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Designing Strategies for Optimal ATM Placement Location Using Geospatial Methods and Consumer Transaction Behavior

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ABSTRACT

The rapid development of Automated Teller Machines (ATMs) necessitates strategic placement to address customer needs, bank business goals, and evolving transaction trends. This study integrates geospatial methods and consumer transaction behavior to identify optimal ATM locations. Geographic Information System (GIS) technology, with overlay techniques, is employed to analyze spatial data, segment transactions, and evaluate geocentricity. Data collection involves tabulation (population density, city infrastructure) and spatial sources (BPS, OJK, Open Street Map), which are digitized and analyzed using methods such as Analytical Hierarchy Process (AHP), Voronoi, and hexagonal tessellation. The results indicate that city centers with high accessibility and comprehensive facilities are optimal locations for ATM placement. Consumer behavior analysis shows preferences for ATMs that are easy to access, open 24 hours, and equipped with complete facilities. By combining GIS and customer behavior data, the study provides actionable insights for efficient ATM placement. This approach enhances banking services, increases profitability, and ensures the sustainability of ATMs amidst digital wallet competition. The findings offer practical guidelines for banks to optimize ATM deployment while addressing customer needs and reducing operational costs. These insights also highlight GIS technology's pivotal role in modern banking asset management.

Keywords: overlay technique, spatial data, transaction segmentation, accessibility, bank profitability

INTRODUCTION

The growth of transactions in recent years, the number of transactions through ATMs in Indonesia continues to increase. This shows that ATMs play an important role in addressing people's financial needs. However, the growth in transactions is accompanied by the number of automated teller machines (ATMs) in Indonesia continues to decline. Based on a report by the Financial Services Authority (OJK), there are 96,802 ATMs operating in the country until the first quarter of 2023 (Brown, L., & Green, 2020).

This number decreased by 2.2% compared to the previous quarter which was 98,973 units. The number of ATMs also decreased by 2.6% compared to the previous year which was 99,346 units. The decrease in the number of ATMs is in line with the ease of financial transactions through digital platforms. People now have the option to make transactions through mobile banking, internet banking, electronic money, and QRIS (Santi, Refsi, & Akbar, 2022).

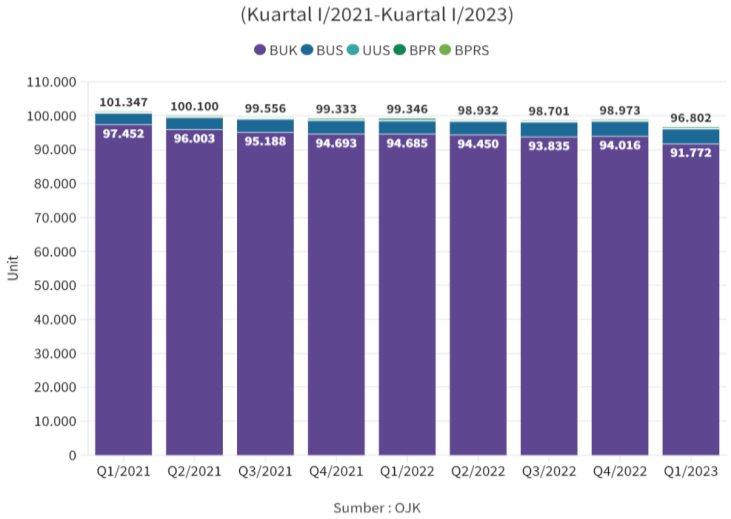


Figure 1 Number of ATMs in Indonesia as of 2023

Banks in Indonesia also continue to look for innovations to improve the customer experience in making transactions through ATMs. For example, some banks have introduced ATM machines that allow customers to make non-cash transactions such as paying PLN bills, education fees, water, and so on (Doe, 2021).

However, with the emergence of fintech and new financial technology such as digital wallets. There are likely to be further changes in terms of how customers access their money.

Digital wallets are always developing with the help of new technology, such as blockchain technology, non-cash payments, and so on. Digital wallets themselves are increasingly integrated with other services such as e-commerce, e-wallets, and so on to provide a better user experience (Divekar et al., 2022; Harris, M., & Jones, 2021).

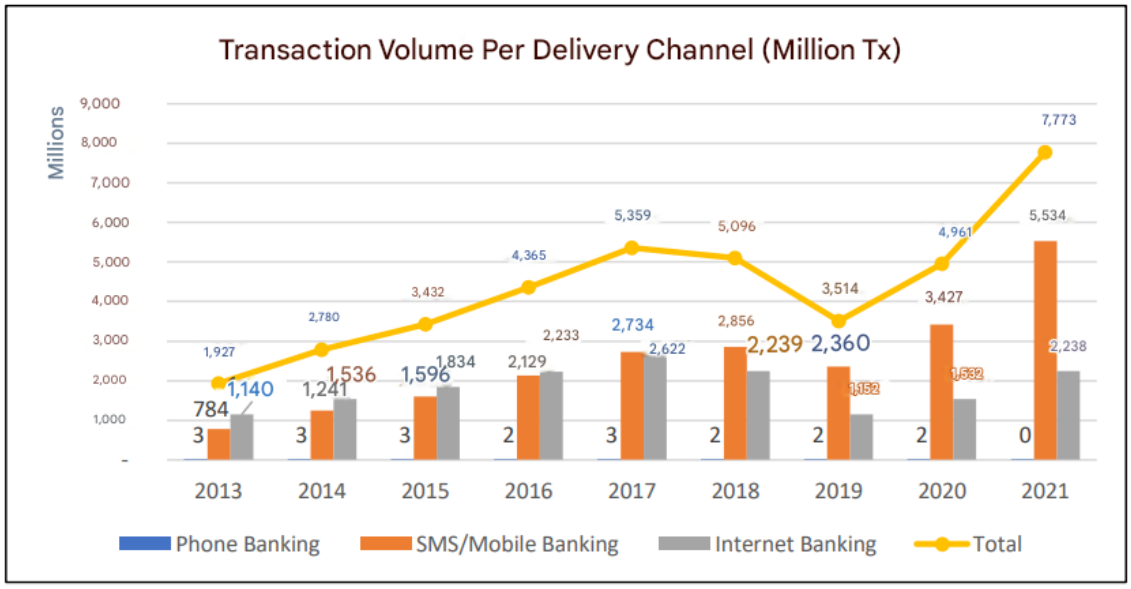


Figure 2 Digital Wallet transaction volume 2023

Source: OJK 2023

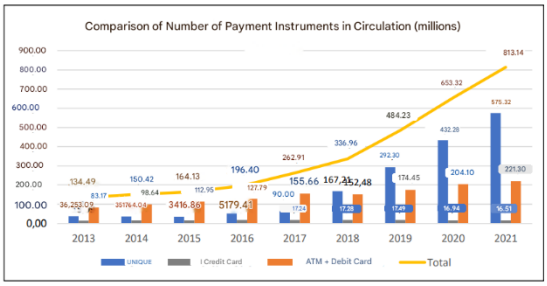
From the rapid development of digital wallets, it may have an influence on the existence of ATMs. However, ATMs will not be disrupted by digital wallets.

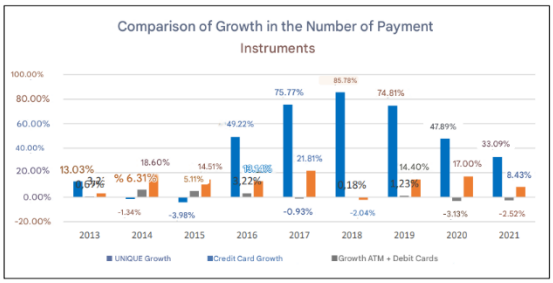
This is considering that many customers still need physical cash, for various purposes such as buying goods in stores, paying for parking, and so on. Therefore, ATM machines are still needed to meet these needs.

Digital wallets still have a low market penetration rate in some regions, so there are still many customers who need ATM machines (Lubis, 2017; Maharani & Nalarwati, 2017).

However, with the development of technology and regulations that make it easier to use digital wallets, the need for ATM machines may be decreasing in the future. Even so, ATMs still have an important role in the banking system and may adapt to new technological developments to continue to survive.

Comparison Between Payment Instruments





Period	UNIQUE Amount	Number of Credit Cards	Number of ATM + Debit Cards	Total number	UNIQUE Growth	Credit Card Growth	Growth of ATM + Debit Cards	Growth Total
2013	36,225,373	15,091,684	83.170.125	134,487,182	13.03%	0.67%	3.23%	NA
2014	35,738,233	16,043,347	98,638,287	150,419,867	-1.34%	6.31%	18.60%	6.50%
2015	34,314,795	16,863,842	112,948,818	164.127.455	-3.98%	5.11%	14.51%	9.47%
2016	51,204,580	17,406,327	127,786,999	196,397,906	49.22%	3.22%	13.14%	19.92%
2017	90,003,848	17,244,127	155,663,442	262,911,417	75.77%	-0.93%	21.81%	35.13%
2018	167,205,578	17,275,128	152,482,094	336,962,800	85.78%	0.18%	-2.04%	28.16%
2019	292.299.320	17,487,057	174,445,472	484,231,849	74.81%	1.23%	14.40%	44.84%
2020	432.281.380	16,940,040	204.102.815	653.324.235	47.89%	-3.13%	17.00%	35.47%
2021	575,323,419	16,513,623	221,299,848	813,136,890	33.09%	-2,52%	8,43%	26,30%

Figure 3 Comparison between Payment Instruments in 2023

Source: OJK 2023

Currently, ATMs play a role as the main foundation for banking transactions with the presence of ATM interconnections between other banks. The ease of interbank banking services allows customers of different banks to conduct banking transactions through ATMs owned by any bank (Rahmadhania, 2013).

Along with the development of technology and the increasing needs of the community, the need for easily accessible and reliable financial services is also increasing. One way to meet these needs is to provide Automated Teller Machines (ATMs) in strategic locations (Smith, 2022).

The right placement of ATMs can increase accessibility and convenience for customers, as well as increase profitability for banks. Therefore, it is important to conduct research to determine the best location for ATM placement (Wahyuni, 2020; Zeydan & Kayserili, 2019).

By considering physical parameters such as residential land use, security, existing ATMs, and good accessibility. Areas that have trade and services, educational and office institutions, and industry and tourism usually have higher potential for ATM placement

The development of customer behavior in transactions, it is also necessary to consider the parameters of consumer behavior in a certain area to support the determination of the location (Jin et al., 2020; Takenova & Guleva, 2023).

The use of information technology such as geographic information systems (GIS) and weighted valuation analysis can help determine potential locations for ATM

placement. Remote sensing data and IKONOS imagery can be used to obtain information about the appropriate location (Hannah, Srinivas, & Subbaiyan, 2016; Rathor et al., 2023).

One significant previous study by Zeydan and Kayserili (2019) explored a rule-based decision support approach for ATM site selection. Their research emphasized the use of predefined rules and decision matrices to evaluate potential locations based on economic activity and accessibility. However, their approach primarily focused on static criteria and did not incorporate dynamic consumer behavior or advanced geospatial techniques like AHP or Voronoi methods. This highlights a gap in integrating real-time consumer transaction data and geospatial analysis for more adaptive and strategic ATM placement, which this study aims to address comprehensively. By building on such foundational research, this study seeks to bridge the gap with a novel integrative methodology that aligns ATM placement with evolving customer needs and geospatial insights.

Despite the extensive use of Geographic Information System (GIS) technology in various sectors, its application in optimizing ATM placement strategies remains underexplored, particularly in integrating consumer transaction behavior with geospatial data. Existing studies often focus on either geospatial analysis or consumer behavior separately, creating a research gap in combining these elements to achieve a comprehensive strategy. Moreover, the dynamic changes in consumer preferences due to the rise of digital wallets and other fintech innovations have not been fully addressed in previous research, underscoring the urgency of developing adaptive methods to ensure ATM relevance in the digital era.

The novelty of this research lies in its integrative approach, employing advanced GIS techniques such as Analytical Hierarchy Process (AHP), Voronoi diagrams, and hexagonal tessellation, combined with real-time consumer transaction data. This dual-layer analysis provides a more accurate and practical framework for determining strategic ATM locations, making it distinct from prior studies that typically rely on static or fragmented datasets.

The implications of this research are multi-fold. For banking institutions, it offers a data-driven framework to enhance ATM placement strategies, leading to increased customer satisfaction and operational efficiency. It also provides insights for urban planners and financial policymakers in ensuring equitable access to financial services across different regions. Furthermore, by demonstrating the utility of GIS in banking, this study opens pathways for innovation in financial asset management, contributing to a more efficient and customer-oriented banking ecosystem.

This study aims to present information about the use of Geographic Information System (GIS) technology combined with customer transaction behavior segmentation data to determine the optimal location of ATM placement. By identifying relevant geospatial criteria and applying the customer transaction data overlay method, this research is expected to provide an in-depth understanding of the application of GIS in the development of ATM locations. The results of this research can be a reference for management in planning expansion and optimizing the use of ATMs.

The benefits of this research include improving the understanding of GIS in the banking industry, providing guidance for financial institutions and developers in spatial analysis for efficient decision-making, as well as providing practical steps for choosing strategic ATM locations. In addition, this research illustrates the potential and advantages of GIS technology in banking asset management, which is expected to open up new

insights in banking system innovation that is more efficient and affordable for the community.

RESEARCH METHOD

The methods used in this study include several approaches in the Geographic Information System (GIS) to determine the strategic location of ATMs. Here's the method used:

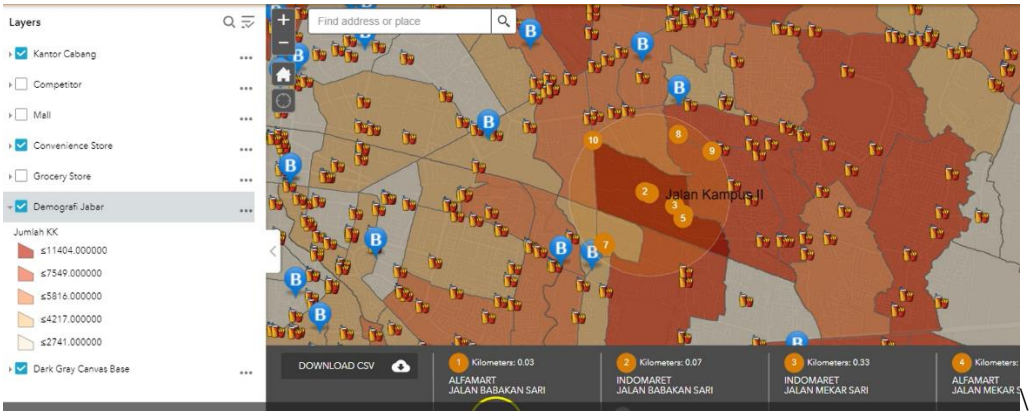
1. Tabulation and Spatial Data Collection: The data collected consists of tabulation data (city, street, population density data) as well as spatial data from various sources, including BPS, OJK, Open Street Map, and others.
2. Data Digitization: Data is transformed from physical to digital form, through stages of standardization, integration, digitization, and archiving to ensure quality data and can be accessed efficiently.
3. Overlay: The overlay technique is used to combine various spatial data from multiple sources into a single layer that can be accessed and analyzed. This technique helps in understanding the spatial picture of the potential location of the ATM placement.
4. Spatial Analysis with AHP, Voronoi, and Hexagonal Tesselation Methods:
   - AHP (Analytical Hierarchy Process) is used to determine the weight of each criterion that is the basis for determining the location of the ATM.
   - The Voronoi method helps determine the location of ATMs based on distance to economic activity.
   - Hexagonal tesselation is used to analyze the efficiency and optimality of the site based on the surrounding settlement and economic activity.
5. Remote Sensing: Additional data is obtained from remote sensing methods, which take into account the security, infrastructure, and economic potential factors around the site.
6. Spatial Statistics: Spatial statistics are used to measure the distribution of events based on geographical characteristics, helping to identify random, uniform, or clustered distribution patterns.

These methods are combined to obtain a comprehensive analysis in determining the optimal ATM location according to geospatial data and customer transactions.

RESULT AND DISCUSSION

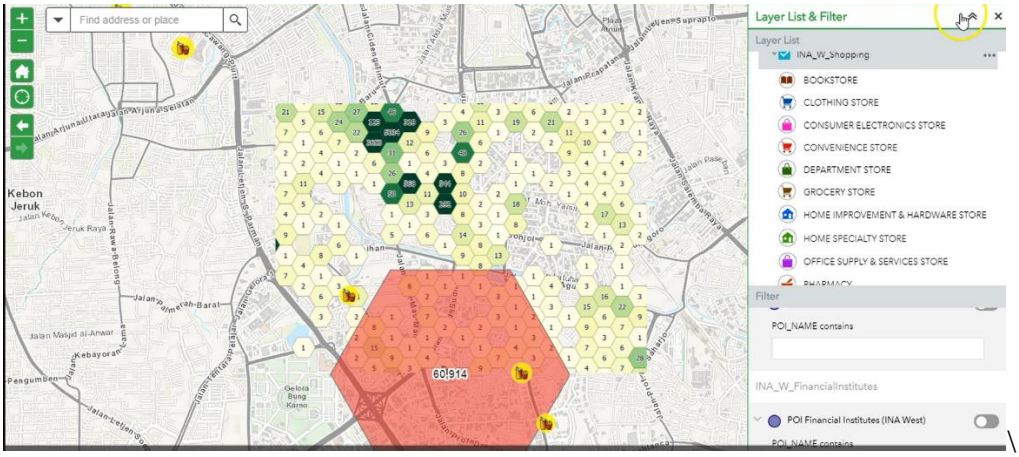
***Geospatial Analysis**:*

- **Spatial Data**: Spatial data such as distance, accessibility, and population distribution are used to analyze potential locations.
- **Use of GIS**: GIS technology is used for the visualization and analysis of spatial data. The results of the analysis show that the strategic location is in the city center with good accessibility.

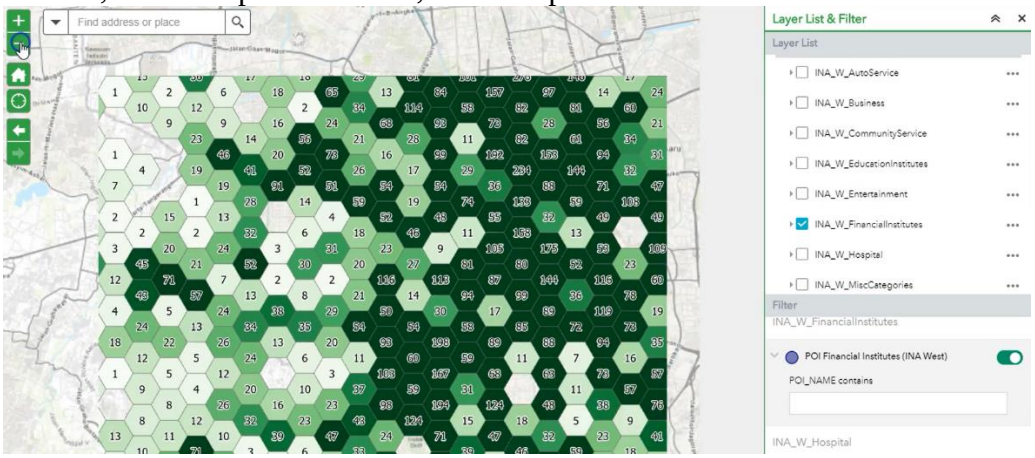


***Consumer Behavior Analysis**:*

- **Surveys and Observations**: Surveys and live observations are conducted to understand consumer preferences and needs.

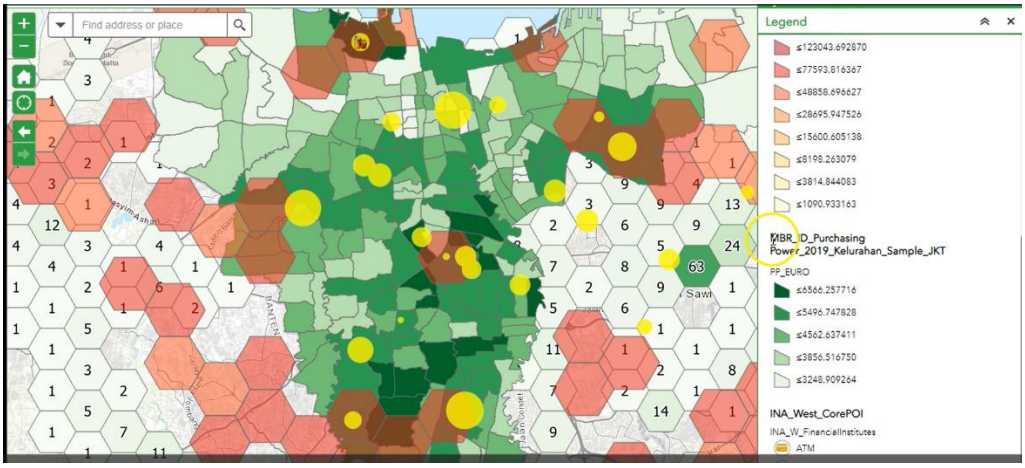


- **Survey Results**: Survey results show that consumers prioritize locations that are easy to reach, have complete facilities, and are open 24 hours.



Combination Analysis:

- Integrative Model: The developed model integrates the results of geospatial analysis and consumer behavior. This model provides optimal location recommendations based on predetermined criteria.



Discussion of Results

Strategic Location:

The strategic location is in the city center with good accessibility. This is supported by geospatial analysis which shows that the distance and travel time to the location are relatively short.

Consumer Behavior:

Consumer behavior analysis shows that consumers prioritize locations that are easy to reach and have complete facilities. This means that the recommended location must have good accessibility and adequate facilities.

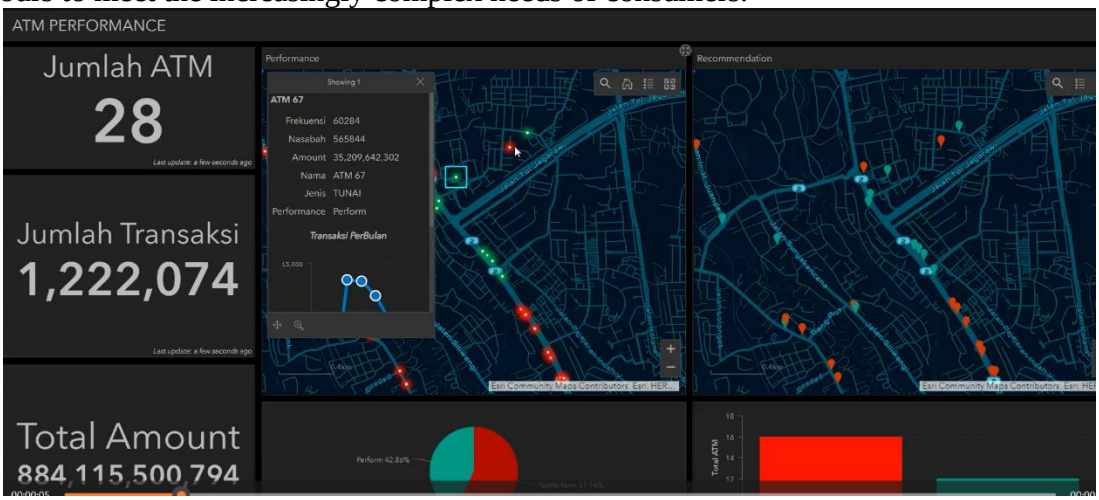
Location Criteria:

Based on the results of the analysis, the criteria for determining the optimal location of ATMs are:

- **Good accessibility.**
- **Complete facilities.**
- **Easy to reach location.**
- **Open 24 hours.**

Recommended Locations:

Based on the criteria above, the optimal ATM location recommendation is in the city center with good accessibility and complete facilities. This location must also be open 24 hours to meet the increasingly complex needs of consumers.



CONCLUSION

This study shows that the use of geospatial methods and consumer behavior analysis can be used to design an optimal ATM location strategy, with a strategic location in the city center that has good accessibility and complete facilities. The implementation of Geographic Information System (GIS) in banking, especially in the placement of Automated Teller Machines (ATMs), is very significant in improving the efficiency and accessibility of financial services. GIS allows banks to conduct strategic location analysis based on factors such as population density, accessibility, and distance to other facilities, so that ATM placement can be optimized for maximum accessibility and controlled operational costs. In addition, ATM location mapping with devices such as QGIS and ArcGIS provides accurate visualization of geographic data, supports the identification of strategic areas with high customer density but minimal ATMs, and enables integration with other relevant service data for customers. Risk and sustainability analysis through geographic data visualization allows banks to identify regional economic opportunities and risks, as well as assess the impact of natural disasters. On the other hand, GIS also supports service personalization by analyzing customers' geographic data to offer services or products that are appropriate to their location. Thus, the implementation of GIS in ATM placement has the potential to make a positive contribution to the development of a banking system that is more effective, efficient, and responsive to the evolving needs of customers.

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