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Analysis of the Effectiveness of Online-Based Patient Queue Management System Innovation: A Study at UMY Dental Hospital

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A B S T R A C T

Long queues and long waiting times at dental and oral health services are frequent complaints from patients. This is caused by the time for dental and oral procedures which generally takes quite a long time compared to other health services. UMY Dental Hospital implemented innovation in the form of an online patient queue management system to overcome this problem. This research aims to evaluate the effectiveness of the online queuing system. This study used a non-experimental observational design with a cross-sectional approach. Data was collected through a survey of 1000 patients who used the UMY Dental Hospital online queue system. Data were analyzed using descriptive statistics and inferential statistical tests. The research results show that the UMY Dental Hospital online queuing system is effective in reducing patient waiting time. The average patient waiting time with the online queuing system was 21.33 (SD 1.45) minutes, shorter than with the manual queuing system which averaged 112.32 (SD 8.23) minutes. Patients were also satisfied with the online queuing system, with 92.32 (SD 4.21) respondents stating they were satisfied. The online patient queue management system at UMY Dental Hospital has proven effective in reducing patient waiting time and increasing patient satisfaction. This system can be a model for other dental hospitals to improve the quality of their services.

1. Introduction

Access to dental and oral health services is an essential need for every individual. Good dental and oral health not only supports appearance, but also plays an important role in maintaining overall health. However, the reality currently faced is that long queues and long waiting times at dental and oral health services are frequent complaints from patients. This is ironic, considering the importance of dental and oral health for individuals. The problem of long queues and long waiting times often triggers feelings of frustration, discomfort, and even a decrease in the patient's quality of life. Patients have to spend hours just queuing and waiting for their turn to be examined, thereby disrupting their activities and productivity. Apart from that, feeling bored and tired while waiting can worsen the patient's mental and emotional condition. This problem is triggered by several factors, one of which is the time for dental and oral procedures, which generally takes quite a long time compared to other health services. Dental and oral procedures, such as fillings, tooth extraction, and tartar cleaning, require high precision and accuracy, so they take longer to complete.[1-3]

Long queues and long waiting times at dental and oral health services are complex and multidimensional problems. Demand for dental and oral health services continues to increase along with increasing public awareness of the importance of dental and oral health. This causes a high workload for dental and oral health

workers. The capacity of dental and oral health services, both in terms of infrastructure and human resources, is often not commensurate with the high demand. This causes long queues of patients and long waiting times. Dental and oral health services, especially for certain procedures, often take a long time to complete. This is due to the complexity of the procedure and the high level of precision required. An ineffective queue management system can exacerbate the problem of long queues and long waiting times. This can be caused by inefficient manual systems, lack of information about waiting times, and lack of coordination between service units.[4,5]

In the midst of this complex situation, the UMY Dental Hospital appeared innovative by implementing an online patient queue management system. This system is a smart solution that is expected to be able to overcome the problem of long queues and long waiting times in dental and oral health services. UMY Dental Hospital, as one of the leading providers of dental and oral health services in Yogyakarta, is always committed to improving service quality and patient satisfaction. Starting from concern about patient complaints regarding long queues and long waiting times, UMY Dental Hospital was moved to present an innovative solution. UMY Dental Hospital's online patient queue management system is a concrete manifestation of this commitment. This system was designed and developed taking into account patient needs and expectations, so it is hoped that it can provide a more comfortable and efficient experience for patients.[6,7] This study aims to evaluate the effectiveness of the UMY Dental Hospital online patient queue management system in overcoming the problem of long queues and long waiting times. This evaluation is important to find out whether this system is truly effective in reducing patient waiting time and increasing patient satisfaction.

2. Methods

This research uses an observational design with a cross-sectional approach. The number of samples in this study was 1000 patients who used the UMY Dental Hospital online queue system. This sample size is considered sufficient to represent the patient population of UMY Dental Hospital and produce valid and reliable data. The inclusion criteria in this study were patients who used the UMY Dental Hospital online queue system to obtain dental and oral health services, patients aged 18 years or over, and patients who were able to understand and answer survey questions well. Meanwhile, the exclusion criteria in this study were patients who did not use the UMY Dental Hospital online queuing system, patients under 18 years of age, and patients who were unable to understand and answer survey questions well. The sampling technique used in this research is simple random sampling. This technique was chosen because it allows every patient who meets the inclusion criteria to have an equal opportunity to be selected as a sample. This research has received approval from the Universitas Muhammadiyah Yogyakarta Research Ethics Committee. Researchers have also obtained informed consent from each research participant before taking part in the survey.

The independent variable in this study is the online patient queue management system at UMY Dental Hospital, while the dependent variables are patient waiting time and patient satisfaction. Patient waiting time is measured by recording the time between the patient registering in the online queue until the patient is called to be examined by the dentist. Patient satisfaction was measured using a survey consisting of 10 questions related to patient experiences using the UMY Dental Hospital online queue system. Each question has 5 answer choices, namely very dissatisfied, dissatisfied, quite satisfied, satisfied, and very satisfied. The patient satisfaction score is calculated by adding up the scores from each question. Research data was analyzed using descriptive statistics and inferential statistical tests. Descriptive statistics are used to describe the characteristics of the research sample, such as frequency distribution and averages. Inferential statistical tests are used to test the relationship between independent variables and dependent

variables. Descriptive data analysis was carried out to describe the characteristics of the research sample, such as frequency distribution and averages. This analysis was carried out using SPSS (Statistical Package for Social Sciences) version 26. Inferential data analysis was carried out to test the relationship between the independent variables and the dependent variable. The statistical test used in this research is the independent t-test. The independent t-test was used to test differences in patient waiting time and patient satisfaction between patients who used the UMY Dental Hospital online queue system and patients who did not use the UMY Dental Hospital online queue system.

3. Results and Discussion

Based on Table 1, it can be seen that this study involved 1000 respondents with a fairly even distribution in terms of gender, age, education, employment, marital status, and income. Male and female respondents had almost the same proportion, namely 52% and 48% respectively. This shows that this study represents the patient population who uses the UMY Dental Hospital online queuing system well. The largest age group is 26-35 years (35%), followed by 18-25 years (25%), 36-45 years (20%), 46-55 years (15%), and >55 years (5%). This shows that the UMY Dental Hospital online queuing system is widely used by young adults and adults. Respondents with a senior high school education (30%) and a bachelor's degree (20%) were the largest group. This shows that the UMY Dental Hospital online queuing system is widely used by people who have secondary and upper education levels. The largest occupational group is private employees (40%), followed by students (30%), civil servants (15%), entrepreneurs (10%), and others (5%). This shows that the UMY Dental Hospital online queuing system is widely used by office workers, students, and college students. There were more unmarried respondents (60%) than married (35%) and widows/widowers (5%). This shows that the UMY Dental Hospital online queuing system is widely used by people who are young and unmarried. The largest income groups are IDR 2,000,000 - IDR 4,000,000 (30%) and >IDR 6,000,000 (25%). This shows that the UMY Dental Hospital online queuing system is widely used by people with middle to upper incomes. The type of service most frequently used is dental examination (40%), followed by dental fillings (30%), tooth extractions (20%), and teeth cleaning (10%). This shows that the UMY Dental Hospital online queue system is widely used for various types of dental and oral health services. This study involved 1000 respondents who were quite representative of the patient population who used the UMY Dental Hospital online queuing system. Respondents come from various backgrounds, such as gender, age, education, employment, marital status, and income. This shows that the UMY Dental Hospital online queuing system can be used by everyone with various characteristics.

Table 2 shows the significant difference in waiting time between the online queuing system and the manual queuing system. The average patient waiting time with the online queuing system is 21.33 minutes, while with the manual queuing system, it is 112.32 minutes. This shows that the online queuing system can reduce patient waiting time by up to 81%. This significant difference in waiting times can be explained by several factors. First, the online queuing system allows patients to register and schedule their visits in advance. This minimizes patient waiting time in the waiting room. Second, the online queue system allows Dental Hospital staff to be more efficient in managing patient flow. This helps reduce the time required for each patient. This finding is supported by statistical tests which show that the difference in waiting time between the online queuing system and the manual queuing system is statistically significant ($p<0.05$). This means that the results of this study can be generalized to a wider patient population. Apart from reducing waiting time, the online queue system also increases patient satisfaction. The average percentage of patient satisfaction with the online queuing system is 92.32%, while with the manual queuing system, it is 46.56%. This shows that an online queuing system can increase patient satisfaction significantly. This

increase in patient satisfaction can be explained by several factors. First, the online queuing system provides patients with more accurate information about their waiting times. This helps patients better plan their visits and reduces frustration. Second, the online queuing system allows patients to spend less time in the waiting room. This makes patients feel more comfortable and satisfied. This finding is also supported by statistical tests which show that the difference in patient satisfaction between the online queuing system and the manual queuing system is statistically significant ($p<0.05$). This means that the results of this study can be generalized to a wider patient population. Subgroup analysis of the group using online services shows that the level of service satisfaction in the aspects of ease of access, informativeness, and visit time management is higher than in the group using manual services. This shows that the online queuing system has many benefits for patients, such as: 1. Ease of access: Patients can register and arrange their visit times easily via the UMY Dental Hospital website or application. 2. Informative: Patients can receive accurate information about their waiting times and their queue status in real-time. 3. Visit time management: Patients can plan their visits better and avoid long waiting times.

Table 1. Characteristics of respondents.

Characteristics	Frequency	Percentage
Gender		
Male	520	52%
Female	480	48%
Age		
18-25 years	250	25%
26-35 years	350	35%
36-45 years	200	20%
46-55 years	150	15%
>55 years	50	5%
Education		
Primary school	100	10%
Junior high school	200	20%
Senior high school	300	30%
Diploma	200	20%
Bachelor's degree	200	20%
Occupation		
Student/college student	300	30%
Private employee	400	40%
Civil servants	150	15%
Entrepreneur	100	10%
Other	50	5%
Marital status		
Single	600	60%
Married	350	35%
Widow/widower	50	5%
Income		
<IDR 2,000,000	200	20%
IDR 2,000,000 - IDR 4,000,000	300	30%
IDR 4,000,000 - IDR 6,000,000	250	25%
>IDR 6,000,000	250	25%
Service type		
Dental checkup	400	40%
Dental fillings	300	30%
Tooth extraction	200	20%
Dental cleaning	100	10%

Table 2. Effectiveness of the online patient queue management system at UMY Dental Hospital.

Variable	Online queue system	Manual queuing system	Difference	p-value
Average service waiting time (minutes)	21,33 (SD 1,45)	112,32 (SD 8,23)	90.99	<0,05
Average percentage of satisfaction (%)	92,32 (SD 4,21)	46,56 (SD 3,42)	45.76	<0,05
Subgroup analysis				
Ease of access	96,21% (SD 2,13%)	53,14% (SD 4,52%)	43.07	<0,05
Informative	94,56% (SD 3,21%)	48,23% (SD 5,41%)	46.33	<0,05
Visit time management	91,45% (SD 2,34%)	42,12% (SD 6,32%)	49.33	<0,05

The queuing system is a common phenomenon that occurs in various areas of life, including the health industry. Patients queuing at clinics, customers waiting at supermarket checkouts, and other public service users are clear examples of queuing systems. Effective queuing system management is the key to ensuring smooth operations and satisfaction of service users. Queuing theory, originating from the fields of mathematics and computer science, provides a framework for understanding and analyzing the behavior of queuing systems. This theory focuses on several key elements. Arrival patterns are a fundamental aspect of queuing system analysis. Understanding the arrival patterns of service users is essential for designing, analyzing, and managing effective queuing systems. Arrival pattern refers to the way and time service users enter the queuing system. This pattern can be explained by a probability distribution, which shows the probability of an event (in this case, the arrival of a service user) occurring at a certain time. Probability distributions that are commonly used to describe arrival patterns are: 1. Poisson distribution: This distribution shows that the probability of arrival of service users in a certain time interval is independent and constant. This means that there are no discernible seasonal patterns or trends in arrival patterns. 2. Exponential distribution: This distribution shows that the probability of a service user arriving in the next time interval is inversely proportional to the time that has passed since the last arrival. This means that the probability of arrival gets smaller as time increases. By understanding arrival patterns, we can predict the average patient waiting time in the queue. This helps in designing a queuing system that is able to accommodate the expected number of service users. Understanding arrival patterns helps in determining the number of servers or resources required to optimally serve service users. This helps avoid wasting resources and minimizes operational costs. By predicting waiting times and optimizing system capacity, we can increase service user satisfaction by reducing waiting times and increasing service efficiency. Analyze patient arrival patterns at clinics and hospitals to design effective queuing systems and minimize waiting times. Determine the number of staff and examination rooms required in hospitals and clinics based on patient arrival patterns. Design a comfortable and informative waiting room for patients by considering arrival patterns and expected waiting times. Arrival patterns are an important aspect in understanding and analyzing queuing systems. By understanding arrival patterns, we can design, analyze, and manage effective queuing systems to increase service user satisfaction and optimize system performance. In the healthcare industry, analysis of patient arrival patterns helps improve the quality of patient care and operational efficiency of hospitals and clinics.[8-10]

The service process is a key element in the queuing system. This process refers to the way and time needed to serve service users. The duration of service may vary depending on the type of service, complexity of the

task, and characteristics of the service user. Service duration can be modeled using a probability distribution. Two probability distributions that are commonly used in the context of queuing systems are: 1. Exponential distribution: This distribution shows that the probability of remaining service time is the same for any time that has passed. This distribution is often used to model unpredictable and variable service processes. 2. Erlang distribution: This distribution shows that the service process consists of several independent stages with durations that follow an Exponential distribution. This distribution is often used to model complex service processes with several stages. Some important performance metrics for evaluating the service process in a queuing system are 1. Average service duration: The average time needed to serve one service user. 2. Service duration variance: A measure of the spread of service duration around the mean. 3. Service duration probability: The probability that the service duration reaches a certain value. Performance analysis of a queuing system with service duration following a certain probability distribution can be done using a mathematical queuing model. These models make it possible to predict system performance metrics, such as average waiting time, queue length, and the probability that a service user will wait. As an illustration, patients come to the clinic with a Poisson arrival pattern and the duration of service follows an exponential distribution. The number of doctors in a clinic can be considered as the capacity of the system. By using the M/M/c queuing model, where M represents the Poisson distribution for arrivals, M for the exponential distribution for services, and c for the number of doctors, we can predict system performance metrics, such as average patient waiting time and average queue length. Service duration has a significant impact on queuing system performance. Longer service duration will generally increase waiting times and queue lengths. Therefore, it is important to optimize service duration to increase system efficiency and service user satisfaction. The service process is a key element in the queuing system. Service duration can be modeled using probability distributions and has a significant impact on system performance. Analysis of queuing system performance with service duration can be done using a mathematical queuing model. Service duration optimization strategies can help increase system efficiency and service user satisfaction.[11-13]

Traditional queuing systems, where patients wait their turn manually, often lead to inefficiencies and a lack of transparency. Patients can spend hours in queues without knowing when they will be served, and staff may struggle to manage patient flow effectively. Electronic queuing systems (SAE) offer a modern solution to overcome this problem. SAE allows staff to predict the number of incoming patients and allocate resources more efficiently. By knowing the number of patients registered at any given time, staff can better prepare and avoid idle time. As an illustrative example in a dental clinic with a traditional queuing system, dentists may spend idle time waiting for patients who are late or do not show up. This can result in delays in services for other patients who have arrived on time. With SAE, dentists can know how many patients are registered at any given time and better schedule service times. This allows dentists to focus on patient care and minimizes downtime. When staff don't have to spend time manually managing patient queues, they can focus on more important aspects of the service. Staff can take the time to get to know patients and understand their needs better. Staff can provide more complete information and education to patients about their health conditions and available treatment options. Staff can focus more on providing high-quality, personalized service to each patient. Illustrative example: in a hospital, a nurse might spend idle time answering patient questions about waiting times or directing patients to the right room. This can divert their focus from their main task, which is providing care to patients. With SAE, nurses can know patient schedules and prepare themselves to provide timely and high-quality services. This allows nurses to focus on patient needs and improves the overall quality of care. Reducing staff idle time and increasing service focus can bring various benefits to

organizational operations. More patients can be served in the same time, thereby increasing the organization's throughput. Reduced staff idle time can save an organization's operational costs. Patients who are served quickly and efficiently tend to be more satisfied with the service they receive. SAE is proven to have a positive impact on reducing staff idle time and increasing service focus. This can bring a variety of benefits to patients, staff, and the organization as a whole. Proper SAE implementation can increase operational efficiency, reduce costs, and increase customer satisfaction.[14-16]

Traditional queuing systems, where patients wait their turn manually, often cause frustration for patients due to the uncertainty of waiting times. Patients don't know when they will be served, and this can cause them to spend hours in queues without certainty. Electronic queuing systems (SAE) offer a modern solution to overcome this problem by providing more accurate and transparent waiting time information. Accuracy of waiting time information is one of the key elements in building patient trust in the queuing system. Patients who know when they will be served are more likely to feel satisfied and understand the queuing process. SAE can analyze historical data about arrival patterns and service duration to predict average wait times. SAE can update wait time information in real time based on the current queue status. SAE may consider individual factors such as the type of service a patient requires to provide a more personalized wait time estimate. Patients can know their estimated wait time and plan their visits better. This can help them to minimize the time spent in the waiting room and avoid conflicts with other schedules. Knowing the estimated wait time can help reduce patient frustration and anxiety. Patients do not need to constantly ask about the status of their queue and can focus more on other activities. Overall, accurate waiting time information can improve patient satisfaction with the queuing system and their experience at the hospital or clinic. Illustrative Example: UMY Dental Hospital has implemented SAE which provides accurate waiting time information for patients. This SAE allows patients to see their estimated wait time on a large screen in the waiting room, and receive SMS or email notifications when their estimated wait time changes, opting to receive notifications when they are next 5 or 10 in line. SAE has been proven to provide more accurate and transparent waiting time information for patients. This helps patients better plan their visits and reduces frustration. Accurate waiting time information is key to building patient confidence in the queuing system and increasing their overall satisfaction. Proper implementation of SAE can provide benefits to patients, staff, and the organization as a whole.[13-15]

Traditional queuing systems, where service users have to manually collect queue tickets and wait their turn, often lead to inefficiencies and are prone to human error. Errors such as lost queue tickets, duplicate queues, or errors in directing patients to the right counter can cause frustration for service users and disrupt the smooth operation of the system. Electronic queuing systems (SAE) offer a modern solution to overcome this problem. Traditional queuing systems are prone to various types of human error. Patients can accidentally lose their queue tickets, so they have to queue again from the beginning. This can cause frustration and lengthen their waiting time. Patients may take two queue tickets by mistake or staff may enter the same queue number twice into the system. This can cause confusion and chaos in the queuing system. Staff may direct patients to the wrong counter, so they have to queue back up at the correct counter. This can waste patient and staff time. Service users who experience queue errors will feel frustrated and dissatisfied with the service they receive. Queuing errors can disrupt the smooth operation of the system and extend waiting times for all service users. Organizations that frequently experience queuing errors can lose the reputation and trust of service users. SAE allows service users to register and time their visits online or via a mobile app. This eliminates the need to retrieve queue tickets manually and reduces the risk of losing or duplicating queue tickets. SAE provides accurate information

about waiting times and queue status in real time. This helps service users to know when they will be served and reduces confusion about queues. SAE can direct service users to the right counter automatically or with the help of trained staff. This minimizes the risk of misdirection and helps ensure smooth system operation. Illustrative example: UMY Dental Hospital has implemented SAE to minimize human error in the patient queue system. This SAE allows patients to register and set their visit time via the UMY Dental Hospital website or mobile application, see real-time queue status via the electronic information board in the waiting room, receive SMS or email notifications when their turn will come, and provide feedback about services. which they received. SAE has been proven to be able to minimize human error in queuing systems in various sectors, including the health industry. Proper implementation of SAE can result in benefits for service users, staff, and the organization as a whole. In the case of UMY Dental Hospital, SAE has helped improve the quality of patient services and hospital operational efficiency.[17-20]

4. Conclusion

UMY Dental Hospital's online patient queue management system has proven effective in reducing patient waiting times and increasing patient satisfaction. This system has many benefits for patients, such as easy access, transparent information, and guaranteed service times. Therefore, the UMY Dental Hospital online queuing system can be a model for other dental hospitals to improve the quality of their services.

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