Implementing IOT in Effective Project Management

Mounir El Khatib*
Hamdan Bin Mohammed Smart University Dubai Academic City, Dubai, United Arab Emirates

Raed Abu Zitar
Sorbonne University Abu Dhabi, United Arab Emirates

Ahmed Alnaqbi†, Abdulla Alnaqbi†, Hamad Alsuwaidi†, Meera Al Marri‡, Ahmed Ankit§
Hamdan Bin Mohammed Smart University Dubai Academic City, Dubai, United Arab Emirates

Abstract

The Internet of Things (IoT) can revolutionize project management by allowing devices to communicate and share data, automate tasks, and improve communication and coordination among team members. However, this comes with challenges, such as data security and privacy, interoperability, and managing the complexities of IoT systems. This research proposes identifying the benefits and shortcomings of using IoT in project management and identifying solutions and best practices for implementing and managing IoT systems in this context. The research was conducted through semi-structured interviews on questionnaires. The research found that IoT can offer significant benefits in project management, including cost reduction, increased efficiency, and improved communication and coordination. However, these benefits can only be realized if data security and privacy challenges, interoperability, and system complexity are addressed through careful planning, design, and management. Key lessons include considering the end-to-end user experience, carefully managing data and devices, and properly testing the system.

Key Words: Internet of things (IoT), project management, technology, implementation.

1 Introduction

The Internet of Things (IoT) is the hook via the internet of computing appliances fixed in daily items, allowing them to dispatch and obtain data (Brous et al., [7]). This technology has the potential to connect everything from cell phones, washing machines, and cars to roadways, healthcare facilities, and power grids. IoT is a transformational technology with the potential to change the way we live, work, and play. It can connect people, devices, and data in impossible ways. IoT can help organizations improve efficiency, optimize resources, and create new revenue streams when correctly leveraged. IoT is already being used in several industries, including manufacturing, healthcare, transportation, and retail. In the coming years, IoT will become increasingly prevalent in our everyday lives (Brous, et al., [7]). As IoT becomes more widespread, organizations must consider leveraging this technology to achieve their business goals. Project managers ensure that IoT projects are appropriately planned, executed, and monitored. Project managers must deeply understand IoT technology and its potential applications (Brous et al., [7]). They must also communicate effectively with stakeholders, sponsors, and team members.

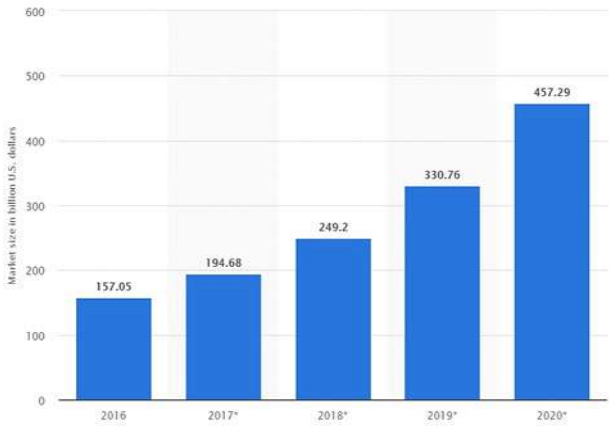

Figure 1: Size of the IoT market worldwide from 2016 to 2020 (in billion U.S. dollars)

1.1 Background Information

Project management is persistently changing to adapt to the more efficient way to control organizations. Although project management has been excellent in recent years, the introduction of IoT by the ever-changing or adapting technology has brought a new breath in management. Therefore, IoT has transformed modern business – project management can utilize the practical application of IoT to achieve overall goals. The IoT has positive ramifications on project management. In the Internet of Things (IoT) and

* Associate Professor, School of Business & Quality Management, P.O.Box 71400, Email: m.elkhatib@hbmsu.ac.ae.
† Graduate Project Management, Email: (200118800@hbmsu.ac.ae; 200118764@hbmsu.ac.ae; 200121128@hbmsu.ac.ae.
‡ Assistant Professor, School of Business & Quality Management, P.O.Box 71400,Email: M.Alreyaysa@hbmsu.ac.ae.
§ Professor, Dean of Scientific research and Doctoral Studies, Email: a.ankit@hbmsu.ac.ae.

shifting the current prospect of Project Management dissertation, PrasherVikram gave a synthetic scope of project management based on the IoT.

The Internet of Things (IoT) is a chain of concrete items ingrained with sensors, programs, and other mechanization that enables them to acquire and exchange information (Durmic, [8]), please see Figure 2. The IoT has the potential to revolutionize daily activities by providing individuals with real-time data that can be used to improve efficiency, safety, and productivity. Project management is the process of monitoring, executing the progress, and planning of a project (Khalafi et al., 18). Project managers use various tools and techniques to plan and execute projects, and they are in charge of ensuring the project is finalized on time, within budget, and within scope (Khalafi et al., 18). The IoT field is rapidly growing, and project managers must stay updated on the latest developments. IoT project management requires a unique set of skills and knowledge, and it is crucial to partner with an experienced IoT service provider who can help you navigate the challenges of this dynamic field.

IoT has been identified as a game-changer in project management, as it can revolutionize how work is carried out and monitored. IoT-enabled project management systems can provide real-time data and insights to help project managers make better decisions, optimize resources, and improve project delivery. IoT can also help project managers better understand work progress and identify potential issues and risks. By connecting devices and sensors to project management software, project managers can receive alerts about problems as they happen and take corrective action to prevent them from becoming more significant issues. In addition, IoT can be used to automate project tasks. For example, IoT-enabled sensors can track the location of assets and equipment and trigger alerts when moving to unauthorized areas; This can help to prevent theft and loss and to ensure that assets are being used as intended (Brous et al., [7]). IoT can also monitor susceptibleness, such as humidity and temperature. This information can be used to adjust the work environment to improve comfort levels and prevent equipment damage.

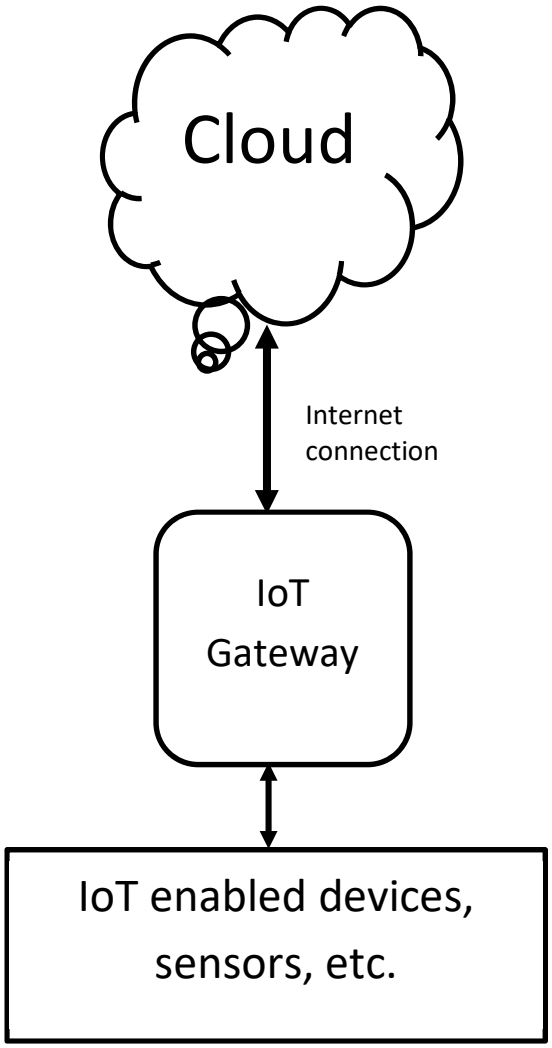

Figure 2: Architecture of IoT with clouds

1.2 Problem Statement

Although there has been tremendous advancement in technology application in business, there is a problem with how IoT is applied in project management. In 2017, a Cisco survey revealed that almost 75% of the project using IoT fail– this shows a significant challenge (Rivett, [29]). With the growing technological advancement, some industries have been scared of incorporating IoT in project management. The failure of IoT in management is making some industries lose confidence in investing in the growing IoT technology. There are several factors contributing to the delinquency of those projects.

One major cause of failure of project failure using IoT is human factors ranging from managerial and technical skills to general culture. The unavailability of universally recognized organizational techniques is causing significant challenges in implementing IoT in project management. Since current projects incorporate many systems, there is the potential for huge risks. The prevailing traditional information technology is straightforward to handle project management across all phases. Therefore, project managers should be integral in researching and developing IoT in significant organizations' projects.

1.3 Hypothesis

- The Internet of Things presents numerous pros and cons that affect the overall effectiveness of project management.
- IoT could help managers make better-informed decisions about their projects by providing real-time data.
- IoT can help automate tasks and processes, making projects more efficient and reducing manual labor.
- Moreover, IoT can improve communication and collaboration between team members, managers, and clients.
- IoT could help track, and monitor project progress, making it easier to identify and resolve issues as they arise. (Deleted, it is not covered in the literature review, questionnaire, or analysis)

- IoT can give managers insights into how their projects are being used and accessed, allowing them to optimize and improve their offerings.

1.4 Research Question

This study purposely explores the function of implanting IoT in the effective management of a project. Additionally, it emphasizes the requisite positive and negative ramifications of implementing IoT in modern project management. Therefore, the research questions will be:

- What is the relationship between IoT and project management, and how to implement IoT technology in effective project management?
- What are the advantages and disadvantages of using IoT in project management?
- How can data from IoT be used to monitor and track project progress effectively?

1.5 Research Objectives

This research aims to effectively develop a framework for managing Internet of Things (IoT) projects. Therefore, this study will focus on the following objectives.

- To understand how IoT can be used in effective project management.
- To investigate the advantages of using IoT in project management.
- To identify the disadvantages of using IoT in project management.
- To explore the feasibility of using IoT in project management in a range of different contexts

2 Literature Review

2.1 The Role of IoT in Changing Project Management

Internet of Things (IoT) and changing face of project management research by PrasherVikram [26] is an excellent article discussing IoT in business management. The study revolves around IoT in varying project management. Prasher [26] explained that regardless of the non-tech or tech, IoT is a huge technological advancement that covers all business domains. In addition, the research pinpoints that IoT is the foundation of the hardware and software combination of components that disrupts traditional perceptions in manufacturing. Therefore, this article aims to explore the role of the Internet of Things in project management's changing face. The article's central idea rests on the importance of self-efficacy when discussing the Internet of Things (IoT), as this can influence many aspects of our lives (Prasher, [26]). For example, a person's self-efficacy may influence their decision to purchase a smart home device or whether they believe they can successfully use it. Self-efficacy may also affect how people interact with and use IoT devices (Prasher, [26]). The author struggles to express the research scope, but this article provides a roadmap toward realizing the goal of my paper.

2.2 Impacts of IoT on an Organization's Project Management

The impact of Internet of Things unification with project management disciplines in project-based organizations research using concepts of project management in IoT - oriented organizations instill the prevalent practices of IoT. Percudani & Batrawi [25] explained that IoT and project management are two close disciplines in a business environment. In addition, the research pinpoints four motivational concepts of IoT in managing projects. Percudani & Batrawi [25] explained that IoT could work independently and make decisions without human intervention. IoT motivational concept does not end there; instead, it is a profound concept that includes connectedness – the ability of devices to connect and share data with other systems. In addition, the research identified that IoT is proactive – the power of machines to take action in anticipation of user needs or changes in the environment. Later, the study narrowed down the capability of IoT as context-awareness – the ability of devices to understand and respond to the user's current situation and context. For instance, IoT can monitor the progress of different project segments and give real-time updates to requisite authorities. This research relies on Percudani and Batrawi's multi-facet ideas in IoT and explains the deep-lying concept of IoT in the business project management sector.

The Internet of Things provides numerous advantages and benefits for all sectors. It ushered the next industrial revolution characterized by radical changes, disruptions, and new paradigms focusing on the environment Babun, et al. [6] argued that IoT extends current connections between users and computer devices. IoT can help share and transfer data from simple numbers to complex details shared using multiple data streams and sensors. IoT facilitates machine-to-machine communication, enabling physical devices to remain connected. This aspect increases overall transparency, efficiency, and quality (Babun, et al., [6]). The connected infrastructure of digital devices can be controlled remotely and centrally, increasing the potential for control and ensuring faster and more timely activity completion; this enables individuals and organizations to save money, time, and other resources. IoT increases information access, allowing individuals to enhance their knowledge and make better decisions.

2.3 Concepts of Technology in Project Management

The article discusses the various aspects of IoT project management and how it can help organizations manage their IoT projects. It also highlights the importance of clearly understanding the multiple stakeholders involved in the project and the need for effective communication and coordination among them (Hurtoi & Avadanei, [16]). Moreover, the article emphasizes the importance of setting clear objectives and milestones for the project and regularly monitoring and assessing the project's progress. In addition, the report covers the basics of IoT project management and details the critical components of a successful IoT project (Hurtoi & Avadanei, [16]). It offers tips for managing an IoT project from start to

finish, including selecting the right platform and tools, setting up a development environment, managing devices and data, and troubleshooting and debugging issues (Hurtoi & Avadanei, [16]). The research also sheds light on the role of IoT in project management. For example, it can lead to improved project outcomes as managers become more confident in their ability to complete tasks and make decisions. In addition, IOT self-efficacy increases job satisfaction as managers feel more capable and empowered in their roles. IoT's self-efficacy is multi-dimensional; thus, it can lead to better team dynamics as managers are more likely to delegate and trust team members. Lastly, the article pinpoints that IoT can reduce stress and anxiety as managers feel more capable of handling challenges and setbacks. This article is integral to my research since it summarizes the importance of IoT in project management. It sheds light on what project managers should expect when incorporating IoT in a business environment.

2.4 Disadvantages of IoT on an Organization's Project Management

Patel et al. [24] argued that IoT delivers multiple benefits but presents numerous challenges. This study identified security as a top concern as IoT creates an environment of constantly connected devices and continuously communicating over networks. IoT's sophistication allows devices to share a substantial amount of personal data without the owner's consent or participation. Internet systems may not provide adequate control and protection due to the need to upgrade security measures continuously. This aspect exposes users to malware and intrusion that could result in data breaches and substantial losses. IoT uses complex designs and deployment and maintenance techniques that make it increasingly sophisticated. Some individuals may find it challenging to use IoT systems due to the numerous technologies and enabling structures embedded within such tools.

Parteek [23] evaluated IoT's potential drawbacks, including increased unemployment with increased efficiency and automation. The author highlighted how IoT promotes unemployment, including developments in robotics, smart surveillance, automated machines, and artificial intelligence. He argued that the development and maintenance of such systems require substantial finances. IoT is a high-risk system due to the high chance of being corrupted. One factor that maintains this issue is the lack of international standardizations, which makes it challenging to satisfy compatibility requirements, especially for devices from different manufacturers communicating with each other.

3 Methodology

3.1 Research Design

Based on the research method description in Percudani & Batrawi [25], it is an approach that can be divided into two categories – quantitative and qualitative. Qualitative research relies on studying and observing a particular phenomenon before making an interpretation and final judgment on the specific matter they are learning. Scholars can use several qualitative research methodologies to study a phenomenon (Goyal et al., [15]). Some standard qualitative research methodologies include ethnography, case study research, grounded theory, and phenomenology (Goyal et al., [15]). On the other hand, quantitative research methodologies allow for the collection and analysis of numerical data. This type of research is often used in the social sciences and can be used to study various topics. Some of the most common quantitative research methodologies include surveys, experiments, and observation.

In this research, the methodology used to achieve the outlined objectives is quantitative research, namely semi-structured interviews. Semi-structured interviews on questionnaires were used to collect qualitative data concerning the use of IoT in project management. One advantage of semi-structured interviews is that they can be utilized to collect open-ended data. Another benefit of using this methodology is that it is effective in capturing the thoughts and perceptions of participants regarding the topic of interest. The research paper aims at establishing the feasibility of IoT in project management, and this can be determined by collecting feedback from relevant people concerning their experiences in using IoT and their reaction toward its usability. Since the data collected is open-ended, participants are granted flexibility in answering the questions.

3.2 Data Collection and Analysis Tools

The author uses qualitative data collection methodologies to obtain primary data in this research. For instance, in this research, the author used questionnaires to get data from interviews. The participants in answering questionnaires were based on various factors, such as having at least five years of experience and a professional background in project management. During the collection of data, this research used semi-structured. In a semi-structured interview, the interviewer has a general guide of what topics will be covered but allows the conversation to flow somewhat naturally rather than sticking strictly to a predetermined set of questions (Rebelo, et al., [28]). It will enable the interviewer to explore areas of interest that may arise during the conversation while still covering the main topics that were initially planned. The semi-structured approach allows a more in-depth exploration of the interviewee's thoughts and experiences on a given topic (Prasher & Onu, [27]). Therefore, this research used it to dig deeper into understanding the underlying knowledge in this field.

3.3 Research Approach

The study utilized two ways of establishing incorrect and correct data – deduction and induction, as explained in Ghimire et al. [14]. Since the research was more probing and emerging, it often used an inductive approach – which is suitable for this situation, according to Nord, et al. [22]. In addition, the study will uncover data unavailable in the literature review. Later, the research will establish the

connection between IoT and project management following Alazzawi & Alotaibi [2] approach. Lastly, the study will incorporate the finding with the existing knowledge and improve the overall strategies.

4 Result Analysis

The IoT research shows that the internet of things can revolutionize how we live and work. It can connect physical objects and devices to the internet, enabling them to liaise with each other and share information. This data can facilitate the efficiency of processes and help make better decisions. In terms of the development of IoT technology, it is mainly based on applying various sensors. IoT presents diverse advantages, including enhancing customer engagement and addressing the current blind spots in organizational analytics. It would help optimize technology to enhance customer experience and improve device use. This aspect would reduce wastage and provide users with real-time information to enhance the management of their resources. Despite the benefits, IoT presents various cons associated with security and privacy concerns. IoT also presents other challenges resulting from its complexity and low flexibility, making it challenging to integrate easily. A multi-layer security approach would help protect users when exposed to diverse degrees of security and privacy threats (Tukur, et al., [33]). A multi-layer approach would secure the entire architecture, ensuring the system is secure. This aspect would help to increase the advantages and minimize the threats from the cons.

4.1 Interview Analysis

The interview was conducted among 20 people; only 75% cooperated throughout the interview and answered all questions. All fifteen respondents agreed that the project is divided into five phases. All respondents agreed that the project reaps enormous benefits when technology is implemented in all stages. In addition, all respondents believed introducing IoT in the project would ease the operation and boost team workings. Additionally, 60% out of those who cooperated agreed IoT still needs to be developed in some organizations and maybe their framework is limiting them from realizing IoT's full potential. In addition, one of three interviewees indicated a change in approaches and paradigms in the initial project phase when the project manager implemented IoT. In this idea, the respondents supported their claim by explaining that IoT gave the project flexibility that enabled it to perfect the outcomes. On top of that, 50% of respondents claimed IoT deeply impacted the project's bidding phase.

In the project planning phase, 73.3% of respondents agreed that IoT enabled efficient and effective communication with multiple clients and contractors. IoT implementation in this phase helped staff and was a guide throughout the project. During planning, the communication between stakeholders and project managers was efficient since the manager gave a real-time update on the progress (Liu, [20]). In the execution phase, 60% of respondents agreed that the implementation of IoT had a significant impact. For instance, they all decided that IoT improved effectiveness, efficiency, and productivity. IoT is a strategy feature for the project manager since they are responsible for aligning the project to achieve the organization's goals. In the closing phase of the project, all interviewees agreed that collecting and storing data in this stage is essential since it will act as a reference in the future. Therefore, they all decided that the implementation of IoT was crucial since it would ease collecting future referencing data.

Table 1: Participants

Number of participants	20
Participants that cooperated	15 (75%)
Participants that did not cooperate	1 (25%)

4.1.1 Benefits of Implementing IoT in Project Management. IoT gives a project innovation in organizational systems. It allows digital transformation that drives change and enables efficient product and project scope control (Respondent 1;4;10).

Examining the depth of IoT, it is the heart of product and service delivery. It is the most impacted sector by IT and engineering (Gal et al., [13]). 40% of the interviewees agreed that the primary advantages of IoT are protecting assets information and availing the data for analysis in real-time (2, 4, 5, 7, 8, 9, 10, 15). In addition, 40% of the respondents agreed that implementing IoT technologies positively impacted the organization's flow and improved processes (Xie & Yang, [37]).

In addition, IoT provides a high degree of transparency and data sharing (3, 7; 12). The IoT also forms the foundation for leveraging the value of products and allows project managers to examine any requisite information (7, 9, 12, 13, 14, 15). Information recognition from the entire project process is more accessible when the organization has implemented it than when it uses traditional information technology (1; 3; 4; 6; 11; 15). One of the most significant benefits is that it can help improve project management efficiency because IoT can provide real-time data and information about project status. Project managers can make decisions based on accurate and up-to-date information rather than relying on guesswork. According to 100% of respondents, it can lead to projects being completed more quickly and efficiently and can also help reduce project management costs.

5 Discussion

5.1 Impacts of IoT on Project Management

IoT has a significant impact on project management, as discussed by Saariko, et al., Percudani and Batrawi. [25]. Implementation of IoT in project management improves it in all phases. This statement is correlated with the interviewee's acceptance that IoT benefits the whole project phase. There is an unprecedented increase in production, increased awareness and efficient decision-making, and sensible improvement in project management (Tang et al., [32]). Since IoT can send real-time information to users, there is an increased flow of information in the entire project management and process (1, 2, 5, 6, 8, 10, 13, 14). Most organizations that have

implemented IoT in their projects have reported a decrease in cost and time and making controlling operations easier (Sanchez, [30]). In addition, implementing IoT in project management reduces the wastage of resources. When an organization formulates a proper tracking technique of goods and resources, whether in project operation or storage ensures that resources are not misused, according to Percudani & Batrawi [25].

5.2 Barriers to Implementing IoT in Project Management

Adopting new technology is always challenging due to two distinct barriers to implementing IoT in project management. Technical and cultural issues are the main challenges facing organizations implementing IoT in their projects (Martens et al., [21]). Implementing new technology affects radical change and influences all organizational operations (Kozak-Holland & Procter, [19]). For instance, the IoT in a project has no guarantee of compatibility with stakeholders (4, 8; 9, 15). As discussed in previous chapters, IoT is the interconnection of various technological devices; therefore, these connections can be exposed to potential failures, which can stop key project sectors (Martens et al., [21]). In addition, implementing IoT in the project requires huge capital, according to all interviewees. For instance, continuous information collection needs massive cloud storage, which is costly.

6 Research Limitations

One of the critical limitations of IoT implementation research is the need for more standardization around IoT technologies, protocols, and data formats. This lack of standardization makes it difficult to compare and contrast different IoT implementations and to identify best practices. In addition, many IoT implementations are still in the early stages of development and must be rigorously tested or evaluated. As a result, there is a lack of empirical evidence to support the claims made about the benefits of IoT implementations. For instance, all fifteen interview respondents were from different organizations using various distinct standardization, which makes it difficult to relate. The research limitations of this study include the need for a comprehensive understanding of the role of IoT in effective project management. Furthermore, the study should have included a detailed analysis of the data collected from the survey.

7 Lessons Learned

One lesson is that it is essential to have a clear understanding of the goals and objectives of the project before implementation begins. Another takeaway is that it is crucial to clearly understand IoT technology's capabilities and limitations before the performance starts. Additionally, it is vital to consider IoT technology's security and privacy implications before the implementation begins. Finally, it is essential to have a clear plan for collecting and managing data before the implementation begins (Wang et al., [35]).

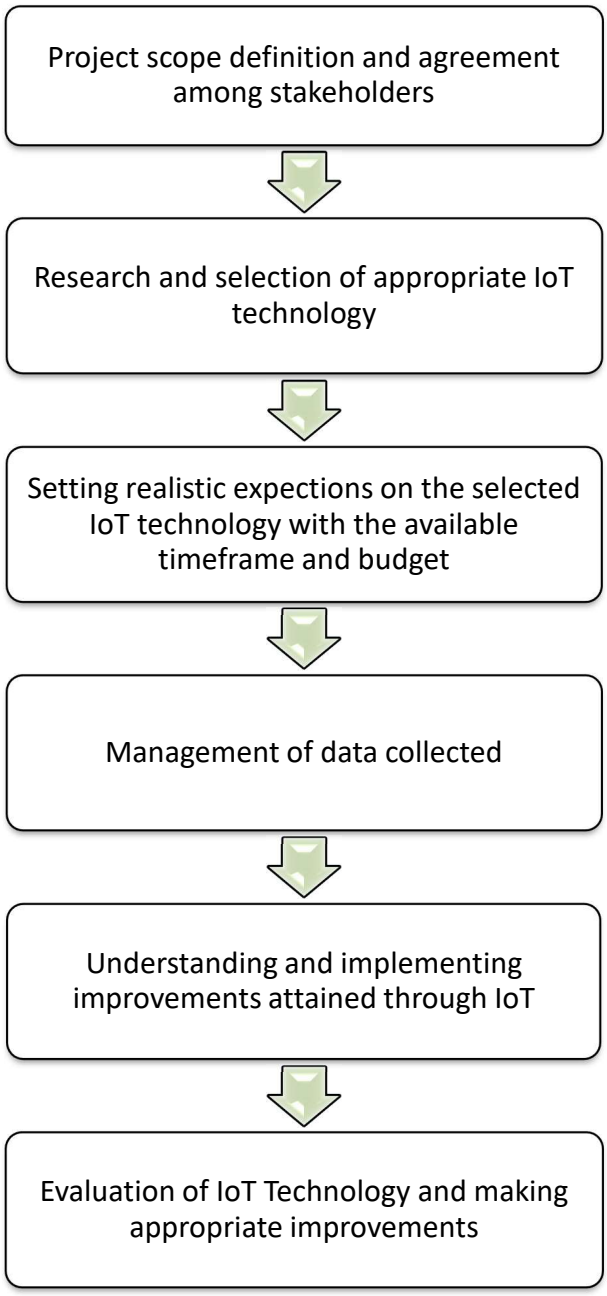

Figure 1: Recommendation steps

8 Recommendations

The following are research recommendations for implementing IoT in effective project management:

- From the outset, clearly define the project scope and objectives and ensure that all stakeholders agree (Prasher & Onu, [27]).
- Research and select the most appropriate IoT technology for the project requirements (Arnesen, [5]).
- Manage expectations around IoT's potential benefits and capabilities, and be realistic about what can be achieved within the timeframe and budget (Iriarte & Bayona, [17]).

- Manage the data collected by IoT devices carefully, considering data security, privacy, and compliance issues from the outset (Ancarani et a., [4]).
- Understand how IoT can improve project management processes and workflows and implement them accordingly (Adzmi & Hassan, [1]).
- Regularly review and assess the performance of the IoT implementation, and make necessary adjustments to ensure continued success (Shokouhyar et al., [31]).

9 Conclusion

The implementation of IoT in effective project management can help to improve the quality of project management and make it more efficient. IoT can monitor project progress, identify potential risks and issues, and provide real-time feedback to project managers. In addition, IoT can help automate project management processes, improve communication between project managers and stakeholders, and provide data-driven decision-making. IoT has the potential to transform project management into a more proactive, predictive, and adaptive field. By using IoT, project managers can gain insights into the behavior of project stakeholders, the status of project resources, and the performance of project deliverables. In addition, IoT can monitor and control project progress, identify and resolve issues in real-time, and improve communication between project managers and stakeholders.

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Mounir El khatib has a long and varied experience in Digital Government and Digital Transformation in the UK, Middle East and UAE. He has worked as a practitioner and in academic focused areas like Project and Program Management, Information Systems, Strategy and Operations, Business process and Service Management, providing teaching, training, consulting, advising, research and professional services.

Raed Abu Zitar (BS 88, MS 90, and PhD 93) is a senior research scientist in the context of Thales Endowed Chair of Excellence, Sorbonne Center of Artificial Intelligence (SCAI), Sorbonne University- Abu Dhabi (SUAD), UAE. Prof. Abu Zitar has joined SCAI-SUAD in Feb-2021. Prof. Abu Zitar is directing the research at Thales/SCAI in the fields of Intelligent detection and tracking of drones in cooperation with industrial experts from Thales and Aveillant (France and the UK). Prior to that date, he was the founding coordinator for the Master of Artificial Intelligence Program (one of the first in UAE), Head of the Center of Artificial Intelligence, and Manager for the Teaching and Learning Center at Ajman University, UAE. He has more than 30 years of experience in teaching, research, and administration in the USA, Jordan, and the UAE. He has published more than 100 Journal and conference papers.

Ahmed Alnaqbi (photo not available) is an operations plant supervisor at ADNOC Offshore company. In 2018, Ahmed got his bachelor degree in chemical engineering at Khalifa University. Ahmed is graduate master in Project Management at Hamdan Bin Mohamed University. Ahmed has 4 years of experience in the oil and gas Industry.

Abdulla Alnaqbi (photo not available) is a Trading Operations Specialist at ADNOC Trading. In 2018 Alnaqbi graduated with a Bachelor's in Chemical Engineering from Pennsylvania State University. From 2019 to 2022 he supervised the refinery operations for ADNOC Refining. Abdulla is a graduate of Master degree in Project Management from HBMSU and just started his research journey by publishing his articles.

Hamad Alsuwaidi (photo not available) is an Inspection Engineer at ADNOC Onshore Under Projects & Technical Centers Division. In Dec 2018 Alsuwaidi graduated with a Bachelor's in Mechanical Engineering from the HCT. Joined ADNOC Onshore since 2019. Hamad is a graduate of Master degree in Project Management from HBMSU.

Meera Al-Marri (photo not available) holds a PhD in Project Management. She is an Assistant Professor at the School of Business and Quality Management at HBMSU. Research interests include project management, online learning, sustainability, and CSR.

Ahmed Ankit is an accomplished academic leader with a passion for promoting research excellence. He earned his Bachelor's degree from Mohammed the First University in Morocco, and currently serves as the Dean of Research and Doctoral Studies at Hamdan Bin Mohammed Smart University, Dubai, U.A.E. Prof. Ankit has played a key role in securing licensure and accreditation for several academic programs, showcasing his dedication to academic quality. His research interests lie in the areas of smart education and higher education management, and he has co-authored numerous papers on these topics. Through his work, Ahmed strives to foster a culture of innovation and excellence in academia.

Appendices

Interview Questions

After a brief introduction, the interviewer welcomed the interviewee in the next chapter, where they were required to answer questions based on IoT. The research questionnaire progressed using the following questions.

i. Please tell me about yourself – your area of specialization and occupation.
ii. In brief answers, please describe your experiences in research.
iii. In your previous research, have you ever handled IoT? If yes, how did you engage in this topic?
iv. Based on your knowledge, what are the advantages of an IoT system?
v. What barriers do you face while implementing IoT in project management and using it?
vi. What are your thoughts on using IoT in project management?
vii. How can IoT be used to improve project management?
viii. Are the barriers mentioned above and difficulties prevalent in all industries or organizations?
ix. Do those challenges, difficulties, and barriers vary based on the situation?
x. If those challenges were prevalent in a different organization, what is prevalent among all industries?
xi. In project management, the program has several phases; which one is more affected by implementing IoT technology?
xii. Why does IoT mainly impact the phase you selected in (ix) above? Give examples.
xiii. Will the introduction of IoT technology impact the role of the project manager? If yes, describe your opinion on how the effect will be.
xiv. If a project incorporates new technology, are there common skills required from the manager?
xv. Will the project manager develop a new skill?
xvi. What are the new skills that project managers will acquire?
xvii. Since the project manager has different functions, which is more affected by IoT technology, and which is less impacted?