The Role Of The Pharmacist In The Presence Of Modern Technology In Healthcare Facilities

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Abstract
Background: As like other medical fields, structural changes and technological developments are taking place in the field of Pharmacy also. Under the Saudi vision 2030 many of the policy related changes are taking place, some of these changes are related to technological upgradation of healthcare infrastructure. In relation to the continuous changes in the field of pharmacy, the patient and the pharmacist both are getting benefited but still there is a scope for change at the level of infrastructure, training and related aspects. This present study will evaluate the pros and cons of the technological upgradation, implementation and required changes. Study was conducted in Jeddah city of Saudi Arabia. Study Objectives: The study aims to determine the degree of technology adoption among Saudi healthcare institutions' pharmacists and the perceived influence of contemporary technology on pharmacy practice and patient outcomes.

a. Materials and Methods: Study is based on selected medical facilities in the city of Jeddah in Saudi Arabia, the respective sample of the study was 300 pharmacists from hospitals, clinical setting and some community pharmacists. Study includes Cross sectional study design and uses ANOVA (One way) as statistical tool. SPSS ver. 27.0 will be used to analyze the data.

Keywords: Modern technology, AI, Nanotechnology, Implementation of AI, health security**.**

BACKGROUND

Quick developments in information and communication technology are driving a significant digital revolution in the global healthcare system. Mobile health (mHealth), tele-health, health information technology, and customized medicine are all parts of digital health, which has enormous potential to improve healthcare services' quality, efficiency, and accessibility. **(Almontashiri et al 2024)** Digital health technologies have become more popular in Saudi Arabia in recent years, which is in line with the Kingdom's Vision 2030 objectives of diversifying the economy and enhancing healthcare.
Leading this digital revolution as important healthcare providers are pharmacies. The way pharmacies run and interact with patients is changing as a result of the integration of technologies like automated dispensing systems, electronic prescription, and medication monitoring apps. **(Fagihi et al 2024)** These technologies present chances to improve processes, lower pharmaceutical errors, offer individualized patient education, and remotely check on drug adherence. However, little is known about how these technologies actually affect patient outcomes and pharmacy services in Saudi Arabia. **(Nawees et al 2025)**
All over the world the healthcare sector is changing by leaps and bounds, even Saudi Arabia is not an exception to these changes. Coming under the vast umbrella of Saudi Vision 2030, Saudi Arabia is making large investments in the sector of healthcare and providing digital

health infrastructure is one of them. Under this various aspects are being covered like

improvement in service delivery, safety of the patients, improvement in logistics and operational efficiency. **(Kumar et al 2024)** On this shining road of evolution, the scope and role of pharmacist have become more vivid and vibrant. **(Lee et al 2022)** In the earlier times when pharmacist were stick to the medicinal aspects only, in the present times they are engaged in clinical decision making, educating patients and even participating actively in the other disciplines of healthcare. Such a change is crucial and very important for the overall development of the Saudi healthcare sector, thanks to the implementation and integration of modern technologies in the pharmacy related practices. **(Al-Mutairi et al 2025)**

The various technologies that incorporated in the pharmacy sector are like, introduction of Electronic Prescribing Systems (eRx), Automated Medicine Dispensing, use of Artificial Intelligence for interaction to drug alerts and even the automated or electronic management of inventory at clinical or hospital level. These platforms are becoming common in the present times and regularly used by the healthcare facilities in Saudi Arabia. **(Singh et al 2023)** The usage and application of such technologies and facilities is working seriously and effectively towards the streamlining of various operations related to pharmacy, increasing the level of precision in drug delivery and improving the overall quality of healthcare in the region. **(Ibrahim et al 2024)** Currently the pharmacist are expected to simplify the complex medicinal data, integrating with nurses and physicians in different departments and also making sure that the available technology is used in positive direction and with greater efficiency. **(Yamamoto et al 2021)**

All the refined technologies and innovations are available, but then again it is not an easy task to adopt and implement them in a hassle free manner. This is because of the reason that there is great variation in the available regions, in terms of infrastructure, access to professional training, tools to deal with the resistance for changes, and even the trained staff that can assist in complete integration of modern technology in pharmacy department. **(Al-Mansour et al 2022)** Then on the other hand, willpower to bring about the changes is not sufficient enough, there is a dire need to ensure that the pharmacist are well equipped to engage in the new system with great effectiveness and efficiency. **(Alghamdi et al 2023)** Healthcare modernization is one of the important aspects in the policy document of Saudi vision 2030 and gradually is becoming a national priority. Now there is a need to understand the barriers in the path of pharmacists, their perceived effectiveness of this new technology and even the ways & means to incorporate them in the right direction. **(Park et al 2021)** The incorporation of the new technology includes the ready state of the available workforce to their fullest, upgradation of the system to inculcate the changes in positive form. This present study is focused to evaluate the role of pharmacist in the new version of healthcare facilities, as the new technologies are emerging with a rapid pace in Saudi Arabia. **(Silva et al 2024); (Rahman et al 2022)** The study was conducted using a cross-sectional study design with an objective of find the extent of modern technology adoption, its impact on various pharmacy related practices, its role in patient outcomes and various challenges in the process. The respective findings of this present study will add value to the future policy formation and the planning of required infrastructure to support the digital transformation process of pharmacy professionals in Saudi Arabia.

LITERATURE REVIEW

Overall as a country Saudi Arabia has made a respective progress in the field of digital health transformation and the associated aspects of the same and all this has taken place in the recent past only. (**Kumar et al 2024); (Alqahtani et al 2023)** Major role was played by the the government agencies by framing futuristic policies, private sector by making huge investments and then the ever increasing consumer demand. The overall

incorporation of health information technology in the overall healthcare system is guided by the eHealth strategy started by the MoH, KSA. This was one initiative towards the conversion of existing healthcare system to digital healthcare system. **(Davis et al 2022)** The major aspects of this strategy were unified system of EHR, digital platforms for tele-medicine and starting of various mobile healthcare applications that are directly related to centralized database. **(Al-Mazroui et al 2021); (Torres et al 2024)** On the other hand pharmacist were motivated towards the learning and incorporation of modern day technology for the improvement in patient care and management of severe diseases. The emergence of COVID-19 pandemic has brought about major changes in the delivery of healthcare all over the world. **(Garcia et al 2025); (Alfifi et al 2025)** In Saudi Arabia also, the digital healthcare solutions were incorporated and the same are continuing in the present times as well. **(WHO 2021)** Here the role of pharmacist become more crucial in terms of medicinal aspects, patient care and even managing the system of remote healthcare. On an average, more than 70% of the world's population shifted to tele-medicines during the pandemic and most of them had continued using the system till present times, in such a scenario the role of pharmacist become even more important for the system of drug delivery, elongated patient care, etc. In the present times, it is of acute importance that the pharmacist learn about he modern day system of digital healthcare and contribute accordingly.

The digital healthcare system is still undergoing many of the rapid changes and these changes are widespread in terms of adoption and efficient usage of available health technologies.**(El-Masri et al 2023)** Then there are certain challenges and limitations to the system as well, like infrastructure of healthcare is still in the development phase, lack of coordination between the systems at operational level, then the issues of privacy and security are there and above all the low digital literacy plays the role of barrier. If these barrier are addressed with efficiency then the path for enhanced role of pharmacist in the healthcare system will certainly emerge as a major one.

As compared to the recent years the system of digital technologies in the pharmacy related practices has improved a lot in the last few years. The systems of electronic prescribing of medicines has gained popularity in the recent times, then the automated system of drug dispensing has added value to the pharmacy sector and has also reduced the margin of error in the same. The automated dispensing of medicines, which is a blend of integrated software and robotics, is becoming popular for its efficiency and accuracy. The level of precision in such a system is up to 96%. Such systems are really helping the pharmacist in saving there time and effort which can be used for other development related activities.

Research gaps

Some of the main research gaps identified by the above given literature review are as follows:

- Most of the studies have focused on the development part and minimum studies have given importance to limitations and shortcomings of system.
- Studies have significantly mentioned the need of coordination between the departments but not stated the issues that are responsible for delayed process.
- Lastly, only a few studies were conducted on primary data, i.e. most of the studies were available in the form of review studies.

This present study will attempt to fill these gaps by the way of a cross-sectional study conducted in selected area of Saudi Arabia.

Research Objectives

The study aims to determine the degree of technology adoption among Saudi healthcare institutions' pharmacists and the perceived influence of contemporary technology on pharmacy practice and patient outcomes.

Research Hypothesis

Hypothesis 1

H_0: There is a significant relationship between the integration of modern technology in Saudi healthcare facilities and enhanced clinical effectiveness of the pharmacists.

H_1: There is no significant relationship between the integration of modern technology in Saudi healthcare facilities and enhanced clinical effectiveness of the pharmacists.

RESEARCH METHODOLOGY

Research Design

As this present study is majorly inclined towards the inculcation of primary data, hence the respective research design is being used for the same i.e. the cross-sectional research design. Here the researcher will select a small segment of the given population at a given point of time and assess the collected data using tools of inferential statistics. Here it important to state that all the selected sample units must possess the same characteristics in terms of demographics. This study is based on the role assessment of pharmacist working in different capacities in various medical facilities in Jeddah, Saudi Arabia and the focus will be on including the perception and experiences of selected pharmacists.

Study Area and Population

The present study was conducted in Jeddah, Saudi Arabia where most of the public and private healthcare facilities were contacted, but majority of the urban facilities were included in the study. There are more than 3500 pharmacist working in the region mentioned above.

The target population of the study will include the following:

- Pharmacies in the hospitals
- Clinical pharmacy departments
- Community pharmacies, and
- Outpatient and ambulatory care units

Sampling

The researcher has included the stratified random sampling in the present study, the main reason to use this sampling method is that all the regions and types of medical facilities get included in the study. The total sample of the study was 300 pharmacist across the regions and medical facilities in Jeddah city of Saudi Arabia.

Tool of Data Collection

Data was collected by using a detailed structured questionnaire, that will include the following parts:

- Demographic details
- Level and type of technology used
- Impact of Technology on pharmacy practice
- Issue and Challenges

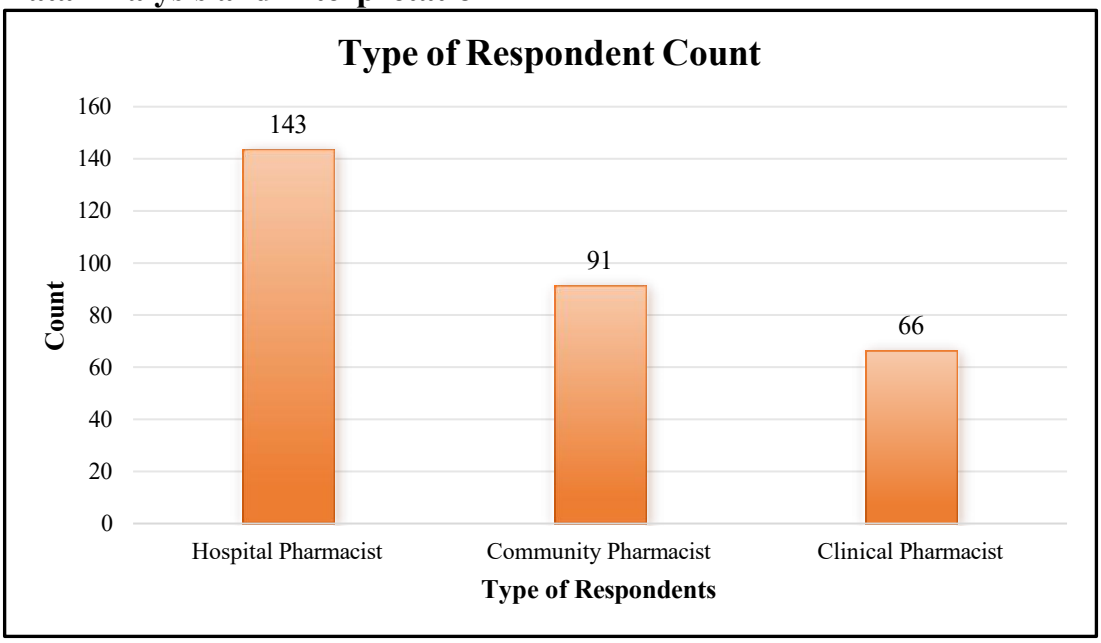
The questionnaire included the questions based on 5 point scale, multiple choice questions and some open ended questions. This questionnaire was exercised in a face to face interaction with the respondents, though in some of the cases the questionnaires were also mailed to the respondents and the responses collected thereof.

The data was collected in the duration of June 2025 to July 2025.

Statistical Analysis

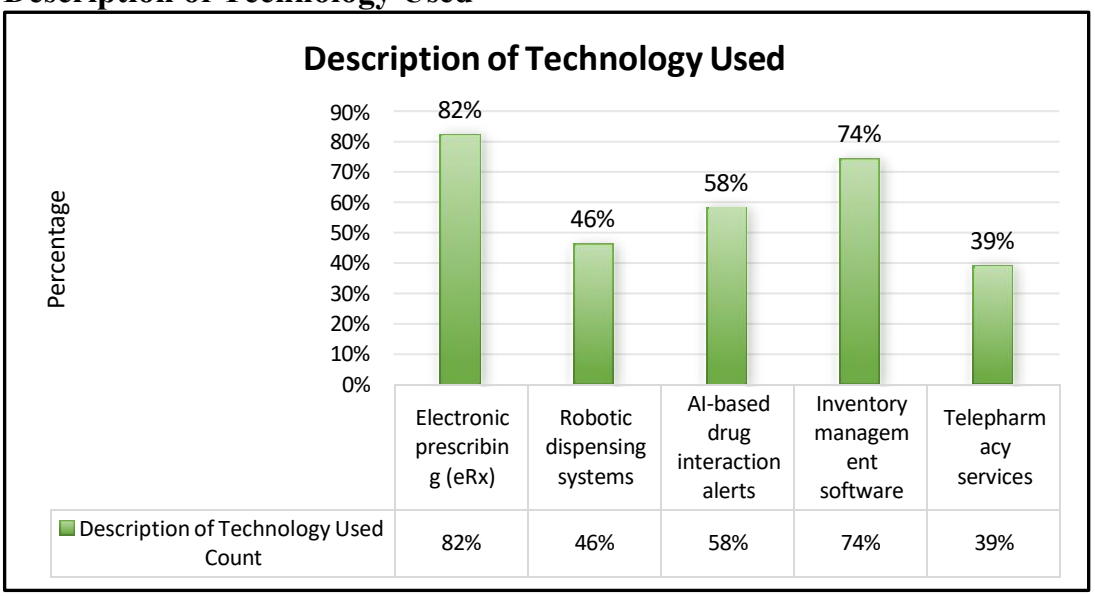
The data collected by the use of above questionnaire was analyzed using SPSS Ver. 27.0, where the major statistical tool of data analysis was ANOVA (One Way) test. This test was used so as to identify difference in the responses of sample units, this high or low difference in the opinion of the respondents will judge the acceptance or rejection of the hypothesis.

Data Analysis and Interpretation



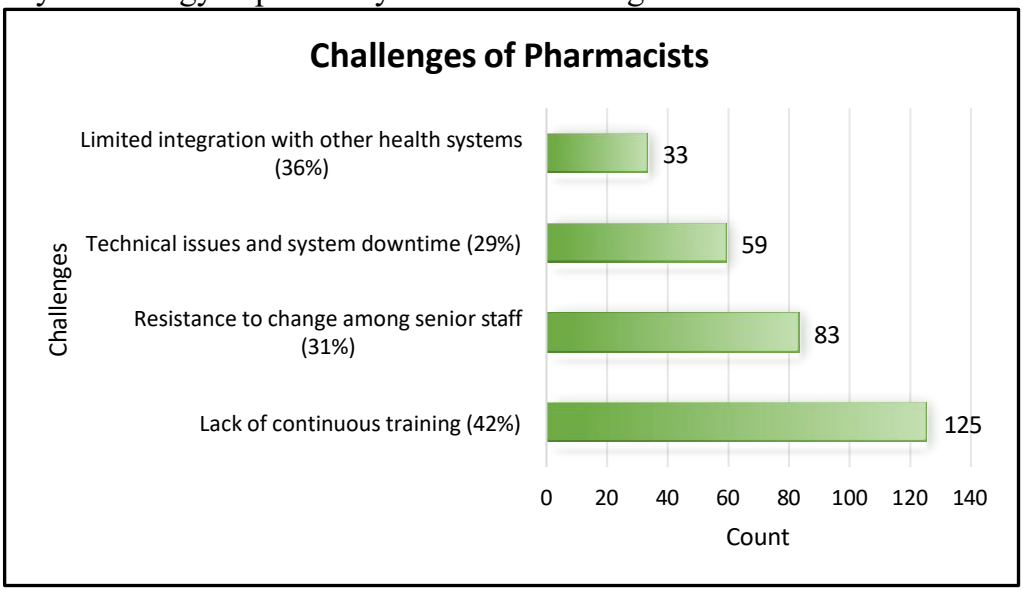
The above figure states the different types of respondents in medical facilities of Jeddah city. 47.7% of the respondents were hospital pharmacist, 30.3% of the pharmacist were community pharmacist and 22% of the respondents were clinical pharmacist. The total sample size was 300 respondents and most of them were from hospital background, this can be linked to the desired employment status of the respondents.

Description of Technology Used



The above chart states the most common type of technology used by the pharmacists, due to the limited space all the popular technologies are stated in the same chart for easier description. Electronic prescribing of medicine was the most common type of modern day technology used and the acquired percentage of the same was 82%, then at the second level, 74% of the respondents used the software for inventory management. 58% of the respondents have used AI based drug interaction alerts and 39% have used tele-pharma

services. This data is an indication that most of the pharmacist were aware of the modern day technology in pharmacy and have working hands on the same.



125 pharmacist stated that there is a dire need of training in the field of pharmacy, as because the technology is developing at double the pace and the time taken to understand the present technology is more. Hence the extended training programs and learning kits should be provided to the pharmacists. Then 83 respondents stated that, in some of the cases the senior level of pharmacists are resisting the changes as they are prone to the orthodox system, they use to work with, there is a need to change this system and motivate them for adopting new technology. Then some of the respondents stated that server errors, downtime and many other related components use to hold back the processing of technology. Minimum number of respondents were cautious about the integration of pharmacy with other departments, in terms of technology.

Test of Hypothesis

Researcher has applied ANOVA (One way) to evaluate the responses of the pharmacists. Here the main concern was to find out that if all the selected pharmacists were having similar opinion about the advent and spread of technology or there is any variation in the same. If there exist a variation then, what are the respective reasons and what are the remedies.

The researcher has chosen the following demographic aspects:

- Pharmacist's type (hospital, Community, Clinical, etc.)
- Age group of the respondents
- Level of formal training

Components tested were:

- Adaption of technology
- Perceived impact
- Challenges

Summary of ANOVA Test

		Type of Pharmacists		Age Group		Level of Training	
S.No.	**Variable**	**F Ratio**	**Sign. Value**	**F Ratio**	**Sign. Value**	**F Ratio**	**Sign. Value**
1	Electronic prescribing (eRx) has made the drug delivery easier	.485	.487	.183	.669	.422	.034
2	Automatic dispensing	.861	1.354	.663	1.416	1.162	.315

	system have reduced the downtime in drug delivery						
3	AI-based drug interaction alerts have decreased in margin of error	.652	1.105	.532	.767	1.016	.135
4	Inventory management software helped in arranging for the medicines in time	.663	.816	.236	.628	.010	.019
5	Tele-pharmacy services have brought the patients and pharmacists closer	.036	.850	.106	.745	.099	.018
6	Technology has promoted medication safety	.523	1.471	.177	.674	.052	.131
7	Workflow efficiency has improved	.046	.830	.495	.483	.159	.000
8	Patient counselling is being made easier	.195	.659	.025	.873	.614	.901
9	Precision level of inventory management has improved	.220	.640	.304	.582	.297	1.103
10	The level of training is not sufficient	.006	.938	.396	.530	.081	.280
11	Technological changes are resisted by the senior pharmacists	.346	.557	.955	.329	.549	.080
12	System downtime is required to be improved	.024	.877	.956	.329	.847	.430
13	Integration with other health system is required	.884	1.171	.229	.633	.686	.187

Interpretation

In case of ANOVA the thumb rule of acceptance of hypothesis is that if in all the cases significance value (Sign.) is more than the F (F Ratio) then the hypothesis is accepted or else rejected. In case of technology used by the pharmacist, in most of the cases the results are favorable except a few cases like for automatic dispensing under level of training, where the value of f ratio is 1.162 and Sign value is .315, then in the same section for AI based drug interaction alerts the F ratio is 1.016 and Sign. Value is .135. On the basis of age group of the respondents for work flow and efficiency the F ratio is .495 and sign. Value is .483, then in the same section for resistance for technological changes the F ratio was .995 and Sign value was .329, then for system downtime the F ratio was .956 and Sign. Value was .329. Then for the types of pharmacists in all the cases the results were found to be favorable.

As far as level of training is concerned, for electronic prescription the F ratio was .422 and Sign value was .034, then for automatic dispensing F ratio was 1.162 and Sign value was .315, then for AI based drug interaction the F ratio was 1.016 and Sign. Value was .135, then for tele-pharmacy services the F ratio was .099 and Sign value was .018. In case of workflow efficiency the F ratio was .159 and Sign value was .000. for rest of the cases the results were favorable.

RESULTS

The above given results of ANOVA test state that apart from some of the variation in different aspects, the results for almost all the sections were found to be favorable. The results also state that apart from the desired level of training the pharmacists were found to be satisfied with the present system. Hence the null hypothesis '*There is a significant relationship between the integration of modern technology in Saudi healthcare facilities and enhanced clinical effectiveness of the pharmacists.*' can be accepted and the alternate hypothesis is rejected.

CONCLUSION

Finally, this study shows that digital health technologies have a favorable effect on pharmacy services and patient involvement in Saudi Arabia. Better patient outcomes, drug safety, and adherence are linked to the use of electronic prescribing, automated dispensing, medication monitoring apps, and patient portals. For these technologies to reach their full potential, however, issues with compatibility, pricing, technical support, and digital literacy must be resolved. According to the study, encouraging patient usage of digital health solutions requires patient-centered design, intuitive user interfaces, and focused outreach. It also highlights the necessity of stakeholder collaboration in order to create standards, offer assistance and resources, and increase capacity for the use of digital health in pharmacy practice.

The results of this study can help guide evidence-based strategies and regulations to maximize the use of these technologies in improving patient care and pharmacy services as Saudi Arabia continues to invest in digital health as part of its Vision 2030 aspirations. Evaluating the sustainability and long-term effects of digital health interventions, creating customized solutions for various patient populations, and investigating the potential of cutting-edge technology in medication management should be the main goals of future study.

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