Research Article: Citation date: 2021/11/04

Investigating the Impact of Omni-Health Integration on Waiting Time in Healthcare Centers

Mohamed Adel Mahmoud Abdelmaged

ORCID

How to cite:

Abdelmaged, M. A. M. (2021). Investigating the Impact of Omni-Health Integration on Waiting Time in Health Care Centers. *ResearchBerg Review of Science and Technology*, *1*(1), 41–49.

Article history:

Received: 2021/09/15
Available online: 2021/11/04

Abstract

One of the most crucial steps in improving the patient experience is to reduce outpatient wait times. Patients wait for long periods of time for a physician to attend to them due to a lack of a functioning system. Health Care Centers can benefit from omni-health approach that enable patients to make payments and complete other necessary tasks before their visit to reduce patient wait time. This study aims to investigate whether the omni health approach can benefits in reducing the wait time of patients. The Random Forest Regression and and correlation analysis have been carried out. To remove biases, this study also included other factors such as number of office-staffs, number of physicians, number of equipment, and costs. The Random Forest Regression shows that the omni health integration is crucial to reduce the wait-time of the patients. However, the number of office-staffs, number of physicians, number of equipment are also important factors in reducing the wait time. The cost factor is found to be the least important factors in reducing the wait time. Our results suggest that that the health care center should increase the integration of omni- health approach to reduce the wait time and to improve the experience of health center clients.

Keywords: *Health care, Omni- health, Pearson correlation, Random forest, wait-time*

1. Introduction

Traditionally, hospital and health-care institutions competed primarily on the basis of service quality, treatment specialization, and the cost of care. Today, however, there is a tidal wave of change (Blakeney, 2015). While providing high-quality health treatment remains a priority, patients entering the hospital are also concerned about the whole experience they will have throughout their stay (Kiptoo, 2018).

The integration of an Omni health solution is required when mapping the patient experience with technology. Currently, service providers in all domains have no control over the communication route they use (Kronqvist and Leinonen, 2019); (Azoev, Sumarokova and Butkovskaya, 2019). Customers can contact their service operators via email, text, social networks, the web, and their mobile phones (Betcheva, Erhun and Jiang, 2019) (Shakyawar *et al.*, 2021). However, these channels frequently exist in silos, posing operational issues.

The amount of time a patient waits in the clinic before being seen by a member of the medical staff is referred to as waiting time. The length of time patients wait in clinics is an essential indicator of the hospital's service quality. One element that influences the use of healthcare services is the length of time a patient waits to be seen. Long wait times are seen by patients as a barrier to receiving services. Keeping patients waiting excessively can be stressful for both the patient and the physician (Shaheen, 2021c) (Shaheen, 2021a) (Shaheen, 2021b). Waiting time, more than knowledge or expertise, is a tangible part of practice that people will use to rate health professionals (Oche and Adamu, 2013).

Omni- health approach in healthcare system have the potential to not only relocate waiting time from uncomfortable waiting areas and waiting rooms to a more comfortable environment such as one's own home, but they may also aid in the reduction of waiting periods (Goiana-da-Silva *et al.*, 2019). The findings clearly illustrate that the Omni- health approach, which has influenced retailers is beginning to impact the healthcare sector as well. In the event of an unexpected delay, patients can be notified of the change in appointment through text or email, reducing wait time even further. This will also reduce the number of no-shows, which cost hospitals a lot of time and money.

2. Literature review

A study in China by (Xie and Or, 2017) looked at the relationships between real waiting time, perceived wait time acceptability, actual service time, perceived service time acceptability, actual visit duration, and patient satisfaction with care. Endocrinology outpatients attending a large teaching hospital in China were the subjects of a cross-sectional time study and questionnaire survey. Their findings demonstrate that real waiting time was negatively related to patient satisfaction with a variety of features of their care. Patients who were dissatisfied with the sociocultural environment and the identity-oriented approach to their care also rated the lengths of time they spent waiting and receiving care as unacceptably long. The study recommends that health-care providers be encouraged to continue to show empathy and respect for patients, that patients be given private areas where they can speak with health-care professionals without being overheard, and that hospital staff treat patients' family members or friends with respect.

The purpose of research by (Aburayya *et al.*, 2020) is to gain a deeper understanding of the problem and to offer appropriate recommendations for reducing WT. In health care service facilities that adopt a universal sample approach, an electronic medical record audit is used to tally the patients' WT throughout a four-week period. According to the survey, 45.2 percent of patients were registered within 7 minutes of arriving, and the average wait time was 11.7 minutes. While over two-thirds (75.3%) waited less than 30 minutes, the average consultation WT was 34.2 minutes. The average appointment wait time was 35 days, and 65.9% of patients waited fewer than 28 days for their visit. Employee data revealed that high workload levels, poor work procedures, employee-supervisor interface issues, and adequate facility availability were the main causes of patients' WT. Healthcare leaders and administrators in charge of this sector must work to lessen patient complaints while they wait and to handle the WT problem in a systematic manner.

(Alrasheedi *et al.*, 2019) looked into the relationship between wait times and patient satisfaction in a few basic health-care institutions in the Al Qassim region of Saudi Arabia. The response rate (n 14 620) was 72.94 percent. According to the report, 27.90 percent of participants said their wait time to see a doctor was between 21 and 30 minutes. Wait times for prescription dispensation, vital signs measurement, dental consultations, and radiological inspection were the top sources of dissatisfaction among patients. The study discovered a link between patient happiness and their education, marital status, and occupation. Patient satisfaction and age-group and literacy were found to have a significant regression relationship.

(Tran *et al.*, 2017) analyzed patient waiting time in the outpatient clinic at Viet Duc Hospital in Hanoi, Vietnam, so that stakeholders may better guide evidence-based initiatives to improve healthcare quality. From June 2014 to June 2015, a cross-sectional study was done at the outpatient clinic at Viet Duc Hospital. Waiting time was taken from Hospital Management software and stratified by years (2014 and 2015), months of the year, weekdays, and hours of the day. A total of 137,881 patients took part in the research. In 2014, the average time from registration to preliminary diagnosis was 50.41 minutes, and 42.05 minutes in 2015. Early in the morning and among individuals with health insurance, there was a greater wait time. Their findings showed that, despite a decrease in waiting time from 2014 to 2015, people with health insurance had significantly longer wait times than their non-insured peers. The findings imply that outpatient clinics should concentrate human resource promotion and distribution, and health insurance-related administrative procedures should be streamlined.

3. Problem statement and objectives of the research

Problem statement: Long wait times have been shown in studies to reduce results and lower patient satisfaction levels. Previous research suggested that customer unhappiness could lead to a loss of long-term earnings due to lower customer retention, fewer repeat visits, and the transmission of displeasure with the company to others (Alrasheedi *et al.*, 2019). As a result, the value of shorter wait times is clear, and it should be a strategic focus for every healthcare company.

Objectives of this study: The central objective of this study is to investigate the if omni- health integration in healthcare service can reduce wait time and increase the service pace.

4. Methodology

We applied Random forest regression and Pearson correlation to investigate whether the integration of omni- health can boost the speed of service in different healthcare centers.

i) Random Forest

The random forest algorithm is composed of a group of decision trees, and each tree in the ensemble is made up of a bootstrap sample, which is a data sample obtained from a training set with replacement. One-third of the training sample is set aside as test data, referred to as the out-of-bag (oob) sample. Using feature bagging, another instance of randomness is injected into the dataset, increasing the dataset's variety and decreasing the correlation between decision trees. The prediction will be determined differently depending on the type of difficulty. Individual decision trees will be averaged in a regression task, and a majority vote—i.e. the most frequent categorical variable—will produce the predicted class in a classification task. Finally, the OOB sample is used for cross-validation, bringing the prediction to a conclusion.

The three primary hyperparameters of random forest algorithms must be established before training. The size of the nodes, the number of trees, and the number of characteristics sampled are all factors to consider. The random forest classifier can then be used to tackle problems involving regression or classification.

When employed for classification or regression tasks, the random forest approach has a number of major advantages. First, the overfitting risk is reduced. Decision trees are prone to overfitting because they tend to tightly fit all samples within training data. When a random forest has a large number of decision trees, the classifier will not overfit the model since the averaging of uncorrelated trees reduces overall variance and prediction error. Random forest is a popular method among data scientists because it can handle both regression and classification jobs with a high degree of accuracy. The random forest classifier is especially useful for estimating missing values because it retains accuracy even when a portion of the data is missing thanks to feature bagging.

Second, it is easy to assess feature importance: Random forest makes assessing variable relevance, or contribution to the model, a breeze. There are a few methods for determining the relevance of a feature. When a variable is removed from a model, the Gini importance and mean decline in impurity (MDI) are commonly used to determine how much the model's accuracy falls. Another important metric is permutation importance, often known as mean decrease accuracy (MDA). By randomly permuting the feature values in OOB samples, MDA detects the average loss in accuracy.

ii) Correlation analysis

Pearson Correlation is a method for determining the linear relationship between two variables.

$$Correlation(X,Y) = r_{XY} = \frac{Cov_{XY}}{S_X S_Y} = \frac{\frac{\sum(X-\overline{X})(Y-\overline{Y})}{(N-1)}}{S_X S_Y} = \frac{\sum(X-\overline{X})(Y-\overline{Y})}{S_X S_Y} \times \frac{1}{N-1}$$

Where, X, and Y are two continuous variables. N represents the number of instances.

The data sample were collected from different healthcare centers. But there are other factors that might affect the speed of service in the healthcare. The omission of these factors can lead to the biased results. Therefore, this study includes the other factors to in order to achieve unbiased results. The data for the variables are collected online from Department of Health and Community Services, Newfoundland and Labrador, Canada.

The list of other factors and omni along with descriptions, role, and purposes are reported in the table 1.

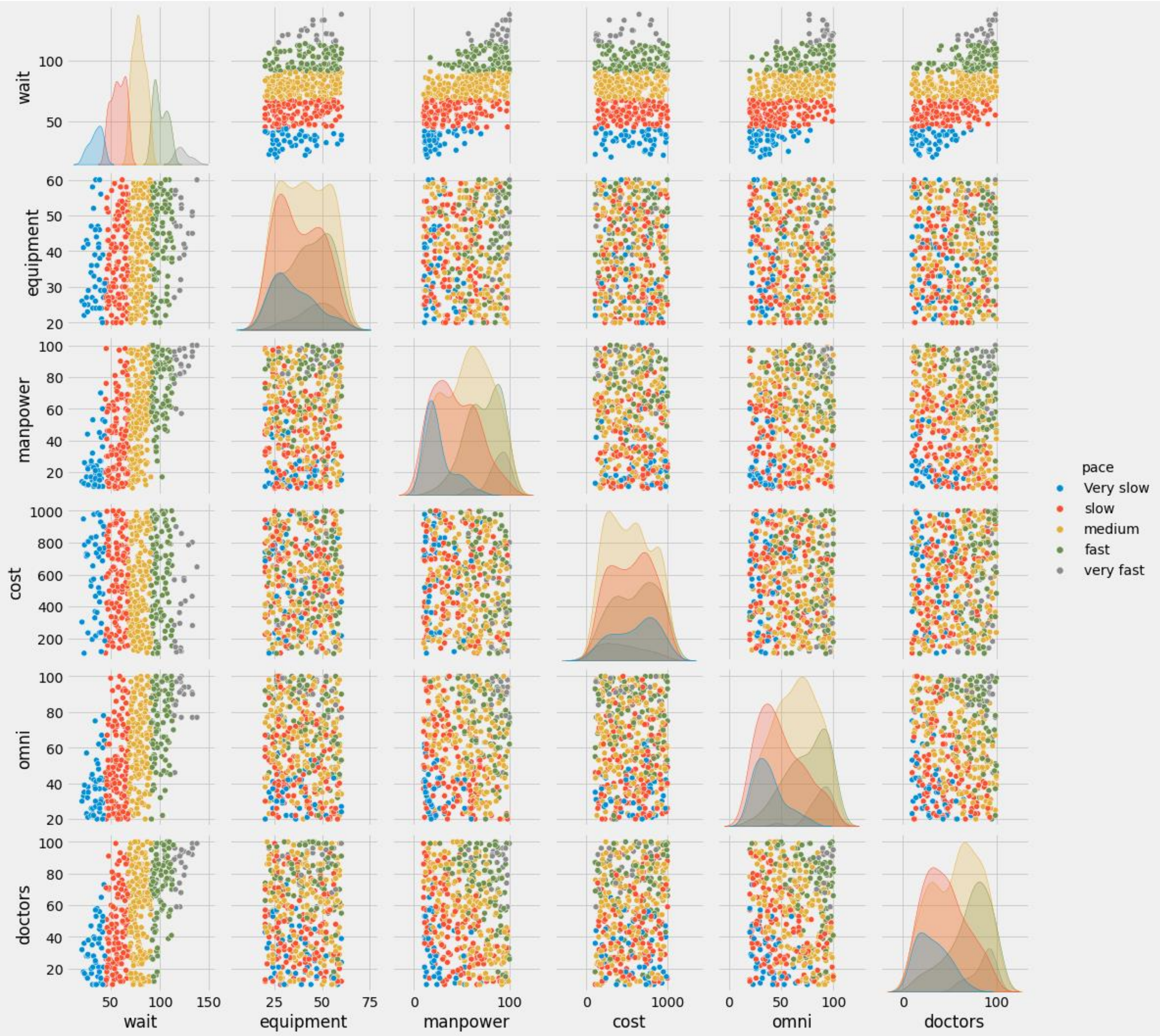
Table 1. descriptions of outcome and feature variables.

Variables	Definition	Calculation	Role in the model	Purpose
Service Pace Index	Indicates how fast The health care centers provide their services to clients	The index ranges from 0 to 100. The values close to zero suggest slower pace of service. The values. The values are calculated by the authors with the negative of Average Wait Time (AWT)	Target/Dependent variable	To check the level quickness in providing services considering the different features.
Equipment	Indicates the number of well functioning equipment present in a health center	Continuous data type	Feature/Independent variable	To check inf the number of equipment has relationship with the service speed in a health center.
Manpower	Indicates the number of staffs and communicating personnel in the healthcare centers	Continuous data type	Feature/Independent variable	To check inf the number of staffs in the health centers has relationship with the service speed in a health center.
Doctors	Indicates the number of doctors and in the healthcare centers	Continuous data type	Feature/Independent variable	To check inf the number of doctors in the health centers has relationship with the service speed in a health center.
Cost	This include fees and other associated cost after the arrival to the healthcare	Continuous data type	Feature/Independent variable	To check inf the quantity of costs in the health centers has relationship with the service speed in a health center.
Omni	Indicates the degree to which a health care center provides it services using omni health approach	The index ranges from 0 to 100. The values close to zero suggest low degree of Omni-health integration; and value closer to 100 indicates high level of Omni channel integration	Feature/Independent variable	To check inf the degree of Omni-health integration in the health centers has relationship with the service speed in a health center.

5. Results

This study begins by displaying the pairplots among the variables. The pairplots are drawn with hue= level of speed in service. The blue dots indicate very slow pace and the grey dots indicate fast pace. Looking at the different pair, we can see that the blue dots are at the origin of plots. This indicate that the speed of service is slow if number of equipment, doctors and staffs are low. Most importantly, the speed of service is slow if the score of omni- health approach is low.

Figure 1. Pairplots among the variables.



This study achieved a good accuracy score of 94.56 percent. According to random forest results, the most important factor for quick service is the number of staffs. The second most important factor is the number of physicians. The third and fourth important factors are the Omni- health and and equipment, respectively. The results show that the least important factor is the cost. These results are reported in table 2. The graphical presentation of the variable importance are shown in figure 2.

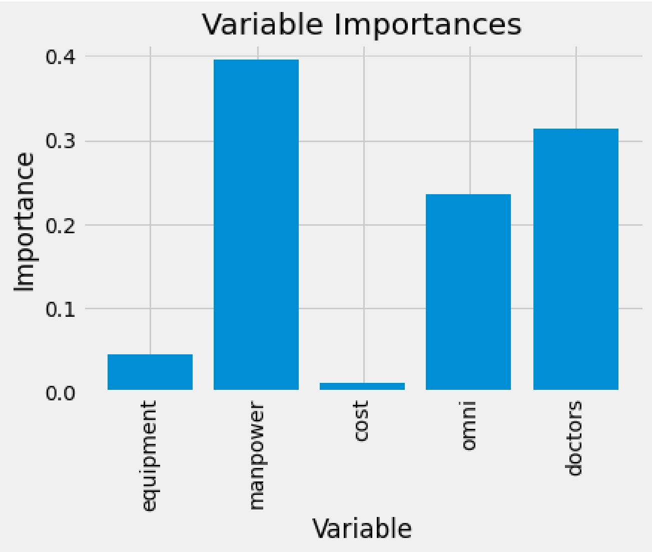
Table 2. MAE, accuracy score and feature importance in Random Forest Regression

```
Mean Absolute Error: 4.01 degrees.
```

```
Accuracy: 94.56 %.
```

```
Variable: manpower             Importance: 0.40
Variable: doctors              Importance: 0.31
Variable: omni                 Importance: 0.24
Variable: equipment            Importance: 0.04
Variable: cost                 Importance: 0.01
```

Figure 2. Importance of the variables.



This study also performed a correlation study. The correlation between the target variable pace and the features variables are presented in bold in the table 3. The results reveal that the correlation between pace/speed and other features are positive and significant, except for the feature, cost. This means, except cost, the relationship between speed of service and the other features are positive and significant.

Table 3. Correlation results

Sample: 1 480
Included observations: 480

		Correlation	t-Statistic	Probability
Pace	Pace	1.000000	-----	-----
Doctors	**Pace**	**0.528610**	**13.61479**	**0.0000**
Doctors	Doctors	1.000000	-----	-----
Equipment	Pace	0.538716	13.98012	0.0000

Equipment	Doctors	-0.029036	-0.635093	0.5257
Equipment	Equipment	1.000000	-----	-----
Cost	**Pace**	**-0.017781**	**-0.388803**	**0.6976**
Cost	Doctors	0.115467	2.541468	0.0114
Cost	Equipment	-0.039900	-0.873041	0.3831
Cost	Fees	1.000000	-----	-----
Manpower	**Pace**	**0.600973**	**16.43903**	**0.0000**
Manpower	Doctors	-0.064247	-1.407563	0.1599
Manpower	Equipment	0.091418	2.007092	0.0453
Manpower	Fees	-0.077950	-1.709444	0.0880
Manpower	Manpower	1.000000	-----	-----
Omni	**Pace**	**0.262808**	**5.955159**	**0.0000**
Omni	Doctors	0.017948	0.392474	0.6949
Omni	Equipment	-0.055890	-1.223858	0.2216
Omni	Fees	-0.072760	-1.594998	0.1114
Omni	Manpower	0.039131	0.856180	0.3923
Omni	Omni	1.000000	-----	-----

5. Conclusion

Patients spend a significant amount of time in clinics waiting for physicians and other health practitioners to provide services. Clinic wait times must be efficiently managed by healthcare companies that aspire to provide great services. Patient and provider displeasure may result if consumer-driven features are not incorporated into the design of the wait experience. The omni-health strategy, which incorporates both physical and digital channels, can aid healthcare professionals in reorganizing workflow frameworks for triage nurses, physical patient visits, patient-related back office duties, and case management involving patient contact. This method is effective for automating various workflow frameworks and treats the patient as an active participant. As a result, there is fewer paperwork, manual activities, and manual resource allocation, resulting in higher utilization efficiency and shorter patient wait times.

References

Aburayya, A. *et al.* (2020) ‘An investigation of factors affecting patients waiting time in primary health care centers: An assessment study in Dubai’, *Management Science Letters*, 10(6), pp. 1265–1276.

Alrasheedi, K. F. *et al.* (2019) ‘The association between wait times and patient satisfaction: findings from primary health centers in the Kingdom of Saudi Arabia’, *Health services research and managerial epidemiology*, 6, p. 2333392819861246.

Azoev, G., Sumarokova, E. and Butkovskaya, G. (2019) ‘Marketing communications integration in healthcare industry: digitalization and omnichannel technologies’, in *International Scientific and Practical Conference on Digital Economy (ISCDE 2019)*. Atlantis Press, pp. 635–640.

Betcheva, L., Erhun, F. and Jiang, H. (2019) ‘Healthcare supply chains’, in *The Oxford Handbook of Supply Chain Management*.

Blakeney, J. (2015) ‘What are the benefits of creating an omnichannel brand experience?’, *Journal of*

Brand Strategy, 5(1), pp. 57–66.

Goiana-da-Silva, F. *et al.* (2019) 'Disrupting the landscape: how the Portuguese National Health Service built an omnichannel communication platform', *Public health panorama*, 5(2–3), pp. 314–323.

Kiptoo, H. K. (2018) 'A Service Oriented Architecture Approach to Implementing an Omnichannel Personal Health Record System'. University of Nairobi.

Kronqvist, J. and Leinonen, T. (2019) 'Redefining touchpoints: an integrated approach for implementing omnichannel service concepts', in *Service design and service thinking in healthcare and hospital management*. Springer, pp. 279–288.

Oche, M. O. and Adamu, H. (2013) 'Determinants of patient waiting time in the general outpatient department of a tertiary health institution in North Western Nigeria', *Annals of medical and health sciences research*, 3(4), pp. 588–592.

Shaheen, M. Y. (2021a) 'Adoption of machine learning for medical diagnosis'.

Shaheen, M. Y. (2021b) 'AI in Healthcare: medical and socio-economic benefits and challenges'.

Shaheen, M. Y. (2021c) 'Applications of Artificial Intelligence (AI) in healthcare: A review'.

Shakyawar, S. K. *et al.* (2021) 'Big Data Analytics for Modeling COVID-19 and Comorbidities: An Unmet Need BT - Computational Intelligence Techniques for Combating COVID-19', in Kautish, S., Peng, S.-L., and Obaid, A. J. (eds). Cham: Springer International Publishing, pp. 185–201. doi: 10.1007/978-3-030-68936-0_10.

Tran, T. D. *et al.* (2017) 'Patient waiting time in the outpatient clinic at a central surgical hospital of Vietnam: Implications for resource allocation', *F1000Research*, 6.

Xie, Z. and Or, C. (2017) 'Associations between waiting times, service times, and patient satisfaction in an endocrinology outpatient department: a time study and questionnaire survey', *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*, 54, p. 0046958017739527.