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Research paper

Reduction of Patient Wait Time at a Multi-Specialty Hospital using DMAIC Methodology and Factor Analysis

BP Mahesh[1], Bhimasen Soragaon[2], Anandkumar R Annigeri[3]

[1,2,,]*Professor, Department of Mechanical Engineering, JSS Academy of Technical Education, Bengaluru, India*

Abstract

In medicine, cardiology is a very crucial specialization, as sometimes sudden deaths occur if there is no periodic check performed. Cardiology deals with disorder of hearts including the circulatory system. Physicians specialized in cardiology are cardiologists, and pediatricians specialized in cardiology are Pediatric cardiologists. In this paper, cardiology department concerning with adult patients is considered for the study; the out-patient section is taken up in specific. It is noticed that the patient wait time at the cardiology department of a small private hospital in Bangalore city, India, is very high; sometimes the wait time is almost about one hour. The patient wait time data has been collected; statistical analysis has been carried out; brainstorming and cause and effect diagram have been constructed to determine sub-causes and root causes of longer patient wait time. Also, a new schedule for treating cardiac patients has been developed to reduce the wait time.

Keywords: *cardiology, patient wait time, factor analysis, DMAIC methodology*.

1. Introduction

The wait time of a patient at Out-Patient Department (OPD) can be described as the time duration between the patients entering the OPD (after registration) till he meets the doctor for consultation. Many of the health care centers find the patient wait time as a very serious issue and constantly channelize efforts to reduce it. This is actually a barrier to efficient flow of patients. Most of the time, patients become frustrated and look for alternate health centers. Especially, in Bangalore city, there are numerous health centres specialized in cardiology, and offering world class service to patients.

In such a competitive scenario, any hospital has to strive hard to retain the patients and offer excellent service not only in terms of cardiac care but also in easy registration process, taking doctor's appointment, meeting the doctor, laboratory tests and procedures, billing and revisits. Patient satisfaction and revisit become very vital in building brand for any hospital. Some of the variables largely affect the patient satisfaction / dissatisfaction; a few important ones are service of the consultant at the OPD, seating arrangement, wait time, receiving staff and their concern and behavior towards the patients, appointment system, ease of billing, procedure for revisit and facilities such as water, washrooms, check of body vitals. Many health systems provide greater importance to the consulting services of health care at the OPD and ignore auxiliary services at the OPD. As a matter of fact, even auxiliary services add to patient satisfaction and revisit. In any health centre set up, there are many specialized clinics wherein the patients find it difficult to wait for longer times at the OPD, leading to patient dissatisfaction. A private hospital in Bangalore city has one of its super specialty departments as Cardiology and the OPD patient wait time is much longer at this department. Therefore, cardiology OPD has been selected for study.

2. Literature Review

According to Bergenmar [1], waiting time can be described as time duration that is evaluated for the quality of service one receives with respect to individual's expectations. In this paper, patient waiting time was described as an algebraic sum of all section waiting times. Patients spend a substantial amount of time in health centers waiting for consultation from the doctors and health professionals.

Delayed access to health care is assumed to negatively affect health outcomes due to delays in diagnosis and treatment [2] plus unforeseen cost implications on the patients and public health system [3]. One index in healthcare delivery by which the quality of service provided to patients can be evaluated is the uninterrupted movement of patients, known as patient flow. Patient flow, similar to a product flow in the production department, is the capability of the hospital to serve patients quickly and efficiently so that there is very little wait time between sections or stages. Obstruction in the flow of patients can actually amplify waiting, thus having an impact of health care outcomes [4]. This is, however, not the case in most developing countries, as several studies have shown that patients spend about 2 hours in the outpatient departments before seeing the doctor.

A study was conducted at the OPDs in Mulago hospital and it was established that the patient satisfaction is closely related to their contentment with waiting time [5]. Reducing OPD waiting times has been the focus of a great number of studies as waiting and treatment times are usually regarded as performance indicators of service. However, regardless of the affirmed significance of ensuring apt access to care, little research has, in reality, calculated how long patients wait and also inspected any observed relations with patient wait time at OPD [6].

Consultation length often varies from one country to another and is determined by both patient's and doctor's characteristics. Studies from abroad have shown that the average consultation time in a

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primary care setting ranges between 10 to 15 minutes [7]. In general, studies have shown that patients prefer longer consultations [8]. Doctors with longer consultations tend to prescribe less and offer more advice on lifestyle and other health-promoting activities. Consultation time increases to nearly twice as long when doctors explore psychosocial issues and this is associated with better recognition and handling of psychosocial problems.

Factor Analysis is a technique for modeling experiential variables, and their covariance arrangement, in provisions of a lesser number of fundamental unobservable (latent) "factors" [9]. The factors characteristically are viewed as wide concepts or ideas that may explain an observed phenomenon [10]. Factor analysis is normally an investigative/descriptive method that necessitates many subjective decisions. It is an extensively used tool and often contentious as the models, methods, and prejudice are so flexible that deliberates about interpretations can occur.

Factor Analysis can be classified into two types: Principal component analysis and Common factor analysis. Principal component analysis - this technique provides an exclusive solution, so that the new data can be restructured from the results. It looks at the whole variance among the variables, so the answer generated will consist of as many factors due to many variables present, although it is improbable that they will all convene the criteria for maintenance.

Common factor analysis – Here, the number of factors will for all time be fewer than the number of novel variables. So, choosing the number of factors to maintain for additional analysis is more difficult using common factor analysis compared to principal components. This will assist in identifying the number of variables that are connected.

3. Problem background

In this study, a super specialty hospital in Bangalore city, India, was considered for obtaining the data on patient wait time. The patient wait time was ranging from 45 minutes to 2 hours at the cardiology OPD (as opined by the patients at that hospital). Patient wait time was very high and needed techniques and methodologies to reduce it incessantly. Various methods and techniques are available for wait time reduction and Six Sigma Methodology [11] has been found closely appropriate for this study. Hence, Six Sigma Methodology (DMAIC) has been employed.

4. Six sigma methodology

It is a data-driven quality strategy for continually improving processes. Six Sigma has two key methodologies − DMAIC (Define, Measure, Analyze, Improve and Control) and DMADV (Define, Measure, Analyze, Design and Verify) [12]. This paper uses DMAIC approach to reduce the patient wait time at the cardiology OPD.

4.1 Define

This is the first step in the DMAIC approach, wherein the particular problem will be identified and the goals are set.

On an average, 30,000 patients visit the cardiology OPD for consultation at this hospital every year. On oral communication with some of the patients at this section, it was found that the patients were very happy about the consultants and their treatment, but not with the waiting time. They complained of longer waiting times. The support staff working at this section confirmed the same. With this, the problem was formulated as "Longer patient wait time at cardiology OPD".

4.2 Measure Phase

The key measurable is the patient wait time for consultation at this OPD. The waiting time data at this OPD has been collected for a period of five months, from 10:00 AM to 6:00 PM during Monday to Friday. The average wait times for these months are presented in table 1.1.

Table 1.1: Patient wait time data

Month	Average value
February	74 mins
March	63 mins
April	85 mins
May	68 mins
June	97 mins

From table 1.1, the average wait time is found as 77.4 minutes, which is more than an hour. This patient wait time is very high and needs significant reduction.

Conduction of a patient satisfaction survey was felt necessary to identify the variables that largely lead to the increased wait time. For this purpose, a survey questionnaire was prepared in consultation with hospital staff, few of the patients, similar health system staff and cardiologists. The survey questionnaires were distributed to selected patients (random selection) at the cardiology OPD and 230 responses were obtained. The variables considered for the study are shown in table 1.2. Some of the respondents expressed not to answer few of the questions. This consideration has been provided to them. The patient data related to date of consultation, gender, age and first visit/revisit has also been collected, which is not shown in the table.

Table 1.2: Variables considered for the study

Q. No.	Question	Never 1	few times 2	Moderate 3	many times 4	Always 5
1	I visit the OPD after taking an appointment					
2	I more or less arrive at the OPD at the appointment time.					
3	I find many patients waiting for consultation when I arrive					
4	The consultant has arrived at the OPD and has started treating the patients one after the other					
5	There is only one consultant at the OPD, most of the time					
6	The consultant takes longer time with the patients					
7	The consultant unnecessarily delays the consultation time					
8	The auxiliary staff are insufficient					
9	The consultant leaves the OPD for an emergency cardiology patient visit					
10	The support staff is able to provide an approximate wait time to the patient at the OPD.					

4.3 Analysis Phase

Factor analysis has been carried out for the collected data using SPSS software package. The first step is to calculate Karl Pearson's correlation coefficient to determine the existing relationships among the variables. Table 1.3 shows the correlation matrix.

Table 1.3: Correlation matrix

Correlation Matrix[a]

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Correlation	Q1	1.000	-.193	.359	.035	-.014	-.057	-.212	.251	-.372	.071
	Q2	-.193	1.000	-.476	.340	.336	.454	.166	-.226	.334	-.164
	Q3	.359	-.476	1.000	.039	-.365	-.453	-.236	.272	-.658	.015
	Q4	.035	.340	.039	1.000	.024	-.025	.187	.128	.100	.381
	Q5	-.014	.336	-.365	.024	1.000	.126	-.147	.034	.400	.270
	Q6	-.057	.454	-.453	-.025	.126	1.000	.021	-.193	.266	-.052
	Q7	-.212	.166	-.236	.187	-.147	.021	1.000	-.384	.246	.279
	Q8	.251	-.226	.272	.128	.034	-.193	-.384	1.000	-.081	.062
	Q9	-.372	.334	-.658	.100	.400	.266	.246	-.081	1.000	.285
	Q10	.071	-.164	.015	.381	.270	-.052	.279	.062	.285	1.000

a. Determinant = .036

The determinant is 0.036, (being greater than 0) indicating the absence of multicollinearity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.528, this is greater than the cut-off 0.50. The significance level for Bartlett's Test of Sphericity is obtained as 0.011; this is less than 0.05 and hence the data shows patterned relationship. Hence, the sample size was found to be adequate. Table 1.4 shows communalities i.e. the amount of variance in the variables that can be accounted for by the extracted factors. The communality value must be greater than 0.5 if the variables have to be considered for further analysis. In table 1.4, it is noticed that the communality values for all the variables are greater than 0.50.

Table 1.4: Communalities

	Initial	Extraction
Q1	1.000	.505
Q2	1.000	.828
Q3	1.000	.778
Q4	1.000	.819
Q5	1.000	.699
Q6	1.000	.569
Q7	1.000	.770
Q8	1.000	.585
Q9	1.000	.775
Q10	1.000	.792

Table 1.5 shows the total variance explained, with principal component analysis as the extraction method. From the extraction sums of squared loadings, it is noticed that first four factors are significant.

Table 1.5: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.935	29.349	29.349	2.935	29.349	29.349	1.984	19.843	19.843
2	1.623	16.227	45.576	1.623	16.227	45.576	1.798	17.983	37.826
3	1.439	14.390	59.966	1.439	14.390	59.966	1.782	17.820	55.646
4	1.123	11.227	71.193	1.123	11.227	71.193	1.555	15.546	71.193
5	.874	8.739	79.932						
6	.706	7.058	86.990						
7	.530	5.303	92.292						
8	.360	3.604	95.897						
9	.259	2.593	98.489						
10	.151	1.511	100.000						

Extraction Method: Principal Component Analysis.

Figure 1.1 shows the scree plot obtained from SPSS, in which the curve starts to flatten after factor 4 and also for factors 5 onwards the eigen values are less than 1. Hence, only four factors are retained. Table 1.6 shows the component matrix, in which values less than 0.50 are suppressed for easy interpretation. The larger the absolute value of the loading, the greater that factor contributes to the variable.

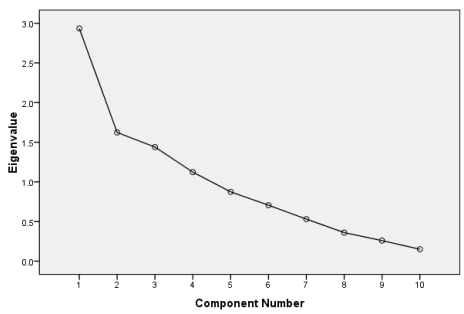

Fig. 1.1: Scree Plot

Table 1.7 shows the rotated component matrix. The idea of rotation is to minimize the number of factors on which the variables under examination have significantly high loadings. Rotation makes interpretation of the analysis much easy. From this matrix, it is seen that component 1 is substantially loaded on factors 5 and 9; component 2 on factors 2 and 6. This is useful for further analysis.

From the analysis phase, following inferences can be drawn about the data:

- absence of multicollinearity
- data shows patterned relationship
- four factors are very significant
- A patient visiting the OPD with an appointment depends on whether there is only one consultant at the OPD and if he often leaves OPD for emergency visit.
- The patient arriving at the OPD on the appointed time depends on whether the consultant takes longer consultation time. Hence, these variables become very essential for further analysis.

Table 1.6: Component matrix

	Component			
	1	2	3	4
Q1				
Q2	.698			.546
Q3	-.843			
Q4		.675		.560
Q5			.570	
Q6	.550			
Q7			-.759	
Q8			.511	
Q9	.774			
Q10		.826		

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table 1.7: Rotated Component Matrix

	Component			
	1	2	3	4
Q1			.599	
Q2		.859		
Q3	-.639			
Q4				.870
Q5	.759			
Q6		.726		
Q7			-.765	
Q8			.714	
Q9	.807			
Q10				.693

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

4.4 Improve Phase

During the improvement phase of DMAIC methodology, suggestions have been provided to upgrade the existing system at the cardiology OPD. Second cardiology consultant has been provided at the OPD, who will attend the patients along with the existing consultant; he will also attend the emergency visits in the hospital, not disturbing the existing consultant. As the consultation time depended on the criticality of the patient, there was an assistant practitioner provided to both the consultants who would guide the patient on consumption of medicines and laboratory tests, if needed.

With all this on a test run for a period of one week, the patient wait time data has been collected and shown in table 1.8.

The overall average patient wait time for one week is 26.57 minutes, as compared to that initially.

4.5 Control Phase

The focus of this stage is to ensure that the action item generated in the Improve phase is well-applied and maintained. Hence, suggestion has been given to the hospital management to maintain the action item generated for long term benefits.

Table 1.8: Patient wait time data for one week trial period

Month	Average value
Day 1	24 mins
Day 2	29 mins
Day 3	35 mins
Day 4	18 mins
Day 5	22 mins
Day 6	26 mins
Day 7	32 mins

5. Conclusion

The present study was aimed at studying the waiting time of patients at cardiology OPD at a super specialty hospital in Bangalore city. The observation revealed that the patient wait time was very high, which also had led to reduced patient satisfaction at the hospital. The DMAIC procedure of Six Sigma Methodology has been applied to reduce the patient wait time and in Analysis phase, Factor analysis has been conducted for the patient data that had been collected by carrying out a survey. With the application of Six Sigma Methodology and Factor analysis, the patient wait time is reduced from 77.4 minutes to 26.57 minutes. This has led to increase in the satisfaction of the patients.

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