



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY



Ain Shams University
Faculty of Engineering
Architectural Engineering

Internet of Things (IoT) and Smart Technologies Impact on Resources Efficiency in Building

A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Architectural Engineering

by

Esraa Ahmed Ismail Metwally Ahmed

Bachelor of Science in Architectural Engineering
Faculty of Engineering, Ain Shams university, 2018

Supervised By

Prof. Mostafa Refat Ahmed Ismail

Professor of Architecture, Faculty of Engineering,
Ain Shams university, Cairo, Egypt

Dr. Ayman Ahmed Farid Gamal Eldin Hamza

Lecturer of Architecture, Faculty of Engineering,
Ain Shams university, Cairo, Egypt

Cairo - (2021)



Ain Shams University
Faculty of Engineering
Architectural Engineering

Researcher Name: Esraa Ahmed Ismail Metwally Ahmed.

Thesis Title: Internet of Things (IoT) and Smart Technologies Impact on Resources Efficiency in Building.

Degree: Master of Science Degree in Architectural Engineering.

Defense Date: -----/-----/-----

Examiners' Jury Committee:

Name and Affiliation	Signature
Prof. Ayman Hassaan Ahmed Mahmoud. Professor of Landscape Architecture Head of Architectural Engineering Department, Faculty of Engineering, Cairo university.	 (Examiner)
Prof. Khaled Mohamed Dewidar. Professor of Architecture, Faculty of Engineering, Ain Shams university.	 (Examiner)
Prof. Mostafa Refat Ahmed Ismail. Professor of Architecture Vice Dean for Education and Student Affairs Office, Faculty of Engineering, Ain Shams university.	 (Supervisor)

Post Graduate Studies:

Approval Stamp	Faculty Council Approval
-----/-----/-----	-----/-----/-----
The Thesis was approved on	University Council Approval
-----/-----/-----	-----/-----/-----

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Architectural Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Student name

Esraa Ahmed Ismail Metwally Ahmed

Signature

.....

Date: ----/-----/-----

Researcher Data

Name : **Esraa Ahmed Ismail Metwally Ahmed.**

Date of birth : **17th of December 1995.**

Place of birth : **Cairo, Egypt.**

Last academic degree : **Bachelor of Science.**

Field of specialization : **Architectural Engineering.**

University issued the degree : **Ain Shams University.**

Date of issued degree : **2018.**

Current job : **Demonstrator, Faculty of Engineering,**
Architecture Department, Ain Shams University.

Abstract

The current development pace of the internet of things (*IoT*), digital controls, networks, and software are exerting profound changes. With increasing the number of *IoT* devices, the economic markets are shifting towards those technologies. According to the market insights for the *IoT* reports, the number of *IoT* devices is expected to grow up to 22 billion by 2025 versus 12 billion non-*IoT* devices. According to McKinsey & Company global media report in 2015, it is expected to spend \$11 trillion of economic impact via *IoT* technologies by 2025. The integration of *IoT* technologies will enhance the quality of controlling our buildings.

Moreover, the challenges posed by the rapid digitalization, applying new applications, dealing with the full interoperability of various devices in buildings. However, much research had studied how *IoT* systems are technically applied, but more research is required to study the adaptation and standardization of applying *IoT* applications in architecture buildings. Moreover, there is a lack of approaches for evaluating *IoT* solutions in the architectural buildings, to validate those applications within the space before their deployment in real-life and properly emulate the *IoT* solutions in buildings. Besides, to link the gap between applying *IoT* solutions, engineering requirements, and the building resources' impact (lighting, HVAC, and appliances). Also, filling the gap in the current literature by focusing on the current state and potential future of *IoT* in the building industry.

The main aim of this study is to propose a criteria framework to develop a simplified method, to assess *IoT* implementation level and the impact of *IoT* applications in the building. This is significant to emphasize the functionalities improved by *IoT*, the current enabling technologies, and recent developments of *IoT*. Besides, to guide researchers, architects, designers, and stakeholders using *IoT* to address related issues and inspire researchers' thoughts in the industry for future advancement. To achieve this aim, a qualitative study is conducted based on a literature review for a set of previous studies and research. Then, we analyzed the impact of internet and connectivity development on developing the buildings' control milestones of some selected disciplinary systems. Also, analyzing some academical and industrial study cases, that implemented *IoT* solutions in the architecture building.

Subsequently, we identified the related parameters for applying *IoT*, advanced technologies on architectural buildings and their impact on buildings' resources. This results in performing the final design of the proposed *IoT* criteria framework. It is based on 3 main domains: input (embedded parameters), throughput (controlled variables), and outcome (impact) domains. Each domain collects a set of indicators and attributes with different *IoT* automation readiness levels. This framework contains 16 indicators and 124 attributes arranged in 5 main *IoT* levels.

Then, developing a proposed assessment method and the weights of this evaluation method. In order to cover all the possible indicators of our framework, the weights are based on two verified rating systems that are used in evaluating the smart and green buildings. To make a preliminary theoretical validation of the proposed criteria framework, a comparison was made among four different selected international cases, that implemented *IoT* applications in their buildings. Then, applying the proposed framework to each selected building, to present the enhancement of integration and implementation of the *IoT* applications in buildings. We could also identify which building is comparatively much in an advanced *IoT* level based on the overall score and level. Also, we covered the gaps and challenges gained from this study.

Finally, we conducted an online and personal structured interviews to discover the current situation concerning the practice of *IoT* of local projects in Egypt. Also, discussing the current enabling technologies, applications, and recent developments of *IoT*. Along with application recommendations for adopting *IoT* for the function improvement in buildings. Those interviews targeted the researchers, engineers, and the local Egyptian development organizations/firms, which are being leaders in software technologies and developing *IoT* platforms in the buildings. In the end, we concluded the findings of this study to ensure the achievement of the main aim and all research questions. Also, setting an *IoT* design model proposal, an action plan, and the future work towards enhancing the *IoT* solutions in the architecture buildings.

Keywords:

Building Control Systems, Building Resources, Building Technologies, Intelligent Buildings, Internet of Things (*IoT*).

Acknowledgment

First and foremost, praises and thanks to God for the uncounted blessings throughout this dissertation to accomplish the research work successfully.

I would like to extend my sincere thanks to my research supervisors **Prof. Mostafa Refat**, and **Dr. Ayman Farid** for their motivational words, patience, immense knowledge, persistent help, and valuable comments throughout my whole work on this dissertation. It was a great honor and privilege to work and study under their guidance.

Besides my supervisors, I would like to thank the rest of my thesis committee: **Prof. Ayman Hassaan**, and **Prof. Khaled Dewidar** for their encouragement, and insightful comments. Special thanks go to my friends and colleagues especially **Arch. Mai Adel** for her always support and constant encouragement.

Furthermore, thanks to all the participants of this dissertation survey and interviews, who shared their precious opinions.

Last but not least, I am extending my heartfelt thanks to my dad **prof. Ahmed Ismail**, my mum **prof. Gehan Ali**, my **sister** and **brother** for their caring, love, prayers, and sacrifices for preparing, educating, and supporting me spiritually throughout my all stages in life.

