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Planning For Sustainability: Future Retail Centre Locations

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Abstract

The concept of 'sustainable retail development' implies that retail centres should serve their communities economically and socially, while not degrading local environments. However, existing evidence shows that shopping malls often negatively impact both the core and peripheries of city regions from environmental, social, and economic perspectives. This paper adapts commuting data to estimate the hypothetical shopping-related emissions associated with travelling to-and-from retail centres. We perform this analysis at the Small Area level for Ireland's five major city regions. Our results suggest that the environmental degradation from retail centres increases as distances from urban cores increase.

Keywords: cities; retail sprawl; CO_2 emissions; travel mode choice.

Introduction

Urban sprawl refers to the uncontrolled spread of low-density built environments around city centres. Sprawling built environments are generally characterised by segregated land-use, low-density residential housing, and poor transport accessibility.[6] This means that these built environments tend to exhibit a dependency on private cars as the primary mode of transport for residents due to the relative dispersion and isolation of land-use types.[3,6]

These common characteristics help explain why sprawl is often regarded as synonymous with suburbanisation. Suburbanisation is typically characterised by inadequate public transport networks and increased car-use, alongside the segregation of residential, leisure, and commercial land. Ultimately, this process creates a region/city that has expanded geographically, increasing the travel needs of individuals. These increased mobility needs become problematic over time as suburbs typically fail to provide adequate public transport, and regular walking/cycling is impractical, meaning people may become dependent on cars, worsening prob-

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lems associated with excessive traffic and congestion.

Consequently, a consensus has emerged that urban sprawl in all forms contributes to excessive environmental degradation. Here, we focus on a particular dimension of urban sprawl, namely *retail sprawl*, and its relationship with environmental degradation. Retail sprawl refers to when businesses follow people by leaving city centres to avail of cheaper and more abundant land in suburban environments.

International literature has addressed many sprawl-related problems, and specifically calls for more research investigating the relationship between built environments and travel behaviour.[1,2] From a policymaking perspective, this research is situated at the heart of the United Nations' Sustainable Development Goals (specifically Goal 13.2.1) and compliments the strategic objectives of *Project Ireland 2040* which provides a roadmap on how Ireland can grow sustainably from a land-use and transport policy perspective.

We build upon O'Driscoll et al., (2022)[5] where we model retail development in terms of minimising the travel-related emissions associated with travelling to-and-from existing retail environments. Specifically, here we model environmental degradation in the context of hypothetical retail sites, investigating where retail centres are hypothetically most environmentally damaging. Geographic Information Systems (GIS) facilitate our analysis by showing how transportation networks, residential locations, and retail centre characteristics are related and the hypothetical environmental impacts involved.

Background

Suburbs as we know them today would not have developed were it not for the modern car. Increased car usage in the twentieth century resulted in increased road construction as road space demand outpaced supply. This happened because it quickly became apparent that people with a car could live further away from city centres without compromising their economic and employment opportunities, whilst also being able to avail of cheaper residential land. This ultimately raised the demand for cars.

Increasingly large road networks worsened traffic and congestion problems, as people became incentivized to purchase cars and use this new infrastructure. Whilst this was inherently a global phenomenon in the decades proceeding WW2, in an Irish context, political pressure to embrace car technology and growth during the roaring Celtic Tiger was reflected in regional development through the persistent development of car-orientated suburbs. This intertwined sprawl and car use, which has led to the creation of car-exclusive regions.

The economic theory of sprawl stems from theories which generally argue that regions geographically expand uniformly around a central hub.[7] This expansion reduces population densities and land values as distances from this hub increase, reflecting some of the trade-offs people face when choosing residential location (i.e., distance between home and work).

In economic terms, sprawl is more expensive than compact developmental forms. This is because the more space an area takes up, the more expensive roads, pipes, and other infras-

tructure become to install. Compounding this, is that these types of developments inefficiently use natural resources, resulting in habitat degradation. Generally, the main tangible benefit surrounding such wasteful developmental forms revolves around private transport... and bigger back gardens.

If the primary costs of sprawl stem from its spatial demands, measures countering these demands should be prime counterbalancing options. Measures like mixed-use regional development policies offer these counterbalances by inherently invoking efficient infrastructure and land usage, alongside increased accessibility to alternative transport modes, reducing the costs of sprawl as a consequence.

Retail sprawl encapsulates this issue of inefficient regional development. Given that these retail centres are so big, require heavy investment/planning, and cannot be easily altered once built, their development ought to be in line with sustainability goals by discouraging excessive car use and inefficient infrastructure use. In reality, these centres tend to be developed along regional fringes, with little regard for any mode of transport except for cars. This creates problems as they worsen local congestion, degrade regional environments, and can negatively impact local economies. Fortunately, making developers pay for these hidden problems has been found to alleviate retail park establishment because it discourages locating retail environments far from population centres and far from areas adequately served by alternative transport.

Data and Methods

Our analysis focuses on Ireland's five administrative city regions: Dublin, Cork, Limerick, Galway, and Waterford. Building on a current project, which investigates existing retail dynamics, we model travel-related environmental degradation attributable to hypothetical retail centre sites. Our objective is to investigate the hypothetical retail locations which are most environmentally damaging. Our population sample is ringfenced according to travel times to these hypothetical sites from residential areas. Specifically, people living beyond a 1-hour drive are excluded. This regulates population statistics, preventing the inflation of estimated environmental degradation.

Using Irish Census (2016) and OpenStreetMap data, we construct an Origin-Destination (OD) Matrix comprised of residential locations (origins) and retail locations (destinations). An OD-Matrix calculates routes from each origin to every destination along a given network (i.e., roads), creating a dataset containing the shortest route taken from each origin to every destination along the network. In the context of this study, every origin assumes the capability of hosting a retail centre. As a result, Figure 1 displays results showing the hypothetical environmental degradation attributable to travelling from every origin to every destination. The transport mode people take during these shopping trips is cars. All trips are assumed to be direct, meaning people begin their journeys at home, go directly to their retail centre, and go directly home afterwards.

Small Areas (SA) within the Irish Census are the spatial unit of analysis used. The network

people travel along is the national road network with travel speeds manually inputted. Environmental degradation is proxied by producing emission output estimates in terms of CO_2 released per minute travelled per person. The numbers of car users per origin is the proportion of car commuters per Small Area. These estimates are then accumulated to measure the prospective travel-related environmental impact attributable to placing a retail centre in these locations.

Results and Discussion

The results of our analysis are presented below in Figure 1. For ease of interpretation, hypothetical environmental degradation is presented on an interval scale, whereby 1 indicates sites where retail centres will be least damaging, while 5 indicates sites which will be the most damaging. Departures from the pattern in the city-specific illustrations display the results of an identical analysis conducted on existing retail centre sites.

Figure 1 below illustrates that environmental degradation generally increases as distances from central areas increase. Within central areas, these simulated results generally show hypothetical environmental degradation problems to not be prevalent, something attributable to the less dependent nature of these areas on private cars, and the more even distribution of trips across transport modes. These results generally support existing evidence by showing developments which incentivize alternative transport usage can minimise travel-related emissions when travelling for leisure by discouraging car use.

Also embedded within Figure 1 is the travel-related emissions attributable to existing retail centres, as in O'Driscoll et al., (2022).[5] Specifically, clear departures from the general patterns presented within Figure 1's city-specific illustrations show existing retail centre sites, and thus their relative environmental degradation in the context of existing retail dynamics. Whilst generally upholding the results presented here, O'Driscoll et al., (2022)[5] illustrate that alongside location is the importance of accounting for the relative attractiveness of specific retail centres.

While in principle, the travel-related environmental degradation attributable to travelling to retail environments can be expected to increase as distances from city cores increase, in practice, it appears that a retail centre's design plays an important role in determining environmental degradation once retail centres leave central areas. In other words, retail centres situated outside city cores which are designed for cars can be expected to attract cars and generate disproportionately environmental impacts, while those designed for sustainable transport will attract sustainable transport users, reducing environmental impacts, no matter their relative peripherality.

Clearly, as the travel distances to places of economic and social interest (retail centres) increase, travel-related emissions increase. This suggests that as distances from urban cores increases, the modal share of car transport is also greater, meaning that the amount of people hypothetically using sustainable transport in leisure trips decreases as distances from city centres increase, meaning cars tend to dominate, inflating environmental impacts. This highlights how out-of-town retail centres are generally ill-suited to facilitate shifts from excessive

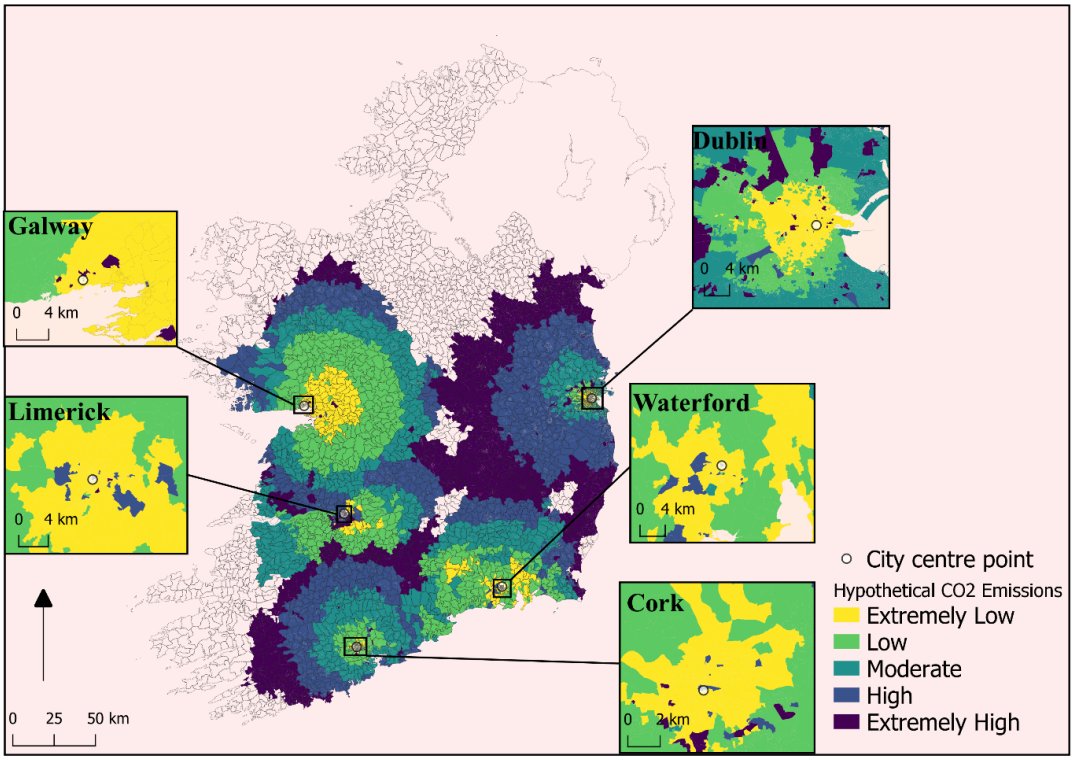


Figure 1: Simulated travel-related emissions attributable to hypothetical rail centres.

car usage, underlining car dependency as a problem causing these hypothetical retail centres to generate disproportionately large environmental impacts.

Conclusion

Here, we highlight the environmental issues associated with out-of-town retail developments. Our objectives revolve around investigating where retail centres are the most environmentally damaging. Thereafter, specific comparison between central and peripheral locations is made.

Our principal finding is that negative environmental impacts occur when retail centres are in out-of-town areas. These retail centres generally witness disproportionately increasing environmental impacts as distances from central hubs increase, a problem attributed to increased car-use and inadequate alternative transport options. In city centres, we find that environmental impacts are not as prevalent because more trips are conducted using alternative transport and the required travel distances to reach these retail centres are reduced. Considering this problem, making retail environments less car dependent could be a first step in alleviating excessive environmental impacts produced by global transport sectors. Our results highlight the unsustainable character of retail developments in areas characterised by car dependency, arguing centrally located retail centres offer optimal conditions to minimise carbon impacts because of their infrastructural tendency to facilitate sustainable transport usage.

This evidence supports current trajectories of global policymaking which advocate for the implementation of mixed use, accessibility-driven developments to alleviate car dependency

and uncoordinated sprawl. Subsequently, we support calls for developments which accommodate multi-modal travel as a mechanism to pursue long-term reductions in environmental impacts by encouraging sustainable transport usage, increasing land-use efficiency, and reducing car dependency. Developments of this nature should therefore aim to make public and active travel as appealing and competitive as possible. One tangible mechanism to do this is through the development of compact, mixed-use settlements. These settlements reduce the required travel distances to places of interest and are known to encourage greater public and active transport use.

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Suggested Further Reading

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