Spatial Analysis for Better Marketing Decisions with Special Focus on Consumer Behaviour Patterns

Pasupuleti Pavani[1*], *Sanjay* Reddy Komatireddy[1], *Venkata* Teja Yarasuri[1], *Vivek* Reddy Police[1], *Sunil* Kumar Tanneru[1] and *Mohammed* I. Habelalmateen[2]

[1]Department of Computer Science and Engineering, Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad, Telangana, India.
[2]The Islamic university, Najaf, Iraq.

Abstract. The study explores the pivotal role of Geographic Information Systems (GIS) in shaping marketing decisions, with a special emphasis on consumer behaviour patterns. Distinct studies are scrutinized, spanning diverse applications of GIS in marketing, from spatial consumer behaviour in small towns to the visualization of consumer sales promotions. The analysis encompasses the integration of GIS with methodologies such as spatial point pattern analysis, kernel density estimation, and RFID systems, offering insights into optimal retail site locations, consumer preferences in shopping centers, and the spatial distribution of data. The findings underscore GIS's capacity to enhance decision-making processes, offering a valuable resource for marketers seeking to leverage spatial intelligence for strategic advantage.

1 Introduction

Spatial analysis, anchored by the formidable capabilities of Geographic Information Systems (GIS), has emerged as an indispensable asset cutting across industries and sectors. The strategic amalgamation of GIS into decision-making frameworks marks a paradigm shift, proffering nuanced insights into spatial intricacies and consumer dynamics. Within the multifaceted tapestry of GIS applications, its role in decoding consumer behavior stands out prominently, becoming a linchpin for businesses, especially within the dynamic realm of the retail sector.

In the evolutionary trajectory of GIS applications, addressing challenges in optimal site selection, market segmentation, and deciphering consumer preferences has been a focal point. The consummate versatility of GIS is conspicuously demonstrated in research endeavors investigating its role in retail site selection dynamics. Such investigations unfold layers of intricacies involved in understanding how geographic locations impact consumer decisions. This juncture between GIS and marketing is not merely about plotting points on a map; it is

---

* Corresponding author: pavani20891@gmail.com

an intricate dance with data, unraveling spatial narratives that are pivotal for business strategies.

Take, for instance, the exploration of consumer preferences within the framework of shopping centers in Bratislava. This study delves into the globalizing trends that have morphed consumer behaviors, driving a preference for shopping centers. However, the study doesn't stop at this broad observation. It scrutinizes the spatial distribution of consumer preferences, discerning patterns based on the specific locations and attractiveness of these shopping centers. Such granularity in analysis is empowered by the GIS tools employed, underlining its pivotal role in not just understanding consumer behavior but also in tailoring marketing strategies.

Furthermore, the study by Ilieva echoes the transformative potential of GIS in marketing, shedding light on its applicability in retail and services. The acceleration of mobile communications and the internet has instigated a surge in demand for geo-information products. GIS, in this context, emerges not merely as a mapping tool but as a dynamic apparatus for spatially contextualized marketing problem-solving. The paper meticulously dissects GIS applications, ranging from determining optimal retail locations to targeted marketing based on spatial factors. This breadth of application underscores GIS as not just a tool but a strategic ally in the arsenal of contemporary marketing.

The contours of GIS applications in marketing decisions become even more intricate when we navigate through the study by Musyoka et al. Here, GIS is not just a map-making tool; it is a dynamic participant in market segmentation for the soft drink industry in Kenya. By infusing analytical and visualization capabilities into GIS, the study transcends conventional data presentation methods. The study doesn't merely predict sales; it crafts optimal routes and times for distribution outlets based on demographic and socio-economic characteristics. This exemplifies GIS not only as a visual storyteller but as an active decision-making partner in marketing planning.

The trend continues in Sliwinski's spatial point pattern analysis for targeting prospective new customers. This paper is not just about analyzing customer data; it is about strategically deploying geodemographic insights to reduce expenditures in customer targeting. GIS, in this context, is not a passive tool but an active partner in the workflow, supporting the targeting of prospective customers through systematic spatial analysis (see Fig. 1). The fusion of spatial point pattern analysis within a GIS framework facilitates a targeted approach, optimizing the effectiveness of direct marketing efforts.

As the technological landscape evolves, GIS applications in marketing burgeon, as exemplified by Gürder et al.'s study. This work marries RFID systems with GIS for visualizing the success of consumer sales promotions. It's not just about promotions; it's about visualizing success through GIS-generated maps. These visualizations become pivotal for marketing managers, providing insights into which type of loyal customers react to promotions and helping in deciding the course of future promotions. This integration of GIS and RFID systems is not just a technological collaboration; it's a strategic move in enhancing the efficiency and effectiveness of marketing campaigns.

The significance of GIS in marketing transcends traditional boundaries, as illustrated by McMullin's work. This paper implements a systematic approach, linking consumer data with spatial marketing techniques. It's not just about mapping; it's about understanding the spatial extent of the customer base and strategically using this information for targeted mailings. The

raster/grid-based GIS framework becomes more than a visual aid; it becomes a decision-support system, helping in the selection of potential customers based on a suitability model.

These studies collectively paint a vivid canvas showcasing GIS not as a passive map-making tool but as an active participant in the dynamic field of marketing decisions. The trajectory of GIS applications in marketing is a journey from spatially contextualized insights to active decision-making collaboration. It's about understanding not just where customers are but why they make certain choices in specific locations. As businesses grapple with the challenges of an ever-evolving market, the marriage of GIS and marketing becomes a potent strategy, offering not just insights but actionable intelligence for strategic decision-making. This review paper, against this backdrop, aims to comprehensively explore recent GIS techniques in marketing decisions, placing due emphasis on the challenges encountered and outlining a roadmap for future research endeavors.

2 Literature Review

In the expansive realm of consumer behavior, an intricate tapestry of spatial dynamics is unfurled through the lens of diverse studies, each shedding light on nuanced aspects of this complex phenomenon. Rietveld and Leeuwen's investigation [1] into small and medium-sized towns across Europe unravels a narrative where these urban centers emerge not just as nodes of retail transactions but as crucial contributors to local economies. Their revelation that over half of household purchases within or near these towns occur locally underscores the persistent significance of these smaller hubs.

Krizan et al.'s research [2], delving into the post-communist landscape in Bratislava, captures the winds of change in consumer behavior. Their study of 11,389 respondents unveils not only the quantitative surge in shopping centers but the subtleties of consumer preferences dictated by both location and the inherent attractiveness of these commercial spaces. This spatial lens adds a new dimension to the understanding of consumer behavior, urging marketers to navigate the geography of preferences.

The work of Ilieva [3] propels us into the digital age, where the fusion of GIS technology and marketing becomes a linchpin in decision-making. As mobile communication and the Internet reshape the informational landscape, the study underscores the indispensability of GIS in handling spatially localized marketing data. From determining optimal retail locations to managing sales representatives and fine-tuning advertisement strategies, GIS emerges as a versatile ally in the marketer's toolkit.

These foundational studies, drawn from disparate corners of Europe and various facets of consumer behavior, coalesce into a narrative that beckons exploration. The spatiality of consumer choices, whether in the quaint charm of small towns or the gleaming expanse of shopping malls, invites marketers to engage with a complex interplay of factors. As we traverse the contours of these studies, a comprehensive tapestry of spatial consumer behavior unfolds, laying the groundwork for a more profound understanding of the contemporary market landscape.

The GIS Business Analyst, a pivotal tool in contemporary business analytics, stands at the forefront of transformative technologies, heralding a new era in decision-making processes [4]. Rooted in the integration of Geographic Information System (GIS) capabilities, statistical prowess, and advanced visualization tools, it emerges as a multifaceted solution. Its significance lies not merely in data representation but in the synthesis of diverse data

streams—geographic, demographic, consumer lifestyle, and business-specific—culminating in a holistic comprehension of intricate market dynamics [4].

In the vast landscape of business intelligence, the GIS Business Analyst serves as a beacon, illuminating hidden patterns that elude conventional analytical approaches. It acts as a dynamic compass, guiding businesses through the labyrinth of market trends, thereby conferring a distinct competitive edge. Beyond its conventional role, the utility of GIS Business Analyst extends its tentacles into diverse domains, encompassing an exhaustive spectrum from market share analysis to the strategic orchestration of new site expansions or judicious reductions.

Essentially, the GIS Business Analyst transcends the realm of a conventional analytics tool. It metamorphoses into an indispensable partner in decision-making, an ally that not only decodes the intricacies of market landscapes but also provides actionable insights. Its integration of GIS capabilities introduces a spatial dimension, allowing businesses to discern patterns and relationships that might otherwise remain obscured.

Picture a scenario where businesses are not merely analyzing data but immersing themselves in a dynamic visualization of their market environment. Through the GIS Business Analyst's lens, the market becomes a living, breathing entity with its own set of geographical nuances. The spatial overlay of demographic data, consumer behavior patterns, and business-specific variables provides a nuanced understanding that transcends traditional analytical frameworks.

Consider, for instance, the ability to scrutinize competition in a spatial context. The GIS Business Analyst transforms market share analysis from a numerical exercise to an immersive spatial experience. It unravels not just the percentage figures but the spatial dynamics of market dominance. Businesses, armed with this spatial intelligence, can strategically position themselves, identifying not only market gaps but also optimal locations for expansion.

Furthermore, the GIS Business Analyst's role in guiding site expansions or reductions is akin to having a seasoned navigator in the unpredictable waters of business landscapes. Its spatial analytics allows businesses to evaluate potential sites not merely in isolation but in the context of their surroundings. The tool goes beyond raw data, considering the socio-demographic fabric, consumer preferences, and even the spatial distribution of competitors. In this way, it doesn't just provide data points but a comprehensive narrative, enabling businesses to make decisions that are not only informed but strategically sound.

The GIS Business Analyst, therefore, isn't merely a tool; it's a strategic ally, a navigator steering businesses through the complexities of modern markets. As businesses grapple with ever-increasing volumes of data, this tool serves as a compass, not just pointing north but providing a detailed map of the terrain. Its fusion of GIS capabilities with advanced analytics isn't just a technological feat; it's a paradigm shift, empowering businesses to not just survive but thrive in the dynamic landscapes of the digital age. In essence, the GIS Business Analyst is more than a tool of analytics; it's a transformative force shaping the future of decision-making.

In the realm of academia, the GIS-based Student Profiling System leverages GIS mapping to visualize the demographic distribution of students in specific municipalities and barangays [5]. Beyond a mere representation of locations, this system becomes a crucial tool for

educational institutions, aiding in recruitment strategies, marketing plans, and proposed development programs. It transforms data into actionable insights, providing a basis for intelligent decision-making in academia.

The application of GIS in marketing planning and decision-making takes center stage, notably in Sivas and other cities in Turkey. Through consumption maps, generated by GIS, the study illuminates the spatial nuances of consumer preferences [6]. By meticulously integrating data on GIS platforms and developing user-friendly interfaces, it facilitates seamless queries and analyses. The city of Sivas becomes a canvas where GIS paints intricate pictures of consumption patterns, offering valuable insights for marketers and investors.

Moving to Kenya, the GIS application takes the form of market segmentation. The case study of the soft drink industry marks a foray into the realm of market segmentation using GIS [7]. By harnessing the analytical and visualization capabilities of GIS, the study transcends conventional data presentation. It crafts a digital map, delineating market zones and predicting product sales based on demographic and socio-economic characteristics. The amalgamation of geospatial methods with traditional marketing techniques unveils a potent approach to sales and marketing planning.

Austria introduces a unique application of GIS in retail—spatial point pattern analysis for targeting prospective customers [8]. By employing kernel density estimation, this approach provides a preliminary hint for the selective employment of geodemographic data. The spatial point pattern analysis, seamlessly integrated into GIS, emerges as a potent tool for retailers. The case study unfolds a novel approach, demonstrating the potential of spatial analysis in refining customer targeting strategies.

Fig. 1. Depicting GIS usage in consumer segmentation

Table 1. Literature Review Table

Reference	Authors	Year	Title	Key Focus
1	Rietveld, Piet & Leeuwen, Eveline S.	2011	Spatial Consumer Behaviour in Small and Medium-sized Towns	Retail services in small towns, shopping behavior
2	Krizan, Frantisek & Bilková, Kristína & Barlík, Peter & Kita, P.	2018	Spatial distribution of consumer preferences: Case study of shopping malls in Bratislava	Consumer preferences in shopping malls
3	Ilieva, Galina	2013	Aspects of Applicability of GIS Technology in Marketing	GIS applications in marketing, spatial behavior
4	Carmen, Radut	2009	The GIS and data solution for advanced business analysis	GIS Business Analyst, site evaluation, market analysis
5	Julve, Jaypee & Etchon, Fae Mylene & Etchon, M & Acevedo, Rienar	2020	GIS-BASED STUDENT PROFILING SYSTEM BASIS FOR MARKETING PREDICTIVE ANALYTICS	GIS-based student profiling, marketing analytics
6	Türk Phd, Tarık & Kitapci, Olgun & Dortyol, Ibrahim	2014	The Usage of Geographical Information Systems (GIS) in the Marketing Decision Making Process: A Case Study for Determining Supermarket Locations	GIS in marketing decision-making, supermarket locations
7	Musyoka, S.M. & Mutyauvyu, Maithya & Kiema, John & Karanja, Faith & Siriba, David	2007	Market segmentation using geographic information systems (GIS): A case study of the soft drink industry in Kenya	GIS in market segmentation, soft drink industry
8	Sliwinski, A.	2002	Spatial point pattern analysis for targeting prospective new customers: bringing gis functionality into direct marketing	Spatial point pattern analysis, GIS in direct marketing
9	F. Gürder Et Al.	2011	Visualization of Success of Consumer Sales Promotions Through GIS Based on RFID-Captured Consumer Behavior	GIS-based visualization of consumer sales promotions

10	McMullin, S.K.	2000	Where are your customers: Raster based modeling for customer prospecting	GIS in customer prospecting, raster-based modeling

3 Observations and Findings

The reviewed literature offers a multifaceted exploration of Geographic Information Systems (GIS) applications in diverse realms. The study on small and medium-sized towns reveals the continued centrality of these towns in providing retail services, with over half of local purchases occurring within these locations. Globalization's impact on consumer behaviour, particularly in shopping preferences for malls, is evident in the study on Bratislava, emphasizing the intersection of economic shifts and consumer choices. The applicability of GIS technology in marketing highlights its role in addressing the spatial component of data, offering insights into consumer behavior for more effective decision-making in retail and services.

The GIS Business Analyst stands out as a comprehensive tool for business analytics, integrating GIS capabilities with statistical analysis and visualization, empowering businesses to decipher complex market dynamics. The GIS-based Student Profiling System provides a unique perspective, visually representing the demographic distribution of students and aiding marketing predictive analytics. Determining optimal supermarket locations using GIS showcases GIS as integral to decision-making processes, particularly in creating consumption maps for investors and marketers.

Market segmentation within the soft drink industry in Kenya integrates GIS with conventional marketing techniques, enhancing data communication and understanding. Spatial point pattern analysis for targeting prospective customers introduces a novel approach, utilizing GIS for decreased expenditures through selective deployment of geodemographic data. The visualization of consumer sales promotions through GIS and RFID [9] illuminates GIS's role in understanding customer reactions and making informed decisions about promotional strategies. In [10-12] the authors explored about image classification and security with machine learning. Raster-based modeling for customer prospecting [13] demonstrates GIS's systematic approach in analyzing the spatial extent of customer bases for targeted marketing.

These studies collectively underscore the versatility and transformative potential of GIS in diverse industries. From retail and services to education and consumer goods, GIS emerges as a powerful tool for spatial analysis, offering nuanced insights for strategic decision-making and operational optimization. The findings collectively contribute to a comprehensive understanding of GIS applications in enhancing marketing strategies and overall business effectiveness.

4 Conclusion

In conclusion, the reviewed literature underscores the pervasive influence of Geographic Information Systems (GIS) across diverse sectors. The studies encompass various dimensions, from the continued significance of small and medium-sized towns in local retail services to the nuanced analysis of consumer preferences in the globalized landscape of shopping malls. The GIS Business Analyst emerges as a transformative force, unravelling hidden patterns and providing a holistic understanding of market dynamics. The GIS-based

Student Profiling System exemplifies the application of GIS in education, facilitating marketing predictive analytics.

Across retail, services, and industries like soft drinks, GIS integrates seamlessly with traditional marketing techniques, offering enhanced data communication and visualization. The novel approaches, such as spatial point pattern analysis for customer targeting and GIS-based visualization of consumer sales promotions, underscore GIS's adaptability to evolving business landscapes. Raster-based modeling for customer prospecting introduces a systematic approach, allowing for targeted marketing strategies.

In essence, GIS emerges as more than a mere mapping tool; it stands as a powerful ally in strategic decision-making, market analysis, and operational optimization. Its spatial analysis capabilities bring a new dimension to understanding consumer behavior, facilitating precise and informed decision-making. As businesses continue to navigate complex and dynamic markets, GIS stands as an invaluable asset, offering insights that drive success in an increasingly spatially conscious world.

References

1. Rietveld, P., & Leeuwen, E. S. (2011). Spatial Consumer Behaviour in Small and Medium-sized Towns. Regional Studies, 45(9), 1107-1119.
2. Krizan, F., Bilková, K., Barlík, P., & Kita, P. (2018). Spatial distribution of consumer preferences: Case study of shopping malls in Bratislava. Theoretical and Empirical Researches in Urban Management, 13, 13-21.
3. Ilieva, G. (2013). Aspects of Applicability of GIS Technology in Marketing. Management and Sustainable Development, 39, 42-46.
4. Carmen, R. (2009). The GIS and data solution for advanced business analysis. Economia. Seria Management, 12, 171-180.
5. Julve, J., Etchon, F. M., Etchon, M., & Acevedo, R. (2020). GIS-BASED STUDENT PROFILING SYSTEM BASIS FOR MARKETING PREDICTIVE ANALYTICS, 32(3), 289-293.
6. Türk Phd, T., Kitapci, O., & Dortyol, I. (2014). The Usage of Geographical Information Systems (GIS) in the Marketing Decision Making Process: A Case Study for Determining Supermarket Locations. Procedia - Social and Behavioral Sciences, 148, 227–235.
7. Musyoka, S. M., Mutyauvyu, M., Kiema, J., & Karanja, F., & Siriba, D. (2007). Market segmentation using geographic information systems (GIS): A case study of the soft drink industry in Kenya. Marketing Intelligence & Planning, 25, 632-642.
8. Sliwinski, A. (2002). Spatial point pattern analysis for targeting prospective new customers: bringing GIS functionality into direct marketing. Journal of Geographic Information and Decision Analysis, 6(1), 31-48.
9. F. Gürder et al. (2011). Visualization of Success of Consumer Sales Promotions Through GIS Based on RFID-Captured Consumer Behavior. Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi, 30(1), 321-340.
10. S. R. Komatireddy, K. Meghana, V. Gude and G. Ramesh,,"Facial Shape Analysis and Accessory Recommendation: A Human-Centric AI Approach," 2023 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA), Bengaluru, India, 2023, pp. 182-191, doi: 10.1109/ICIMIA60377.2023.10426487.

11. Venkataramaiah Gude, Sujeeth T, K Sree Divya, P. Dileep Kumar Reddy, G. Ramesh. (2024).,Machine Learning for Characterization and Analysis of Microstructure and Spectral Data of Materials. International Journal of Intelligent Systems and Applications in Engineering, 12(21s), 820–826.

12. Ramesh, G., Gorantla, Venkata Ashok K & Gude, Venkataramaiah(2023) A hybrid methodology with learning based approach for protecting systems from DDoS attacks, Journal of Discrete Mathematical Sciences and Cryptography, 26:5, 1317–1325, DOI: 10.47974/JDMSC-1747.

13. McMullin, S. K. (2000). Where are your customers: Raster based modeling for customer prospecting. In Proceedings of the Annual ESRI International User Conference (pp. 795-823).