driven by local residents purchasing supplies for Christmas (which is not captured within the residential expenditure estimates), the model predicts sales to within 5% of actual observed trading patterns. This is particularly encouraging since the store format, location and level of local competition is very different to the Padstow example. The SIM performed particularly strongly in April and July (April coinciding with an early Easter during the modelled year – traditionally marking the start of the tourist season), whilst overall store revenue predictions for May and June showed slightly less correspondence between observed and predicted store revenues (whilst still within a 95% accuracy threshold). These small variations are likely to be driven by a combination of store-specific factors (e.g. promotions) and natural fluctuations in tourist numbers and their expenditures which are impossible to capture within these expenditure estimates.

[Figure 2 about here]

Modelling the seasonal sales variations driven by tourism presents considerable challenges for the retail planning process since 'traditional' approaches to predict sales, market shares and local economic impacts of proposed store developments often fail to account for the spatial and temporal characteristics of visitor demand, instead a more simplistic revenue 'upscaling' process is used, discussed in section 7 The evidence provided here shows that the new demand estimates and SIM can support this process, modelling predicted seasonal sales fluctuations. In the following section a final more detailed case study is presented which demonstrates the utility of this modelling framework within the public sector arena (an assessment of impact to support the planning and RIA process), enabling an evaluation of the impact of proposed new service provision on consumer choice, consumer trip-making behaviours and trade diversion from existing stores.

6. Case study 3: Public Sector Retail Planning - Looe

Looe is a popular tourist destination located on the south coast of Cornwall. Tourism represents the town's main economic activity and much of its retail and service provision directly caters to the needs of visitors. Whilst the resort is well-catered for in terms of gift and craft shops, grocery retail provision is limited (at the time of analysis) to two small stores under the Co-op brand, suitable primarily for top-up shopping. Looe lacks the choice or provision of grocery retail services for residents or visitors to carry out a typical main weekly food shop, many being forced to travel to the nearest large supermarket (a ~25,000 square foot Morrisons store in the town of Liskeard, around 8 miles away) for this purpose (API 2012; Cornwall Council 2013b).

Our demand estimation (using the approach outlined in section 3) suggests an average total weekly expenditure on food and drink in Looe of around £300,000 per week in January, rising to over £600,000 per week during the August peak tourist season. Residential demand is distributed fairly uniformly across the demand zones (OAs) that make up the Looe catchment area. By contrast, peak season visitor demand (average weekly expenditure by visitors in August) exhibits a much higher tendency to be clustered towards the coastline (Figure 3), driven by visitors staying within the numerous holiday parks and camping and caravanning sites found here. Modelling suggests that residents and visitors within this catchment are dependent on the town centre Co-op stores. These have a combined market share of around 27% of all food and drink expenditure originating within the Looe catchment, well in excess of estimated averages for this brand and store format. The model also estimates that many residents and visitors living or staying in Looe travel beyond the town to carry out their main food shop, resulting in expenditure leakage to mid-sized Morrisons stores in Liskeard (around a 20 minute drive from Looe) and Bodmin (around a 30 minute drive from Looe). Visitors staying in over 1,500 accommodation units located in the OAs to the west of Looe face poor access to grocery stores, experiencing journey times in excess of 30 minutes to reach larger stores in Liskeard, St Austell or Bodmin due to the rural nature of this catchment and its poor road network.

[**Figure 3 about here**]

During 2012-13 three major retailers expressed an interest in developing a food store to serve the town of Looe. Tesco submitted a full planning application in February 2012 for a proposed ~25,000 square foot out-of-town store and an associated housing development to the north east of the town, which was refused against the recommendation of the local planning officer(s) (Cornwall Council 2013b). In October 2012 ASDA sought pre-application advice for a proposed store on land adjacent to the town (Coles 2012). In 2013 Morrisons outlined interest in opening a new supermarket of around 25,000 square foot via development of a brownfield edge-of-centre site at Polean in West Looe (Langford 2013) (shown on Figure 4). Their proposal utilises a site which is a natural expansion of the Millpool car park serving the town centre, providing good access for those residents and visitors to the west of Looe, already the most remote from food store provision. As an edge-of-centre brownfield site, Polean is planning policy compliant in an era of 'town centre first foodstore development' (see Lambiri *et al.* 2016). It is the only site specifically outlined in the former Caradon District Local Plan (Caradon District Council 2007) as suitable for a retail development. That proposal is used for modelling in this paper in order to demonstrate the potential application of the model and this paper does not seek to compare the three individual proposals.

The model suggests that a 25,000 square foot supermarket development on the Polean site would achieve an average weekly sales of around £300,000, with evidence of considerable seasonal sales fluctuations driven by visitor demand (Figure 4). The use of expenditure estimates at a small-area level enables detailed impact assessment which takes account of modelled expenditure flows which can be compared pre- and post-new store construction. Modelled expenditure inflows (Figure 5) indicate that the store would draw trade primarily from the town of Looe itself, alongside the rural and coastal catchment predominantly to the west of the town. The modelled trade area corresponds very closely with the distribution of visitor demand (Figure 3), offering considerable benefit to both residents and visitors to the town. The store is estimated to trade at an average sales density of £12.23 per square foot per week, well below the estimated company average (£17.83 per square foot per week) for Morrisons' Cornish stores. However, modelled sales densities increase to over £18 per square foot per week during the August peak-season. As such, a store of this size would be well placed to cope with the summer seasonal influx of visitors, plus future population growth within Looe (see below), but must address operational challenges driven by low sales densities at times during the off-peak season. Seasonal visitor demand thus improves the viability of this store which provides facilities for local residents, but where current residential demand alone may not be sufficient to support this level of floorspace provision.

[**Figure 4 about here**]

Whilst offering much needed retail facilities and opportunities for linked-trips with other town centre stores and services, the proposed store would inevitably impact upon trade at other nearby grocers. Retail location planners have an obvious interest in assessing these impacts, not least to ensure that new store development draws trade from competitors rather than cannibalise trade from retailers' existing stores. In this case modelling suggests that some trade will be lost at Morrisons' existing store in Liskeard, where 52-week average sales fall by over 11 % as a result of this investment. Nonetheless, with the incorporation of the proposed Morrisons' store in Looe, Morrisons' market shares within the Looe catchment area are estimated to increase by just over 30%, generating a net sales increase to the company of almost £220,000 per week. Little trade at the new store is estimated to be drawn from areas to the north east of Looe, from where it remains more convenient for residents and visitors to visit stores in Liskeard. Thus there is a good spatial fit between the existing Liskeard and proposed Looe store catchment areas.

[**Figure 5 about here**]

The model thus suggests that interest in opening a modest sized new store to serve the resort of Looe is justified and would enhance retail provision for both residents and visitors, whilst retaining expenditure currently leaking to other local retail centres. Cornwall Council's Strategic Housing Land Availability Assessment (Cornwall Council 2013a) suggests that Looe has a number of sites that are available and potentially suitable for the construction of up to 670 new dwellings, including 500 on a site in West Looe close to the proposed Polean supermarket development site. The potential for further housing development in Looe strengthens the case for a large-format foodstore to serve the town and may alleviate some concerns about potential under trading outside the tourist season.

7. SIMs as a tool for impact assessment

Since the 1980s in the UK SIMs have fallen out of use in typical RIAs (performed either by local authorities or by consultants for planning enquiries). Guy (1991) explains this as resulting from a lack of trust of the models, especially when presented by different parties to a planning enquiry. Some local authorities also claim the models have substantial weaknesses around methods and data (i.e. Aberdeenshire Council 2004) despite their growing use in the private sector (and the accuracy of results presented here). England (2000) and Khawaldah *et al.* (2012) discuss the alternative procedures usually implemented instead. Retailers are responsible for providing local planning authorities with a suitable RIA as part of the planning process, with retailers typically outsourcing these to retail consultancies. Khawaldah *et al.* (2012) note that RIAs are based largely on surveys of consumers to understand their store choice behaviours before and after proposed store investment. They highlight the commonly used 'step-by-step' RIA approach which uses these surveys to determine catchment areas (for existing and proposed stores) and to estimate consumer expenditures (multiplying the number of households by expenditure multipliers). Subsequent stages involve estimating new store sales and trade diversion from existing stores using turnover estimates based on average customer spend per unit of floorspace. Khawaldah *et al.* (2012) show the weaknesses embedded in these alternative RIA methods. The most important weakness is that many small centres are not mentioned by consumers as main retail destinations and thus they get ignored in any subsequent impact assessment. It is precisely these small centres which would in reality be hit the hardest. The case studies presented here shows the benefits of this tourist-based SIM for public sector planning which includes all existing retail centres, however small, and a more accurate and complete representation of the demand side.

A RIA undertaken in 2012 on behalf of Tesco (for their alternative store development proposal in Looe, relative to our case study presented in section 6) estimated new store trading potential using the step-by-step approach typical of RIA. It determined that the proposed store would achieve a turnover of £17.2m p/a, incorporating a 'sales uplift' of 30% above their baseline sales predictions (which were themselves derived from residential demand) in an attempt to account for additional visitor-induced expenditure (API 2012). Their analysis is based on a notion that sales derived from visitors represents a static 30% uplift (approx. £100,000 per week) and incorporates no seasonal fluctuations. The RIA undertaken also identified that a new foodstore serving Looe would have a limited impact on existing food and drink retailers within the catchment, with an estimated reduction in sales at these retailers of around 12.5% (API 2012). Our analysis suggests that this assessment is unrealistic, with the Co-op stores in the resort estimated to experience a 65% fall in trade. The survey based 'step-by-step' approach used for RIA fails to account fully for the complex spatiotemporal demand-side fluctuations and their interactions with the supply side. In common with Khawaldah *et al.* (2012) this paper suggests that SIMs offer a number of benefits over the commonly applied RIA methodology.

SIMs generate a more realistic representation of store catchments than a survey based approach, as they are disaggregated by consumer type and exhibit seasonal fluctuations. The SIM can also incorporate all retailers on the supply side (rather than the larger retailers typically considered in the RIA) and estimate their sales based on modelled flows rather than turnover ratios (which may not recognise local brand strength or preference). The modelling approach presented in this paper enables detailed impact assessment and can accommodate demand and supply side changes (such as new store development or new house construction). Modelling of this nature, incorporating underlying spatiotemporal demand estimates within a robust spatial model, offers considerable benefits to the private and public sector retail planning process as discussed in the following section.

8. Conclusions

Retailers and local planning authorities struggle to account for seasonal visitor demand fluctuations in a robust manner when assessing proposed new store developments (Newing *et al.* 2013a). Incorporation of seasonal visitor demand within a modelling framework enables more informed location-based decision making and impact assessment to be undertaken at every stage of the development process. This paper demonstrates the models' power in three very different 'what-if?' case studies. First the model has been used to explore the implications of store extensions. This is very useful application of the model as retailer's can try experiments on existing stores which will have to be made to work harder in future, more competitive retail environments. Second, drawing on very rare access to post-investment store trading data, this paper has demonstrated the excellent predictive capacity of the SIM to predict new stores trading characteristics. Such tests have rarely been seen (or been possible) in the academic literature. Third, in Looe, the paper has demonstrated the considerable utility this model offers both the commercial and public sector retail planning process. The trading potential of proposed new stores influences how much retailers are prepared to pay to secure a site and ultimately determines whether there is a sufficient financial business case to justify a proposed investment (Birkin *et al.* 2014). In many cases retail investment of this nature fulfills a social good, securing facilities for local communities and generating additional benefits via trade retention and linked trip generation (Lambiri *et al.* 2016). Stores serving smaller tourist resorts often provide much needed facilities, supporting both local populations and a seasonal influx of visitors. This modelling clearly demonstrates that the incorporation of visitor demand considerably improves the viability of store investments in coastal resorts (such as Looe) where residential demand alone could not support such investments.

Most notably, this modelling framework also offers considerable benefits to the RIA process. Planning policy dictates that a RIA should include assessment of the following, for which suitable indicators are captured within a spatial modelling framework:

> *"the impact of the proposal on existing, committed and planned public and private investment in a centre or centres in the catchment area of the proposal; and the impact of the proposal on town centre vitality and viability, including local consumer choice and trade in the town centre and wider area…"* (Communities and Local Government 2012, p8).

The potential value of this modelling approach (incorporating spatially and temporally disaggregated demand estimates within a framework which considers modelled expenditure flows at the small area level) in supporting location-based decision making is thus clear. It is vital that retailers, service providers and local planning authorities can accurately assess the trading potential and impacts of developments, especially in tourist resorts. The incorporation of seasonal visitor demand within a modelling framework such as this enables complex location-based decision making and impact assessment to be undertaken. This extends far beyond the estimation of seasonal fluctuations in store sales or service utilisation. Incorporation of seasonal visitor demand fluctuation throughout the modelling process enables planners, developers and local planning authorities a more complete and robust evidence base to support the planning, evaluation and assessment of local economic and social impacts arising from service development and delivery in seasonal tourist resorts.

References

Aberdeenshire Council (2004) *Assessing the impact of retail developments in Aberdeenshire: a guide for applicants, planning and services*, Aberdeenshire Council, Aberdeen.

API (2012) *Retail Assessment: Proposed Foodstore, Land off Barbican Road Looe,* Amethist Property Investments Limited, Bristol.

Beatty C, Fothergill S and Gore T (2014) *Seaside Towns in the Age of Austerity*, Centre for Regional Economic and Social Research, Sheffield.

Bell M (2015). "Demography, time and space", *Journal of Population Research*, 23(3-4), pp.173-186.

Berry T, Newing A, Davies D and Branch K (2016). "Using workplace population statistics to understand retail store performance", *The International Review of Retail, Distribution and Consumer Research,* 26(4), pp.375-395.

Birkin M and Clarke GP (1991) "Spatial interaction in geography", *Geography Review,* 4(5), pp.16-21.

Birkin M, Clarke GP and Clarke M (2010) "Refining and operationalising entropy-maximising models for business applications", *Geographical Analysis,* 42(4), pp.422-445.

Birkin M, Clarke GP and Clarke M (2017) *Retail location planning in an era of multi-channel growth,* Routledge, London.

Caradon District Council (2007) *Caradon Local Plan (First Alteration)*, Caradon District Council, Liskeard.

Coles M (2012) *Planning Pre-application advice for a Retail Foodstore (2323sq.m net) plus petrol filling station, car parking, service yard and major landscaping at land off St Martin's Road, Looe, Cornwall, PL13 1LP. Cornwall Council Reference Number: PA12/03167/PREAPP*, Broadley Park Properties Ltd., Looe.

Communities and Local Government (2012) *National Planning Policy Framework*, Department for Communities and Local Government, London.

Cornwall Council (2013a) *Planning Future Cornwall: Strategic Housing Land Availability Assessment,* Cornwall Council, Truro.

Cornwall Council (2013b) *Strategic Planning Committee Report - PA12/06664*, Cornwll Council, Truro.

Cornwall Single Issue Panel (2004) *The impact of tourism on Health Services in Cornwall*, Cornwall Single Issue Panel, Truro.

England J (2000) R*etail impact assessment: a guide to best practice*, Routledge, London.

Guy C (1991) "Spatial interaction modelling in retail planning practice: the need for robust statistical methods", *Environment and Planning B: Planning and Design, 18(2),pp.191-203*

GVA Grimley (2010) *Cornwall Retail Study*, GVA Grimley, Bristol.

Hood N, Clarke GP and Clarke M (2015) "Segmenting the growing UK convenience store market for retail location planning", *The International Review of Retail, Distribution and Consumer Research,* 26(2), pp.113-136.

Johns N and Lynch P (2007) "The self-catering accommodation market: A review of electronic and other sources", *Hospitality Management,* 26(2), pp.293-309.

Khawaldah H, Birkin M and Clarke GP (2012) "A review of two alternative retail impact assessment techniques: the case of Silverburn in Scotland", *Town Planning Review,* 83(2), pp.233-260.

Lambiri D, Faggian A and Wrigley N (2016) "Linked-trip effects of 'town-centre-first' era foodstore development: An assessment using difference-in-differences", *Environment and Planning B: Planning and Design,* 44(1), pp.160-179.

Langford R (2013) *Letter from WM Morrison Supermarkets Plc. to Cornwall Council dated 4th February 2013 Re: Polean, West Looe, Cornwall*, Morrisons, Bradford.

Maguire M (2010) *Application for Planning Permission Submitted to Cornwall Council: Erection of a Temporary Extension to Tesco store, Padstow. Ref: 2010/00221*, Finch Associates, Carnoustie.

Martin D, Cockings S and Leung S 2015. "Developing a Flexible Framework for Spatiotemporal Population Modelling", "*Annals of the Association of American Geographers", 105(4), pp.754-772.

NEF (2015) *Blue New Deal: Good jobs for coastal communities through healthy seas*, New Economics Foundation, London.

Newing A, Clarke GP and Clarke M (2013a) "Identifying seasonal variations in store-level visitor grocery demand", *International Journal of Retail & Distribution Management,* 41(6), pp.477-492.

Newing A, Clarke GP and Clarke M (2013b) "Visitor expenditure estimation for grocery store location planning: A case study of Cornwall", *International Review of Retail, Distribution and Consumer Research,* 23(3), pp.221-244.

Newing A, Clarke GP and Clarke M (2014a) "Developing and applying a disaggregated retail location model with extended retail demand estimations", *Geographical Analysis,* 47(3), pp.219-239.

Newing A, Clarke GP and Clarke M (2014b) "Exploring small area demand for grocery retailers in tourist areas", *Tourism Economics,* 20(2), pp.407-427.

Reynolds J and Wood S (2010) "Location decision making in retail firms: evolution and challenge", *International Journal of Retail & Distribution Management,* 38(11/12), pp.828-845.

Rogers D (2016). *Location Planning Research in a new location landscape. Presentation delivered at the 2016 Retail Location Analysis (RLA) programme at the Saïd Business School, University of Oxford, 15th - 17th March 2016.* Saïd Business School, Oxford.

Scanlon K Sagor E and Whitehead C (2014) *The economic impact of holiday rentals in the UK: Final Report*. London School of Economics, London

Sturley C, Newing A and Heppenstall A (2017). "Evaluating the potential of Agent Based Modelling to capture consumer store choice behaviours", *International Review of Retail, Distribution and Consumer Research*, Online first publication: http://dx.doi.org/10.1080/09593969.2017.1397046

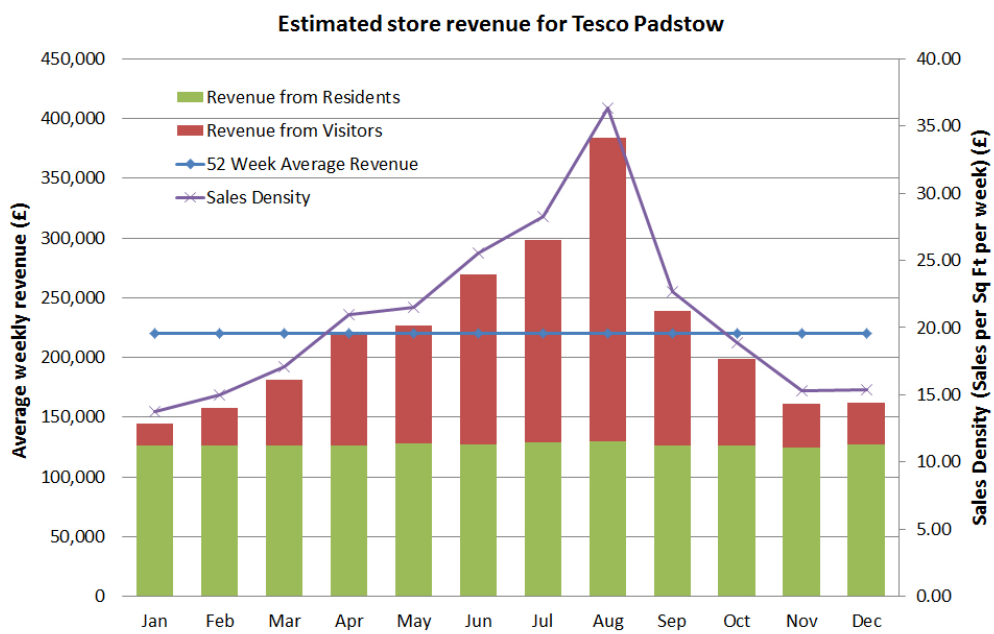
Thompson C, Clarke GP, Clarke M and Stillwell J (2012) "Modelling the future opportunities for deep discount food retailing in the UK", *The International Review of Retail, Distribution and Consumer Research,* 22(2), pp.143-170.

Visit Britain (2016) *The GB Tourist: Statistics 2015*. TNS, Edinburgh.

Waddington T, Clarke GP, Clarke M and Newing A (2017) "Exploring spatiotemporal fluctuations in UK grocery store sales", *International Review of Retail, Distribution and Consumer Research,* Online first publication: http://dx.doi.org/10.1080/09593969.2017.1333966.

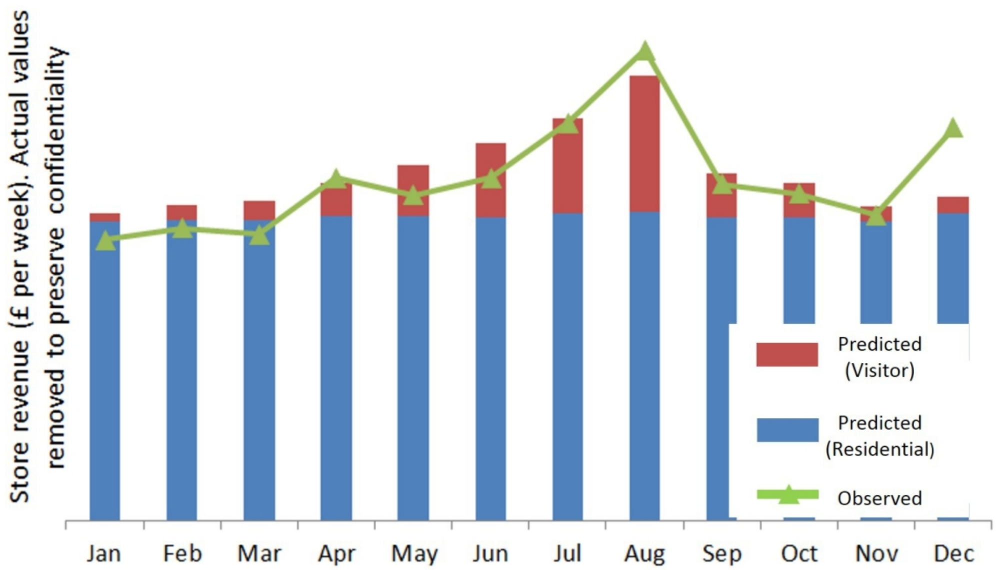
White S (2010) *Measuring Tourism Locally: Guidance Note Five: Measuring the Supply Side of Tourism.* Office for National Statistics, Newport

Wood S and Reynolds J (2012) "Leveraging locational insights within retail store development? Assessing the use of location planners' knowledge in retail marketing", *Geoforum,* 43(6), pp.1076-1087.



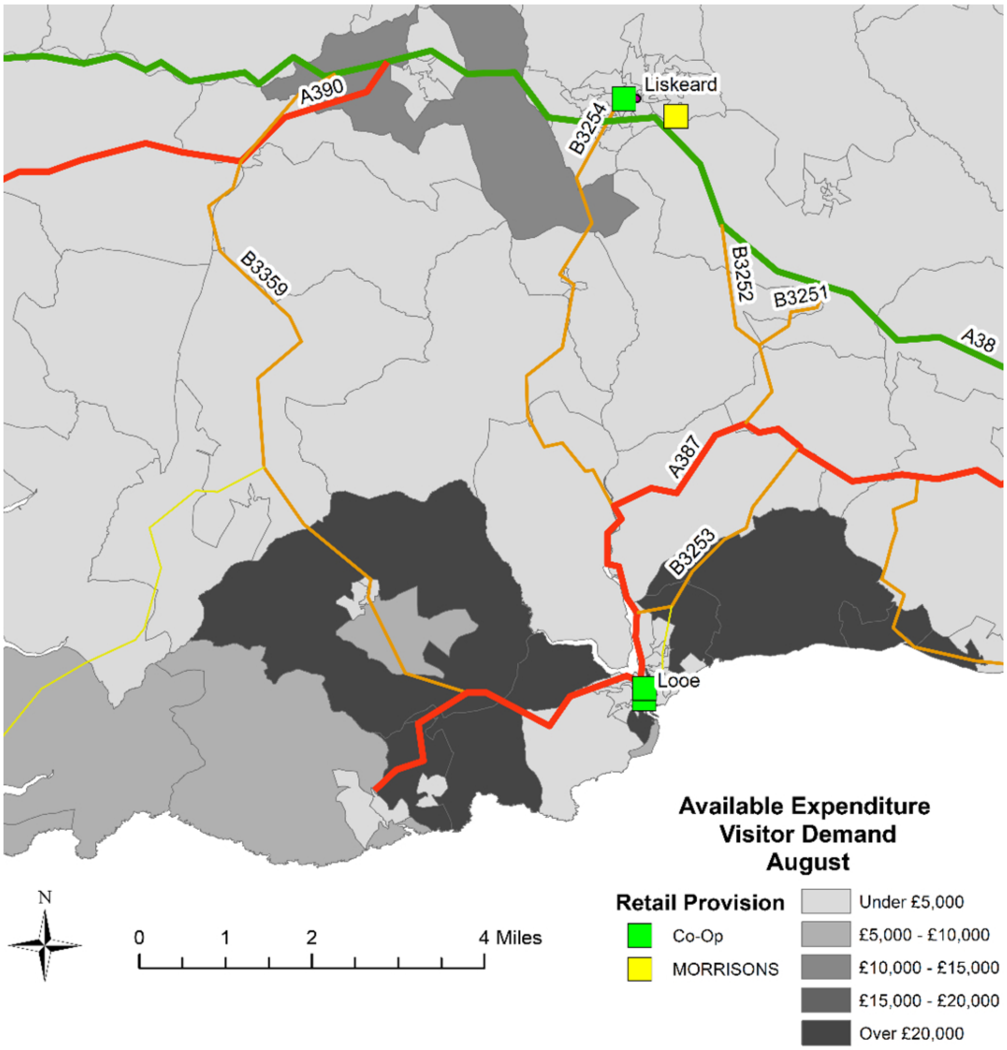
Modelled (estimated) store sales and sales density for Tesco Padstow (based on 2010 data)

253x162mm (96 x 96 DPI)



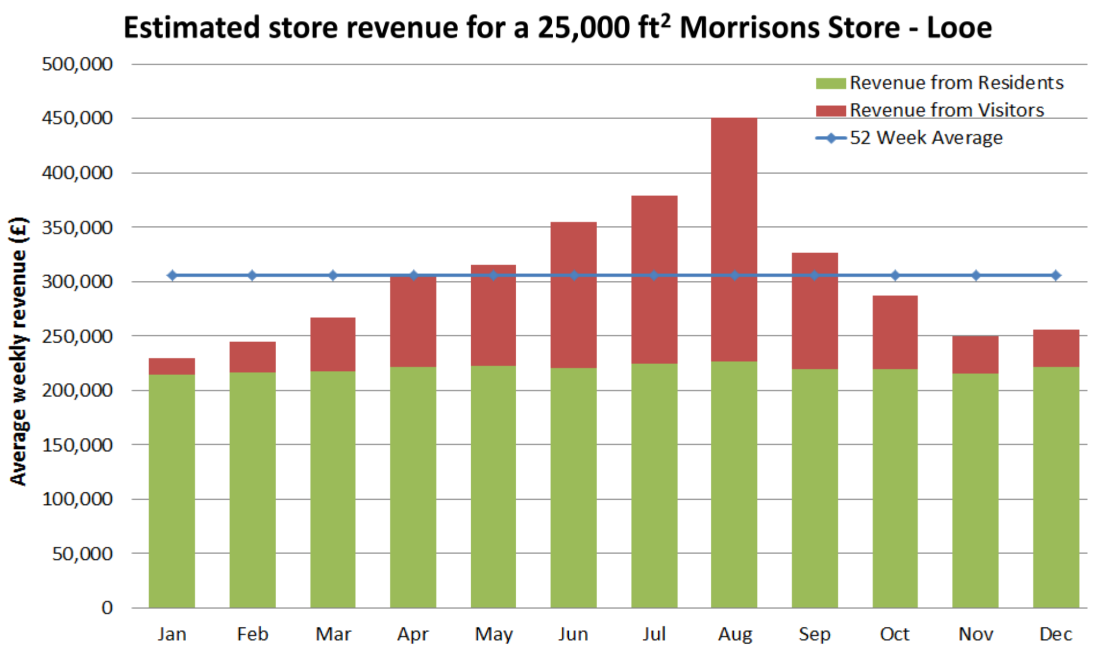
Observed (post-investment) and predicted (pre-investment) seasonal sales estimations for collaborating retailers' Cornish test store.

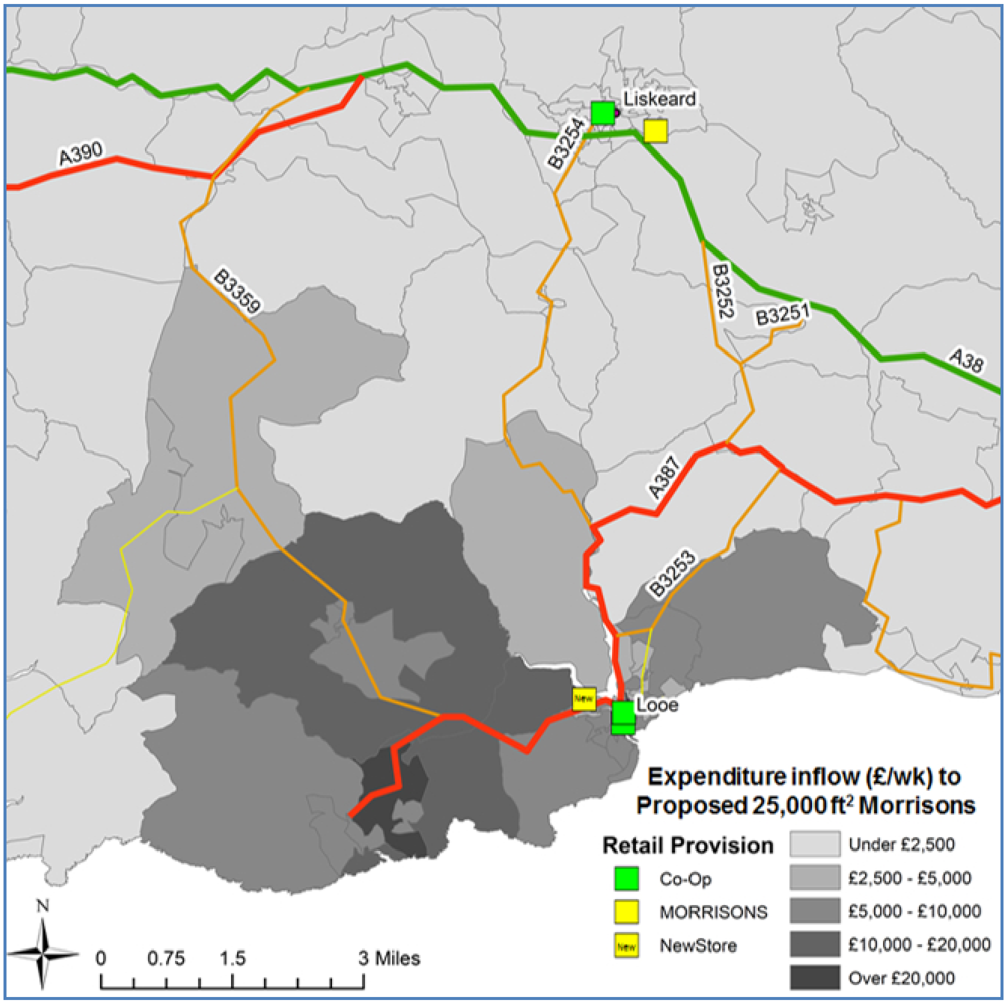
258x147mm (150 x 150 DPI)



Visitor grocery expenditure estimates (£ per week) (August) by OA

171x180mm (150 x 150 DPI)


Estimated store revenue for a 25,000 ft² Morrisons Store - Looe
Average weekly revenue (£)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Revenue from Residents
Revenue from Visitors
52 Week Average
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Modelled expenditure inflow (£/week) by census Output Area to proposed new Looe food store

112x111mm (150 x 150 DPI)

Table 1: Evaluating alternative store sizes (Tesco Padstow)

	Current 10,500 square foot store	15,500 square foot store	20,500 square foot store	25,500 square foot store
Peak sales (per week)	£373,340	£452,780	£512,677	£561,539
Peak trading intensity	£35.56	£29.21	£25.01	£22.02
52 week average weekly sales	£219,201	£262,004	£299,754	£331,473
52 week average trading intensity	£20.88	£16.90	£14.62	£12.99
Impact on Wadebridge Tesco 52 week average weekly sales (per week)	n/a	-£16,947	-£30,853	-£41,783
Impact on Tesco overall 52 week average sales (per week)	n/a	£25,856	£49,700	£70,489

Response to reviewers

Manuscript: IJRDM-10-2017-0253.R1

We thank both reviewers for their detailed and incredibly helpful reviews. We are incredibly pleased that Reviewer 2 thought so highly of the paper and recommended publication with no revisions.

We are grateful for the suggestions and comments raised by reviewer 1 and are pleased to detail below the amendments and improvements made in relation to the specific comments and suggestions raised by reviewer 1. Where page or line numbers are given, these relate to the PDF of the 'Revised manuscript for review':

1. "Restructuring is needed with more relevant sub-heading". *On reflection we agree! We hope you'll now find the structure more logical – with a new section (section 7) added 'SIM as a tool for impact assessment' and considerable restructuring within sections 2, 3 and 6, plus amended sub-headings for sections 1 and 2.*
2. "The data used needs more clarity" and "For example, k = consumer type. How many types of consumers are there? It is unclear whether the different types of consumers are residents, visitors, etc, or whether there is just one type of consumer. This needs more clarity. The same goes for zones." W*e have clarified aspects of the input data and model structure in section 3, in particular on page 3 lines 26-37) we now outline fully the disaggregation of consumer type and the use of OAs as the zonal system and spatial building block for this study.*
3. "The importance of the results needs to be more significant" and "There should be more focus on the importance of this model for companies and the public, particularly if it is better than traditional RIA models". *We have revisited all sections of the paper and strengthened our discussion of the importance and significance of these results. We are now clearer in the abstract and introduction that a major contribution is the demonstration of the value these models can offer the RIA process (in additional to the novelty and originality of the model testing that we carry out). The addition of a new section (section 7) specifically highlighting this aspect of our work also addresses this valuable point.*
4. "More emphasis on the difference between the SIMs model compared to the traditional retail impact assessment". *We hope that this is now clearer in section 7, whilst we have also embedded greater reference to the differences between SIM and RIA throughout the manuscript, especially in our discussion of the findings and implications from each of the three case studies.*
5. "The literature was relevant, there could have been more focus on papers that have used this particular model previously. There is focus on its importance and that it has been used widely but lacks specific studies of its success/failure". *In section 2 (particularly page 2 lines 19-32) we cite a number of examples of specific studies that have used disaggregated SIMs in the grocery sector, including papers that use this exact model. We have made it clearer (in our discussion of those papers) of their 'success' and also cite key review/summative papers that reinforce those points.*
6. "The methodology section needs restructuring. It begins with a discussion of a two-stage process, but the second stage in the process is not clearly portrayed". *We agree entirely. We have restructured the methodology (Section 3) and we hope you'll agree that the two stage process is now explicit and clear.*

7. "The three case studies are interesting, it seems that the three case studies could have been three separate papers. It is unclear how the three fit together." *You're right that each case study could have been a paper in its own right. We have focussed on three different case studies in order to demonstrate the versatility of this model to support location-based decision making in different location types (coastal resort, small town, large town etc.) and for store development proposals of very different scales. We have made it clearer in our manuscript that these are three distinct case studies, which are linked by:*
    a. *Utilising the same model and input demand layers*
    b. *Geographical proximity – all are within Cornwall and benefit from the same tourist demand uplift which presents challenges for the modelling process*
    c. *Representing 'live' schemes at the time of analysis*

8. "The final case study is the biggest contribution to knowledge but the results are rather short and there is no reference to literature here." *We note that our discussion of this case study does include reference to academic literature and industry documents. However, with the reorganisation and addition of section 7 we are confident that this discussion is now stronger and more firmly embedded within both the literature and our overall argument.*

9. "As the paper uses someone else's model, there needs to be a more significant focus on the practicalities of using the model and the final case study could have displayed this" and "At first it seems that the paper has designed the model, not just testing it. A general reader may get this confused." *This is our own model! We have tried to make this as clear as possible (e.g. using terms such as 'new model' and 'custom built', whilst maintaining anonymity to enable peer review. Post-peer review we are happy to amend to make this explicitly clear.*