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أ.م. د. مها كامل جواد

كلية الإدارة والاقتصاد / جامعة بغداد

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Selecting Service Facility Location of Automatic Teller Machine (ATM): A Case Study

اختيار موقع مراكز الخدمة لمكائن الصراف الالي: دراسة حالة

Assistant Prof. Dr. Maha K. Jawad*
College of Administration & Economics/University of Baghdad

أ.م. د. مها كامل جواد*
كلية الإدارة والاقتصاد / جامعة بغداد

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المستخلص:

يُعدّ نمو شبكات أجهزة الصراف الآلي أمراً بالغ الأهمية لتعزيز الخدمات المالية، لا سيما في المناطق الحضرية النامية كبغداد، العراق. ومع ذلك، غالباً ما يواجه مديرو العمليات في البنوك الخاصة الصغيرة صعوبة في تحديد أفضل مواقع أجهزة الصراف الآلي نظراً لمحدودية وصولهم إلى الأدوات التحليلية المتطورة والمعرفة التقنية اللازمة. تُطبّق هذه الدراسة أسلوب التحليل الهرمي (AHP) لمساعدة مديري العمليات على اتخاذ قرارات مدروسة بشأن اختيار مواقع الأجهزة. يُسلّط البحث الضوء على حالة عملية تتعلق ببنك خاص صغير يرغب في إنشاء جهاز صراف آلي في أحد ثلاثة مواقع مُقترحة. من خلال مناقشات مع إدارة البنك، تم تحديد أربعة معايير رئيسية: الأمن، والمنافسة، وحركة العملاء، وتكاليف التركيب. استُخدم أسلوب التحليل الهرمي لإجراء مقارنات ثنائية بين المعايير والمواقع المُحتملة، مما مكّن البنك من تحويل التقييمات النوعية إلى بيانات قابلة للقياس وترتيب خياراته. يُثبت البحث أن أسلوب التحليل الهرمي يُقدّم طريقة واضحة وقابلة للتكرار وفعّالة لاتخاذ قرارات اختيار المواقع متعددة المعايير في قطاع الخدمات. يقدم هذا البحث أداة مفيدة لتخطيط القرارات الاستراتيجية في القطاع المصرفي. يتميز هذا النموذج بمرونته وقابليته للتكيف مع مختلف السيناريوهات، كما يمكن تعديله وفقاً لإمكانيات مرافق الخدمة، مما يجعله مفيدًا بشكل خاص للمصارف الصغيرة والمتوسطة الحجم التي تسعى إلى تحسين مواقع أجهزة الصراف الآلي. وختامًا، تؤكد الدراسة على أهمية أسلوب التحليل الهرمي (AHP) كأداة لتحسين جودة الخدمة، ورضا العملاء، والقدرة التنافسية لمرافق الخدمة.

الكلمات المفتاحية : مراكز الخدمة، الصراف الآلي، صناعة الخدمات، عملية التحليل الهرمي

Abstract:

The growth of Automated Teller Machine networks is essential for promoting financial services, particularly in developing urban areas like Baghdad, Iraq. Nevertheless, operations managers at smaller private banks often struggle with identifying the best locations for ATMs due to their limited access to sophisticated analytical tools and technical know-how. This study applies the Analytical Hierarchy Process to operations managers in making better-informed choices about facility site selection. The research highlights a practical situation concerning a small private bank that wants to set up an ATM in one of three suggested locations. Through discussions with bank leaders, four main criteria were identified: security, competition, foot traffic, and installation costs. AHP was used to carry out pairwise comparisons of both the criteria and the possible locations, allowing the bank to turn qualitative assessments into measurable data and rank its options. The research establishes that AHP offers a clear, replicable, and effective method

*Corresponding Author: Maha K. Jawad

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for making multi-criteria location decisions in the service sector. This research provides a useful instrument for strategic decision planning in the banking industry. The model is adaptable to different scenarios and can be adjusted according to the service facility capabilities, making it particularly beneficial for small to medium-sized banks facilities looking to enhance ATM location. In conclusion, the study emphasizes the significance of AHP as a tool that improves service delivery, customer satisfaction, and the competitiveness of service facilities.

Keywords: Service Centers, ATM, service industry, AHP

1.Introduction

The implementation of Automated Teller Machines (ATMs) is essential in improving financial accessibility and operational efficiency within the banking industry. As financial institutions increasingly transition to digital service channels, the strategic deployment of automated teller machines (ATMs) has emerged as a critical element of service provision, customer satisfaction, and competitive advantage. In emerging areas like Baghdad, Iraq, the growth of ATM infrastructure has been progressive, influenced by elements such as restricted technological capabilities, diminished banking awareness, and variable security circumstances .

In recent years, the Central Bank of Iraq has augmented its initiatives to enhance financial inclusion and modernize the banking sector. Consequently, both public and private banking institutions have augmented investments in the deployment of ATMs, especially in high-traffic locations such as shopping malls, universities, and commercial zones. For instance (Al-Janabi and Askari, 2025) mention that between 2018 – 2023 Iraq witnessed a great spread of ATMs, POS, and e-Wallets which served 4.98 million citizens. Elsewhere, (Nasih and Al-Mashadani, 2025) indicated that the number of ATMs in Iraq grew from 865 in 2018 to 2223 in 2023. Nevertheless, numerous small banks encounter considerable difficulties in formulating evidence-based location decisions owing to insufficient technical expertise and the absence of decision-support tools .

This study examines a fundamental inquiry: How can a small private bank, characterized by its limited knowledge in analytical method, utilize a scientific methodology such as the AHP to determine the most suitable location for a new ATM? The objective is to offer a structured approach that facilitates strategic planning by assessing various site location based on pertinent criteria, including security, competition, foot traffic, and installation expenses .

The importance of this research resides in its capacity to connect intricate decision-making frameworks with practical application in resource-limited contexts. Through the provision of a functional and replicable model employing the AHP, this study seeks to enable smaller service institutions to engage in data-driven, site location that enhances service provision and customer accessibility.

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2. Research Methodology

2.1. Research Problem

Automated teller machines began to appear in Baghdad (Iraq) on a limited scale in the early 2000s, as part of Iraqi banks' efforts to keep pace with technological developments in the banking sector and provide electronic services that facilitate withdrawal and deposit transactions for citizens. However, their spread was slow at first, due to multiple challenges such as weak technological infrastructure, low banking awareness, and limited use of bank cards. With the gradual improvement of the security and economic situation, and the Central Bank of Iraq support to financial inclusion plans, the capital witnessed a significant expansion in the number of ATMs, particularly in commercial areas and vital centers such as malls, universities, and bank branches. Competition between private and public banks also contributed to accelerating this expansion, with the aim of providing more efficient and convenient services to citizens. Given these facts, the research question is: how can a small private bank, with limited knowledge in quantitative experience, apply the Analytical Hierarchy Process to rank location sites to install new ATM?

2.2. Research Objectives

This research attempts to achieve the following objectives:

1. To introduce the process of AHP as a ranking methodology to help banks in selecting a location of ATM.
2. To identify spatial and non-spatial factors that affect the effectiveness of ATM locations, such as population density, traffic, security, and accessibility.
3. To achieve maximum customer accessibility and convenience by selecting locations that ensure easy access for customers at all times.
4. To improve the quality of banking services.

2.3. Research Significance

The selecti0n of an ATM location is a critical factor affecting service efficiency and quality. Properly positioning the ATM directly contributes to improving the customer experience and increasing machine usage. This selection is based on a comprehensive analysis of spatial factors such as population density, traffic, proximity to commercial centers or vital interests, as well as non-spatial factors such as security, availability of banking services in the area, and ease of access. Therefore, conducting thorough and thoughtful research helps achieve the highest possible benefit from the ATM by ensuring that its location meets customer needs and enhances their satisfaction. It also contributes to reducing operating costs and increasing the return on investment for the operating entity. In light of the increasing competition among financial institutions, the importance of scientific research as a strategic tool for ensuring successful decisions in selecting optimal ATM locations is highlighted .

2.4. Research Method

A case study approach was used based on primary data derived from a private bank to form the pairwise comparisons to rank three sites and then to select one of them based on four criteria through the application of the Analytical Hierarch Process.

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2.5. Research Sample

A small private bank (which preferred to remain anonymous), with limited knowledge in quantitative tools, is interested for the first time in selecting a site for a new ATM. Through personal interviews with a bank executive, three alternative sites were named to install the ATM (neighborhood 1,2,and 3), and four criteria were identified to compare between the sites. These criteria are: Security, Competition, Foot Traffic, and Installation Costs.

3. Definition and Evolution of ATMs

ATMs are widely used nowadays, however its use in the developing countries still lags behind that in the developed countries. ATM is defined as a machine that allows customers to withdraw , deposit, or transfer money using a bank card. ATM witnessed great development over time, and it became now a sophisticated tool within the banking systems. Table (1) provides a concise review of ATM development.

Table (1): Evolution of ATM

Time Period	ATM Status
Early Concepts (1930s–1950s)	1939: Luther Simjian's Bankograph allowed deposits but was not widely adopted.
First ATM (1967)	Installed by Barclays Bank in London. Invented by John Shepherd-Barron. Dispensed cash using paper vouchers and PINs; not connected to a live network.
Networked ATMs (1970s)	Linked to bank systems for real-time account access. Installed by Barclays Bank in London. Invented by John Shepherd-Barron. It dispensed cash using paper vouchers and PINs; not connected to a live network. PIN-based authentication became standard
Expansion & Interbank Networks (1980s)	Global spread of ATMs. Networks like Cirrus and Plus allowed cross-bank usage. Added features like balance checks and deposits.
Advanced Functions (1990s)	Touch screens, multilingual interfaces, and full-service capabilities. Magnetic stripe cards became common.
Digital Integration (2000s)	Biometric security, Windows-based systems, and online banking integration.
Modern Innovations 2010-present	Cardless transactions, mobile integration, AI-powered security, and smart ATMs with cash recycling and real-time fraud detection.

Source: Safarzadeh, A., Jamali, M. and Moshiri, B. (2025). Enhancing precision of ATM network quality assessment : Machine Learning, *Journal of Expert System with Application,* arXiv.

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4. The Factors Affecting the Site Selection for ATM

When banks and financial institutions attempt to select a new site for installing ATM they should consider a range of factors to ensure profitability, security, and customer satisfactions. In general, these factors are grouped into several categories: demographic, geographic, economic, and technical. We shall, next, introduce in a chronological order some related studies to the factors affecting the selection of a new site for ATM.

4.1. Real Estate and Installation Costs

In their research Alkass & Merza (Alkass & Merza,2003) attempted to integrate fuzzy clustering algorithms and GIS mapping to optimize ATM location. By processing uncertain and imprecise data (e.g., customer behavior), the study presents a model that aids banks in selecting sites that balance demand, cost, and coverage. Costs for renting or purchasing the location, power supply availability, maintenance, and connectivity (e.g., internet or satellite) can affect feasibility. This study is characterized by its innovatively by combining fuzzy clustering with GIS to handle uncertainty in location planning. But the model is complex and may require specialized expertise, limiting its practical adoption by smaller banks. The proposed model is ideal for academic exploration and advanced research settings rather than direct commercial use.

4.2. Competitive Landscape

Li & Yeh (Li & Yeh, 2005) showed how urban growth patterns and land use changes can be tracked with remote sensing and GIS. These insights are critical for banks to anticipate demand shifts and strategically place ATMs in developing areas. Proximity to competitor ATMs can either be an advantage (due to high traffic) or a disadvantage (reduced differentiation). The study provides a broader urban planning context for understanding spatial dynamics over time. It does not focus specifically on ATMs; insights need to be translated for financial applications. However, the study is useful for strategic, long-term ATM location in rapidly urbanizing areas.

4.3. Regulatory and Legal Compliance

The Reserve Bank of India (RBI,2011) proposed guidelines to outline regulatory requirements for ATM installation in India, including mandates for financial inclusion, site approval, and security protocols. They shape how banks decide where and how to install ATMs to ensure compliance and promote equitable access. Local laws or municipal regulations may impact site viability, especially concerning zoning and business permits. The guidelines provide essential regulatory compliance information, particularly for financial inclusion and rural deployment. But its highly jurisdiction-specific; it does not provide a methodology for site selection. The study is considered crucial for understanding legal constraints but insufficient for standalone decision-making.

4.4. Accessibility

Sujit, K. (Sujit,2013) applied a Geographic Information System (GIS) tools to identify optimal ATM sites by examining factors such as population density, road networks, and land use. The study demonstrates how spatial data can enhance decision-making in ATM planning and improve service accessibility. Locations must be easily accessible to users, including those with disabilities. 24/7 availability and proximity to roads or walkways influence usage rates. The study demonstrates effective use of GIS tools for spatial analysis, which is critical for optimal placement for

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ATM. However, the design restricts its scalability; and it lacks a robust cost-benefit analysis. The study could be considered as a good starting point for banks with GIS capabilities looking to incorporate location intelligence.

4.5. Brand Visibility and Marketing

Hernández, D., & Benavides, F. (Hernandez & Bena,2013) proposed an optimization model to identify ATM locations that maximize customer coverage and profitability while minimizing operational costs. Using demand forecasting and spatial analysis, it offers a practical framework for banks to enhance ATM service delivery. ATMs at visually prominent and branded locations can serve dual purposes: customer service and brand promotion. The study combines operational research and spatial planning to create a solid optimization model. However, it is limited by the mathematical complexity of the model which may hinder its adoption by banks without analytics teams.

4.6. Infrastructure and Connectivity

Ojha, M., & Pandey, A. (Ojha & Pandy,2015) presented a model based on the Analytical Hierarchy Process (AHP) to rank potential ATM sites according to factors like footfall, security, cost, and proximity to commercial zones. The study demonstrates how AHP simplifies complex, multi factor decision-making in ATM location. Availability of electricity, network connectivity (VPN/satellite), and physical infrastructure is vital for operational efficiency. The AHP model used in this study provides a structured and transparent way to rank multiple site options. However, the results are highly sensitive to subjective weight assignments in the AHP process. On the other hand, the study is effective for comparative evaluation when clear criteria are available and stakeholders agree on priorities.

4.7. Customer Traffic and Demand

Kumar, S., & Kanchana, R. S. (Kumar & Kanchana,2016) proposed a decision support framework to aid banks in selecting optimal ATM locations by analyzing criteria such as customer density, accessibility, cost, and transaction volume. It employs a multi-criteria decision-making (MCDM) approach to balance competing factors and improve service coverage and profitability. High footfall areas such as shopping malls, transit hubs, business districts, and universities are preferred due to increased transaction likelihood. Areas with a large population of bank customers or unbanked individuals present significant opportunities. The study offers a practical decision-support model integrating multiple factors that are highly relevant to bank, but the model lacks empirical validation through real-world case studies and may not account for regional market dynamics. On the other side, the model is highly applicable for theoretical modeling, but needs adaptation for local banking environments.

4.8. Security and Risk Assessment

The study of Adedokun, & Ajao (Adedokun & Ajao,2017) focused on the Nigerian banking environment, they emphasized on the importance of security in ATM location. The study identified common threats such as vandalism and fraud, and offers recommendations for location choice based on crime rates, law enforcement proximity, and security infrastructure. The safety of the location is paramount. ATMs are often targets of theft or vandalism. Presence of surveillance systems, adequate lighting, and proximity to law enforcement increases a site's attractiveness. The study addresses the often-overlooked aspect of security in ATM site planning, especially in high-risk areas. The

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study is, also, limited by its geographic focus on Nigeria may impede its generalizability. The study is largely qualitative and could benefit from quantitative data. However, it is valuable for contexts where crime and ATM fraud are major concerns.

4.9. User Satisfaction

In their study Sutresno & Affandi A. (Sutresno & Affandi,2023) focused on determining the priority level of factors influencing the acceptance of MyGraPARI ATM machine services at Jam Gadang, Bukit Tinggi. By utilizing the Analytic Hierarchy Process (AHP), the research aims to systematically evaluate and rank various criteria affecting user satisfaction and service adoption. The findings are intended to guide improvements in user engagement and technology acceptance, ensuring the MyGraPARI ATM service meets local user needs more effectively. The research effectively communicates the relevance of using AHP in evaluating user acceptance of technology services. Its structured and methodical approach is well-suited for handling complex, multi-criteria decision-making scenarios. However, the passage leans heavily on generalized statements and theoretical benefits of AHP without providing concrete examples or data specific to the MyGraPARI ATM service at Jam Gadang. Moreover, terms like "predictive capability" and "value proposition" are used vaguely without clarification. For a stronger impact, the argument would benefit from empirical evidence, a clearer description of the evaluation criteria used, and a brief mention of key findings or results from applying the AHP model.

4.9. Compatibility

Abdullahi, F. & Naghibi, M. (Abdullahi & Naghibi, 2024) stated that the development of educational-recreational complexes for children plays a vital role in fostering cognitive development and positive behavioral outcomes. In their study they focused on identifying the optimal site for such a complex in Shiraz, Iran. Utilizing a descriptive-comparative and survey-based methodology, expert input was gathered through questionnaires to determine key site selection criteria. The Analytical Hierarchy Process (AHP) was applied, incorporating factors such as natural potential, accessibility, land size, social context, expansibility, and land use compatibility. Among three evaluated locations, the most suitable site was found near residential zones, green spaces, and natural features. The study also recommends integrating the SWOT-AHP approach for future planning and emphasizes the importance of presenting supporting data through reliability tests and visual aids. The use of the Analytical Hierarchy Process adds methodological rigor by allowing a systematic comparison of multiple criteria and alternatives. In addition, incorporating diverse criteria (e.g., accessibility, natural potential, social context) ensures a comprehensive evaluation of potential sites. However, while the study suggests using a SWOT-AHP method in future projects, it does not explain how this would be operationalized or what added value it would bring over AHP alone.

The strategic placement of ATMs involves a complex interplay of technical, economic, legal, and social factors. The reviewed studies collectively highlight that effective site selection requires a multidisciplinary approach that balances real estate costs, customer demand, accessibility, regulatory compliance, infrastructure, and security considerations. Advanced tools like Geographic Information Systems (GIS), fuzzy clustering, AHP, and MCDM models significantly enhance decision-making by offering structured, data-driven methodologies. However, despite their analytical strength, many models remain limited in practical application due to complexity, lack of empirical validation, or geographic

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specificity. While innovations in spatial analysis and user-centric planning show promise, banks must adapt these frameworks to local conditions, operational capabilities, and customer preferences. Ultimately, an integrated, context-aware, and scalable approach is essential for optimizing ATM location in a competitive and evolving financial landscape.

5. Multiple Criteria Decision Making (MCDM)

Researchers have differed in classifying MCDM methods. (Watthayu & Peng, 2004), (Zeleny in Fuller & Carlson, 1996), (Zopounidis & Doumpos 2002), (Vincke in Tarp & Helles, 1995), and (Fülöp, 2005) have limited MCDM methods to three main groups as follows:

1) The Outranking Approach based on the pioneering work of Bernard Roy. These methods assume the wide availability of data to the decision maker, i.e. they require the identification of alternatives and criteria. To develop the outranking relationship, the decision maker must cooperate with the decision analyst to determine the weights of the evaluation criteria and some technical measures such as preferences.

2) Multi-Attribute Utility Theory (MAUT) or Value & Utility Theory VAUT is an extension of traditional utility theory. MAUT aims to represent or model the decision maker's preferences across all evaluation criteria for alternatives. The MAUT model has been solved using a number of methods, the most important of which are the SMART (Simplified Multi-Attribute Weighting Technique) and the AHP (Analytical Hierarchy Process) method (Saaty, 2002).

3) Interactive Multiple Goal Programming (IMGP), which was developed by P.L.Yu, Stanley, and Zionts (Yu, Stanly & Zionts,1975), Zeleny & Steuer (Zeleny & Steuer, 1976) and others. In reality, it is impossible to achieve optimal solutions for all of goals simultaneously. Therefore, the decision maker cannot obtain an ideal solution, but rather a satisfactory solution. On the other hand, MCDM methods can be classified into three groups (Al-Najjar, 1993):

1- A Priori Articulation of Preference Information
   These methods belong to the group where the decision maker is able to
   provide acceptable level of information before applying an algorithm to solve a multiple criteria problem.
2- Interactive Methods: The decision maker does not have to provide the preferred information outwardly before applying the solution algorithm. The most famous methods are the Geoffrion, Dyer & Fenberg method (Geoffrion, Dyer & Fenberg,1972), interactive object programming, and the Zionts and Wallenus method (Zionts and Wallenus, 1976).
3- A Posteriori Articulation of Preference Information
   The decision maker intervenes in these methods after the algorithm is executed by choosing the final solution. Therefore, the decision maker does not work with the analyst during the algorithm execution. Among the solution methods used here are multi-parametric programming and multi-objective linear programming.

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6. The Analytical Hierarchy Process

The AHP process is one of the most widely applied multi-criteria decision-making methods and one of the most widely used algorithms for comparing alternatives when multiple criteria are required for each alternative. This method was developed by American Professor Thomas L. Saaty of the University of Pittsburgh in the mid-1970s. It is defined as a method for ranking decision alternatives and selecting the best alternative when the decision maker has multiple objectives or criteria upon which to base the decision, such as when comparing multiple sites to locate an ATM. The AHP consists of several systematic steps, which we will illustrate.

6.1. Hierarchy Development

Hierarchy development is an important component that facilitates the analysis of complex problems. The problem is structured to form a multi-level pyramid that includes the overall goal, sub-criteria, and alternatives. This is done by developing a problem diagram that describes the problem hierarchy. The pyramid begins at the top, where the problem goal is established. The main criteria that will be considered during decision-making are placed directly below it, given their direct impact on the overall goal of the problem at the top of the pyramid. These main criteria can be divided into sub-criteria. There is generally no limit to the size and number of levels within the pyramid. However, in practice, the number of levels ranges from two to three levels of criteria and sub-criteria. Finally, the alternatives are listed at the base of the pyramid, with each alternative linked to a criterion at the top, or to each sub-criteria if present.

6.2. Preparing Pairwise Comparisons

Pairwise comparisons are used in the AHP method to determine the scores each alternative achieves according to each criterion. The decision maker compares each alternative according to each criterion individually using a preference scale, which was defined by researchers experienced in the AHP method as a logical basis for comparing two items or alternatives, as shown in Table (2).

For example, if a bank strongly prefers location A over location B with respect to the safety criterion, then this preference will be (5) for location A. If location B is preferred over location A under the same criterion, the preference value will be the opposite of the previous comparison, i.e., (1/5) for location B, and so on.

Table (2)
Preference Indexes for Pairwise Comparison

Preference Level	Value
Equally Preferred	1
Equally to moderately preferred	2
Moderately Preferred	3
Moderately to Strongly Preferred	4
Strongly Preferred	5
Strongly to Very Strongly Preferred	6
Very Strongly Preferred	7
Very Strongly to Extremely Preferred	8
Extremely Preferred	9

Source : Taylor, B. W., (2002), Management Science, 7th ed., Pearson Education Inc., Upper Saddle River, New Jersey, p. 375.

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At the first level, the pairwise comparison is prepared in a quadratic form, i.e. : A_{NxN} as in matrix (A).

$$A= \begin{bmatrix} 1 & \alpha_{12} & \alpha_{13} & \ldots\ldots\ldots & \alpha_{1n} \\ 1/\alpha_{12} & 1 & \alpha_{23} & \ldots\ldots\ldots & \alpha_{2n} \\ 1/\alpha_{13} & 1/\alpha_{23} & 1 & \ldots\ldots\ldots & \alpha_{3n} \\ . & . & . & . \ . \ \ldots & . \\ . & . & . & . & . \\ . & . & . & . & . \\ 1/\alpha_{1n} & 1/\alpha_{2n} & 1/\alpha_{3n} & \ldots\ldots & 1 \end{bmatrix} \ldots\ldots (1)$$

Where:

n= number of alternatives.

A= matrix symbol

α_{ij}= an element of matrix A that can be determined by the decision maker's choice from the preference scale that contains the integers extending between (1) and (9) for a specific criterion, such that:

$1/9 \geq \alpha_{ij} \geq 9$

$\alpha_{ij} \neq 0$

$i \neq j \rightarrow \alpha_{ij} = 1/\alpha_{ji}$

6.3. Synthesis

Synthesis is a mathematical procedure in which two or more eigenvalues and eigenvectors are compared with each other as alternatives based on criteria. The mathematical procedure required to perform the synthesis includes calculating eigenvalues and eigenvectors (Anderson, Sweeny & Williams, 1995). Eigenvectors are relative weights, i.e., the degree of relative importance of an element among a set of elements (Atthirawong & MacCarthy, 2005). The steps involved in performing the synthesis are:

a) Preparing the normal matrix A_{norm} by dividing each element in matrix A in column i, by the sum of all items in the same column, such that:

$$r_{ij} = \frac{\alpha_{ij}}{\sum_{i=1}^{n} \alpha_{ij}} \ldots\ldots\ldots\ldots\ldots (2)$$

This step will yield the normalized matrix A_{norm}

b) Calculating the weights of matrix "W" these weights represent the preference vectors of the alternatives among each other with respect to a given criterion, where w_i is calculated by the following formula:

$$w_i = \left(\frac{1}{N}\right) \sum_{i=1}^{N} r_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

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w_i = preference or a priority vector
i= 1,2,3,……N

6. The Practical Aspect

7.1. Hierarchy Development

After reviewing the factors affecting the location of ATM with the bank's executive the following hierarchy was developed. At the top of the hierarchy is the general goal which is the site selection for the new ATM. At the second level we notice the four criteria (factors) on which the selection will be based. At the bottom of the hierarchy we placed the three neighborhoods (sites) which we will select one of them. Figure (1) presents the hierarchy.

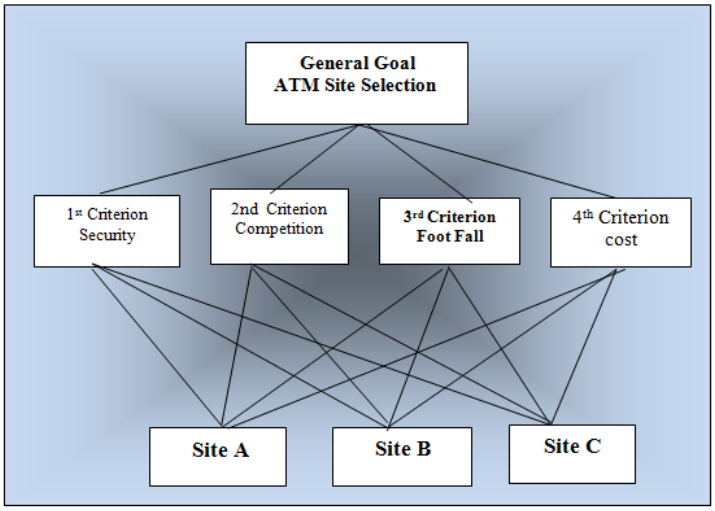

Figure (1): Hierarchy Development

7.2. Developing the Pairwise Comparison

Working with the bank's executive and by using the preference indexes from Table (2) the pairwise comparison for the criteria with respect to the proposed sites were developed as it appear in Table (4) -Table (7).

Table (4)

Security			
Site	*A*	*B*	*C*
A	*1*	*5*	*4*
B	*1/5*	*1*	*1/3*
C	*1/4*	*3*	*1*
total	*29/20*	*9*	*16/3*

Table (5)

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Competition			
Site	A	B	C
A	1	4	1/5
B	1/4	1	1/8
C	5	8	1
total	25/4	13	53/40

Table (6)

Foot Fall			
Site	A	B	C
A	1	1/3	3
B	3	1	1/9
C	1/3	9	1
total	13/3	31/3	37/9

Table (7)

Cost			
Site	A	B	C
A	1	1/5	1/4
B	5	1	7
C	4	1/7	1
total	10	47/35	33/4

7.3. Normalization

Applying formula (2) and by dividing each value that appear in each column by the sum of the corresponding column we obtain the normalized matrix for each pairwise comparison. The normalized matrix (W) for the security is given below.

Table (8)

Security				Row Sum	Row Avg.
Site	A	B	C		
A	0.69	0.56	0.75	2.00	0.67
B	0.14	0.11	0.06	0.31	0.10
C	0.17	0.33	0.19	0.69	0.23
total	1	1	1		1

Preference Vector (formula (3)

From the preference vector it appears that site A is preferred over the other sites on the basis of security, while site C comes next and site B is the least preferred on this criterion. The same procedure is repeated to the other pairwise comparison. By applying formula (3), the preference vectors for the other decision criteria obtained are:

Competition Preference Vector		Foot Fall Preference Vector		Cost Preference Vector	
A	0.21	A	0.33	A	0.10
B	0.07	B	0.27	B	0.70
C	0.72	C	0.40	C	0.20

By combining the four preference vectors for the four criteria we obtain the following matrix:

Table (9): Preference Vectors for the Four Criteria

Site	Security	Compe-Tition	Foot Fall	Cost	Sum	Average
A	0.67	0.21	0.33	0.10	1.31	0.32
B	0.10	0.07	0.27	0.70	1.14	0.29
C	0.23	0.72	0.40	0.20	1.55	0.39
Sum	1.00	1.00	1.00	1.00		1.00

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From the above matrix it appears that sit A is preferred on security criterion, while sit B is preferred on cost criteria, and site C is preferred on the competition criterion.

7.4.Ranking the Criteria

In this step we shall apply formula 2 & 3 to determine the relative importance or weight of the criteria from most important to lease important. This shall be accomplished in the same procedure we ranked the sites within each criterion using pairwise comparisons. The following pairwise comparison is developed with the cooperation of the bank's executive.

Table (10): Pairwise Comparison for the four Criteria

Criteria	*Security*	*Competition*	*Foot Fall*	*Cost*
Security	*1*	*1/8*	*7*	*5*
Competition	*8*	*1*	*9*	*9*
Foot Fall	*1/7*	*1/9*	*1*	*5*
Cost	*1/5*	*1/9*	*1/5*	*1*

The normalized matrix is obtained in two steps :

Table (11): Summing the Columns

Criteria	*Security*	*Competition*	*Foot Fall*	*Cost*
Security	*1*	*1/8*	*7*	*5*
Competition	*8*	*1*	*9*	*9*
Foot Fall	*1/7*	*1/9*	*1*	*5*
Cost	*1/5*	*1/9*	*1/5*	*1*
Total	*9.34*	*1.35*	*17.20*	*20.00*

Table (12): The normalized Matrix

Criteria	*Security*	*Competition*	*Foot Fall*	*Cost*	*total*	*Average*
Security	*0.10*	*0.09*	*0.41*	*0.25*	0.85	0.21
Competition	*0.86*	*0.75*	*0.52*	*0.45*	2.58	0.64
Foot Fall	*0.02*	*0.08*	*0.06*	*0.25*	0.41	0.11
Cost	*0.02*	*0.08*	*0.01*	*0.05*	0.17	0.04
Total	*1.000*	*1.000*	*1.000*	*1.000*		*1.000*

Criteria preference vector

From table (12), it appears that competition is highest priority criterion for the decision maker, next comes the security criterion. Foot fall and cost seem to be unimportant to the decision maker.

7.5. Developing an Overall Ranking

To perform an overall ranking we shall multiply the preference vectors for the four criteria with respect to the three sites (Table 9) by the criteria preference vector which appears on the far left of Table (12), this will yield an overall score for each site as follows:

Site A score= 0.21(0.67)+0.64(0.21)+0.11(0.33)+0.04(0.10) = 0.3154

Site B score= 0.21(0.10)+0.64(0.07)+0.11(0.27)+0.04(0.70) = 0.1235

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Site C score= 0.21(0.23)+0.64(0.72)+0.11(0.40)+0.04(0.20) =0.5611

Based on these scores, site C should be selected as the location to install the new ATM.

7. Discussion and Conclusion

The findings of this study underscore the value of structured decision-making in banking operations, particularly for institutions operating under technical or financial constraints. By applying the Analytical Hierarchy Process (AHP), a small private bank in Baghdad was able to objectively evaluate three potential sites for a new ATM installation based on four key criteria: security, competition, foot traffic, and installation cost. The structured methodology allowed decision-makers to break down complex qualitative judgments into a quantitative framework that supports rational site selection.

A key insight from the AHP model was the weight assigned to the competition criterion, which emerged as the most influential factor for the bank's executive. This suggests that in rapidly evolving financial environments, smaller banks may prioritize competitive positioning over traditional considerations such as foot traffic or cost efficiency. While security was also ranked as a critical concern, cost and footfall were deemed less influential in this specific context—likely due to the bank's strategic emphasis on market presence and differentiation.

Site C emerged as the most suitable location, driven primarily by its superior standing in the competition criterion and overall balanced performance across other criteria. Importantly, the consistency ratio of the decision-making process remained within acceptable limits, lending credibility to the pairwise comparisons and overall ranking.

The study not only demonstrates the practicality of the AHP model in a real-world banking scenario but also highlights its adaptability and scalability for other institutions with similar constraints. By offering a replicable, transparent, and systematic decision-support tool, this research bridges the gap between advanced analytical models and their practical implementation in developing regions.

Future studies could expand on this work by incorporating more alternatives, additional criteria (such as demographic data or GIS-based analysis), and validating the results through post-installation performance metrics. Nonetheless, the application of AHP in this context provides strong evidence that service institutions can enhance operational efficiency and customer satisfaction through data-informed, structured decision-making processes.

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Conflicts of Interest

The author declares no conflict of interest.

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