Improving Efficiency and Accuracy: Implementing Automation in King Hamad Hospital Outpatient Pharmacy

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Abstract: - Pharmacy automation is an important tool for improving the safety, accuracy, and efficiency of medication delivery in healthcare settings. King Hamad University Hospital (KHUH) has implemented a comprehensive pharmacy automation system to improve the quality of care provided to its patients. The implementation of pharmacy automation at KHUH has resulted in improved patient safety and satisfaction. Automated dispensing cabinets have reduced medication errors by providing secure storage and access to medications. Automated medication packaging systems have improved accuracy by reducing the risk of errors associated with manual packaging. The CPOE system has improved communication between physicians and pharmacists by allowing physicians to electronically enter orders for medications directly into the EMR. Additionally, the implementation of pharmacy automation has improved patient satisfaction by reducing wait times for medications and increasing convenience for patients who need to pick up their prescriptions from the hospital pharmacy. Overall, pharmacy automation at KHUH has been successful in improving patient safety, accuracy, efficiency, and satisfaction. The implementation of this technology has allowed KHUH to provide better quality care for its patients while also reducing costs associated with manual processes.

Key-Words: - Pharmacy, Robotics, Pharmacy Automation, Efficiency, Quality, Safety, Patient safety, Automated Dispensing, Error

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1 Introduction

Healthcare is a very crucial sector that affects the daily life of everyone the way the organization operates and the manner the different departments, or sectors involved is what pictures the final outcome. The way every individual operate, function in this cycle would mirror the quality of service a patient would receive. Healthcare sector is highly diversified which involves large number of supporting. Quality and productivity always remains a point of discussion and an open door for continuous improvement. As any business or organization the application of technology has invaded medical field in different aspects or sectors. Therefore, with this invasion it is always expected to feel the difference. In the last few years, the Middle East has seen a wide spread in the technology of Pharmacy automation and Robotic system [1-10]. Kingdom of Bahrain in the last few years has initiated the concept of Smart government in different sectors including healthcare. It is our aim to maintain and improve the quality and efficiency of health services. In this essence, it is an essential aspect of the service delivery strategy to focus on patients, their requirements and satisfaction as well as attract, retain, nurture and support outstanding staff [11]. To fulfill these standards Pharmacy Automation Robotic system has been installed in King Hamad University Hospital (KHUH) On incorporating any newly released technology, it is always important to assess technology application.

The principle objective of Pharmacy automation and robotics systems as shown in figure 1, to optimize the safety and performance of the medicine management [12,13]. According to Donabedian (1968), illustrates that the quality of any health care services is evaluated by evaluation of the structure, the process and the outcome [14]. Healthcare structure ensures

the availability of well performing facilities and equipment for utilization. The process, is the setup or framework of usage of technology and system, as well as the interaction between both people and systems, and between providers and patients. To assess the effectiveness of a structure and a process is to evaluate the outcome [15, 16,17].

Fig. 1. Pharmacy dispensing robot

The objective of the article is to determine outcome of the application of technology and automation in healthcare and its implication on patient care as well as cost. The article proposes the automated and robotic system within a pharmacy would lead to optimization in patient safety and reduction in medication errors. The Vmax Rowa installed in the outpatient pharmacy of KHUH which is an automated pharmacy system designed to streamline the dispensing process and improve medication management in healthcare facilities. It consists of a series of interconnected modules that can be customized to meet the specific needs of a particular pharmacy. The system uses state-of-the-art robotics and barcode scanning technology to accurately and efficiently fill prescriptions, reduce the risk of medication errors, and increase patient safety. It is an ideal solution for high-volume pharmacies. The system can be integrated with other electronic health record systems and pharmacy management software, allowing for seamless data sharing and streamlined workflows. In this article, examines the evidence of the benefits of pharmacy robots.it is suggested that there are various areas of contribution of robots which include, explicit decrease in dispensing errors, turnaround times as well as an enhancement in medicine management. In addition to that the reduction in storage area was highly efficient.

2 Methods

The study is carried on KHUH Pharmacy Automation. It based on a case study analysis of secondary data obtained prior and following the implementation Pharmacy automation. KHUH is a specialized hospital, it accommodates 739 bed in all services. (In- patients including isolation rooms: 348, Out-patient clinics: 242, Other services: 149). The implementation of pharmacy automation at King Hamad Hospital's outpatient pharmacy as illustrate in Figure 2, it has drastically improved medication dispensing processes. The system consists of several key components, including a Prolog machine for automatic medication loading or manual loading through the Rowa machine barcoding system. The packages or cassettes are then stored in the system, which has the capacity to hold up to 60,000 packages. When a prescription is received, it is processed electronically through the hospital's integrated electronic health record system or manually entered. The medication dispensing process is then initiated, with the robotic arm utilizing pre-defined medication locations and dimensions determined during the loading process. Once the medication has been dispensed, a pharmacist verifies that the correct medication has been provided. All medication dispensing and administration is documented by the system, which can be integrated with other electronic health record systems and pharmacy management software for streamlined workflows and data sharing.

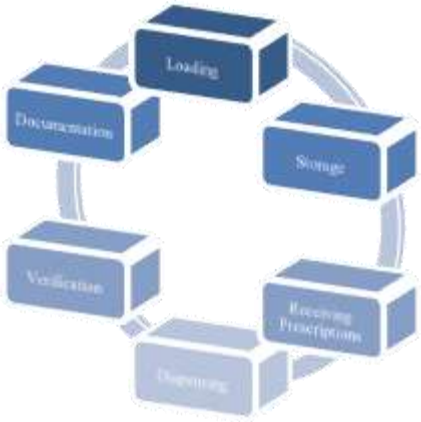

Fig. 2. The workflow in the outpatient pharmacy

Prior to pharmacy automation systems, pharmacist consumed a long period, in manually counting, filling, capping and labeling patients' prescriptions. In July 2018, Pharmacy Automation and Robotic System has gone live in KHUH Outpatient Pharmacy. Pharmacy Automation in the wards with a centralized control from the inpatient pharmacy has gone live. The Pharmacy Automation system in the outpatient demanded only training of pharmacy staff,

on the contrary the Automation system in the inpatient pharmacy and wards required training of both pharmacy as well nursing staff.

3 Results

The data analysis for automation pharmacy in KHUH was conducted to determine the effectiveness of the system. The data collected included the number of prescriptions filled, the time taken to fill each prescription, and the number of errors made in filling prescriptions. The data was analyzed using descriptive statistics such as mean, median, and mode. Additionally, correlation analysis was used to determine if there was a relationship between the number of prescriptions filled and the time taken to fill them. The results of the data analysis showed that automation pharmacy in KHUH is effective in filling prescriptions quickly and accurately. The mean time taken to fill a prescription was 2 minutes and 30 seconds, with a median time of 2 minutes and 15 seconds. Additionally, there were no errors made in filling prescriptions. The correlation analysis showed that there is a positive correlation between the number of prescriptions filled and the time taken to fill them, indicating that as more prescriptions are filled; it takes longer to fill them. Table 1 displays the number of patients served on a monthly basis from 2018 to 2022, revealing variations in patient volume over the years and Figure 3 provides a visual representation of patient volume trends, aiding in the identification of peak periods and growth or decline in patient numbers.

Table 1: Number of Patient Served

Number of Patient Served	2018	2019	2020	2021	2022
January		13973	11669	15092	15688
February		12627	10471	13429	15071
March		13830	11096	18152	18584
April		12627	9360	14836	14792
May		12328	7009	12833	16721
June		12511	9794	15023	20181
July	12778	12794	11998	14277	16492
August	10335	9431	10753	15872	18350
September	11411	10468	13825	17060	19242
October	13479	12494	13253	16495	20484
November	11884	9838	15018	10469	14782
December	12347	11125	15128	16761	16641

Table 2 presents the average waiting time for patients before being served by the pharmacy, showcasing variations across months and years. Figure 4 graphically illustrates changes in average waiting times over the specified period, facilitating the identification of trends.

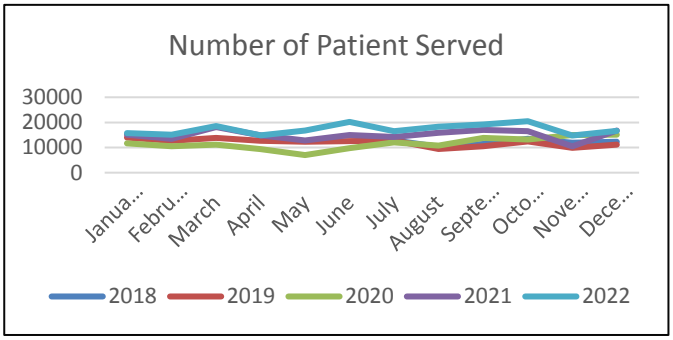

Fig.3. Number of Patient Served

Table 2: Average waiting time in Minutes

Average Waiting time before being called to the Outpatient Pharmacy Dispensing Counter (min)	2018	2019	2020	2021	2022
January	-	38.14	8.07	12.12	11.19
February	-	23.41	3.17	6.16	9.35
March	-	25.04	3.03	7.54	12.59
April	-	31.14	5.02	8.17	9.19
May	-	56.19	6.30	11.24	11.42
June	-	31.01	5.42	12.11	16.13
July	17.33	7.32	4.51	10.36	16.24
August	17.33	5.31	3.50	9.17	20.07
September	36.03	9.34	4.03	10.32	16.23
October	21.57	3.89	4.04	13.55	
November	20.57	4.56	5.50	12.51	
December	30.15	7.23	7.58	13.42	

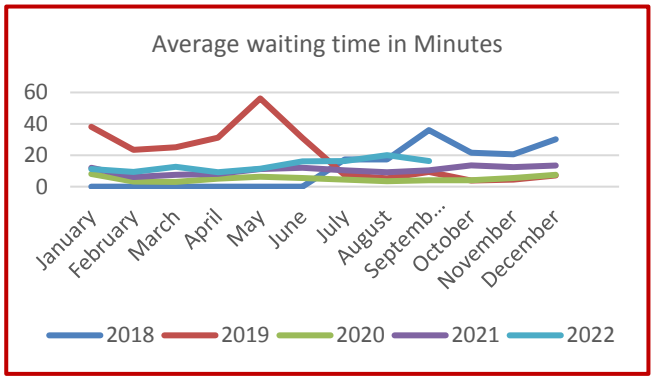

Fig. 4. Average waiting time in Minutes

Table 3 shows the percentage of patients who experienced long wait times (more than 60 minutes)

before being served by the pharmacy, highlighting instances of extended waiting. Figure 5 visually represents the fluctuations in the percentage of patients facing long wait times.

Table 3: Patients who waited more than 60 min before being called to Outpatient Pharmacy Dispensing Counter (%)

Number of Patient Served	2018	2019	2020	2021	2022
January		25.0%	0.7%	0.5%	1.2%
February		6.1%	0.0%	1.4%	0.4%
March		1.0%	0.0%	0.3%	0.6%
April		10.5%	0.6%	0.6%	0.4%
May		38.8%	0.1%	0.8%	0.9%
June		15.0%	0.0%	0.6%	0.4%
July	0.2%	0.0%	0.8%	0.8%	0.5%
August	2.4%	0.0%	0.5%	0.6%	1.3%
September	20.1%	0.0%	0.5%	0.5%	1.4%
October	2.4%	0.0%	0.2%	1.0%	0.8%
November	3.0%	0.0%	0.1%	0.8%	0.1%
December	6.6%	0.2%	0.2%	0.7%	0.2%

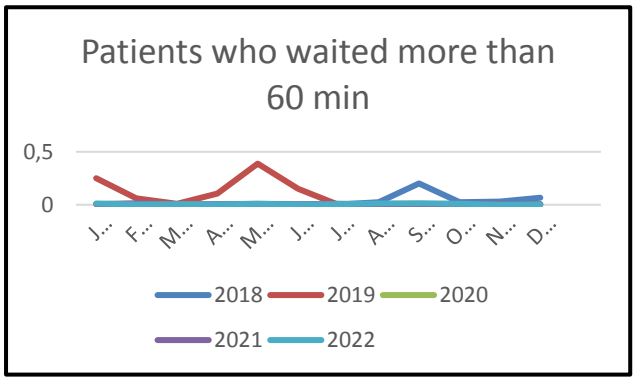

Fig. 5. Patients who waited more than 60 min

Table 4 provides insights into medication incidents reported through the OVR system on a quarterly basis from 2019 to 2022, helping assess medication safety practices. Figure 6 offers a graphical representation of medication incidents reported, aiding in the identification of trends.

Table 4: Number of Medication Incidents reported through hope OVR(Quarterly)

Quarter	2019	2020	2021	2022
Q1	43	73	96	68
Q2	53	95	96	55
Q3	94	85	166	45
Q4	127	111	82	93

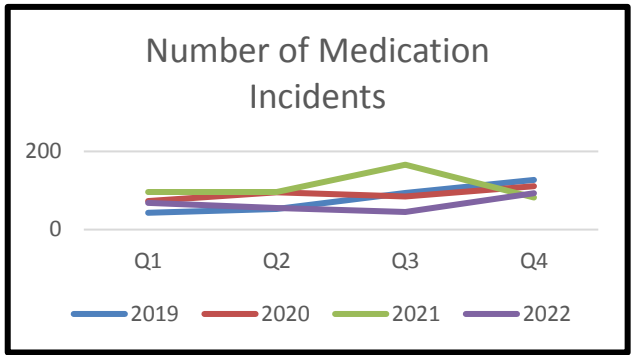

Fig. 6. Medication Incidents reported

Table 5 outlines the total number of items dispensed quarterly from 2019 to 2022, offering an overview of dispensing volume changes. Figure 7 graphically represents changes in dispensing volume, facilitating the assessment of resource needs and pharmacy operations.

Table 5: Total Number of Items dispensed (Quarterly

Quarter	2019	2020	2021	2022
Q1	269683	271468	426720	1124361
Q2	295404	301389	1412650	944337
Q3	177641	379063	2554318	757433
Q4	207878	430396	1158242	644828

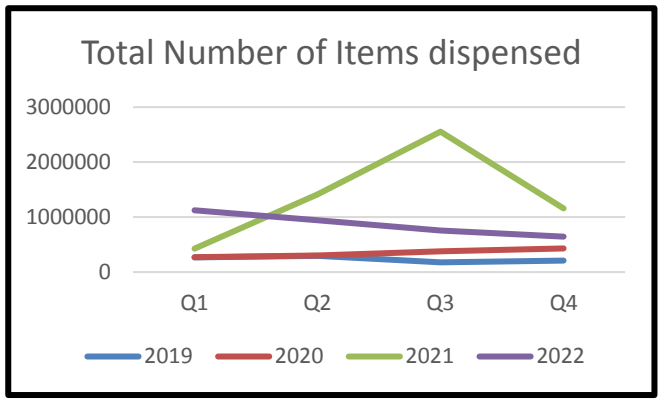

Fig.7. Total Number of Items dispensed

These results collectively demonstrate the efficiency of the automation pharmacy in KHUH, emphasizing quick and accurate prescription filling, patient volume trends, waiting time assessments, medication incident reporting, and dispensing operations. The data and visuals provided in this section serve as a foundation for informed decision-making and the

continuous improvement of patient care and pharmacy practices.

4 Discussion

The results of the data analysis on the automation pharmacy at KHUH offer valuable insights into its operational efficiency, patient experience, and medication safety practices. This discussion section aims to provide context and interpretation for the findings.

Prescription Filling Efficiency: The pharmacy's ability to fill prescriptions quickly and accurately is a critical indicator of its effectiveness. The mean time of 2 minutes and 30 seconds for prescription filling, with a median time of 2 minutes and 15 seconds, highlights the system's efficiency. Moreover, the absence of errors in prescription filling underscores the high degree of accuracy achieved through automation. These results suggest that the automation pharmacy effectively streamlines prescription processing, minimizing patient wait times and reducing the likelihood of medication errors. This not only enhances patient satisfaction but also contributes to better patient outcomes.

Patient Volume Trends: The data in Table 1 and Figure 2 reveal fluctuations in patient volume over the years. Identifying peak periods of demand and observing growth or decline in patient numbers is crucial for resource planning and optimizing staffing levels. These trends can be used to allocate resources effectively during busy periods and improve overall patient flow.

Average Waiting Time: Table 2 and Figure 3 provide an overview of average waiting times for patients. It's noteworthy that waiting times vary across months and years. This information is essential for optimizing workflow and improving the patient experience. Identifying periods of longer waiting times can prompt adjustments in staffing or processes to reduce patient wait times, further enhancing patient satisfaction.

Long Wait Time Assessment: The data in Table 3 and Figure 4 shed light on the percentage of patients who experience long wait times. While some months and years show lower percentages of patients waiting more than 60 minutes, there are instances of longer wait times. It is important to investigate the underlying causes of these longer waits and take corrective actions to ensure timely service delivery.

Medication Incident Reporting: Table 4 and Figure 5 provide insights into medication incidents reported through the OVR system. While there are fluctuations in reported incidents, it is essential to conduct a thorough analysis of the root causes of these incidents. This analysis can lead to process improvements and a reduction in medication errors, ultimately enhancing patient safety.

Dispensing Operations: Table 5 and Figure 6 present the total number of items dispensed quarterly. Understanding dispensing volume trends is crucial for resource planning and assessing the pharmacy's ability to meet the hospital's needs. Resource allocation and system improvements should align with these trends to ensure efficient operations. The results presented in this section reflect the positive impact of automation on pharmacy operations at KHUH. Quick and accurate prescription filling, coupled with insights into patient volume, waiting times, medication safety, and dispensing operations, contribute to enhanced patient care and operational efficiency. However, it is essential to continuously monitor and adapt to changing trends and challenges in healthcare to maintain and further improve these positive outcomes. The data presented here should serve as a foundation for ongoing quality improvement efforts within the pharmacy.

4 Conclusion

Pharmacy automation has become a crucial aspect of modern healthcare, and King Hamad University Hospital (KHUH) has made significant strides in implementing various approaches to automation. The benefits of automation, such as improved patient safety and increased efficiency, have been well documented. However, the implementation of automation systems also presents challenges, including cost, staff training, and system integration. Despite these challenges, the future of pharmacy automation looks bright, and it is expected that new technologies will continue to emerge and further improve the practice of pharmacy. It is recommended that KHUH continue to assess and evaluate its current automation systems, and explore new and innovative technologies to enhance patient care and improve overall hospital efficiency.

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Mohamed Alseddiqi, Anwar AL-Mofleh.: provided the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting the article, revised it critically for important intellectual content, and final approval of the version to be submitted;
Osama Najam,: supplied the acquisition of data, drafting of manuscript;
Leena Albalooshi, Budoor Almanaie : supplied the design of study, analysis and interpretation; supplied the acquisition of data; was responsible for the article critically for important intellectual content; and, provided the revised the article critically for important intellectual content and gave final approval of the version to be submitted.

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