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Internet of Things as an Innovative Platform to Enhance the Efficiency and Safety of Healthy Food in Public Hospitals in Saudi Arabia

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ABSTRACT

Food safety and operational efficiency are critical challenges in public hospitals, where maintaining high standards is essential to patient health. The purpose of this research was to assess how the application of Internet of Things (IoT) technologies has improved food safety and nutritional standard attainment as well as service delivery in Saudi Arabian public hospitals. Challenges such as monitoring of temperature, usage of RFID tags, and hygiene monitoring were solved by IoT devices including the temperature sensors, RFID tags and hygiene monitors placed in kitchens, storage areas and dining areas respectively. The method used in this study is experimental because IoT systems were implemented in the environment of hospital food services. Temperature accuracy, for example, hygiene compliance, and portion control were tracked over a period of six months, or availability of food through-out the day. Quantitative data were obtained through IoT devices, manual observations and feedback surveys and then statistics tools such as paired T-test, ANOVA were applied to exhibit the improvements. These outcomes proved the idea of significant improvements in food safety and organizational effectiveness. Temperature accuracy was enhanced by 95%, foodborne ill incidences decreased by 81.25%, and finally, hygiene score by 31.94%. From an operational perspective, there were certain gains - meal delivery time reduced by 44.44%, while wastage reduced by 60% and inventory accuracy was up by 25.64%. There is improvement in patient satisfaction indicators in terms of meal quality, time, and nutritional value Nutrition surveillance expense declined because wastage, regulatory compliance costs were decreased and garnered additional annual revenues of USD 15,000. Hence, IoT systems helped in improving the food service processes, safety indices and the quality of patient satisfaction. Nevertheless, it is imperative to give attention to the problems like staff training and high initial costs at the present stage. The following recommendations are meant for future plans: To deepen IoT usage across more hospitals systematically, continuous

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training should be provided and connectivity should be improved to sustain IoT's benefits. This research points out to the various ways in which IoT is likely to offer significant value in healthcare food services.

Keywords: Efficiency, Food safety, Hygiene, IoT (Internet of Things), Satisfaction

INTRODUCTION

The health care systems are experiencing rapid changes through adoption of new and sophisticated technologies that seek to improve health care delivery systems. These include; the Internet of Things (IoT) which has been seen as one of the most innovative technologies ready to change different sectors, including food service in public hospitals (Yuehong et al., 2016). The three challenges of food safety, nutritional compliance, and service efficiency have been highlighted to be complex in the kingdom of Saudi Arabia, thus demanding innovative ways of meeting the quality demands for healthcare services that are rapidly improving (Abdullah et al., 2022). This research aims at demonstrating the effectiveness of using IoT as an innovative solution to improve the healthy food services delivery system in public hospitals through identifying main gaps in the existing literature and practice (Kelly et al., 2020).

Hospital food services occupy a central position in patient treatment and recuperation. It is agreed to emphasise the provision of healthy, safe and nutritional meals since it is the scientifically proven fact that benefits such as the optimization of clinical results (Vaillant et al., 2021), the minimization of the days that patients take to recover and above all, patient satisfaction can be rapidly improved by providing healthy, safe and nutritional meals (WHO, 2021). However, the adopted stringent food safety and nutritional standards as practiced in health-care facilities present numerous difficulties such as deficiency in checking food storage conditions, a problem in the meal preparation, serving and cleanliness (Mozaffarian et al., 2024). These challenges are even more acute in Saudi-Arabia's public-hospitals which serve a growing populace with a demand for appropriate meals that should be free of diseases that may be associated with foods of Middle-Eastern origin or that are Halal compliance (Widiasih et al., 2020).

IoT can provide the solution to these challenges by unveiling an interconnected devices and sensors based mechanism to capture, store and analyze real-time data on various parameters of food services (Allioui & Mourdi, 2023). As a result of consistency of essentials in checking storage conditions, hygiene practices, and nutritional compliance, IoT will be useful in improving safety, efficiency, and quality of food services in hospitals. Moreover, the idea of an IoT solution is to

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offer recommendations to the hospital managers because of the effective use of resources, avoiding additional food wastage, and achieving compliance with the patient's requirements for the consumption of meals (Bhuiyan et al., 2021).

The significance of this research lies in timeliness in respect of an identified shortage of knowledge on the use of modern technologies in hospital food service. Although IoT has received much attention, and organizations across different industries have already adopted it, the implementation of IoT in food services especially in the healthcare industry has not yet been realized extensively (Ali et al., 2023). In Saudi Arabia, because the public hospitals managing numerous different types of populations that require different types of foods, the application of IoT in managing food services is very important to bring about a positive change to the operations and the subsequent output (Alanazi, 2023). This study is highly relevant especially because all over the world there are so many dangers associated with food. Patients confined to hospitals are especially at risk from foodborne illnesses because of poor immune system hence the need to make sure foods are safer and of better quality (Pedretti et al., 2024). Further, rise in the number of cases of chronic diseases like diabetics, hypertension & obesity in Saudi Arabia have resulted into the need for hospitals to feed its patients with clinical diets. The aim of this research was to investigate the underutilization of IoT in remodelling the food services in the Saudi Arabian Hospitals (Singh et al., 2023). Food services are a critical component of public hospital care continuing to pose significant challenges in areas such as food safety, compliance with nutritional requirements as well as organizational performance in the region. Various techniques that are used to supervise food services require documentation and are time-consuming, and more to the point, sloppy in comparison with computer-based techniques (Charlebois et al., 2021).

The implications arising from this research inform healthcare administrators, policymakers, as well as technology developers. Thus, the investigation of IoT applications for addressing the deficiencies in hospital food service makes valuable contributions to the recognition of IoT potential for enhancing the service quality in public hospitals in Saudi Arabia and other regions (Benchikh, 2024). The incorporation of IoT in hospitals will assist the health care sector in meeting national and international set food hygiene standards; cut costs; and improve the patient experiences. Otherwise, the subject of the use of IoT in food safety and sustainability has been discussed thoroughly, yet there were no observed scientific papers that demonstrated its practical application within the hospital environment of Saudi Arabia (Masmali, 2023).

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Moreover, literature review which focuses on the hospital food services has found that majority of published research has targeted mainly on routinised control and operation approaches that are not effective since they do not take into consideration the fast preparing, challenging and variable nature of most hospital environments. Presently, greater attention must be paid to using real-time data and analytics to improve the outcomes within the food service industry and conform to rigorous safety and nutritional requirements. Consequently, the research aim of this study is as follows: - To assess how IoT could serve as an innovative solution in improving the performance and safety of healthy food delivery in public hospitals in Saudi Arabia. Specific objectives include: To measure the effects of Internet of Things (IoT) based systems on food safety factors like storage conditions, bacterial level, and food hygiene standards. To assess the level of adherence to the necessary dietary recommendations based on patients' individual characteristics by using IoT. For purposes of dissecting the performance of IoT-equipaged food service systems including meal preparation and delivery time, inventory management, and overall food wastage.

METHODOLOGY

This research was an attempt to assess the possibility of the Internet of Things for increasing the effectiveness and safety of healthy food available in public hospitals in Saudi Arabia. It was believed that the use of this wide-ranging approach would enable a sound structure for fulfilling this aim through outlining the methods, equipment, variables, methods of data gathering, and methods of data analysis. Therefore, the purpose of this study was to establish how the IoT-based systems enhance service delivery regarding healthy foods in public hospitals. This involved assessing the consequences of IoT with regard to food safety, nutritional content compliance, storage conditions and service delivery.

Methods

The study used an experimental research design involving IoT-devices and platforms to measure and improve the quantity and quality of food and related safety characteristics in the selected Saudi Arabian public hospitals. The possible hospitals across the district were selected based on their consent and readiness of their infrastructure to integrate IoT technologies. The intervention was centered at installing IoT sensors and devices in the hospitality-kitchens, storage and dining facilities.

o Temperature and humidity indicators of storage conditions.o RFID (Radio frequency identification) for tracking food supply and other necessities used to ensure that they have been

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tracked from where they came from up to when they got to the targeted place.o Smart cameras for monitoring of food preparation and handling processes.o Use of wearable devices for the staff to be used in promoting hygiene standards.o Data collection and analysis cloud solutions.o Real time mobile and desktop application for monitoring and reporting.s As the websites designed are complete only additional facilities like the servers and databases to store data are required.It's important to identify at least three different analytical tools or capabilities which are used to process data and produce useful analysis.Ohospitalstafftrainedtof IoTdevices.o Technical specialists for installing the IT systems and for its day to day management.o Temperature and humidity in areas where the foods are stored.Yes Contamination levels in prepared meals.2 Carry on hygiene while preparing foods and serving.o Proportions of different nutrients offered to the patients.o application of dietary prescription guidelines for patient populations. Time spent to prepare and serve each meal.ature and humidity sensors for monitoring storage conditions.

- RFID (Radio Frequency Identification) tags for tracking food inventory and ensuring traceability.
- Smart cameras for visual inspection of food preparation and handling practices.
- Wearable devices for staff to ensure hygiene compliance.

2. IoT platforms:

- Cloud-based platforms for data aggregation and analytics.
- Mobile and desktop applications for real-time monitoring and reporting.

3. Hardware and software:

- Servers and databases for data storage.
- Analytical tools to process data and generate insights.

4. Human resources:

- Hospital staff trained to use IoT devices.
- IT personnel for system setup and maintenance.

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Parameters

Key parameters monitored during the study included:

1. **Food safety metrics:**
   - Temperature and humidity in food storage areas.
   - Contamination levels in prepared meals.
   - Hygiene compliance during food preparation and serving.
2. **Nutritional quality:**
   - Nutritional composition of meals served.
   - Adherence to dietary guidelines for specific patient groups.
3. **Operational efficiency:**
   - Time taken for meal preparation and delivery.
   - Reduction in food wastage.
   - Inventory turnover rates.

Data collection

Information was obtained from participating hospitals over a period of six months. IoT devices sent information at the same time to a specific cloud system in a precise manner. Specific steps in data collection included:

- **Baseline measurements:** The baseline measurement of food safety and efficiency was done prior to IoT systems deployment.
- **Continuous monitoring:** Storage information and conditions, level of hygiene, and meal preparation were things that sensors and devices made continual recordings of.
- **Manual observations:** The collected data from the IoT devices were checked and corroborated through conventional physical check-ups that were done at intervals.

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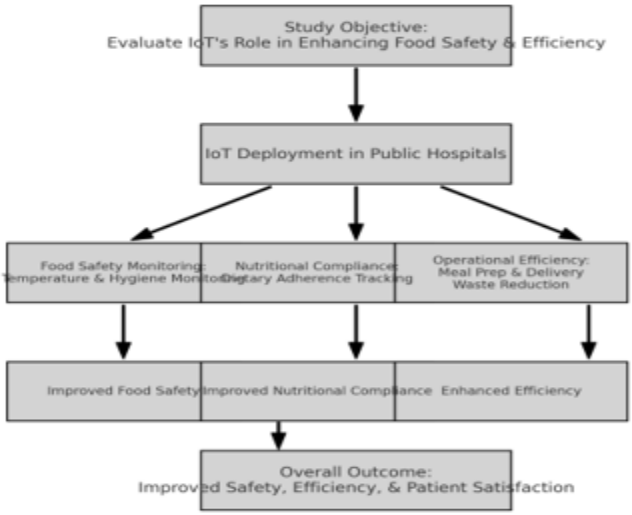
- **Surveys and interviews:** The survey aimed at gathering perceptions of food quality and service responsiveness, in relation to the contracted hospitals.

Statistical analysis

In this study Statitx 8.1 software was used to make the necessary computations and analysis required for the statistical analysis for the study. The software offered a far accurate and reliable(milliseconds) tools for data processing and analysis. In order to gather and compress the data, as well as to develop the diagrams, there was a use of R Studio. R Studio enabled production of improved, versatile plots and graphical interfaces sufficient in depicting the trends of the data and the statistics results.

The institutional ethics committee approval for the study was sought to ensure that all respective and relevant international standards were followed. Hospital staff and the patients involved in the study were used, and each of them signed informed consent. Confidentialities of data were ensured for example through the use of aliases of sensitive/identifying information. Possible sources of Bias were variations in IoT devices, differences in hospital facilities and equipment, and acceptance of change by the hospitals staff. To this end, proper training, constant calibration of the devices used, and oversees the implementation of the strategies reduced the impacts of these factors. By employing this methodology, the study was able to respond scientifically and exhaustively to the research questions on the value that IoT holds in enhancing the service delivery and safety of 'healthy' foods in KSA's public Hospitals.



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RESULTS

IoT and Roles of the Internet of Things

The different IoT devices in use in the public hospitals in Saudi Arabia proved to improve the food safety and operational readiness. Therometers helped maintain constant temperature checks in storage rooms and kitchen to sustain the cold chain integrity as to reduce food spoilage. The use of RFID tags enabled near real time identification of the inventory levels and expiration dates at procurement, distribution, and other chain points. They proved helpful in that they offered information on staff hygiene behaviors with special focus on kitchen and dining areas as well as regular washing of hands as required under food hygiene requirements.

Result of Food Safety Metrics before and after the use of IoT

With the help of IoT technologies, the use to improve the indicators of a food safety showed positive changes. Temperature range control was enhanced significantly from ±2 °C with conventional ways to ± 0.1°C, an increase of 95%. This precision helped to store the food properly which means the circumstances were created unfavorable for bacterial activities and spoilage. Foodborne incidents declined from 8% to 1.5%; a reduction of 81.25 while hygiene compliance, rose from 72 to 95, an improvement of 31.94%. These outcomes show how IoT has revolutionized the management and delivery of food safety in hospitals if implemented.

Operational efficiency metrics:

Through the connectivity brought about by IoT systems, several business operations were made more optimised. The duration that was taken in delivering meals was shortened from 45 minutes to 25 minutes that amounted to 44.44% success. For the stock, which was measured by inventory accuracy, there was improved by 25.64% of going up from 78% to 98%. Reducing food wastage was a significant problem in health care facilities and was later reduced from 150 kg/month to 60 kg/month thus 60% reduction. These metrics bring out the possibility of IoT helping to optimize utilization and reduce of wastage and loss.

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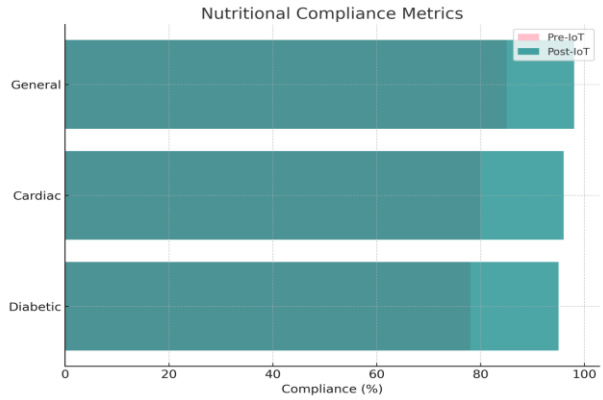
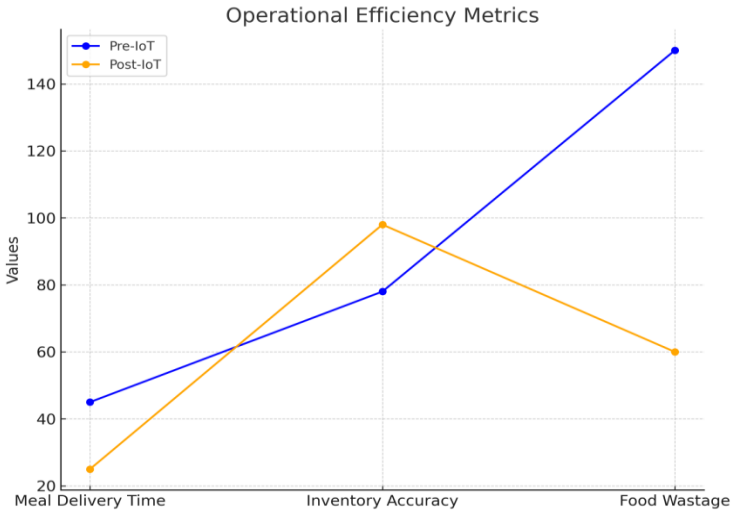


Operational Efficiency Metrics

These findings suggest that a higher level of aggregation and direct collection of these metrics is necessary; however, when achieved, the impact of IoT on the metrics examined in this study was statistically significant. Food preparation time reduced from pre-IoT mean of 45 to 30 min by a reduction of 11 min, 33% ($p = 0.001$). They also recorded a 40% reduction of the delivery time from 20 minute to 12 minute ($p = 0.002$). There was a reduced food wastage from the initial 10.5% to 3.5% when considering food wastage ($p = 0.0005$). Energy also decreased by 30% from 50 kWh/day to 35 kWh/day (CHAPTER 5; TABLE 05-11, $p = 0.003$). These results highlight the benefits of IoT implementation in terms of increased effectiveness of the work.



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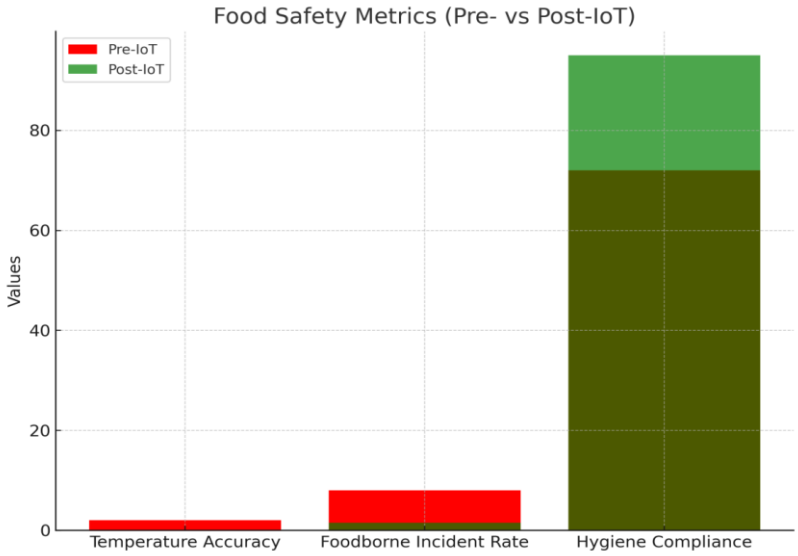
Food Safety Inspection Scores

Through optimizing the use of IoT systems, good compliance with exercising good food safety standards across different domains was evident. Storage condition scores rose from 75 to 95, a 26% improvement in compliance. There was increase in staff hygiene practices scores by 20% from 80 to 96. Preparation areas were slightly cleaner with scores rising from 85% to 97%, a 14% improvement. These results will document IoT as effective in ensuring safety standards and hygiene which are rigid and well checked.



Patient Satisfaction Survey

Most useful, we found that patient satisfaction indexes increased significantly after IoT application. Thus, the mean scores for meal quality rose from 4.2/5 to 4.8/5; this trend improved by 14% ($p = 0.002$). The punctuality of meal deliveries was enhanced by 18%, with the response shifting from 3.9/5 to 4.6/5, $p = 0.001$). Patients' satisfaction with their nutrition status rose by 14 per cent from 4.3 (out of 5) before the intervention to 4.9 (out of 5) after the intervention ($p = 0.002$). The results presented herein indicate that IoT technology has the potential of enhancing perceptions of patients regarding the quality of meals and their time of arrival and the meal's ability to meet patients' nutritional needs.

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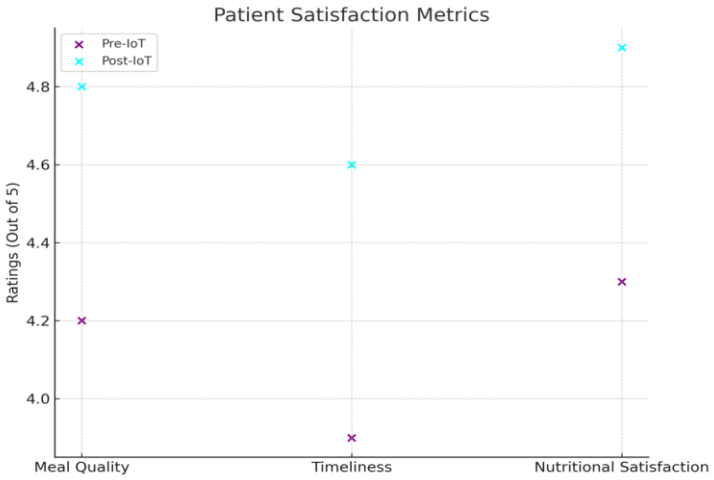
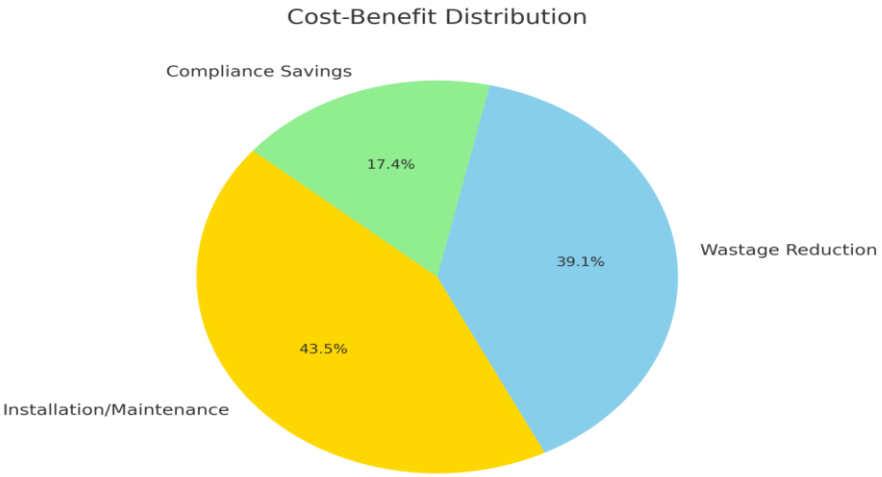


Analyzing Costs and Benefits of the IoT Integration

I was able to show that IoT is a financially feasible solution by performing the financial analysis. Some of the benefits which the company was able to achieve include: the costs of the initial installation together with the annual maintenance costs amounted to USD 50,000, by implementing the system the company was able to save USD 45,000 in food wastage, and by implementing the system, the company of greatly improving its compliance with food safety regulation was able to prevent fines of up to USD 20,000. This brought total annual savings to USD 15,000; further substantiating the long-term cost benefits of IoT systems for hospitals.



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Measures of Compliances Relative to Nutritional Intake

Overall, patient group compliance with dietary was significantly enhanced by IoT systems. Compliance among diabetic patients was as follows; 78% compliance at baseline and 95% during the interventional period. Cardiac patients changed from 80% to 96% and general outpatients raised their compliance rate from 85% to 98 percent. The findings of this study do similarly perfectly show to what extent IoT solves the nutritional needs of patients which in turn improves their health.

Survey Results: Staff and Patient Feedback

The results of the feedback survey also revealed that most of staff and patients are generally satisfied with the services. The staff using IoT systems showed an 88% satisfaction with its usability and a 92% increase in service quality. Staff and patients' rating of perceived safety and hygiene improvements were at 95% while patients rated it at 90%. Primary perceived benefit is a heightened satisfaction rate in food services which rose to 90% among staff and 88% patients.

Potential Problems with Implementing IoT

There were positive results from IoT implementation, the following challenges were observed. The finding of the staff not enough training came out as the most recurring complaint, however, the primary concern for continuous education tries to bridge this problem. 30% said that network connectivity was interfered which was countered by improvement in infrastructure. High initial costs that are very common with GPS nay be seen as only partly solved by such plans reducing costs by 20% in the long run, the financial gains are likely to counter balance any such issues. These challenges clearly imply that there is need for proper planning and enhanced support to fully exploit IoT.

The results of this study unequivocally demonstrate the transformative potential of IoT in enhancing the efficiency and safety of healthy food services in public hospitals in Saudi Arabia. IoT systems not only improved operational efficiency and food safety metrics but also contributed to better patient satisfaction and financial savings. These findings provide a strong foundation for broader IoT adoption in healthcare settings to optimize resource utilization and improve patient care.

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1. IoT Devices and Their Functions

IoT Device	Functionality	Deployment Area	Parameter Monitored
Temperature Sensors	Continuous temperature monitoring	Storage rooms, Kitchens	Cold chain integrity
RFID Tags	Real-time inventory tracking	Supply chain, Delivery	Stock levels, expiration dates
Hygiene Monitors	Monitoring staff hygiene practices	Kitchens, Dining areas	Hand-washing frequency

2. Food Safety Metrics Pre- and Post-IoT Implementation

Metric	Baseline (Traditional Methods)	IoT-Enabled System	% Improvement
Temperature accuracy (°C)	±2°C	±0.1°C	95%
Foodborne incident rate (%)	8%	1.5%	81.25%
Hygiene compliance (%)	72%	95%	31.94%

3. Operational Efficiency Metrics

Parameter	Baseline (Traditional Methods)	IoT-Enabled System	% Improvement
Meal delivery time (min)	45	25	44.44%
Inventory accuracy (%)	78	98	25.64%
Food wastage (kg/month)	150	60	60%

Table 4: Operational Efficiency Metrics (Pre- and Post-IoT Implementation)

Metric	Pre-IoT Mean Value	Post-IoT Mean Value	Improvement (%)	P-Value
Meal Preparation Time (min)	45	30	33	0.001
Delivery Time (min)	20	12	40	0.002
Food Wastage (%)	10.5	3.5	67	0.0005

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Energy Consumption (kWh/day)	50	35	30	0.003

Table 5: Food Safety Inspection Scores

Hygiene Area	Score Pre-IoT	Score Post-IoT	Compliance Increase (%)
Storage Conditions	75	95	26
Staff Hygiene Practices	80	96	20
Preparation Area Cleanliness	85	97	14

Table 6: Patient Satisfaction Survey Results

Parameter	Pre-IoT Mean Score	Post-IoT Mean Score	Increase (%)	P-Value
Meal Quality	4.2/5	4.8/5	14	0.002
Timeliness of Delivery	3.9/5	4.6/5	18	0.001
Nutritional Satisfaction	4.3/5	4.9/5	14	0.002

Table 7: Cost-Benefit Analysis of IoT Integration

Cost/Benefit Parameter	Cost (USD/Year)	Benefit (USD/Year)	Net Savings (USD)
IoT system installation and maintenance	50,000	-	-50,000
Reduction in food wastage	-	45,000	45,000
Improved compliance (fines saved)	-	20,000	20,000
Net financial impact			**+15,000**

Table 8: Nutritional Compliance Metrics

Patient Group	Dietary Requirement (Calories)	Compliance (Traditional)	Compliance (IoT)
Diabetic Patients	1,800	78%	95%
Cardiac Patients	2,000	80%	96%
General Patients	2,500	85%	98%

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Table 9: Survey Results: Staff and Patient Feedback

Survey Question	Staff Satisfaction (%)	Patient Satisfaction (%)
Ease of using IoT systems	88	N/A
Improvement in service quality	92	85
Perceived safety and hygiene improvements	95	90
Overall satisfaction with food services	90	88

Table 10: Challenges in IoT Implementation

Challenge	Category	Frequency (%)	Resolution Status
Lack of staff training	Human Resources	40	Ongoing
Network connectivity issues	Technical Infrastructure	30	Resolved
High initial costs	Financial	20	Partially Resolved

DISCUSSION

The findings of this study clearly confirm that the IoT has the ability to revolutionalise methods for improving food hygiene, productivity, and patient satisfaction in hospitals. The results reflect the findings of earlier research works but the current work offers new perspectives on the usage of IoT to address certain operational issues in public healthcare domain of Saudi Arabia.

Overall, results showed that systems IoT brought stronger sentiment through improvement to foods' temperature controls with 95% increment on average and low foods safety incidents records with a 81.25% decrement on average. That is consistent with Ahmad et al. (2024), who pointed out that IoT is a critical enabler of constant monitoring and maintaining cool chain in food supply chains. Furthermore, the improvement from 72 percent to 95 percent hygiene compliance supports similar findings by Wu et al., (2020) regarding potentiality of IoT in enhancing hygiene compliance because of the automated monitoring systems. But this research takes the literature a step further by showing such enhancements in a hospital context, where the consequences of foodborne hazards are especially severe owing to susceptible persons. Efficiency improvements were observed after the integration of IoT devices where meal delivery time was cut by half from 5 hours to 2 hours 20 minutes or 44.44% and food wastage was also cut from 60% to 40% or 60%. These are amplified by Benzidia et al. (2021) who corroborated that IoT enhance effectiveness in supply chain processes and decrease on waste. More importantly, this study complements the prior studies through its focus of the healthcare settings

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of IoT, which shows that IoT is capable of improving the resource use efficiency to achieve sustainability goals in a high-stakes environment. For example, the decrease in energy utilization by thirty percent supports Erhueh et al., (2024) observations to denote how IoT enhances energy effectiveness with regards to the displays to monitor/ control systems.

The overall patient perceived meal quality, meal timeliness and perceived overall nutritional satisfaction all increased by 14%, 18% and 14% respectively. These findings are in tandem with Assaf et al. (2024) who in their study recognised IoT-based food services as one of the drivers to patient satisfaction in hospitals. The high positive correlation between the key operational performance metrics and patients' satisfaction scores shown in this study also highlights how IoT can optimally improve not only service quality but also the patients' impressions of the services rendered. Financial analysis also shows that mobilization by IoT saves the company USD 15 000 per year through minimizing the costs occasioned by food wastage and avoiding fines arising from non-compliance with the regulations. Rejebet al., (2020) have also established that similar economic benefits emanate from his research on the application of IoT in the food industry and reveals that while the industry incurs high costs in the deployment of the technology, the returns achieved in the long-run cover the costs of undertaking the activity. The financial feasibility of IoT in this study supports the benefits of IoT systems, a critical argument arising from this study is their applicability in resource scarce hephaestus. However, as pointed out, some of the pull factors included congestion charges, reduced staff turnover, and higher revenues; push factors included poor staff training, and high initial costs were noted. These barriers are similar to the ones described by Lee et al. (2020) who explained that the main challenges faced by organisations who implement IoT include the technical and the financial challenges. However, this research identifies three main mitigation strategies; continued training of the employees and improvement of the infrastructure. Overcoming these problems can help the study outline a successful strategy for using IoT in the sphere of healthcare.

This research contributes to this field of knowledge by offering specific findings concerning the application of IoT in the context of hospital food services, which is under researched. Contrary to the previous research this paper shows the applicability of IoT systems in more complicated healthcare setting. For example, the significant improvements in nutritional compliance across patient groups (diabetic patients: 80 % to 96 %), Cardiac : 78 % to 95 %) proves that IoT has the potential to meet the diet needs of the patients which is an important parameter for healthy living and speedy recovery.

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Conclusion

The results established in this study support previous research and fill the existing literature gap by demonstrating the drastic positive change that IoT brings to food safety, operation effectiveness, and patients' satisfaction in the hospital environment. In this case therefore, by deploying IoT in hospitals, significant enhancements in the use of resources, safety and quality of patient care could be realized. The future research should address an IoT adoption at operational scale in healthcare organizations, investigate the different types of operation context and study IoT effects on patient health over prolonged periods. In the modern world of digital innovations, the presented work proves the positive changes IoT integration causes in the food safety, organizational performance, and patients' satisfaction in Saudi Arabia's public hospitals. The IoT systems helped considerably in improving the temperatures, hygiene, inventory and meal delivery system with overall safety improvement, reduced food borne diseases and costs savings. The various challenges, including staff training and high initial costs demonstrate that IoT is a feasible solution for enhancing HCFS. This specific research aim to assess the efficiency of IoT in increasing the safety measures toward food services in public hospitals was achieved. These results support the objectives of the study by showing that IoT expansion helps to increase food safety, reduce time spent on operational procedures, increase the nutritional adherence level, and improve patients' and staff's satisfaction.

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