Assessment of the proposed impact of post-office closure in Leicestershire (UK) using GIS-based network analysis

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ABSTRACT

This paper reports the impact of the proposed Post-Office closure in Leicestershire due to the Network Change Program, initiated to close down up to 2,500 Post Offices across the United Kingdom (UK). The paper explores the spatial relationships between Post Offices and their accessibility to different socio-economic groups in the area under investigation. Network analysis (OD Cost Matrix) was used to denote output areas as the origin (demand) and Post Offices as the destination (supply). The results of this analysis reveal that the number of post offices targeted by the government for closure is not attainable in this particular English county. When the results were linked to the county’s demographic profile and socio-economic data, only the first (part a) and last criteria were met before and after the closure of the Post Offices in this county. Over 99% of the total population of Leicestershire is found within three miles of their nearest Post Office. The total rural population within three miles of their nearest Post Office was recorded at over 97%. Thus, Post-Office accessibility for people in urban areas was recorded at less than 70%, compared to the government minimum criteria of 99% and 95%, for deprived urban areas and the sum total urban areas, respectively. The paper also argues that, although the criterion for rural areas was met, the government minimum standard criteria create a serious imbalance in terms of providing post offices to many rural dwellers. The study concludes by recommending ways for alternatives that minimize the said impact of the proposed closure.

Keywords: GIS, network analysis; accessibility; post offices, closure, cost matrix

1. Introduction

Post Offices exist in the UK, despite the county’s present digital sophistication. In the UK, post offices are believed to be the country’s largest retail network and therefore serve numerous services, ranging from bill payment, foreign currency exchange, and issuing licenses and stamps to offering savings account. In fact, it has been estimated that Post Offices offer well over 170 products and services. (Department for Business Innovation and Skills 2010).

Historically, the general post office was formally established in England in 1660 by Charles II, and it eventually grew to integrate the services being rendered by the state postal system and telecommunication carrier. Not until 1965, when the Post Office Act came into being, was the control of the Post Office under the custody of a department of the central government. Apart from its existence as a public corporation solidified by the Act of 1965, a more organized system of administration was developed in 1981 to separate postal and telecommunication services. Today, the Post Office Limited (as retail business) oversees the whole network of Post Offices across the UK. It has been ascertained that there are 13,500 Post Office branches across the country (Comber et al. 2009).
With the current improvements in science and technology, the government realized that only a few people use Post Offices, and implemented a Network Change Program aimed at the compulsory closure of up to 2,500 branches across the UK. However, the government has thus far designated these minimum criteria for these closures: (I) 99% of the UK population to be within three miles of their Post Offices and 90% to be within one mile of their Post Office outlet (ii) 99% of the total population in deprived urban areas across the UK to be within one mile of their nearest Post Office outlet (iii) 95% of the total urban population across the UK to be within one mile of their nearest Post Office outlet (iv) 95% of the rural population to be within three miles of their nearest Post Office outlet. In this study, these criteria are used to evaluate the impact of these closures in Leicestershire. A GIS-based Network Analysis was used, together with a statistical analysis of demographic data in conducting this investigation. The study aim was to: (i) evaluate whether the access criteria are met in Leicestershire. (ii) Quantify the impact of the proposed closures on the target groups. (iii) Recommend alternatives for good decision-making and planning.

2. Literature review

Development of specialized software packages in Geographic Information Systems (GIS) have done much to reshape the way and manner in which the spatial analysis of data is carried out today. Anselin et al. (2004) cited a number of authors who lamented that, in the late 1980s, the major impediment to this development were then use and the adoption of spatial statistics by the GIS researchers. Smith et al. (2001) noted that several techniques are available in the GIS environment for spatial data analysis and data integration. It is now possible to integrate data, identify overlaps across data, and join attribute table using feature locations. Proximity assessment is one such GIS-based capability, and buffering can be used as a means of ascertaining the proximity of neighboring features. Furthermore, Longley (2011) noted that ‘spatial analysis is the crux of GIS, the means of adding value to geographic data and turning data in to useful information’ This provides a basis for good decision-making and planning, which enables sound policy implementation and evaluation in both public and private corporations.

An expansive literature describing GIS-based accessibility studies are available in the transport, heath, green-space, highway-studies, communication, disaster-management, and general-administration fields. Most of this research is geared towards quantifying distance or travel time in order to evaluate access against certain criteria (Comber, et al. 2008). Accessibility is defined by Paecz (2004) ‘as the potential for interaction between locations in space’. The ArcGIS Network Analyst extension enables facilities to perform network-based spatial analysis for access routes, travel times, direction, and fleet routing, and identifying and locating the closest facilities. The extension determines optimal locations for facilities and network travel-costs, among other things (ESRI ArcGIS 2011). Although the Network Analyst extension is relevant to a study of this nature, only a few studies were conducted on the UK Post Offices using GIS. Comber et al., (2009) conducted similar studies to ascertain the impact of Post-Office closures caused by the Network Change Program. Network Analysis was used in their study, in which output areas were considered as the origin (demand) while Post Offices were destinations (supply). Distances were calculated, and the results were related to urban, rural, and deprived areas, as well as some demographic data. The results revealed that only one criterion was met in that particular English county (The population of a certain age group were considered given the fact that these people did not use the post office). However, the index for the deprived urban population was decided at the 85th percentile. In this study, the post office’s benchmark for deprived urban populations,
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which stands at the 95th percentile, is adopted. Langford and Higgs (2010) identified the impacts of the closures while referencing the same criteria, but they covered a more extensive area (Wales), which required the use of a different spatial scale for modelling the population of the output areas population and different criteria for determining deprived urban areas (their study criteria match those used by the Post Offices Limited for establishing deprived urban-area population). Their results indicated that the first three of the minimum criteria for accessibility that were specified by the government were not attainable within Wales.

White, et al. (1997) studied changes in the provision of Post Offices while paying particular attention to the provision of services in rural areas. The demographic profile of the output areas (OAs) and the prevalent records of Post Offices at different points in time served as the basis upon which spatial relationships were developed over a period of 15 years. They used buffering to evaluate the then Code Practice on Closure and Regrading of the Post Offices Users National Councils (POUNC), which stipulated that, in a rural area, a Post Office should not be within two miles of another Post Office. They also conducted network modelling to ascertain the rural population’s access to Post Offices over time. Their research was sharply challenged, because buffering, unlike network models (which are more objective and scientific), only calculates distance in straight lines, which may not yield accurate results.

Keshkamat (2005) studied transport planning using a multi-criteria assessment and the ArcGIS Network Analyst extension. He stressed the need for a vector approach to network analysis, as the accessibility provided by highways significantly contributed to efficient routing planning, thereby facilitating sustainable development. Similar studies on urban transport planning were carried out by Liu and Zhu (2003), which affirmed that a GIS-based approach to accessibility analysis almost always yielded fruitful results, which in turn could measure travel impedance and provide routines for transportation-related analysis. Comber et al., (2008) used network analysis in a geographic information system to ascertain different religious and ethnic groups’ access to green spaces while accounting for the UK government’s benchmark standards. They demonstrated that, with GIS-based network analysis and some socio-economic data; it is possibly to quantify the access to community equity goods and services allocation.

Bamford and Hugo (2001) conducted a study to identifying gaps in the provision of health services using a GIS approaches. Their aim was, among other things, to show how GIS can be used to establish the areas serviced by different health service providers as a basis for better use of population-health service ratios. They employed buffering as a GIS methodology for identifying the population within a certain distance, measured along roads, of services. However, Comber (2011) argued that network analysis that uses the Network Analyst extension is more realistic when calculating distances, because analyses that use straight lines (such as buffering) do not reflect the actual distances that people have to travel. Sasaki et al. (2010) maintained that network distances provide more accurate results when measuring access distance and travel time. Sasaki et al. (2010) employed the use of Network Analysis to optimize current and future health planning, with a particular emphasis on ambulance locations. Not only was that method successful, it also provides a basis through which the quantification and optimization of the location, number, and physical access of many health facilities and target groups could be identified. Tavares et al. (2008) used 3D GIS modelling to optimize routes for municipal solid waste collection for minimum fuel consumption. A 3D road network was created using ArcGIS 3D and then fuel consumption was calculated along the entire road.
GIS network analysis can provide an enabling platform for achieving Millennium Development Goals, as it provides a more sophisticated analytical tool for socio-cultural and political economic analysis in general (iRevolution 2011). Doriwala and Shah (2010) investigate facility-service provisions with respect to health, educational, and recreational facilities provided to different socio-economic groups. GPS was used to capture the coordinates of various income groups. The generated data was then loaded into ArcGIS, where proximity analysis was used to measuring distance. The results indicate that 75% of the targets groups have access to health facilities within a two km radius from their location, 75% have access to educational facilities within a 0.5 km radius, and 100% are within eight km of recreational facilities. In contrast to Doriwala and Shah (2010), this paper uses OD Matrix to measure distances. Wang and Xu (2011) used the Google Maps API to estimate travel time, using the OD Matrix approach, between locations in order to assess the accessibility of hospitals, a study that was aimed at comparing the advantages and implications of using Google Maps API over ArcGIS Network Analyst. This method is advantageous since it does not require a network dataset or an adequate knowledge of the software. It also uses more up-to-date road data, and accounts for the distinction between peak and off-peak hours. However, not all people have easy access to the Google data, which sometimes require a license; furthermore, the computed results are maintain by Google, and the user thus does not have total control over it, nor the right to edit it. In contrast, ArcGIS Network Analyst provides a golden opportunity for data-quality enhancement, manipulation, transformation, and the like.

From whatever perspective one takes on accessibility studies, be it from the point of view of the health, transportation, disaster management, communication, tourism, architectural design, or green-space sectors, the motive is geared towards strong assessment and evaluation that can accelerate opportunities for fruitful decision-making and planning, helping policymakers to arrive at the rational evaluation and implementation of government and corporation plans that ensure the equitable distribution of resources and the effective delivery of services.

3. Study area

Leicestershire is one of the UK’s counties, situated in the heart of England. The county is part of the area often addressed as the Midlands. It has an estimated population of 644,800, of which up to 68% are believed to reside in urban areas, 20% in town and fringe settlement and 12% in villages. The county has a varied geography is uniquely different with the Eastern side predominantly rural (Leicestershire Profile, Pub 2011).

4. Methods

4.1 Data description

In order to establish a foundation takes into consideration the government’s criteria for Post-Office closures, a geo-data base was constructed containing. Post Offices, demographic data, urban and rural population and road network data. Post Offices data for Leicestershire containing names, addresses, postcodes, and status were presented as both a shapefile and layer file for easy spatial analysis, since all criteria are related to Post Office locations. The total number of Post Offices is 181 from which 149 are to be retained, 24 to be closed, and 8 were considered outreach. Post Offices data for Leicestershire containing names, addresses, postcodes, and status were presented as both a shapefile and layer file for easy spatial
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International Journal of Geomatics and Geosciences
Volume 6 Issue 1, 2015

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![Figure 1: Study area](image1.png)

![Figure 2: Distribution of post offices in Leicestershire](image2.png)

Demographic data for the output census areas were downloaded from Casweb (the UK’s official census website) and deprivation index was calculated using some standard procedure. Employment, home and car ownership are some of the variables considered for measuring deprivation. Urban and rural areas were used to delineate both the deprived urban areas and the total urban and rural areas, which together represent the output areas. Road Network data comprised motor roads, A-roads, B-roads and minor roads were downloaded from the Edina Digitamaps Collection (OS Meridian) with a scale of 1:500,000 (extracted and clipped to the Leicestershire boundary). Due to the fact that some Post Offices exist at or very close to the Leicestershire County border an external buffer of three kilometers was considered necessary, because as people around such areas are more near to than the main Post Offices in the area under investigation.
3.2 Description of method

3.2.1 Network analysis

The material and methods discussed here were selected based on the available data, assessment criteria, and ArcGIS Network Analysis.

A network is defined by Gumussay and Turk (2011) ‘as a system of lines topologically structured’ Gumussay and Turk used network analysis to determine the application of a GIS-based approach to tourism. They identified very important places for tourism, suitable hotel locations, optimum plans for sightseeing places and the shortest distances between places. In this current study, GIS-based network analysis was used to analyses the spatial distribution of and relationships among places based on the provision of Post Offices to various socio-economic groups in Leicestershire. With reference to the government’s requirement for meeting the minimum standards, appropriate data were collected and network data was firmly established with rural and urban areas, represented as the output areas denoted as origin (demand) and Post Offices as the destinations (supply). A line feature was created and polygon was converted from feature to point. Post Offices were already geo-referenced with their postcodes. OD Matrix was obtained for each 181(before closure), 157 (after closure including the outreach) and 149 (after closure excluding the outreach) Post Offices in Leicestershire. A selection of ≤ 1 and ≤ 3 miles for the line feature was made for each category and used for each criterion. The resulting selections were then intersected with different OAs according to the different criteria for each category. The shape file for the deprived areas was joined (spatial join) with urban-rural shape file to identify the deprived urban areas.
4. Results and discussion

The results of this analysis demonstrate that the criteria established by the government to determine the Post Offices that should be closed down may not be realized in this particular English County. The realities of this observable spatial pattern for closure situations have been logically presented. The OD Cost Matrix computed the distances between each origin and destination in line with the proximity limit conditioned by these working criteria. This made it possible to link the socio-economic data and the calculated distances in order to ascertain the required information.

<table>
<thead>
<tr>
<th>Target areas</th>
<th>Criteria</th>
<th>Before closure</th>
<th>After closure</th>
<th>After closure (no outreach)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (all)</td>
<td>1a. ≤ 3 Miles</td>
<td>99.40</td>
<td>99.37</td>
<td>98.85</td>
</tr>
<tr>
<td></td>
<td>1b. ≤ 1 Mile</td>
<td>81.13</td>
<td>67.92</td>
<td>67.69</td>
</tr>
<tr>
<td>Deprived Urban Areas</td>
<td>2. ≤ 1 Mile</td>
<td>84.94</td>
<td>61.07</td>
<td>61.07</td>
</tr>
<tr>
<td>Urban Areas</td>
<td>3. ≤ 1 Mile</td>
<td>83.89</td>
<td>67.73</td>
<td>67.73</td>
</tr>
<tr>
<td>Rural Areas</td>
<td>4. ≤ 3 Mile</td>
<td>97.32</td>
<td>97.19</td>
<td>94.88</td>
</tr>
</tbody>
</table>

The results shown at the different levels of decision-making (with and without the outreach) for the proposed closures were carefully observed. For the first criterion, only part a (total population within three miles of nearest Post Offices) was met. If the outreach Post Offices were ignored, only 98.85% will have access to a Post Office within the specified distance.

**Figure 4:** Population within one and three miles of their nearest Post Office after closure.

Part b of the first criterion, which suggest less-than-or-equal-to (≤) one mile of the total population of the output areas, criterion two, which suggest less-than-or-equal to (≤) one mile of the deprived urban population, and criterion three, which depicts less-than-or-equal-to (≤) one mile of the total urban population across all levels are not attainable in Leicestershire. The deprivation index used in this study to measure the total number of the deprived urban population may not prove adequate in another scenario. However, the benchmark matches that of Post Offices Limited. Only the last criterion, which suggests that the total rural population is within three miles of nearest Post Offices, is met by all categories.
Looking closely from the results, it is obvious that this study assessed the Network Change Program initiated to close down some Post Offices in the UK. The impacts of the proposed closure, with particular reference to the government’s minimum standard criteria, in line with this change program cannot be realized in some areas. The result revealed that only one complete criterion is met before and after the closure of Post Offices.

Therefore, the initiative, if embarked upon, may have serious repercussions for the people within the study area. Some of the impacts due to closures could be observed in many ways. Although certain factors – such as the provision or lack of packing space, nature of the Post Offices route, physical access to branch or proximity to other retail services – will determine how people react to the reduce choice of Post Offices, the results confirmed that at OA levels, the urban population will be adversely affected by these closures, and as such the closures might cause a loss of choice, because the closure of some Post Offices means that some people will have to travel further to obtain these services (Langford and Higgs 2010).

The fact is that the criterion could not be met in rural areas is if the outreach is ignored. The outreach served as a compliment to the attainment of this target in rural areas. This closure may result in a serious threat to the rural network (Postcomm 2005). This paper also argued that the minimum standard criterion that 95% of the rural population to be within three miles of their nearest Post Offices does not favor many rural dwellers. It serves as a strong
imbalance between the rural and urban areas in terms of service provision. Because the Post Office is considered an institution that serves a financial role (for instance, delivering income in the form of welfare payments) to particular social groups and communities such as the elderly, the disabled, and lone parents, a greater proportion of whom might be women. Therefore, the closure means that spatial accessibility and the provision of services will not be maximized, thereby making life difficult for those social and cultural groups (Midgley 2005).

5. Conclusion

Thus, the study recommends some ways to minimize the impact of the closure, as outlined below:

1. Utilizing GIS optimization models can guide the closure process to minimize the number of target groups that experience poor accessibility. This technique was used by Comber et al. (2009) and can be developed further.
2. The move for closure needs to be revisited, since some criteria were not met even before the closure.
3. We recommend dedicated and timely funding to enhance Post Office prospects.
4. Finally, network analysis using GIS show how accessibility of service area to people could be assessed to inform better policy and decision making.

6. References

5. Comber, A. J., Brunsdon, C., & Green, E. (2008), using a GIS-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups. Landscape and Urban Planning, 86(1), pp 103-14


