Applications of Internet of Things in Smart Cities: Bani Walid City as a Model

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Abstract

This research analyzed how people living in Bani Walid, Libya, recognize Internet of Things (IoT) technology, including its usefulness and application. The study aimed to identify how IoT technology can modernize urban framework elements, encompassing transportation, wellness solutions, waste disposal systems, and power-saving tools. The research employed a quantitative approach, gathering responses from 380 residents and 25 key stakeholders, including government officials, urban planners, and technology professionals, through structured surveys. Although respondents demonstrated a strong understanding of IoT and its advantages, they face multiple challenges, including high setup costs, difficulties in handling technology privacy threats, and readiness issues with existing systems. Individuals who have a better understanding of the Internet of Things tend to be more open to using such technologies. Due to these results, the research team advised raising public awareness while addressing technological challenges and budget issues associated with IoT deployments. Organizations that develop cities can utilize these findings to inform more informed decisions about incorporating IoT systems into their plans.

Keywords: Internet of Things (IoT), smart cities, public transportation, healthcare, adoption barriers.

Abstract

The growth of Internet of Things technologies drives cities worldwide to transform into smart cities. Through effective technology deployment, smart cities enhance services by providing residents with beneficial solutions that both improve their experience and promote better health conditions. The Internet of Things (IoT) establishes a connection between physical infrastructure devices and internet access, enabling live data exchanges for improved urban management, as noted by Zanella et al. (2014). The IoT applications benefit transportation, waste management, energy efficiency, and healthcare delivery in various city regions, optimizing operational processes. Bani Walid leverages the IoT by utilizing its computerized system to repair declining infrastructure and introduce new services through technological advancements (Khaleel et al., 2025). The research objective targets both the analysis of IoT technology in Bani Walid and the systematic planning to install smart infrastructure across city properties, aiming to enhance the quality of life for residents.

Keywords: Applications of Internet, Things in smart cities, Bin Walid Ci

The Role of IoT in Smart Cities

The Internet of Things (IoT) serves as the fundamental data tracking platform for smart city management, owing to its ability to facilitate better decision-making and service improvements. According to Gungor et al. (2010), the Internet of Things (IoT) operates as a system that links sensors and machines to respond to modifications in urban demands. Transportation management is the primary application of Internet of Things technology in smart city infrastructures. Smart traffic sensors on the networks track traffic movement while operating traffic signal systems that reduce congestion to enhance urban transport efficiency (Barrett et al. 2016). The Internet of Things (IoT) sensors installed in waste bins provide automation to measure container fill levels, thus improving route planning for waste trucks to save costs and protect the environment, as per Sicari et al. (2015).

The Things that Connect network develops instant energy control platforms to enhance system distribution performance and reduce wasted energy resources, as noted by Gungor et al. (2010). Cities that utilize IoT technology can manage their resources more sustainably while generating reduced waste amounts. Public safety improves through advanced monitoring systems and emergency responses that stem from IoT applications, according to Kurdi (2022).

Challenges in Urban Development: The Case of Bani Walid

The main urban development challenge district in northwest Libya is Bani Walid, where extensive improvement efforts became necessary after the end of the Libyan Civil War. Bani Walid faces the same problems as other places in the region, as it suffers from poor infrastructure, weak utility systems, and economic challenges. The medical facilities in Bani Walid lack proper care, while the electrical systems tend to fail frequently. Basic facility problems and service issues hindered Bani Walid's expansion of its development efforts, thereby preventing improved living conditions. UNDP partnerships enable the United Nations Development Programme to support the enhancement of basic services in Bani Walid (UNDP, 2020).

The town of Bani Walid addresses its problems by implementing Internet of Things technology. The adoption of IoT technology would help Bani Walid improve its urban services and develop a sustainable and efficient environment (Alsharif et al., 2023). Intelligent system solutions within municipal frameworks enable public servants to execute their activities more effectively and enhance citizen participation in community activities during Bani Walid's recovery process following historical disturbances.

IoT Applications for Bani Walid: A Model for Smart Urban Transformation

Through IoT innovation, Bani Walid has the opportunity to execute major improvements in its urban operational management practices. The Internet of Things enables healthcare professionals to enhance remote patient monitoring by tracking patient health conditions through system integration. Medical service providers gain access to live patient health information to detect issues early because medical equipment remains scarce (Papastefanopoulos et al., 2023). By adopting IoT technology, Bani Walid could strengthen its

medical sector, reducing patient hospital attendance while also assisting residents with ongoing health problems.

The Internet of Things technology enhances electric power distribution systems and minimizes power wastage. Power monitoring through IoT sensors enables the collection of real-time energy data, which helps reduce power expenses, as noted by He et al. (2020). The power distribution system of Bani Walid requires advanced management, as the existing network fails to supply sufficient electricity to meet resident needs. Bani Walid residents and power distribution companies will receive specific energy information through smart IoT meters, enabling them to enhance their electrical management decisions and usage behaviors.

The operational efficiency of transportation increases significantly through the inclusion of Internet of Things (IoT) technology within the framework. The system can track traffic flow and adjust signaling times automatically, thanks to traffic lights and road and vehicle sensors that connect to the Internet, according to Zanella et al.. (2014).

The system will enhance traffic flow across the city, improving commuting conditions. Urban mobility system could be enhanced with Intelligent Transportation Systems (ITS) technology that tracks vehicles and public transportation for citizens, as well as monitors road speed data, as reported by Barrett et al. in 2016.

Implementing smart waste management tools would enable fleets to operate more efficiently, reducing fuel consumption and minimizing the environmental impact of waste. Smart garbage bins can transmit their current filling levels to waste trucks, enabling the trucks to take more efficient routes and make fewer unnecessary trips (Sicari et al., 2015). Smart waste management systems would work more efficiently, which means the city adds less pollution to its surroundings.

The Rationale of the Study

This study became necessary to address the problems in cities following conflicts, when basic infrastructure was weakened and services and the economy were disrupted. In northwestern Libya, Bani Walid faced significant challenges in recovering from the Libyan Civil War, which disrupted its basic services, including the water supply and power lines, as well as its healthcare system. The city faced problems that eroded its residents' quality of life and hindered its progress toward development.

Urban communities around the world started adopting Internet of Things technologies because they saw ways to make cities more efficient and dependable. With IoT technology, devices and physical systems connect to the internet, allowing them to collect and transmit real-time data automatically. These functional traits effectively strengthened transportation, energy, waste control, and healthcare operations (Gungor et al., 2010; Sicari et al., 2015). Cities worldwide have demonstrated that incorporating IoT is more effective in saving resources and reducing expenses while making cities more sustainable.

The city of Bani Walid failed to utilize Internet of Things technology for urban development, despite experts predicting its significant potential. Without this research, no one had yet studied how applying IoT technology could help Bani Walid solve its unique problems. Implementing IoT technology in these cities would help address their fundamental service delivery issues and infrastructure shortages, thereby aiding their recovery while fostering

sustainable growth.

Libya and many cities across the MENA region have shown a late adoption of smart city solutions compared to other global regions. This research examined how the Internet of Things operates in developing settings by investigating its benefits and challenges in an area affected by war. The study examined how the Internet of Things (IoT) could serve Bani Walid and provide policymakers with valuable insights into restarting smart city progress in rebuilding regions.

New technology analysis represented a critical step in determining whether these systems can strengthen and preserve urban environments in areas rebuilding after warfare. The research results served as an example for similar cities across the MENA region and Libya, which used them as a guide to integrate IoT technology into their urban development plans.

The study targeted Bani Walid because the IoT technology needed examination as a potential solution to its urban problems. The study aimed to support Libya and other MENA countries in developing smart cities by demonstrating how technology can enhance city life in regions affected by conflict. Bani Walid could establish modern infrastructure and services through this research, thereby enhancing its urban development and making it more robust and effective.

Statement of the Problem

Bani Walid is a city in northwestern Libya that had not experienced smooth development, especially after the Libyan Civil War. The city's physical infrastructure had been deteriorating over the years, with essential services, including those in healthcare facilities, electrical power, transportation, and sewage systems, being underdeveloped. The government services had been somewhat unreliable, and there was a lack of effective hindrances to the city's growth and development. These factors had a significant impact on the quality of life in the city, as many social amenities were in a deplorable state, and the city was unable to attract any development or become sustainable.

However, when learning about smart cities that appeared worldwide with the use of IoT technologies in managing urban facilities and services, Bani Walid realized that it had not strived to develop IoT solutions for managing the city's problems. The town had not explored the benefits that other cities around the world had adopted in utilizing IoT to enhance service delivery, reduce costs, and promote environmental sustainability. The absence of IoT applications in Bani Walid was becoming a significant issue as the city sought innovative approaches to improve the quality of urban management and services and stimulate the economy.

Although IoT was seen to offer various benefits in addressing urban problems, like several other regions, the developed city of Bani Walid faced challenges that originated from post-conflict situations, inadequate technical infrastructure, and a lack of knowledge, which hindered the enhanced utilization of IoT systems. One of the critical issues that arose from the study was the lack of prior evaluation of a proposal for integrating IoT within the framework of a city, specifically Bani Walid. Before understanding how IoT could positively impact the efficient delivery of city services and how it could be used to upgrade the existing and planning the new city infrastructures and facilities, it was rather challenging for the local government authorities, policymakers and urban planners towards making a correct decision

with regard to the future investments in smart technologies.
Thus, the research question for this applied research was constituted by two questions: firstly, how the various IoT applications could optimize the infrastructural and service dimensions of Bani Walid; and second, how the potential and promise of IoT technologies could be best harnessed for a city that was in the process of recovering and rebuilding from conflict and post-war conditions, such as Bani Walid. The objective of the study was to analyze the effectiveness of selected IoT solutions feasible in the city and provide recommendations for applying these technologies within the city planning context of Bani Walid. The conclusions of this study are instrumental in planning the development of new infrastructures for the city and its population.

Objectives of the Study

1. Assessing Awareness and Knowledge of IoT Technologies Among Residents of Bani Walid.
2. Therefore, measure the perceptions of Bani Walid residents regarding the ability of IoT to be utilized in urban services such as transportation, healthcare, and waste management.
3. The factor that we need to identify in order to understand the barriers to IoT adoption in Bani Walid, as well as to recognize the factors that encourage residents to accept IoT devices.

Research Questions

1. How do the residents of Bani Walid stay informed about the current Internet of Things (IoT) technologies?
2. What do Bani Walid residents believe are the benefits that IoT will bring to the city's transportation, healthcare, and waste management services?
3. What barriers present the adoption of IoT in Bani Walid, and what is the relevance of demographic factors to one’s willingness to adopt IoT technologies?

Significance of the Study

In the context of smart city development and IoT adoption in developing regions, such as Bani Walid, Libya, this study holds significant importance for the academic community and policymakers. In the following are the key aspects of its significance.

Contribution to IoT Adoption Knowledge

The findings contribute to broader research on IoT adoption in developing urban environments. Third, it examines how residents perceive and overcome barriers, as well as their readiness to adopt IoT technology, which is crucial for the development of smart cities. This research fills a gap in the literature, as most studies on IoT adoption have primarily focused on developed countries or larger urban centers, often concentrating on a specific location, such as Bani Walid.

This work aims to guide policymakers within smart city initiatives.

These findings provide essential information for local government authorities, urban

planners in the Bani Walid region, and others. Understanding the level of awareness among stakeholders and the expected benefits and barriers to IoT adoption will provide urban planners and decision-makers with valuable insights and direction in designing and implementing effective smart city strategies. It also highlights areas where intervention is necessary, including raising public awareness, enhancing technical expertise, and addressing privacy concerns.

Practical Implications for IoT Implementation

This study will help understand the major challenges to IoT adoption, including costs, infrastructure, and security concerns. Government agencies, companies, and NGOs can utilize this information to develop more effective IoT projects that align with the needs and concerns of residents. In turn, it also surveys the economic, social, and technical aspects of IoT adoptions, which facilitate future investment and collaborative activities for sustainable smart city development.

Conceptual Framework

This is the conceptual framework of the work of the current study intending to determine the applications of the Internet of Things (IoT) in smart cities, especially Bani Walid City, with a view of showing how key variables are related to each other such that they influence the implementation of IoT technologies in an urban setting. It breaks down the complexity into a format that makes it easier to analyze the factors detailing the acceptance process, challenges, or adoption of IoT solutions within the context of a developing city's environment.

The framework is based on five dominant variables that inform the research objectives and questions.

Awareness of IoT

This variable can be defined as the awareness of residents regarding Internet of Things (IoT) technology and its potential enhancement of urban services. Secondly, the awareness factor plays a crucial role in determining residents' willingness to adopt IoT technologies. Consequently, higher awareness will result in a greater inclination among customers to adopt IoT solutions.

Key Elements:

- Familiarity with IoT concepts.
- Knowledge of smart cities.
- Awareness of existing IoT applications in other cities.

Perceived Benefits of IoT

This variable encompasses the residents' views on the potential application of IoT in various areas, including transportation, healthcare, energy, and even waste management. The more residents understand the opportunities the IoT has to offer, the more they will be willing to adopt the concept of the IoT in their city.

Key Elements:

- IoT for public transportation.
- IoT for healthcare services.
- Use of Internet of Things Technology for Waste Management and Recycling.
- IoT for Smart Energy and Water Management.

Willingness to Adopt IoT

This variable measures the degree to which residents in the area are receptive to

incorporating the Internet of Things (IoT) into their daily lives. It is the extent of their knowledge, attitude, and perceived value towards IoT, such as the willingness to pay taxes or embrace innovations. The study assumes that the importance of awareness and the benefits perceived from IoT solutions will interact with the desire to adopt these solutions.

Key Elements:

- Adoption of smart devices in households.
- Participation in smart city services.
- Advantages are considered to be more significant than disadvantages when it comes to such policies as IoT-related taxes.

Barriers to IoT Adoption

This variable examines the IoT inhibitors that define the factors hindering or restricting the use of IoT in Bani Walid. The challenges may entail costs, technical expertise, the readiness of infrastructure, security, and policies, as well as a lack of government support. The study will also examine the extent to which these barriers influence residents' attitudes toward IoT, particularly in terms of adoption levels, and whether such concerns can be addressed to facilitate adoption.

Key Elements:

- High cost of IoT solutions.
- Lack of technical expertise.
- Privacy and security concerns.
- Insufficient infrastructure.
- Lack of government support for IoT.

Demographic Factors

Age, gender, education level, and occupation are significant factors that can influence the perception of IoT adoption and readiness. For instance, it may be the case that some users are more willing to adapt to new technologies than others, such as the resident population of a community that is more inclined towards embracing new technologies than the older generation. Education levels may also influence how the Internet of Things (IoT) is perceived, as well as the benefits and risks associated with it, as illustrated in the following points.

Key Elements:

For example, regardless of whether it was youths or older people, the delegation assisted individuals of all ages affected by the disaster.

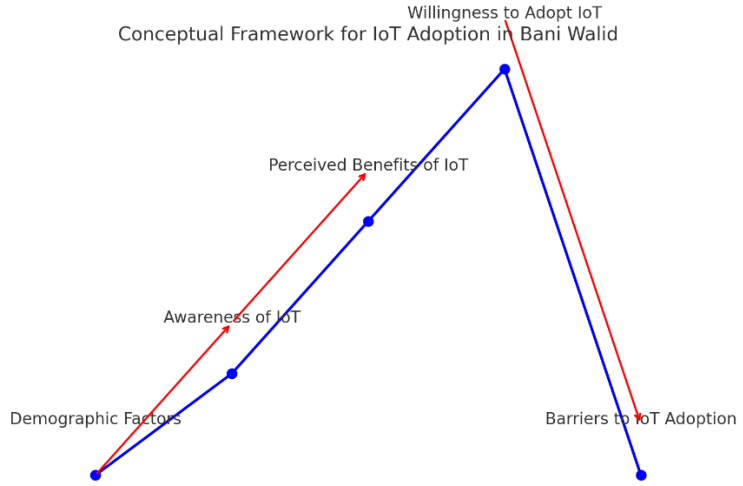
- Gender (e.g., male vs. female).
- This could be their educational level, such as high school nationals, undergraduates, or postgraduates, among others.
- Occupation (e.g., residents, government officials, urban planners, technology experts).

Relationships Between Variables:

It leads to confirmation that the level of Awareness of IoT has a significant impact on Willingness to adopt IoT. Higher awareness should also increase the likelihood of adoption.
Regarding the perceived benefits of IoT, it also has a downstream implication for willingness to adopt IoT, as people are more likely to champion it if they stand to benefit from the resultant improvements in the healthcare sector, transportation system, and waste management, among others.

The forces that constitute Barriers to IoT Adoption reduce the extent of Willingness to adopt IoT. This implies that the more perceived barriers (such as cost or security concerns), the less likely it is that the adoption will occur.

Based on the research, demographic factors have an indirect impact on the relationship between awareness, perceived benefit, and willingness to adopt. For instance, consumers who are educated or in the young bracket would be more inclined to adopt IoT.



Literature Review on IoT Adoption in Smart Cities

Technologies continue to drive urban development forward, with the Internet of Things (IoT) leading the way, bringing significant benefits to city services. This literature study examines the impact of IoT on urban services within smart cities, exploring why organizations adopt it despite facing obstacles and reaping benefits from urban environments.

This paper aims to review the existing literature on how cities worldwide have deployed IoT and identify the emerging research gaps that need to be addressed.

The Concept of IoT in Smart Cities

The Internet of Things works in such a way that through an object, there are sensors that the object contains, which have software that can collect and share information over the internet. Smart city devices utilize the Internet of Things (IoT) to gather information that contributes to improving urban aspects, proposing efficient ways to use resources, and providing better services to create more sustainable urban environments and develop sustainable societies (Gubbi et al., 2013). Patrão et al. (2020) revealed the study outcomes, which depict that IoT tools can conveniently be used to redesign transportation networks, energy systems, healthcare organizations, and waste management. Commodity IoT enables better management in real-time operations and an increased ability to make informed service decisions, thereby improving performance and reducing expenses.

Smart city technology leverages IoT within city services to efficiently share data across the network, making urban precincts more valuable and amenable to inhabitants. Zanella et al. (2014) state that IoT technology made it easy to enhance cities' power grids, traffic systems, and overall healthcare systems.

The Smart Cities, therefore, utilize the IoT technology for certain tasks.

Transportation

Thus, the first area of focus for smart cities where IoT is applied is transportation. The Internet of Things involves the use of IoT sensors and GPS devices, which collect real-time traffic data and the positions of vehicles to improve traffic control (Albino et al., 2015). Therefore, by adopting IoT traffic management systems, the flow of traffic is enhanced, and the time taken to complete a journey is reduced, as noted by Zhu et al. (2024).

In the research conducted by Zhu et al. in 2024, it is illustrated how the application of IoT smart traffic systems and vehicle-infrastructure communication to traffic management in Beijing solves problems of traffic congestion and decreases fuel consumption. According to previous studies, IoT supports the better movement of vehicles and contributes to a decrease in pollution in densely populated cities.

Academicians in London have employed IoT sensors to detect and manage traffic congestion within the UK capital during its traffic test (Bhatti et al., 2019).

Healthcare

The Internet of Things monitors the patient's condition and transmits its data to healthcare networks (Akkaş et al., 2020). Wearable sensor technology and smart Medical technologies enable healthcare providers to monitor patients' health status indicators as well as medical situations. This approach enhances the effectiveness of medical aid, increases access to it, and reduces patient and healthcare facility expenses (Petersen et al., 2006).

According to Gao et al. (2024), the paper showed the role of IoT in remote patient monitoring. Wearable health devices are used by patients with chronic diseases, thereby reducing their hospital attendance in the long term and resulting in lower healthcare costs.

The management team of Mathew et al.. established how the Internet of Things (IoT) integrates medical devices into smart hospital systems in a 2019 study. This is due to several advantages associated with integrating medical equipment through the use of IoT, aiming to enhance daily performance and reduce the likelihood of errors in healthcare facilities.

Waste Management

Smart waste management cities utilize Internet of Things in order to accumulate trash and properly dispose it (Wang et al., 2024). IoT smart bins enable waste management companies to make informed decisions about when to dispatch their trucks to specific areas as they track waste levels, resulting in reduced road time and a lower likelihood of environmental harm (Mitoma & Simion, 2022).

Using IoT sensors placed within the trash cans, authorities in Barcelona monitored garbage accumulation in their bins to improve waste collection, as per Mitoma and Simion (2022). The new system significantly helped provide a more cost-effective means of waste collection and, at the same time, reduced fuel consumption in waste-carrying vehicles.

Factors Influencing IoT Adoption in Smart Cities

The following factors define how smart cities utilize IoT technology. The use of IoT systems depends on how different organizations and societies embrace available technologies.

Technological Readiness

Technological readiness is based on the current arrangements that have been put in place to support the application of Internet of Things technology, as noted by Liu et al. (2017). In terms of the acceptability of these technologies, emphasis is placed on the durability of the network, the ability to handle large data sets, and the number of sensors. The quality of the

hardware must be high enough to manage the large amounts of data and facilitate communication, thereby supporting the implementation of IoT systems (Serpanos & Wolf, 2018).

Hashem et al. (2016) state that a city's digital network development and internet connectivity are key factors in determining the effectiveness of IoT systems implemented in the town. They disclosed this as the necessity of effective communication structures in smart cities in Singapore.

Policy and Regulatory Factors

The IoT technology is mandatory in smart city governments; thus, there is a need for specific rules to be established to facilitate the installation of the technology used. Regulations on data protection and cybersecurity governing the technologies affect the extent and rate at which solutions under IoT are applied (Kummitha & Crutzen, 2019).

Zanella's team (2014) demonstrated that urban IoT projects must adhere to government policies to protect individuals' rights in the use of IoT data.

According to Joyce and Javidroozi (2024), European smart cities face primary regulatory obstacles when adopting IoT, as European data privacy laws provide stringent protection and IoT systems require established technical standards.

Social and Economic Factors

People will accept IoT technology more if social and economic conditions benefit them. The public gives its support because people see that IoT brings better performance at lower prices and can help solve urban problems, such as traffic jams and pollution (Jäger et al., 2023). The use of IoT systems depends on startup investments while also considering their overall operating expenses.

Researchers at Jäger et al. (2023) investigated how Berlin residents perceived smart city technologies in operation. Public acceptance of Internet of Things technology strongly depends on the total cost associated with network devices and infrastructure.

Challenges to IoT Adoption

Despite its potential benefits, the adoption of IoT faces numerous obstacles in developing cities, such as Bani Walid. These include:

High Implementation Costs

Setting up Internet of Things systems needs substantial expenditures on sensors, smart devices, and network equipment. The financial budget of developing country municipalities constitutes a significant obstacle to the large-scale deployment of IoT technologies (according to Patrão et al., 2020).

Security and Privacy Concerns

The fear that IoT networks will compromise personal data security stands as a significant obstacle to people considering the adoption of these technologies. Hassan et al. (2021) support other studies by highlighting the need for effective security measures to protect smart city citizen data from data breaches.

Lack of Technical Expertise

Professionals with expertise in data analytics, cybersecurity, and network management are in short supply, which hinders the widespread adoption of IoT, according to Troublefield (2025). Organizations need to invest in training programs to address this problem.

Conclusion and Research Gaps

Research indicates that smart cities benefit from IoT technology and shows why people embrace or resist its implementation. Although many cities have improved their services, multiple hurdles remain, including high expenses, security challenges, and the need to create perfect systems before implementing IoT technology.

The available research does not cover the exact challenges and benefits of IoT implementation in Bani Walid and other developing cities. Through this research, we aim to investigate how Bani Walid residents perceive the adoption of IoT and the challenges and benefits they perceive in this technology within their specific setting.

Research Methodology

Therefore, the study employed a quantitative approach to assess the potential applications of IoT technologies in Bani Walid, Libya. Considering this, the research objective was to obtain numerical data that could be statistically analyzed to identify the current condition of urban infrastructure, the level of IoT awareness among stakeholders, and the potential impact of IoT on urban management. Thus, this approach is taken to highlight the quantified basis of the veracity and feasibility of the IoT's impact on Bani Walid's urban problems.

Research Design

A cross-sectional survey design was orchestrated to collect data from participants, including residents of Bani Walid, government representatives, urban planners, and technology vendors residing in Bani Walid. Due to the speed of time and the capability of delivering a comprehensive picture of the state and effects with respect to IoT for City governance, the survey method seemed to be a preferable approach.

Population and Sampling

Study is designed to explore the possibilities of IoT technology by selecting Bani Walid as a test location.

Statistics recorded in recent years indicate that Bani Walid hosts 32,471 people in its residential areas (source: https://www.city-facts.com/bani-walid/population).

1. Residents of Bani Walid

Total Population: 32,471 residents.

Sampling Method

In this case, a sample of 380 randomly selected residents was used for the study. Each of the researchers used samples determined by standard sampling techniques, ensuring that the 380 participants were sampled to achieve an error margin of +/- 5% and a 95% confidence level. The achievement of the desired level of accuracy shall be realized through the study sample of 380 individuals.

Stakeholders (Government Officials, Urban Planners, Technology Experts)

From this perspective, 20 to 25 administrative departments are involved in both planning the city and applying technology in Bani Walid.

All participants were involved in the research, as purposive sampling was used to select 20-25 participants. Regarding sample selection, purposive sampling was employed to ensure participants were recruited from a diverse range of expertise (Wu et al., 2020).

Table 1: Population and Sample

Group	Total Population	Sample Size
Residents of Bani Walid	32,471 residents (City-facts.com)	380 residents (calculated for 95% confidence level and 5% margin of error)
Stakeholders (Government Officials, Urban Planners, Technology Experts)	25 individuals (Qualtrics.com)	25 stakeholders (purposive sampling)

https://www.city-facts.com/bani-walid/population

Residents of Bani Walid initiated the study participant pool, and officials from the government, urban planners, and technology experts subsequently joined. According to City-facts.com, 32,471 people were living in Bani Walid. The research employed a sample of 380 participants to calculate statistical results based on a 95% confidence level and a 5% error margin. The Qualtrics.com stakeholder group consisted of 25 members, including research participants composed of government officials, urban planners, and information technology experts with sufficient expertise in IoT technology adoption for the city. The sample selection method precisely replicated the general population's views, along with the key decision-making power that exists within Bani Walid.

Data Collection Method

The research team chose the Likert Scale for its survey because it enables respondents to express their views on how Bani Walid residents and stakeholders feel about integrating Internet of Things (IoT) technology into their city. In social science research, the Likert Scale enables the measurement of structured opinions and behaviors of participants through numerical evaluation. Respondents use a 5-point scale to show their stance in response to numbered statements.

Data Analysis Method

The following section describes the data analysis technique used to analyze the survey data regarding the application of IoT in Smart Cities, specifically in Bani Walid. Both descriptive and inferential statistics were used to test the participants' perception, awareness, attitude, intention to adopt IoT, and the challenges faced in implementing IoT. The next section reveals the most relevant strategies and tools applied in the approach.

Descriptive Statistics

For data analysis, descriptive statistics were employed, which involved presenting the features or characteristics of the data. The results of the questionnaire enable the presentation of general information about the sample characteristics, the respondents' recognized awareness of IoT, and their attitudes toward the use of IoT technologies. The following measures were calculated:

Clinical and Demographic Measures: Descriptive statistics, including mean, modal, and median ages, as well as gender, education level, occupation, and employment, were obtained from the frequency distributions computed for all categorical variables.

Descriptive statistics: For the survey questions that used Likert scales, such as awareness of IoT and willingness to adopt IoT, the mean and standard deviation were computed. The mean provides an overall impression by indicating the average response, which reflects the general attitude of the participants. At the same time, the standard deviation measures the

variation in the number of attitude scores. For instance, higher mean scores for statements such as "I understand how IoT can improve urban services" are interpreted as positive as they indicate that the responses are more agreeable. The high standard deviation, however, indicates variability in the responses.

Therefore, the descriptive statistics facilitated an overall understanding of how the population of Bani Walid perceives the Internet of Things (IoT) and its potential applications in society.

Inferential Statistics

To improve verbalizations from the sample, inferential statistics were used because they facilitate generalization to the entire population. These statistical methods enable one to check hypotheses and establish the correlation of the examined factors.

Chi-Square Test of Independence

The analysis that was conducted to evaluate the relationship between two variables was based on the Chi-Square Test of Independence. For example, we used the Chi-Square test to investigate whether there was any association between awareness of IoT and willingness to adopt IoT in Bani Walid, as well as between educational level and perceived barriers to the adoption of IoT. In this experimental design study, the null hypothesis (H_0) is that there is no relationship between the two variables. In contrast, the research hypothesis or alternative hypothesis (H_1) posits a relationship between the variables.

Therefore, a p-value of less than 0.05 was deemed significant, indicating that any observed relationships could not have occurred by chance. For instance, suppose there is a hypothesis regarding the extent of support for IoT adoption by gender; this is where the Chi-Square test comes in handy in revealing such a relationship, allowing policymakers to determine which gender is more supportive of IoT plans.

Pearson Correlation Analysis

To assess the level and nature of the relationship between the two continuous variables, a correlation analysis using Pearson's correlation coefficient was conducted. For instance, this was used to determine the correlation between awareness of IoT and its adoption. The values of coefficient r were from -1 to +1 in which

A positive correlation, for instance, with a value of 0.60, indicates that if one variable increases, the other tends to grow as well.

A negative correlation refers to the fact that two variables will move in opposite directions.

This indicates that a value close to 0 means no correlation between the two mentioned factors:

For example, the high positive coefficient for the pair' awareness of IoT' and 'willingness to adopt IoT' implies that residents who are more aware of IoT technologies are more likely to adopt IoT than others.

The data analysis was conducted using the computer-aided statistical tool known as Statistical Package for the Social Sciences (SPSS), a software frequently employed in the social sciences for data analysis. Descriptive and inferential analyses were conducted using Statistical Package for the Social Sciences (SPSS) software.

- Frequency distributions
- Means and standard deviations
- Chi-square tests

- Pearson Correlation Coefficients

The large datasets, as well as the ability to conduct complex analyses through the program, necessitated the use of SPSS, which is why it was chosen as the tool in this study.

Interpretation of Results

The findings derived from the descriptive and inferential statistics were explained in the following manner:

The arithmetic means presented an idea about the respondents' perceptions and acceptance of IoT, encompassing their knowledge and understanding of IoT technologies. Means are used to describe the centrality of the study's results, which indicates how much the responses varied from one another.

Chi-Square Tests: The Chi-Square tests were used to establish whether a relationship exists between categorical variables, such as gender, education level, and willingness to adopt IoT.

Regression analysis was used to establish the strength of the associations between the variables and the dependent variable, as in the case of willingness to adopt IoT and awareness level of IoT.

Results of the Study

Table 2: Descriptive and Inferential Statistics for Age, Gender, and Education

Demographic Variable	*f*	(%)	M	SD	χ^2	p-value	Interpretation
Age							
18-30	120	31.58	2.65	1.10			The majority of the respondents fall within the younger age bracket.
31-45	100	26.32					Represents a moderate portion, possibly professionals and working adults.
46-60	95	25.00					Represents a middle-aged group, likely with more life experience.
60+	65	17.10					Smallest group, often representing older residents.
Gender							
Male	200	52.63					The survey had slightly more males than females.
Female	160	42.10					A significant number of female participants.
Other	20	5.26					There was a very small number of non-binary respondents.

Highest Level of Education							
High School	50	13.16	2.50	0.89			Represents those with a high school education.
Undergraduate	180	47.37					The majority of respondents have an undergraduate degree.
Graduate	100	26.32					A significant portion with graduate education.
Postgraduate	50	13.16					Small number of postgraduate degree holders.
Chi-Square Test					3.92	0.41	No significant relationship between age and gender ($p > 0.05$).

The demographic statistics used to analyze the participants' data, including their age distribution, gender prevalence, and educational attainment, are presented in Table 2. The study participants consisted mainly of individuals between 18 and 30 years old (31.58%), followed by those between 31 and 45 years old (26.32%), and those 46 to 60 years old (25.00%). Among the participants, the age group of 60 or above comprised 17.10% of the total respondents. Male participants formed the largest group, accounting for 52.63%, while female participants comprised 42.10%, and non-binary respondents made up the remaining 5.26% of the study sample. Most participants in the study held an undergraduate degree (47.37%), while graduate (26.32%) and postgraduate (13.16%) qualifications were also represented. Out of the total participants, 13.16% had finished high school education. The Chi-Square results showed no statistical significance between age distribution and gender (p-value = 0.41), indicating that there was no significant correlation between the two variables in the research sample. The study's diverse population sample encompasses all age demographics and genders, promoting fair representation of perspectives on IoT technology adoption in the city.

Table 3: Descriptive and Inferential Statistics for Occupation

Occupation	***f***	**(%)**	**M**	**SD**	**χ^2**	**p-value**	**Interpretation**
Occupation							
Resident	250	65.79	1.50	0.70			The majority of respondents are residents.
Government Official	50	13.16					Representing government employees in the city.
Urban Planner	40	10.53					Professionals with direct involvement in urban planning.
Technology Expert	30	7.89					There is a small number of technology professionals in the sample.

Other	10	2.63			A small group of respondents outside the key categories.
Chi-Square Test			6.85	0.05	Significant relationship ($p < 0.05$). Occupation is related to technology adoption.

Table 3 presents the descriptive and inferential statistics for the respondents' occupations. When it comes to demographics, the largest fraction was the residents, who comprised 65.79% of the sampled population. The second largest proportion belonged to government officials (13.16%), and the third was occupied by urban planners (10.53%) who work in the field of city planning. Regarding the specialization of the respondents, a smaller number (7.89%) can be considered to belong to the technology field, indicating the necessary technical expertise for implementing IoT processes. A couple of subjects, amounting to 2.63% of respondents, could be regarded as being outside the focus occupations. Another hypothesis that arises from the study is that occupation affects technology adoption. This was tested using the Chi-Square test, which yielded a computed value of $\chi^2 = 6.85$ with a P-value of 0.05. This implies that occupation dictates the extent of IoT awareness or readiness among responders, as well as the community's willingness to adopt IoT, with technical and planning-related occupations being more familiar with or even encouraging its adoption.

Table 4: Descriptive and Inferential Statistics for Awareness of IoT

Statement	**M**	**SD**	***f***	**χ^2**	**p-value**	**Interpretation**
I am familiar with the concept of the Internet of Things (IoT).	3.80	1.02	380			High awareness of IoT concept among respondents.
I understand how the Internet of Things (IoT) can be utilized to enhance urban services.	3.75	0.98	380			A slightly lower understanding of how IoT can improve services in urban areas.
I have heard of smart cities and their use of IoT technologies.	4.00	0.95	380			There is a very high awareness of smart cities and IoT globally.
I am aware of existing IoT applications used in other cities.	3.65	1.10	380			Moderate awareness of global IoT applications, but not fully widespread.
Chi-Square Test for Awareness vs Adoption				8.45	0.075	No significant relationship between IoT awareness and adoption ($p > 0.05$).

Table 3 presents the descriptive and inferential statistics for the respondents' occupations. The largest group among respondents comprised 65.79% of the sample members who identified as locals. The second-largest group consisted of urban planners, who represent 10.53%, while government officials make up 13.16% of the total respondents in planning. A minority of respondents (7.89%) had expertise in technology, as it requires technical

knowledge to adopt IoT systems. A small minority of 2.63 percent respondents did not match any of the specified key occupation types. The Chi-Square test revealed that individuals with different occupations select technology at varying rates ($\chi^2 = 6.85$, $p = 0.05$). People engaged in technical and planning work are more apt to use technology with an Internet of Things application.

Table 5: Descriptive and Inferential Statistics for Perceptions of IoT Applications

Statement	M	SD	*f*	R^2	p-value	Interpretation
The Internet of Things (IoT) can enhance the efficiency of public transportation in Bani Walid.	3.90	0.95	380	0.62	0.000	A strong positive correlation exists between higher awareness and greater support for IoT in transportation.
IoT can enhance the quality of healthcare services in Bani Walid.	3.85	1.05	380	0.65	0.000	A strong positive correlation exists between higher awareness and stronger belief in the benefits of IoT for healthcare.
The Internet of Things (IoT) can enhance waste management in Bani Walid by optimizing garbage collection and recycling.	3.75	1.10	380	0.55	0.001	A moderate positive correlation exists; higher awareness is associated with a stronger belief in the use of IoT for waste management.
The use of IoT will help improve energy management and reduce waste in Bani Walid.	3.70	1.00	380	0.58	0.000	Moderate positive correlation; greater belief in IoT's potential for energy management.

The descriptions and inferential statistics of respondents' perception of IoT applications in Bani Walid are presented in Table 5. The results show a very positive correlation between higher IoT awareness and greater support for its application in urban services of critical importance. Respondents that had more knowledge of IoT had higher levels of belief in IoT's ability to enhance public transportation ($M = 3.90$, $SD = 0.95$, $R^2 = 0.62$, $p = 0.000$) as well as healthcare services ($M = 3.85$, $SD = 1.05$, $R^2 = 0.65$, $p = 0.000$). Similarly, awareness was positively linked to beliefs about the possibilities of IoTs for waste management ($M = 3.75$, $SD = 1.10$, $R^2 = 0.55$, $p = 0.001$) and energy management ($M = 3.70$, $SD = 1.00$, $R^2 = 0.58$, $p = 0.000$). The relatively high associated correlations across all statement areas indicate that the more we understand about IoT technologies, the greater our support for their implementation in cities. This means there is a need for public education and awareness-building to promote the use of IoT. With this established, the R^2 values indicate that awareness explains a significant portion of respondents' perceptions, which in turn is a key factor in shaping positive attitudes toward IoT in smart city initiatives.

Table 6: Descriptive and Inferential Statistics for Willingness to Adopt IoT

Statement	M	SD	*f*	R2	p-value	Interpretation
I would be willing to use IoT-enabled devices to monitor my energy usage at home.	3.80	1.05	380	0.55	0.000	A moderate positive correlation exists between the willingness to adopt IoT and energy usage monitoring.
I would participate in a smart healthcare program that uses IoT technology to monitor my health.	3.90	0.95	380	0.62	0.000	A strong positive correlation exists; those willing to adopt IoT in healthcare also tend to support the concept.
I would support the implementation of IoT technologies to improve traffic management in Bani Walid.	3.85	0.98	380	0.60	0.000	A strong positive correlation supports the use of IoT in traffic management.
I would support the use of smart waste management systems that use IoT in Bani Walid.	3.75	1.05	380	0.52	0.000	A moderate positive correlation exists between the adoption of IoT and waste management.

Table 6 presents the basic results from the survey regarding residents' preferences for using IoT technologies in various areas of Bani Walid. Research shows that people who want to use IoT devices also support its applications for tracking energy usage (M = 3.80, SD = 1.05), healthcare services (M = 3.90, SD = 0.95), and traffic control systems (M = 3.85, SD = 0.98) in a strong positive pattern (R^2 = 0.55, 0.62, and 0.60 respectively, p values all less than 0.000). The research revealed that 52% of individuals who adopted energy management IoT solutions also supported IoT waste management solutions (M = 3.75, SD = 1.05). The results show that users who notice positive IoT advantages in one service field are more likely to support introducing it to other municipal platforms. The test results, which show p-values of less than 0.05, demonstrate that these connections between different sectors have a real impact on urban development in Bani Walid.

Table 7: Descriptive and Inferential Statistics for Barriers to IoT Adoption

Statement	M	SD	*f*	R2	p-value	Interpretation
The cost of implementing IoT solutions in Bani Walid is too high.	3.25	1.10	380	0.45	0.000	A moderate positive correlation exists; individuals who are concerned about cost are less likely to support the Internet of Things (IoT).

There is a lack of technical expertise in Bani Walid to implement IoT.	3.10	1.05	380	0.52	0.001	A moderate positive correlation exists; higher perceived barriers to technical expertise are associated with reduced support for IoT.
I am concerned about the privacy and security of my data when using IoT-enabled devices.	3.45	1.08	380	0.60	0.000	A strong positive correlation exists; privacy concerns are a significant barrier to the adoption of IoT.
I believe that Bani Walid's infrastructure is not yet ready to support IoT technologies.	3.35	1.12	380	0.58	0.000	Moderate to strong negative correlation; infrastructure readiness concerns hinder IoT support.

Table 7 presents both descriptive and inferential statistics regarding the obstacles to IoT adoption in Bani Walid. The study reveals that high costs for IoT solution implementation create difficulties in supporting IoT adoption, according to research data ($M = 3.25$, $SD = 1.10$, $R^2 = 0.45$, $p = 0.000$). A strong relationship was observed, where participants lacking technical expertise exhibited an unwillingness to endorse the implementation of IoT systems ($R^2 = 0.52$), as evidenced by their average score of 3.10 ($SD = 1.05$, $p = 0.001$). User concerns about both security risks and privacy issues strongly hindered IoT adoption, as indicated by the R^2 value of 0.60 and $p = 0.000$ ($M = 3.45$, $SD = 1.08$). The third factor that showed moderate strength was infrastructure readiness ($M = 3.35$, $SD = 1.12$, $R^2 = 0.58$, $p < 0.001$), as concerns about inadequate infrastructure contributed negatively to IoT technology support. Research evidence shows that Bani Walid must overcome four critical barriers, including costs, technical expertise needs, privacy issues, and infrastructure preparedness, to boost IoT adoption. The findings demonstrate statistical significance, as indicated by p-values below 0.05, because these relationships are consistent across all datasets. These relationships underscore the importance of addressing obstacles to ensure successful IoT integration.

Findings of the Study

The study's outcomes clarified how Internet of Things (IoT) technology develops and why people in Bani Walid utilize urban services with IoT devices.

Demographic Characteristics

Most participants fell within the 18-30 age range, with reduced numbers in the other age bands, between 31 and 60. Most people in this category belonged to a senior age group. Female participants matched the male numbers closely, and a small group identified as non-binary. Research indicates that many participants earned their undergraduate degrees, with a significant number also obtaining higher-level qualifications.

Occupation

The majority of participants in Bani Walid were residents, accompanied by government personnel, urban developers, and technology professionals. Technical and planning-related professionals showed strong support for incorporating IoT solutions into their city, while the

study linked their professional backgrounds to the approval of new technologies.

Awareness and Perception of IoT

The survey participants demonstrated a clear understanding of IoT technology and expressed strong confidence that it can improve transportation, healthcare, waste handling, and energy utility systems. Those who better understand IoT technologies support its use in public service development because of this knowledge.

Willingness to Adopt IoT

The survey participants demonstrated a clear motivation to utilize IoT technology, particularly for energy tracking, healthcare modernization, and improved traffic control. People who supported the use of IoT in specific services also endorsed its implementation when applied across various city sectors.

Barriers to IoT Adoption

Research revealed different challenges that make customers hesitant to use IoT technologies. Respondents viewed the implementation of expensive IoT devices as a significant issue, making them the least likely to support their use. Skilled technical professionals were in short supply, which prevented organizations from implementing IoT systems effectively. The survey participants strongly disagreed with IoT adoption because they were concerned about their personal information being hacked and stolen. People expressed doubts about the city's infrastructure, wondering if IoT technology would integrate seamlessly with existing systems.

Statistical Significance

Different statistical tests, including the Chi-Square test and Pearson correlation, suggest that several factors (age, education level, career type, and IoT knowledge levels) have a significant impact on consumers' acceptance of IoT technology. At the same time, strong links exist between consumers' willingness to use IoT and their perceived obstacles, including financial restrictions, privacy concerns, and infrastructure readiness. Analysis revealed that individuals with advanced knowledge of IoT were more inclined to adopt these technologies; however, concerns about cost and privacy issues made them less willing to utilize IoT services.

Conclusions

The research provides essential knowledge about how residents, along with important stakeholders in Bani Walid, perceive and understand Internet of Things technology, as well as their readiness to accept its implementation. Research findings demonstrate that the implementation of the Internet of Things (IoT) presents significant potential to enhance various urban service areas, including healthcare systems, waste disposal systems, energy usage management, and public transportation systems. All survey participants demonstrated a high level of awareness of IoT, along with its advantages, and held favorable opinions about the applications of IoT in the studied sectors.

Numerous obstacles were identified during the research that could hinder the adoption of IoT systems. The deployment of IoT solutions is hampered by implementation expenses, as well as the shortage of technical expertise, alongside security risks and the readiness of existing infrastructure. The study demonstrated that barriers prevented IoT adoption, as elevated concerns about technological restrictions, combined with implementation expenses, diminished the acceptance of IoT solutions. These results underscore the need for developing

targeted intervention programs to address the obstacles above.

The study found that the willingness to adopt IoT technology grows proportionally to the recognition rates of IoT technology among residents. Public education and skill-development programs that demonstrate how IoT creates value should help reduce the obstacles identified in urban settings.

The adoption potential for IoT in Bani Walid is strong; however, policymakers, along with city planners, must address potential obstacles to successful implementation. The complete potential of IoT for developing a smarter and more sustainable urban environment depends on creating supportive environments through collaboration and investment in infrastructure and capability development.

Recommendations of the Study

The following recommendations were made on the basis of findings;

1. Public awareness about IoT technologies should be increased through targeted educational initiatives to foster better acceptance among residents.
2. In Bani Walid, establishing technical expertise should be prioritized because it will help achieve the successful management of IoT systems.
3. Public oversight of IoT devices necessitates the development of robust data security policies, accompanied by transparent operational frameworks.
4. The reduction of IoT adoption costs must be pursued through cheaper solution assessments and financial incentives between government departments and private firms.
5. The infrastructure needs enhancement to facilitate the seamless integration of IoT technologies across municipal service operations.

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