Defining bank branch trade areas for optimal distribution networks in mergers and acquisitions

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Abstract: This study introduces a methodology that combines geographic information technologies and consumer behaviour principles to define, delineate, and quantify the trade area (TA) of a bank branch within the context of mergers and acquisitions (M&A). The goal is to design an optimal distribution network tailored to the needs of financial institutions involved in M&A activities.

The paper presents a procedure for TA delimitation, grounded in a theoretical model supported by marketing and consumer behaviour theories, focusing on proximity, purchase frequency, and product type. Addressing a gap in the literature, this study highlights TA delineation as a key element in marketing strategy, exploring its role in establishing optimal distribution networks, particularly for financial institutions engaged in M&A. For simplicity, the study focuses on a single bank branch, rather than a broader dataset.

The proposed methodology enables more accurate delineation of TAs in M&A processes, mitigating the negative effects often overlooked by banks during mergers and acquisitions. This approach helps reduce the risk of financial exclusion for vulnerable clients, promoting social and economic equity and fostering a fairer, more cohesive society. This study is innovative in integrating Geographic Information Science metrics into Location Science, proposing fragmentation analysis to quantify the spatial structure and configuration of TAs. This approach departs from traditional practices, as these specific metrics have not been collectively applied in previous research.

Keywords: Banking, Mergers & Aquisitions, Bank Branch, GIS

DEFINING BANK BRANCH TRADE AREAS FOR OPTIMAL DISTRIBUTION NETWORKS IN MERGERS AND ACQUISITIONS

Abstract

Purpose – This study introduces a methodology that combines geographic information technologies and consumer behaviour principles to define, delineate, and quantify the trade area (TA) of a bank branch within the context of mergers and acquisitions (M&A). The goal is to design an optimal distribution network tailored to the needs of financial institutions involved in M&A activities.

Design/Methodology/Approach – The paper presents a procedure for TA delimitation, grounded in a theoretical model supported by marketing and consumer behaviour theories, focusing on proximity, purchase frequency, and product type.

Findings – Addressing a gap in the literature, this study highlights TA delineation as a key element in marketing strategy, exploring its role in establishing optimal distribution networks, particularly for financial institutions engaged in M&A.

Originality/Value – This study is innovative in integrating Geographic Information Science metrics into Location Science, proposing fragmentation analysis to quantify the spatial structure and configuration of TAs. This approach departs from traditional practices, as these specific metrics have not been collectively applied in previous research**.**

Research Limitations – For simplicity, the study focuses on a single bank branch, rather than a broader dataset.

Practical Implications – The proposed methodology enables more accurate delineation of TAs in M&A processes, mitigating the negative effects often overlooked by banks during mergers and acquisitions.

Social Implications – This approach helps reduce the risk of financial exclusion for vulnerable clients, promoting social and economic equity and fostering a fairer, more cohesive society.

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Paper type: Research paper

1. Introduction

The banking industry in 2024 faces significant challenges due to a slowing global economy and a dynamically evolving financial landscape. Despite efforts to address inflationary concerns in various countries, the sector confronts risks arising from supply chain disruptions, changing trade relationships, and ongoing geopolitical tensions, all of which complicate global economic growth. Additionally, extreme weather events such as floods, heatwaves, and hurricanes pose further threats to economic stability.

In this global banking environment, characterised by diverse capital market opportunities in countries like China and India, and the consolidation of the banking union in the euro area (Figueiras *et al.*, 2021), pressures such as rising funding costs, slower loan growth, increased capital and liquidity requirements, and the divestment of low-yielding assets are expected to drive further mergers and acquisitions (M&A) in the banking sector (Deloitte, 2023).

M&A activities frequently involve the closure of redundant bank branches, redirecting affected clients to alternative locations as a cost-cutting measure (Focarelli and Panetta, 2003). However, these closures can lead to increased costs for consumers, including longer travel distances for services, and the loss of personal advisory support. This can result in heightened ‘financial exclusion,’ especially in rural areas, low-income neighbourhoods and minorities where residents often have limited mobility and technological access (Calzada *et al.*, 2023). The issue of financial exclusion is even more pronounced in regions such as Sub-Saharan Africa, where many individuals still lack access to financial services due to low financial literacy, institutional barriers, and market structure (Beck *et al.*, 2015; Mogaji *et al.*, 2021).

To mitigate the negative impacts of branch closures and optimise networks post-M&A, financial institutions can use data-driven models that consider branch proximity and performance potential. Mavri (2015) suggests that incorporating mathematical models for location optimisation helps minimise service disruptions and enhances cost efficiency, while improving customer retention. These models evaluate key factors such as branch profitability, customer traffic, and market penetration, which are crucial for ensuring the long-term success of the newly merged entity. Nevertheless, relocating customers to unfamiliar branches may negatively affect service quality, as proximity to home or work is a key factor in bank selection (Lewis, 1991; Focarelli and Panetta, 2003), potentially leading to adverse consumer responses (Álvarez-González and Otero-Neira, 2020).

M&A has become a critical survival strategy for financial institutions (Shanmugam and Nair, 2004; Tampakoudis *et al*., 2020; Ho and Berggren, 2021), often necessitating branch closures to reduce duplication. However, scholars such as Thorbjørnsen and Dahlén (2011), Álvarez-González and Otero-Neira (2020) and Ngau *et al*. (2023) and highlight the substantial risk of customer loss during M&A, which can lead to rising costs and lower revenues. In particular, branch closures can result in staff layoffs and higher client-to-branch ratios, negatively affecting daily banking activities. Goyal and Joshi's (2011) research in India indicates that bank M&As often harm employee morale, leading to absenteeism, job dissatisfaction, and reduced productivity, suggesting that gaining employee trust is critical for a successful merger. Baldassarre *et al*. (2024) advocate for optimising branch networks by incorporating multichannel distribution strategies, combining digital services with physical branches to meet evolving customer preferences while maintaining essential in-branch interactions.

An essential component in optimising branch networks post-M&A is the accurate delineation of Trade Areas (TAs), which determine the geographical regions from which a bank branch draws its customers. As branch closures and consolidations occur during mergers, understanding and defining these areas becomes crucial to minimising customer disruption and preventing financial exclusion.

The concept of a TA, defined as "the geographical area where a store attracts the majority of its customers" (Ghosh and McLafferty, 1987), has long been a subject of academic interest. Despite decades of research (Huff, 1964; Applebaum, 1966; Gross, 1997; Peterson, 1997; Lea, 1998; Simmons, 1998; Garcia de León *et al*., 2002; Thrall, 2002; Patel *et al*., 2007; Cliquet, 2013), defining TAs remains a complex task. From an academic perspective, the delineation of TA has been a persistent issue. Although it remains crucial today with the development of geographic information systems (GIS) and geomarketing techniques (Reigadinha *et al*., 2017), interest in this topic has diminished in favour of research focused on digital marketing and e-commerce.

Since the 1960s, several methods have been proposed for the delimitation and calculation of TAs, with Applebaum's (1966) method being particularly notable for its generalisation. This method subdivides the TA into primary, secondary, and tertiary sections, identifying the primary area as the geographical core from which the store derives most of its income. However, a precise and generalisable method for defining TAs, especially in intercity areas where trade areas often overlap, has yet to be established.

While Geographic Information Systems (GIS) technologies have advanced, their potential has not been fully leveraged for the precise delineation of trade areas (TA) (Patel *et al*., 2007). Traditional models remain limited in addressing key issues such as spatial fragmentation and competitive dynamics (Baray and Cliquet, 2007; Cui *et al*., 2012). Recent advancements, such as Hammam *et al*. (2023), introduced a GIS-based multi-criteria decision analysis (MCDA) that incorporates geographical, demographic, and socioeconomic data. However, this approach primarily focuses on static data and lacks a dynamic, multi-period perspective. Similarly, the Maximal Covering Location Problem (MCLP) proposed by Namazian and Roghanian (2021) offers a robust method to maximise coverage but does not fully account for competitive forces or changes in market conditions over time. Although GIS technologies have significantly advanced, there remains a notable gap in fully addressing the complexity of spatial fragmentation and consumer behaviour in competitive markets.

The TA delineation process cannot be fully understood or considered complete without a theoretical framework grounded in marketing perspectives and consumer behaviour, particularly in relation to proximity, purchase frequency, and product type. Without precise TA boundaries, measurements of phenomena within the theoretical TA are likely to be erroneous (Patel *et al*., 2007).

Landscape fragmentation refers to the spatial segregation of land uses. The study of TA fragmentation has been approached with varying objectives across fields such as ecology, socioeconomic studies, and land management, as these analyses provide valuable insights for achieving balanced and sustainable development (Salinas, 2009). However, in the context of accurately delineating a TA during M&A processes, to the best of our knowledge, no scientific publications have directly linked the study of fragmentation with the TA delimitation process of a bank branch.

To address this gap, this paper is structured as follows: the theoretical framework considers the importance of distance and its relationship with product type, highlighting the need to incorporate spatial configuration into consumer decision-making processes. Geographical space often presents discontinuities—such as fragmented urban areas—that are frequently overlooked but can significantly impact the accuracy of TA delineation (Baray and Cliquet, 2007; Dolega *et al*., 2016).

This study introduces a new methodological approach to defining and quantifying trade areas using GIS tools, with a specific application to a bank branch in the city of Madrid (Spain). The conclusion emphasizes that more precise TA delineation could help banks involved in M&A reduce customer attrition and mitigate the risks of financial exclusion, particularly in vulnerable areas.

2. Theoretical and empirical considerations on consumer decision processes concerning distance and product type

At first glance, proximity fosters greater face-to-face communication with customers, enabling rich and interactive exchanges of information in real-time, strengthening relational ties, and enhancing customer knowledge acquisition (Shankar *et al*., 2005).

While much of the literature on consumer behaviour focuses on retail shoppers, there are notable parallels with banking customers. Both sectors involve high-frequency, trust-based interactions that are sensitive to geographic proximity. Like retail, banking relies on physical branches to build relationships, particularly for less tech-savvy or older consumers who prefer in-person services. Convenience and accessibility play crucial roles in shaping customer loyalty in both industries, suggesting that insights from retail shopper behaviour offer valuable context for banking (Xue and Harker, 2002; Brevoort and Wolken, 2009).

Recent studies on bank branch closures further underscore the critical role of physical proximity in consumer behaviour. Geographic accessibility influences not only the frequency of in-person transactions but also consumer trust and long-term relationships. As with retail, proximity affects customer engagement, making it a vital factor for understanding retention and satisfaction, particularly in underserved areas or where digital infrastructure is lacking (Barca and Ding, 2023; Ranish *et al*., 2024). The physical presence of banks also addresses financial exclusion by catering to both supply-side factors (such as local service offerings) and demand-side factors (e.g., financial self-exclusion or lack of knowledge). Bank staff play a key role in helping customers understand financial products and services (Fernández, 2011).

Additionally, research by Shankar *et al*. (2005), Giokas (2008), Reigadinha *et al*. (2017), Álvarez-González and Otero-Neira (2020), Palkar *et al*. (2020), Turkoglu and Genevois (2020), Vivek (2023), Goktan and Ucar (2024), seems to suggest that geographic proximity still matters. Firms closer to consumers engage in more frequent face-to-face contact. However, these studies also show that proximity alone does not guarantee strong relational ties. As Saxenian (1994) noted, proximity fosters the interaction necessary for trust, but Shankar *et al*. (2005) questioned the generalisation of such claims, pointing out that relational ties must be actively nurtured, even in nearby locations.

Jiao *et al*. (2016) found that frequent shoppers prefer stores close to home and often use alternative transport, while less frequent shoppers are willing to travel longer distances. Garcia de Leon *et al*. (2002) confirmed that purchase frequency influences how far consumers are willing to travel. Consumers typically travel shorter distances for frequently purchased goods and further for infrequent purchases. E-shopping has further removed spatial constraints from shopping, fragmenting consumer behaviour across time and space (Couclelis, 2004; Dolega *et al*., 2016).

The COVID-19 pandemic accelerated the shift toward digital banking, with many customers downloading mobile apps due to branch closures. While digital banking has gained prominence, traditional banks retain an advantage for resolving complex issues in person (Vivek, 2023).

However, consumers in different areas may weigh the impact of distance differently when selecting stores (Hubbard, 1978; Mittal *et al*., 2004). Incorporating spatial configuration into spatial choice processes requires the use of morphological and topological measures (Hubbard, 1978; Ghosh, 1984). These measures are a set of indices and variables that quantitatively describe the level of fragmentation and the spatial distribution of land uses and land cover, taking into account the morphological, spatial, and typological properties of cartographic objects. The indices are divided into five groups based on the attributes they describe: area and perimeter, shape, aggregation, diversity, and contrast (Sapena y Ruiz, 2016).

The existence of urban barriers, socioeconomic disparities, and topographical features can create fragmented trade areas (TAs), with "holes" or discontinuities that influence consumer movement (Baray and Cliquet, 2007). Traditional methods often ignore these discontinuities, assuming spatial uniformity that departs from reality (Dolega *et al*., 2016). Thrall and McMullin (2000) argue that such assumptions increase error rates. Baray and Cliquet (2007) introduced the Theory of Mathematical Morphology to Location Science to address these gaps. This method, traditionally used in image processing, analyses data as a global entity and has applications in fields like geography, geology, and biology. Applied to TA delineation, it recognises the spatial fragmentation of areas.

Thus, this proposal for a more precise delineation of the trade area (TA) aims to address the gap in the literature concerning the lack of studies linking fragmentation analysis to location decisions. It builds on Baray and Cliquet's (2007) proposal to quantify the "holes" or discontinuities in the TA, but in this case, from the perspective of Geographic Information Sciences rather than Mathematical Morphology. As a result, fragmentation analysis is employed to identify the discontinuities within a bank branch's TA, rejecting the assumption of spatial uniformity accepted by classical methods.

From a commercial standpoint, the delineation of the TA becomes a strategic imperative in mergers and acquisitions (M&A) involving banks. It is not only vital for the success of M&A activities but also plays a pivotal role in ensuring the survival and optimisation of the existing retail banking network within any financial institution. This process is instrumental in identifying locations with the greatest potential to attract a substantial number of target customers, while also enabling the strategic closure of branches located in areas with lower growth potential.

3. Proposed methodologies to delimit and quantify TA fragmentation and discontinuities

To effectively delimit a trade area (TA), it is crucial to understand that TAs are dynamic and influenced by both spatial and temporal factors. The extent of a TA is determined by several variables, including consumer behaviour, the store's offerings, location, and the surrounding environment. These factors define the type and reach of a TA. To evaluate the potential TA of a bank branch or store, it is necessary to define its boundaries, typically based on the distance or time customers are willing to travel to access the product or service.

The methodology proposed for delimiting and quantifying the TA is a refinement of Trade Area Analysis (TAA). This approach builds upon Applebaum's (1966) methodology, applied within a GIS-managed environment, allowing for the classification of customers into primary, secondary, and tertiary areas based on proximity to the bank branch. The primary area represents local customers who generate the majority of sales, while the secondary and tertiary areas include non-local customers, such as daytime employees or tourists (Kures *et al*., 2011). Though the inclusion of non-local customers can introduce biases in TA analysis, their demographics and spending potential are useful for understanding customer behaviour at specific bank branches.

For the delimitation of the TA and testing of hypotheses, this study employs desk research, an exceptional method for synthesising knowledge from various disciplines such as consumer behaviour, marketing, and geography (Cooke, Hastings, and Anderson, 2002; Hague, Hague, and Morgan, 2004). The analysis utilises several databases, including NOMECALLES, CARTOCIUDAD, and SIOSE. With the support of the IndiFrag tool, designed to calculate landscape fragmentation in urban environments, we quantitatively assess fragmentation levels and the spatial distribution of land use. This is achieved by considering the morphological, spatial, and typological properties of cartographic objects (Sapena and Ruiz, 2016). Deployed within ArcGIS software and drawing on land use data from the National Geographic Institute's SIOSE, the analysis quantifies the distribution, interrelation, size, and shape of discontinuities in the primary TA.

The steps followed in this study for delimiting and quantifying the spatial configuration of the TA, along with its application to a specific bank branch located in the city of Madrid, are outlined in Figure 1 and detailed below.

Madrid, as a major European capital with a diverse urban landscape, serves as a strong model for studying retail banking in Europe. Its infrastructure, demographic diversity, and urban transformations mirror key characteristics of other European cities, making the choice of a bank branch in this city a relevant case for analysis. The authors' knowledge of the area's urban geography further aids in interpreting and validating the fragmentation analysis, ensuring accurate and insightful conclusions.

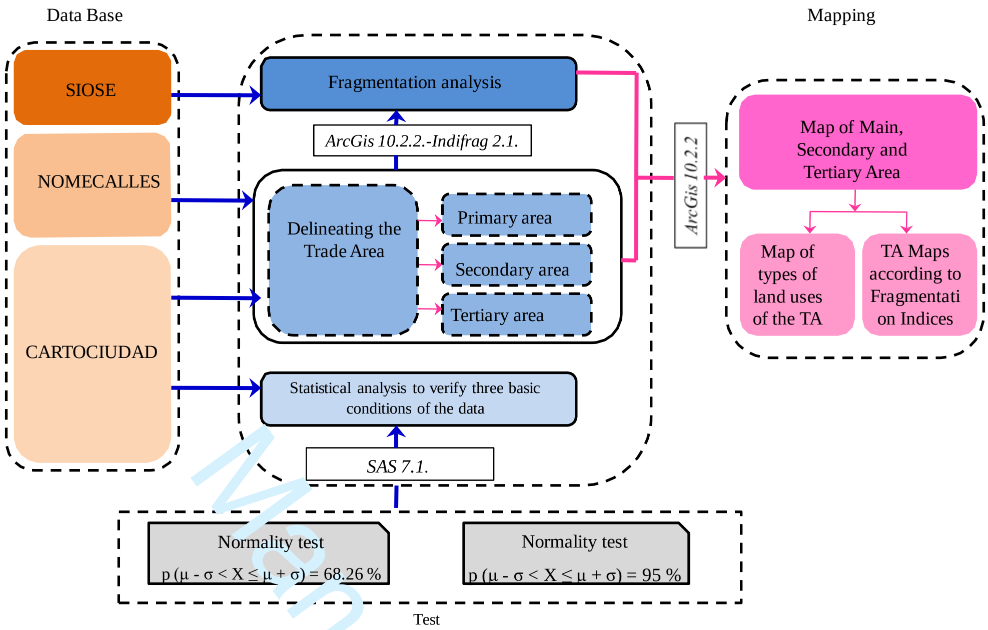

Figure. 1. Flowchart of the proposed approach for the delimitation and quantification of the TA of a Store.
Source: Authors' own elaboration.

To avoid these biases, this new TAA proposal focuses on local customers and divides it into the following four phases.

3.1 Definition of the primary (main) area

(1) Considering the hypothesis of a normal distribution ($p(\mu - \sigma < X \leq \mu + \sigma) = 68.26$ %) we calculate the maximum distance at which 68% of the customers are located.
(2) Selection of the census tracts that are at a distance less than or equal to the maximum distance in the previous phase.

3.2 Definition of the secondary area

(1) Calculation of the perimeter of the secondary area using the isochronous of 18 minutes, which is the time that a pedestrian travels in a city at a speed of 3.5 km/h (TYC-GIS, 2023) the distance of 1,050 meters, representing the lower limit at which consumers are willing to travel for the purchase of a product whose purchase frequency is intermediate, according to García de León *et al.* (2002).
(2) Surface calculation of the secondary area, which is the area between the perimeters of the primary area and secondary one.

3.3 Definition of the tertiary area

(1) Perimeter calculation of the tertiary area using the 26-minute isochronous, which is the time it takes for a pedestrian to travel in a city 1,500 metres, according to the estimates of the aforementioned authors.
(2) Calculation of the tertiary area, which is the area between the perimeters of the secondary and tertiary area. The remaining percentage of customers beyond the perimeter of the tertiary area would be made up of nonlocal people and would constitute the targeted line called fringe demand.

3.4 Calculation or quantification of the primary area structure of the TA using fragmentation rates

(1) The choice of fragmentation rates has been made following the double criteria proposed by Sapena and Ruíz (2015) of avoiding profusions and suitability to the TA study. Under these assumptions, the TA of a branch is analysed from the dimensions of area and perimeter, shape, level of aggregation and level of diversity.

4. Implementation of the methodology for a bank branchin the city of Madrid (Spain)

From 2020 to 2024, the Spanish banking sector entered a second phase of restructuring, involving mergers such as Caixabank with Bankia, Unicaja with Liberbank, and more recently, BBVA's hostile takeover bid for Banco Sabadell. In this context, the delineation and structure of the trade area (TA) gained particular significance, as the optimisation of the retail banking network of the merged banks became essential. During this optimisation process, it was critical to differentiate between customers who utilised face-to-face channels (such as physical branches) and those relying on non-face-to-face channels (e.g., online banking). As Couclelis (2004) noted, the rise of Internet banking has fragmented shopping activities across time and space, making it clear that branch networks do not evolve homogeneously.

Trade areas are neither spatially homogeneous nor uniform in the shopping profiles of the customers residing near branches. Given the spatial fragmentation of both the geographical environment and consumer purchasing behaviour, it is crucial to integrate bank branches within the retail network with precision. Failing to accurately identify the location of customers to be migrated can result in several risks when transferring them to a new branch or a more distant location. Three key risks are identified below.

The first risk stems from potential loss of profitability or revenue. For the most profitable customers, relocating to a distant branch can increase travel costs, which may drive them to transfer their financial products to a competitor’s closer branch in the short to medium term. This would leave the original branch with a less profitable customer base (Calzada *et al*., 2023). The second risk relates to reputational damage, as dissatisfied customers may express their grievances on social media, particularly regarding branch closures or forced transfers (Miklaszewska and Kil, 2017; Hassan and Giouvris, 2021). The third, often overlooked, is the risk of financial exclusion. This occurs when customers are unable to continue accessing the services they previously received at their branch, particularly affecting rural or low-socioeconomic urban areas. These branches tend to be less profitable both in absolute and relative terms compared to others within the retail network (Fernández-Olit, 2011; Calzada *et al*., 2023).

The closure or consolidation of such branches forces customers to rely on more distant branches or non-face-to-face channels. However, not all customers affected by these changes have the means or capacity to use alternative channels (Gloukoviezoff, 2007; Fernández-Olit, 2011; De la Cuesta *et al*., 2021). The inclusion or exclusion of these branches has a profound social impact, as it exacerbates financial exclusion for vulnerable populations.

4.1 Materials and methods for the delimitation of the TA of a bank branch in Madrid (Spain)

The NOMECALLES database which is the dissemination of the Territorial Information System of the Spanish Institute of Statistics, which includes information on geographic delimitations, street maps, cadastral backgrounds and aerial photographs and specific information of georeferenced interest such as the file of bank branches from which the bank branch whose TA is going to be delimited has been selected. On their side, CARTOCIUDAD provides official cartography of the General Administration of the Spanish State in the urban area. It includes cartography of the urban and interurban road network, municipal boundaries, lays building blocks, road network and entrance gates. This information was introduced and processed in ArcGis Software to delimit the TA.

The fragmentation analysis has also required information from the National Geographic Institute of Spain(IGN), specifically from the SIOSE database at a scale of 1:25,000 and from Madrid's Community cadastre. The calculation of the rates was carried out using the toolbox IndiFrag developed by the Cartography, Geoenvironmental and Remote Sensing Group of the Cartographic, Geodetic and Photogrammetric Engineering Department of the Polytechnic University of Valencia (Spain), which is executed from the ArcGis software. IndiFrag is a tool that allows to calculate a set of rates and variables that describe quantitatively the level of fragmentation, the spatial distribution of land use and land cover according to morphological, spatial and typological properties of cartographic objects, as well as to quantify the changes occurred in a period of time, all automatically (Sapena and Ruiz, 2016).The statistical analysis was performed with SAS software.

4.2 Contextualization and description of the study area

The practical application of this work will be limited to the financial field, specifically to bank branches. The region under study, as has been indicated, is located in the central area of the municipality of Madrid (Spain). Starting from public data of portals and the retail banking network in the Spanish capital, we proceed to delimit and outline the TA of a bank branch. Figure. 2 provides an overview of the province as well as the city of Madrid and the central location of the branch under study.

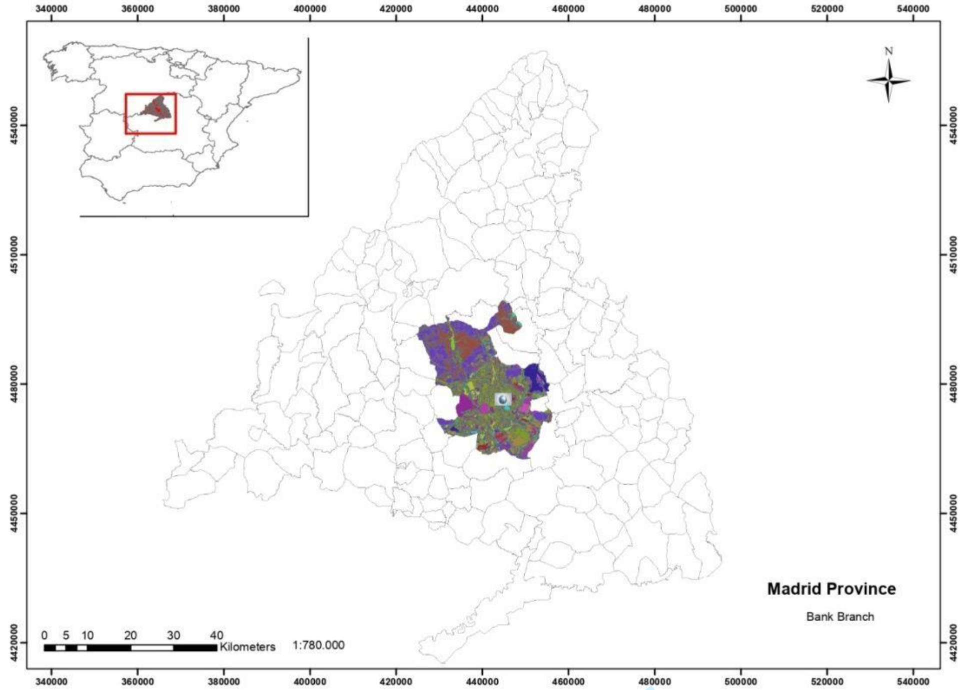

Figure. 2.Bank branch location in the Municipality of Madrid (Spain).
Source: Authors' own elaboration.

4.3 Considerations on the proposed methodology to delimit the TA

The procedure outlined in Figure 3 represents an evolution of the Applebaum Method (1966) within a GIS environment, identifying primary, secondary, and tertiary areas based on local customer demand. In contrast, non-local demand refers to customers residing beyond the perimeter of the tertiary area. Validating the hypothesis of a normal distribution enhances the accuracy of this method by establishing that the primary area consists of 68% of customers, rather than using a broader interval of 60-70%.

The secondary and tertiary areas are defined as the space between the perimeter of the primary area and the surface created by isochrones, which measure the time taken to travel 1,500 metres, thus accurately delineating the TA’s perimeter.

Customers residing beyond 1,500 metres fall outside the TA, forming the non-local demand segment. For these customers, proximity between their residence and the branch is not the key selection criterion.

In summary, this paper proposes an evolution of the Applebaum methodology, enhanced by GIS tools and supported by marketing and consumer behaviour theories related to store selection. It incorporates factors such as purchase frequency and the distance customers are willing to travel (Applebaum, 1966; García de León *et al.*, 2002). The use of planimetric distances and isochrone calculations within a GIS framework allows for more precise delimitation of the TA, in terms of both time and distance, compared to conventional methods. This methodological approach provides a replicable and generalisable mechanism that can be applied to other types of commercial establishments beyond bank branches.

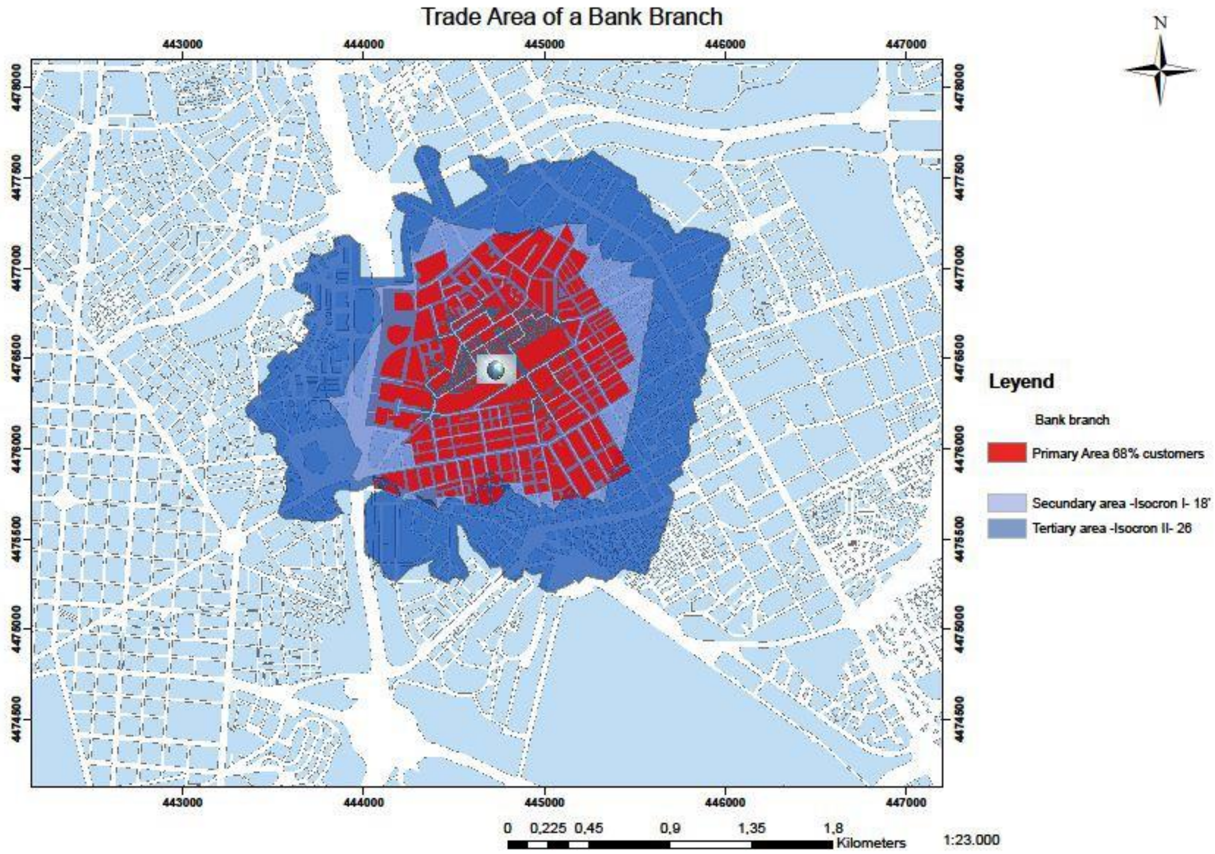

Figure.3. Map of primary, secondary and tertiary areas.
Source: Authors' own elaboration

4.4 Considerations on the proposed methodology for quantifying TA structure using fragmentation rates

Fragmentation refers to the process by which land uses become too spatially separated to achieve optimal functionality (Wei and Zhang, 2012). This phenomenon can affect the environment, the landscape, and the overall quality of life. Urban fragmentation analysis enables the identification of urban growth patterns and characteristics, as well as their impact on the surrounding territory (Sapena and Ruiz, 2016). Originally developed in Geographic Information Science, fragmentation analysis aims to understand which attributes define the urban landscape within a trade area (TA) and how they influence the commercial activity of a bank branch.

We now proceed to visualise the land uses presented in Figure 4.

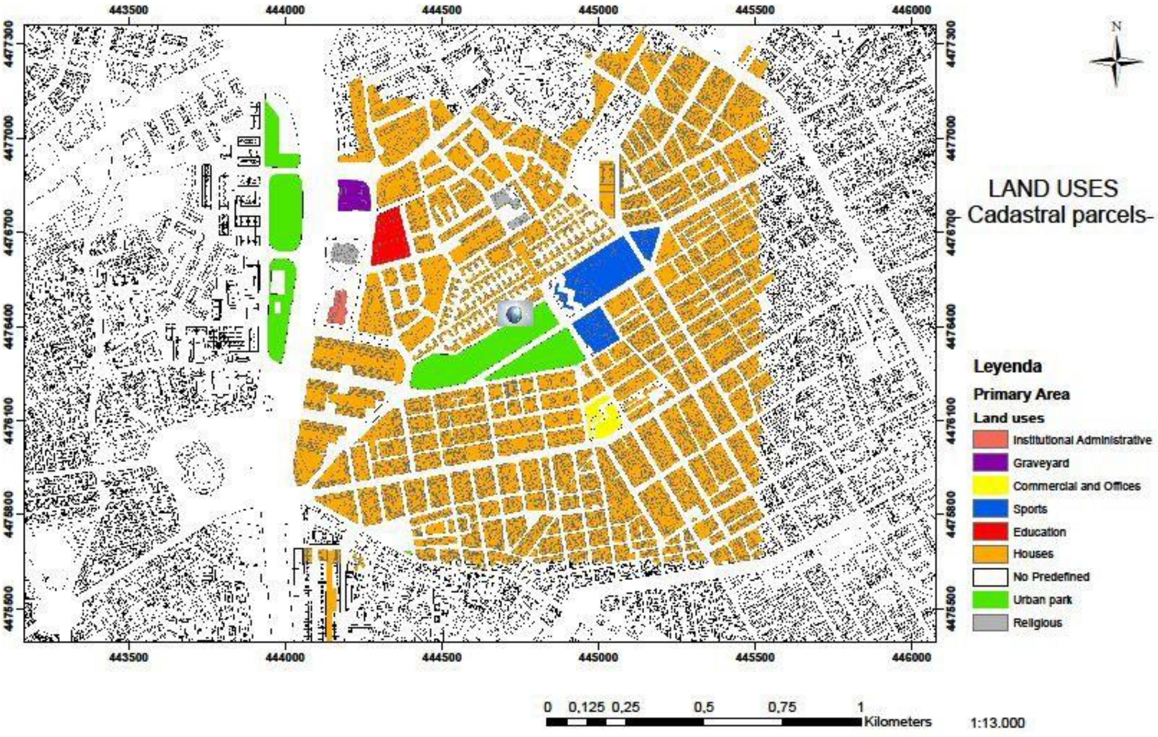

Figure. 4. Map of TA use land types for the bank branch under study.
Source: Authors' own elaboration

An overview of Figure 4 shows that the Madrid bank branch is located in a residential area. The presence of a large number of residential cadastral plots implies a higher demand from the local population. Additionally, the greater presence of commercial spaces and offices, as well as administrative, healthcare, and educational centres, may generate a higher flow of non-local population, directly impacting the demand from non-local customers.

Therefore, the presence or absence of certain types of land, as well as the structure of the cadastral plots near the branch, will determine the theoretical potential of the bank branch's TA. In this case, the presence of urban barriers such as a park and a sports centre limits the flow of people in the immediate vicinity of the bank branch.

Next, the TA of a bank branch in Madrid (Spain) is outlined based on the dimensions of area and perimeter, shape, level of aggregation, and level of diversity. For this, the IndiFrag tool is used, and the results of the fragmentation indices are shown in Figure 5 and Figure 6.

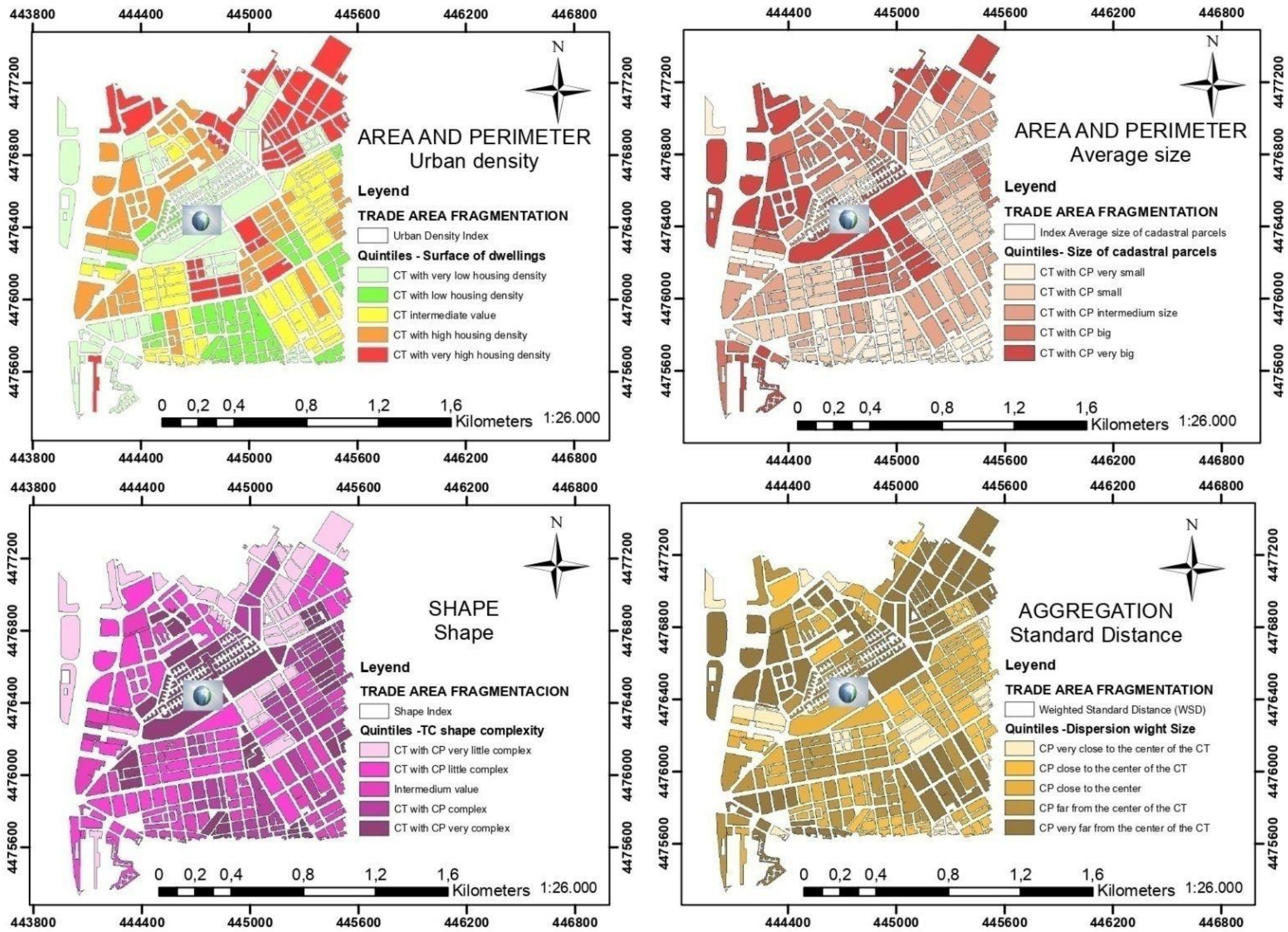

Figure. 5. Maps of the TA according to Fragmentation Rates; Urban density, Average size, Shape and Standard distance.
Source: Authors' own elaboration

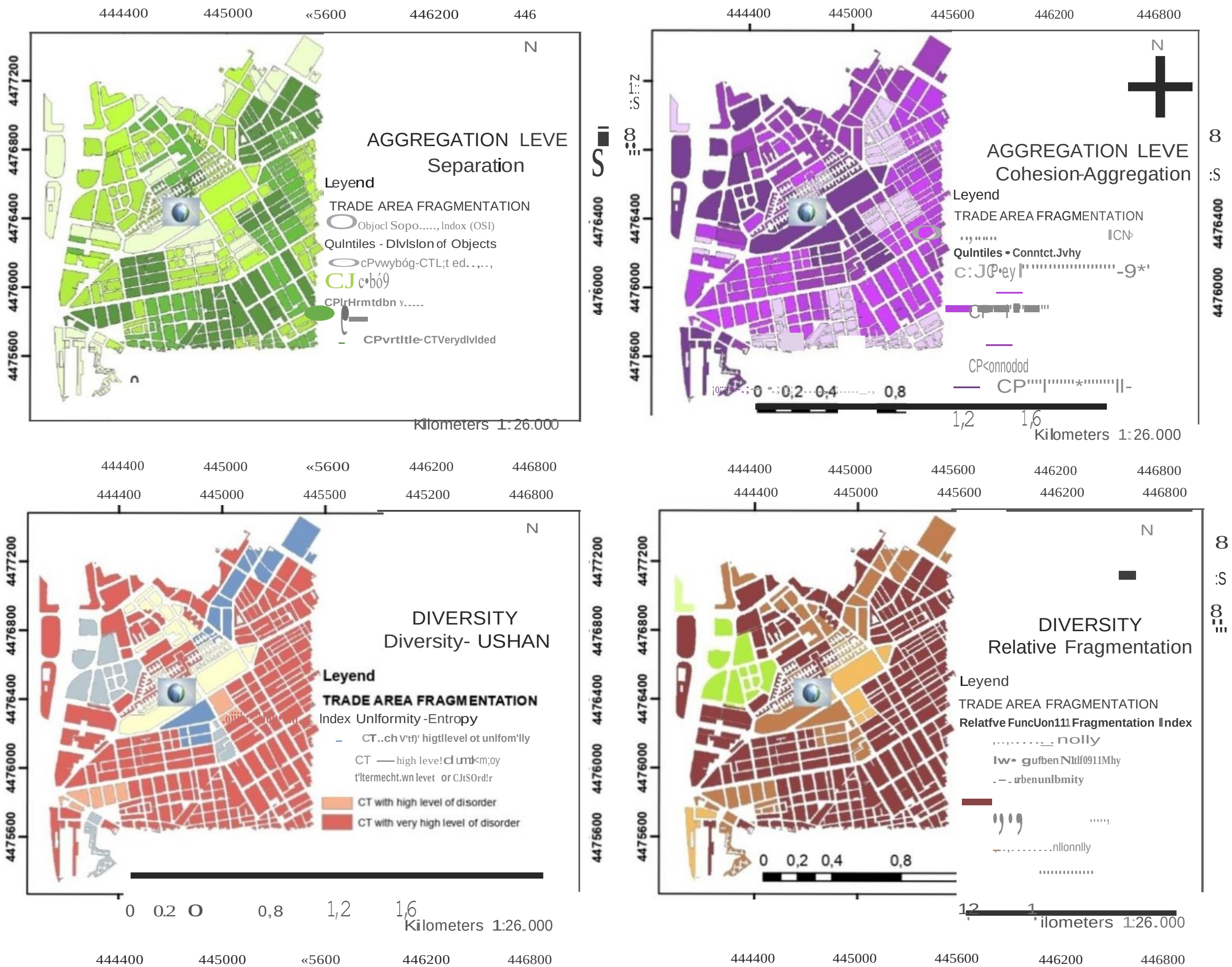

Figure. 6.Maps ofthe TA according to Fragmentation Rates; Separation, Cohesion- Aggregation, Diversity-USHAN, Relative Fragmentation.
Source: Authors' own elaboration

A review of Figures 5 and 6 shows the Urban Density Index (UD) [Value = 0.88], which measures the ratio between the urbanised area and the TA. This indicates the capacity to accommodate a population. The urban area is defined by the aggregation of artificial land classes that were previously assigned. The map shows a highly dense urban area, except in the immediate surroundings of the bank branch. The Census Tracts (CTs) with lower density correspond to urban parks and sports areas. The CTs with a higher density of Cadastral Plots (CPs) are residential areas located to the west, north, and especially northeast, further from the bank branch. Larger census tracts, often related to parks and sports areas, are near the branch, forming an urban barrier. To the south of the bank branch, there are CTs with medium and small CPs (excluding commercial spaces).

The Mean Size Index (MS) [Value = 85 m²] is the ratio between the total area and the number of objects. In the northern region, larger CPs are found, indicating where larger residences are constructed.

The Shape Index (IS) [Value = 2.20] measures the complexity of an object's shape compared to a standard square. A value greater than one indicates complexity, with no upper limit. A value of one represents a square shape, with increasing values corresponding to more irregular and complex forms. On the map, most CTs feature CPs with regular shapes, similar to squares or rectangles, while more complex shapes are uncommon.

The Standard Distance Index (SD) [Value = 648] measures the concentration or dispersion of objects, depending on the distances between CPs and the centroid of the CT, weighted by their size. The most dispersed CTs are in the northeast, where larger CPs are located, while the least dispersed CTs are in the west and southeast of the bank branch. CPs exhibit medium-high dispersion throughout the TA.

The Separation Index (IS) [Value = 424] defines the number of objects obtained by dividing the TA into equally sized objects. Its range covers all positive numbers. A value of one indicates a single parcel, while the index increases as objects become smaller. In this case, the value suggests that the plots are not particularly large, although the index's magnitude should be interpreted relative to other areas.

The Cohesion Index (COHE) [Value = 96] measures connectivity based on the evaluated object. The range goes from 0 to 100 and increases as objects become more aggregated. In the analysed TA, the CPs are highly connected within each class and throughout the area.

The Shannon Diversity-Uniformity Index (USHAN) [Value = 0.4] is a measure of TA uniformity, ranging from zero to one. A value of zero indicates no diversity (only one class), while a value of one represents perfect uniformity among classes. In this case, the area has an intermediate value, indicating neither a homogeneous nor disordered structure.

The Relative Functional Fragmentation Index (RFFI) [Value = 0.3] measures the level of functional integration (land-use classes) and structural integration within the TA. Its range is between 0 and 1. A lower RFFI indicates a higher number of functional classes, while a higher RFFI suggests increasing urban homogeneity. Thus, while the TA contains a high number of functional classes, at the CT level, there are fewer land-use classes, leading to urban homogeneity in certain areas.

The TA of the selected bank branch shows high urban density. The plots are not overly complex in shape, tending to be regular, like squares or rectangles. The TA is cohesive, and spatial aggregation indices suggest that the census tracts show a high level of aggregation or cohesion, with connected plots. There is some disorder, and the area is fragmented, but it is uniform at the census tract level.

5. Discussion

The growing role of information technology and the shift of banking operations to online platforms have made the design of branch networks increasingly complex (Allahi *et al.*, 2015). Whether or not a bank branch is involved in a merger, it must have a thorough understanding of both its own trade area (TA) and that of its competitors in order to compete effectively. This is especially critical for financial institutions undergoing mergers or restructuring. Knowing the characteristics of their TA is vital for the institution's long-term welfare and for maintaining customer satisfaction.

When financial institutions gain insights into the preferences and behaviours of their customers (Gray, 2014) and understand their competitors' TAs, they can better leverage their strengths to retain customers and increase market share. However, an inaccurate TA delineation can result in significant errors, particularly when assessing branch closures or integrations. Over time, these errors may escalate into a "snowball effect" with severe consequences.

Inaccurate calculations of overlaps between branches involved in M&A can lead to the unintended transfer of customers with low financial literacy or those from lower socioeconomic background precisely the customers who rely most heavily on personal financial services. For these clients, transferring to a new branch or experiencing diminished service quality in an overburdened branch can increase their intention to switch to another bank.

While the immediate effects of these issues, such as customer dissatisfaction or underserved areas, may not be evident, branch closures initially reduce costs and improve efficiency ratios. However, a deterioration in service quality following a closure or integration typically leads to lower customer satisfaction, an increase in complaints, and a decline in loyalty, especially when customers decide not to renew or continue with financial products at maturity.

Over time, reduced sales caused by customer dissatisfaction may indicate that the overall sales performance of a branch is lower than it was before the closure or integration. This poses a real risk of losing market share to competitors, including other banks, Big Tech, and Fintech firms, as well as an increase in detractor customers. While these effects may not be immediately visible, they will become apparent in the medium to long term, negatively impacting the institution's income statement, brand image, and operational efficiency (Galariotis *et al*., 2021).

6. Conclusions and implications on the risk of financial exclusion

The actionable insights derived from this study provide a novel methodology for use in mergers and acquisitions (M&A) processes, aimed at accurately delineating the trade area (TA) and target audience for bank branches.

This research offers three key methodological contributions of interest to the academic community. First, to the best of our knowledge, this study fills a gap in the existing literature by highlighting TA delineation as a crucial instrument in marketing strategy, essential for creating an optimal distribution network for financial institutions engaged in M&A. Second, the study proposes a procedure to delimit the TA of a bank branch, based on a theoretical model supported by marketing and consumer behaviour theories. These theories link proximity, purchase frequency, and product type to location decisions. Third, this research incorporates Geographic Information Science (GIS) metrics, such as fragmentation analysis, to quantify the spatial configuration, discontinuities, and structure of the TA. This aligns with two significant research lines: first, the integration of spatial configuration effects in store location decisions, as suggested by Hubbard (1978) and Ghosh (1984); and second, the quantification of TA discontinuities, or "holes," as proposed by Baray and Cliquet (2007). Unlike traditional morphological analysis, this approach employs urban fragmentation rates to describe attributes like area, perimeter, shape, aggregation, and diversity.

The delimitation of the TA at the Madrid branch using the proposed procedure confirms that accepting the assumption of spatial uniformity is unrealistic. A visual analysis of the maps and index values clearly demonstrates that spatial uniformity does not exist across the entire TA. We identify zones of high residential density, "gaps" created by urban parks and sports areas, and varying levels of disorder and fragmentation within the TA. By integrating GIS metrics into Location Science through fragmentation analysis, we provide a qualitative and quantitative advancement over traditional methods that do not account for such spatial complexities. As the saying goes, "what can be measured can be improved."

These contributions have significant implications for location intelligence and marketing managers involved in M&A activities. Managers must be acutely aware of the strategies required for bank branch relocation, closure, and integration, ensuring precise TA delineation. This careful approach can help mitigate the negative effects of M&A, such as potential losses in customer loyalty and satisfaction, geographical and temporal inconveniences, staff reductions, and an increased customer load per branch factors that can drive customers to switch to competitors. Unfortunately, this critical aspect is often overlooked by many financial institutions.

The first methodological contribution is vital in reducing the risk of financial exclusion during retail banking network integration. Financial exclusion extends beyond mere physical access to branches; it also encompasses challenges in accessing and using banking services and products. Difficulty in using these services is a major contributor to over-indebtedness, financial exclusion, and self-exclusion from formal banking in developed economies (Fernández-Olit *et al*., 2019). From both social and business perspectives, it is crucial to maintain service quality for vulnerable customers with limited technological skills and financial literacy, thereby preventing a decline in their banking experience.

In summary, this study offers both practical and theoretical contributions. From an economic and commercial perspective, the methodology provides financial institutions with a systematic approach to optimising branch networks during mergers and acquisitions (M&A). This enables more informed decisions regarding branch closures, relocations, and integrations, helping to reduce operational costs while preserving customer access to essential services. By addressing the unintended consequences of these changes—particularly the loss of proximity to physical branches—financial institutions can mitigate a key driver of financial exclusion. Vulnerable groups, such as those in rural areas, low-income communities, or with limited access to digital banking, face heightened risks of exclusion when branches are closed. The framework proposed in this study aids in identifying and managing these risks, promoting a more inclusive banking environment. From an educational standpoint, this research underscores the value of combining GIS-managed tools with consumer behaviour analysis to accurately delineate TA. By mastering these approaches, future professionals will be better equipped to address the complexities of location intelligence. For instance, advanced machine learning techniques could be utilised to reveal connections between spatial variables and branch profitability. Finally, the findings carry important policy implications, underscoring the need for regulatory strategies that balance commercial objectives with the societal imperative of ensuring equitable access to financial services.

7. Future research

Several promising research directions emerge from the proposals outlined in this study. One potential extension involves integrating more dynamic data sources, such as mobile location data, and expanding the methodology to optimise multi-branch networks. This could include developing predictive models to assess post-M&A performance based on trade area (TA) characteristics.

One key research avenue is the quantification of overlap between bank branches during mergers, using GIS rasters to map geographic coordinates and determine the degree of TA overlap. Incorporating Geographic Information Science metrics into Location Science also presents opportunities to enhance the analysis. By delineating TA boundaries at the coordinate level, Machine Learning techniques, such as Neural Networks or AI Predictive Models, could identify patterns linking urban landscape variables with branch profitability and performance.

Another area of interest is examining how spatial clustering patterns—such as hot spots, cold spots, or outliers within the TA—relate to customer segments using online banking channels, particularly with respect to the geographical characteristics of the TA.

For marketing managers, estimating the saturation level of each bank branch by calculating the number of inhabitants potentially served offers valuable insights. This information can help categorise and compare branches within a retail banking network, minimising the risk of oversaturation. GIS-based interpolation techniques, such as Inverse Distance Weighted (IDW), can further assist in identifying households with internet access, guiding branch placement and customer service strategies.

Multicriteria Analysis can be applied to overlay GIS data and identify vulnerable areas within the TA—those with high concentrations of over-65s, low-income residents, and immigrant populations with limited internet access. These groups, at risk of technological exclusion, may face challenges in accessing alternative banking channels, such as online banking (Fernández-Olit, 2011).

Future research could build on these findings by incorporating dynamic and real-time data, such as mobile location analytics, to refine the delineation of trade areas (TAs). Exploring the application of these methods across multi-branch networks would offer further insights into how branch performance evolves post-merger. There is also scope to investigate the relationship between urban fragmentation patterns and customer behaviour, leveraging advanced machine learning techniques to identify links between spatial variables and branch profitability. Another promising avenue would be to analyse the long-term social impacts of branch closures, particularly on communities where physical banking remains vital. This would provide a deeper understanding of how to balance the commercial priorities of financial institutions with their role in fostering financial inclusion and social cohesion.

8. Limitations

However, despite the new lines of research proposed in this paper, the study is not without limitations. It simplifies the analysis by focusing on a single bank branch rather than a broader set. Nevertheless, this does not affect the replicability or scalability of the proposed methodology, as it can be applied across branches, provided that the relevant precise information is available—typically managed by the Location and Business Intelligence departments of any financial institution involved in M&A processes.

Additionally, the methodology requires geo-positioning of customers and travel times calculated through isochrones, which are based on the assumption that customers prefer walking rather than using other modes of transport. Furthermore, the land use data (SIOSE) used in the study is less current compared to data collected via satellite measurements (LIDAR technology) or drones.

Ultimately, this paper contributes to optimising retail banking networks following M&A activities while addressing the issue of financial exclusion. It is of considerable interest to both the financial and academic sectors. A deeper understanding of the TA) concept in the context of marketing and consumer behaviour offers a valuable perspective in decision-making. Ideally, this approach can confirm or challenge conclusions typically derived from less scientific methods based on intuition and experience.

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