Dental Analysis Report

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***Abstract*---This study evaluates patient satisfaction surveys from Longworth Dental-Bowmanville, spanning 2019 to 2024, to generate actionable insights for enhancing clinic operations and patient care. Leveraging web scraping, sentiment analysis, and Power BI dashboards, the analysis highlights positive feedback centered on staff professionalism and skilled appointment providers. However, challenges such as improving financial communication and refining surveys for deeper insight into patient experiences emerged as key areas for development. The findings demonstrate the value of a data-driven approach in translating patient feedback into strategic improvements, fostering better healthcare delivery and patient satisfaction.**

***Keywords---* dental care, patient satisfaction, web scraping, power Bi, financial communication, healthcare delivery**

# INTRODUCTION

Patient satisfaction is central to evaluating healthcare quality, particularly in dental care, where it directly affects clinic reputation, patient retention, and referral rates. In an increasingly competitive industry, understanding patient feedback is vital not only for enhancing operational efficiency but also for fostering trust and loyalty among patients. For Longworth Dental-Bowmanville, this project aims to systematically analyze patient satisfaction surveys to provide actionable insights for improving clinic operations and patient care.

This study focuses on survey data collected from 2019 to 2024, containing valuable feedback on various aspects of patient experience, such as treatment options, provider performance, and overall clinic efficiency. By leveraging modern data analysis techniques, the project seeks to identify trends, strengths, and areas needing improvement. This effort aligns with the growing emphasis in healthcare on patient-centered approaches, which prioritize understanding and addressing the needs and preferences of patients.

The primary objective of the project is to transform raw survey data into meaningful insights that support Longworth Dental in making data-driven decisions. The methodology involves web scraping using Selenium to extract survey data from the clinic’s backend, followed by rigorous data cleaning and preparation to ensure consistency and reliability. Advanced analytical techniques, such as sentiment analysis using the VADER NLP model, are employed to interpret unstructured patient comments. Furthermore, interactive dashboards developed in Power BI allow stakeholders to visualize trends and access findings easily, ensuring that insights are actionable and relevant.

Patient satisfaction is not an abstract metric but a tangible indicator of a clinic’s success. Satisfied patients are more likely to become loyal advocates, sharing their positive experiences with others and returning for future care. Conversely, dissatisfaction can lead to loss of business and a decline in reputation. Common challenges, such as delays in appointments, unclear communication, or financial concerns, if unaddressed, can have long-lasting negative impacts. Addressing these areas proactively ensures a better patient experience and fosters trust.

This report is structured to provide a comprehensive overview of the project’s process and outcomes. It begins with a review of relevant academic literature to establish the broader context of patient satisfaction in dental care. A detailed description of the dataset follows, outlining its attributes and preparation steps. The methodology section describes the tools and techniques used for data collection, cleaning, and analysis. The results section presents key findings, supported by visualizations, and is followed by a discussion of their significance and potential implications. The report concludes with recommendations for actionable improvements and reflections on future directions.

By adopting a systematic and data-driven approach, this project not only identifies actionable strategies for Longworth Dental but also demonstrates the transformative potential of analytics in healthcare. It emphasizes the importance of understanding patient feedback as a cornerstone for continuous improvement and delivering high-quality care.

1. RELATED WORK

Patient satisfaction is a critical aspect of healthcare quality, with significant implications for patient retention, loyalty, and clinic reputation. In dental care, understanding and enhancing patient satisfaction is essential, as it directly influences the likelihood of repeat visits and referrals. The following review explores key determinants of patient satisfaction in dental services, highlighting the importance of provider-patient communication, the physical environment of dental practices, and technological innovations in feedback analysis.

Effective communication between patients and dental professionals has been consistently identified as one of the most significant predictors of patient satisfaction. Studies have shown that patients who perceive their dentist as approachable and who receive clear explanations about their treatment options are more likely to report higher satisfaction levels. In a study by Buzás et al., communication quality, including the dentist’s ability to explain treatment plans clearly, was found to be crucial for both patient satisfaction and loyalty [2]. Similarly, Surlari et al. observed that interpersonal factors, such as attentiveness and empathy, are key to shaping patients' perceptions of care, aligning with the notion that trust and comfort foster positive patient experiences​ [7].

The dentist's role extends beyond clinical competence; it encompasses emotional intelligence and patient-centered care. Patients report greater satisfaction when they feel their dentist listens to their concerns and engages them in the treatment process. A study on dental satisfaction in Saudi Arabia revealed that dentist attentiveness and clear communication about treatment options were the highest-rated factors influencing patient satisfaction​ [8]. This finding echo research in Finland and Kuwait, where clinicians' empathy and explanation of treatment were also strongly linked to patient satisfaction​ [2][8].

While interpersonal communication is crucial, the physical environment of dental clinics also plays a significant role in shaping patient satisfaction. Factors such as clinic cleanliness, waiting times, and the ease of scheduling appointments contribute to the overall patient experience. Surlari et al. reported that 77.1% of patients rated their satisfaction as excellent when factors like cleanliness and office personnel professionalism were prioritized​ [7]. Similarly, a study on patient satisfaction with dental care services found that cleanliness and infection control in clinics were consistently rated highly by patients, with a strong correlation between these factors and overall satisfaction​ [8].

Moreover, accessibility and waiting times remain important determinants of patient satisfaction. A study by Patel highlighted that long waiting times were often a major source of dissatisfaction among patients. Reducing wait times through improved scheduling or increasing staff availability has been suggested as an effective strategy to enhance patient satisfaction​ [3]. The integration of technology, such as appointment booking apps, has been shown to improve patient satisfaction by reducing waiting periods and streamlining patient flow [2][3].

The use of technology in collecting and analyzing patient feedback has significantly improved the ability to measure and respond to patient satisfaction. Web scraping techniques, such as those used in this project, offer a powerful tool for extracting large volumes of survey data from clinic systems, enabling timely and consistent analysis. Additionally, sentiment analysis techniques, like VADER NLP, are increasingly used to evaluate patient comments and identify key emotional indicators, providing a more nuanced understanding of patient satisfaction [7][2].

The Press Ganey survey, widely used for patient satisfaction in healthcare settings, categorizes satisfaction into multiple domains, including accessibility, treatment quality, and provider communication. Research has shown that these domains are strongly correlated with overall satisfaction, with provider performance consistently emerging as the most significant factor. This aligns with the findings of Surlari et al., who concluded that the quality of dental care provided by the dentist is the primary predictor of patient satisfaction​ [3].

Despite the advancements in patient satisfaction measurement, challenges remain. One issue is the potential bias in patient feedback, as satisfaction scores can be influenced by external factors such as cost, personal expectations, or even the emotional state of the patient at the time of the visit. Studies have suggested that to mitigate such biases, surveys should include a mix of quantitative and qualitative questions, allowing for a more comprehensive assessment of patient experiences​ [7][2]. Furthermore, the integration of demographic data, such as age or socio-economic status, can provide deeper insights into satisfaction disparities and help tailor services to meet the needs of diverse patient groups​ [8].

1. DATASET DESCRIPTION
2. Dataset Overview

The dataset used in this project consists of patient satisfaction survey responses collected over five years (2019–2024) from Longworth Dental-Bowmanville. The data primarily contains feedback regarding various aspects of dental care, including patient-provider interactions, appointment scheduling, clinic environment, and overall satisfaction with the services provided. The data was collected using the clinic’s internal survey system, which provided both structured and unstructured data for analysis.

1. Dataset Attributes

The dataset contains both quantitative (numerical) and qualitative (textual) data. Key attributes of the dataset include:

1. **Survey ID:** A unique identifier for each survey response. This serves as the primary key for tracking individual responses.
2. **Patient Information**: Patients name and email address were collected as part of the survey to identify the patient.
3. **Provider Information**: The name of the dentists and hygienists involved in the patient’s care. The provider information may be a single name, or multiple providers listed per survey response.
4. **Appointment Date and response date:** Appointment and response dates were collected which will be helpful to identify the underlying trends and improvements of overall clinical effectiveness over time.
5. Question Responses: Structured responses to specific survey questions regarding service aspects like wait times, treatment options, ratings of appointment providers, etc. The responses are in the scale of 1 to 10, 1 being the least satisfies and 10 being the most satisfied.
6. **Comments**: Free-text feedback provided by patients regarding their experience. These unstructured comments were analyzed using sentiment analysis to derive meaningful insights.
7. Data Types:

We have numeric, text and Date data types present in our dataset which makes it a data rich file for various analysis, for example, Statistical analysis for numeric data to identify the distribution and spread of data and sentimental analysis for the comment variable.

A screenshot of a computer

Description automatically generatedThe data types of variables present in our dataset is described in the figure 1 below.

Figure 1: Data types of variables in dataset

1. Format and Size

The scraped dataset is stored in a csv format, which is a widely used structure for data storage, making it easy to handle with tools like Python (pandas) and SQL for further analysis. The dataset consists of approximately 1,500 individual survey responses across five years. Each raw response has 18 columns before the data pre-processing. A relational database was created using MySQL Workbench to store the dataset, enabling the project to handle large volumes of data efficiently and ensuring the scalability necessary for future growth. This approach also facilitates the full automation of data processing and querying, allowing for streamlined analysis of patient feedback across multiple years without manual intervention.

1. METHODOLOGY
2. Data Collection

The data collection process for this project involved using web scraping techniques to automate the extraction of survey data from the clinic’s backend system. Selenium, a popular Python library for browser automation, was used to simulate human interaction with the website, ensuring access to dynamically generated content and secure data retrieval. Once extracted, the data was stored in a structured relational database using MySQL Workbench, enabling efficient management and scalability.

The backend system of the clinic, accessible only through secure login credentials, contained patient satisfaction surveys spanning several years. Using Selenium, a script was developed to navigate the login page, authenticate with valid credentials, and scrape survey data. Selenium was selected because it can handle dynamic, JavaScript-heavy websites, ensuring that all the survey data could be extracted from the clinic’s backend. This process involved several key steps:

1. **Login Automation**: The script used Selenium’s WebDriver to launch a browser session and locate login elements (e.g., username and password fields). Credentials were entered programmatically, and the “Submit” button was clicked to access the secure dashboard.
2. **Cookie Authentication**:After login, cookies were extracted from the browser session to establish an authenticated session in Python’s requests library. This allowed for seamless API requests to fetch additional data.
3. **Data Fetching**: Two primary API endpoints were accessed:

* Survey responses for specific years (get\_survey\_responses function).
* Detailed information for individual surveys (get\_survey\_details function).

These endpoints provided structured data, including survey IDs, provider names, satisfaction scores, and textual comments.

Basic cleaning was performed during the scraping process. Empty or invalid fields were replaced with placeholders like "None" to avoid errors during storage and analysis. Additionally, textual data such as provider names were normalized.

To ensure scalability and ease of analysis, the scraped data was stored in a MySQL database using MySQL Workbench. The database schema was designed to handle relationships between surveys, providers, responses, and detailed feedback efficiently.

The database design followed a relational model, with tables structured to minimize redundancy and maintain data integrity. The schema included the following tables (Figure 2):

1. Surveys: Stores basic survey details like survey ID, patient name, and appointment date.
2. Providers: Stores unique information about providers (e.g., dentists and hygienists).
3. Responses: Links surveys to providers, including textual comments.
4. Questions: Stores unique survey questions.
5. Response\_details: Links responses to specific survey questions and their answers.

A diagram of a computer program

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Figure 2: Database Schema

Relational integrity ensures the consistency and reliability of data in a relational database by enforcing rules that govern how data is inserted, updated, or deleted across interconnected tables. In the designed schema for storing patient satisfaction survey data, primary keys play a critical role in maintaining uniqueness within individual tables. For instance, the survey\_id column in the surveys table uniquely identifies each survey record, while the id column in the providers table serves as the unique identifier for each healthcare provider. These keys are essential for distinguishing individual records and preventing duplication, ensuring the accuracy of the database.

Foreign keys are used to maintain relationships between tables by referencing primary keys in other tables. For example, the survey\_id column in the responses table is a foreign key that references the survey\_id column in the surveys table, linking survey responses to their respective surveys. Similarly, the provider\_id in the responses table references the id column in the providers table, establishing a connection between providers and the feedback associated with them. These relationships enable seamless data integration, allowing for complex queries that join information from multiple tables to provide meaningful insights.

To ensure data consistency, cascading actions are implemented for specific relationships. For instance, if a survey record is deleted from the surveys table, the database is configured to automatically delete all dependent records in the responses table that reference the deleted survey. This cascading behavior prevents orphaned records—data that lacks a valid parent—and maintains the logical integrity of the database. By enforcing these constraints, the relational database provides a robust framework for managing the data efficiently, supporting the scalability and reliability of the analysis pipeline.

The relational database design provides key benefits for managing and analyzing patient feedback efficiently. Its **scalability** allows for seamless additions of new survey years or provider details, ensuring the system grows with the clinic’s needs. **Query efficiency** is achieved by organizing data into separate tables, minimizing redundancy and enabling fast SQL queries for insights like provider performance trends. **Data integrity** is maintained through foreign key constraints, ensuring logical relationships between tables and preventing inconsistencies. This automated pipeline supports Longworth Dental-Bowmanville in continuously collecting and analyzing feedback, driving improved patient satisfaction and operational excellence.

1. Cross-Validation for Data Integrity

To ensure that the data collected via web scraping was accurately stored in the MySQL relational database, a robust cross-validation process was implemented. This process involved the use of a Python-based testing framework, which compared the scraped data with the data stored in the database to identify discrepancies. These validations ensured data accuracy, consistency, and reliability, forming a critical step in maintaining the integrity of the dataset.

The primary goal of cross-validation was to verify that all records in the relational database precisely matched the data extracted from the clinic's backend system. This step was essential to confirm that no errors occurred during the data extraction, transformation, and loading (ETL) process.

**Key Test Cases:**

1. **Survey Record Count Validation**: This test compared the total number of unique survey IDs in the CSV file (scraped data) with the number of survey records stored in the database. Any mismatch indicated missing or duplicate entries in the database.
2. **Provider Record Count Validation**: Provider names from the scraped data were normalized to remove inconsistencies such as extra spaces and special characters. The number of unique normalized providers in the CSV file was compared with the count of provider records in the database.
3. **Response Record Count Validation**: This test validated the number of unique survey-provider pairs in the database against the CSV file. These pairs represented individual responses, ensuring that all feedback entries were accurately captured.
4. **Question Record Count Validation**: The number of survey questions in the CSV file was compared with the records in the questions table of the database, ensuring that all questions were stored correctly.
5. **Data Integrity Validation**: This comprehensive test checked that each survey record in the database matched its corresponding entry in the CSV file for critical fields such as name, email, survey date, and appointment date. Date formats were standardized to ensure consistent comparisons, and null values in the email field were handled appropriately.

C. Data Cleaning and Preparation

Data cleaning and preparation were integral to ensuring the dataset's reliability and usability for analysis. Using Python's Pandas library, multiple steps were undertaken to refine the dataset, addressing missing values, normalization, column management, and imputation. These processes ensured that the dataset was clean, consistent, and focused on the relevant information needed for meaningful analysis.

**Handling Missing Data:**

Missing or null values were systematically addressed to maintain the dataset's completeness.

* For textual fields, missing values were replaced with placeholders such as 'None' to avoid analysis interruptions.
* For numerical columns, including survey question responses, missing values were replaced using **column averages**, preserving the overall distribution and trends in the data. For instance, if a question like "How satisfied were you with your dental treatment options?" had missing responses, these were filled with the average of that column.

**Dropping Unnecessary Columns**:

To streamline the dataset, columns irrelevant to the analysis were removed. This step ensured that only pertinent information, such as survey responses, satisfaction ratings, and provider details, was retained. For example, columns like contacted, ratingRaw, and other intermediary fields were dropped. This process reduced noise in the dataset, improved processing speed, and focused the analysis on meaningful metrics.

**Imputation for Missing Provider Ratings**:

Missing values in columns like "How would you rate your dentist?" and "How would you rate your hygienist?" were imputed using a provider-specific approach:

* If a provider (dentist or hygienist) was identified in the dataset, their average rating was calculated and used to fill in the missing values for that provider.
* If no provider was specified, the overall average rating for the respective professional type was used as a fallback. This ensured that imputed values remained contextually accurate and reflective of provider performance.

For key survey questions like "How satisfied were you with the amount of time spent in our waiting room?", missing values were replaced with column averages. This approach preserved the general distribution of satisfaction levels while ensuring no question responses were left blank.

D. Exploratory Data Analysis

Exploratory Data Analysis (EDA) provided an in-depth examination of the dataset to uncover trends, relationships, and potential areas for improvement. By leveraging descriptive statistics, correlation analysis, and visualizations, the EDA offered actionable insights into patient satisfaction and operational factors impacting Longworth Dental-Bowmanville.

1. A graph with colorful lines and a white background

   Description automatically generated with medium confidenceLine Chart of question Ratings

Figure 3: Trend of Question Ratings over time

The first step was to analyze trend of overall survey question ratings to gauge patient sentiment (Figure 3).

The chart highlights upward trends in average satisfaction for most aspects, such as greeting, treatment options, and comfort level. This suggests that the dental practice has consistently improved in these areas over time.

The aspect "how likely are you to refer friends and family" consistently shows strong performance, indicating good patient loyalty.

2020 appears to be a year with significant dips in satisfaction for waiting time and dentist ratings, possibly reflecting challenges during the pandemic.

Post-pandemic years (2021–2024) show recovery and improvements, with ratings for most questions stabilizing above 9 except for the dentist ratings.

1. Distribution of Providers Performance

To understand how the dentist and hygienists have performed, histograms of their ratings were created (Figure 4).

The visualization showed that the majority of providers ratings clustered in the range of 9-10, indicating a generally high

A graph of a person's rate

Description automatically generatedlevel of satisfaction among patients. A histogram revealed a positively skewed distribution with few low ratings.

Figure 4: Distribution of Dentists and Hygienists performance

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Figure 5: Correlation heatmap

1. Correlation Analysis

The correlation matrix (Figure 5) provides insights into relationships between different patient satisfaction factors, ranging from strong to weak. Notably, the strongest correlation (0.68) exists between patient comfort during appointments and hygienist ratings, emphasizing the importance of hygienist performance in shaping patient experiences. Similarly, satisfaction with treatment options strongly correlates with the likelihood of referral (0.55), highlighting the role of perceived service quality in patient loyalty. Moderate correlations, such as greeting satisfaction and referral likelihood (0.51), underline the value of a positive first impression. Conversely, weaker correlations, like wait time satisfaction and dentist ratings (0.28), suggest that while important, certain factors may have less impact on overall patient satisfaction. These insights can guide clinics to focus on priority areas like hygienist training, treatment enhancements, and reception desk interactions to improve patient loyalty and overall satisfaction.

1. A graph with blue and black bars

   Description automatically generated with medium confidenceComments vs No-Comments on surveys

Figure 6: Comments VS No-comments

The bar chart (Figure 6) showed that the total number of surveys has significantly increased over time, peaking in 2024, suggesting improved patient participation in providing feedback.

The proportion of surveys with comments has also steadily grown from 26 in 2020 to 165 in 2024. This rise reflects increasing patient willingness to provide qualitative feedback, which can be invaluable for service improvement.

Surveys without comments are higher in number across all years but show a relatively slower growth compared to surveys with comments, as seen in the transition from 123 (2019) to 286 (2024).

Although, the number of total surveys with comments showed a steady growth, the number of surveys without comments remained significant suggesting the need to design the surveys in a way which would engage the patients writing it and ultimately get higher percentage of complete surveys.

E. Sentiment Analysis

Sentiment analysis was conducted on patient feedback to categorize comments into positive, neutral, and negative sentiments. This process involved tokenizing the text, removing stop words, and applying sentiment scoring using VADER. Positive sentiments highlighted satisfaction with professionalism, friendliness, and cleanliness, while negative sentiments often revolved around long wait times or dissatisfaction with billing processes. Neutral comments typically described routine experiences without strong opinions. This breakdown provided valuable insights into patient perceptions and areas needing improvement.

VADER was the best option for this analysis for its recognition in performing with greater accuracy when it comes to short comments and less data.

F. Dashboard Creation Using Power BI

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Description automatically generated In this section, we focus on the process of creating an interactive dashboard using Power BI, which allows for comprehensive analysis and visualization of the survey data. The dashboard serves as an essential tool for decision-making and allows stakeholders to quickly identify trends, patterns, and areas for improvement within the clinic's operations. With Power BI, we can consolidate the survey results, including patient satisfaction scores and qualitative comments, into a visually appealing and user-friendly interface.

Figure 7: PowerBi dashboard Snippet

**Key Visualizations in the Dashboard:**

The Power BI dashboard included several key visualizations designed to offer actionable insights:

1. Trend of Survey Questions

The line chart representing survey ratings was designed to identify trends in the clinic's performance across various departments over time. The data revealed that most of the ratings fell within the higher range of 9-10, indicating a positive overall performance for each clinical department. To enhance user interaction with the visualizations, filters for year and month were incorporated, enabling a more dynamic exploration of the data within Power BI.

It is important to note that no aggregation methods, such as mean or median, were applied to the analysis. This decision was made because the ratings are subjective and reflect individual experiences. Different patients may rate similar dental treatments differently based on their personal experiences, so aggregating the data could obscure these individual variations. By retaining the original ratings without aggregation, we ensure that the nuances in patient feedback are preserved and accurately represented.

2) Dentists and hygienists’ performance

The "Dentists vs Hygienists" stacked bar chart illustrates the ratings given to the dental professionals involved in providing treatments, specifically comparing dentists and hygienists who work together as a pair. This chart allows users to filter the data by individual dentist, hygienist, or a combination of both, enabling a detailed view of how patients rated the performance of each professional, whether working alone or together. By using the filters, users can analyze the performance of specific dentist-hygienist pairs and gain insights into how each professional contributes to patient satisfaction. This dynamic filtering capability helps provide a more granular understanding of the factors influencing patient experiences with dental care.

3) Comments Vs No comments

The "Comments vs No Comments" pie chart offers a straightforward comparison between surveys that include comments and those that do not. This visual representation provides a clear overview of the overall number of surveys with and without feedback. Additionally, it allows for further analysis by using the year and month filters to compare the data for specific time periods. This enables a more detailed exploration of how patient feedback may vary across different months or years, offering valuable insights into trends in comment submission over time.

4) Total surveys by sentiments

Leveraging sentiment analysis through VADER (Valence Aware Dictionary and sEntiment Reasoner), a clustered bar chart has been created to compare the positive, negative, and neutral comments received in surveys over the years. This visualization allows the clinic to easily identify which years were the most successful in terms of patient sentiment and which years saw more negative feedback. By analyzing these trends, the clinic can make data-driven decisions to improve areas of concern and replicate the successes of the more positively rated years. This method provides a clear overview of patient sentiment over time, helping the clinic target areas for improvement and further enhance the overall patient experience in the coming years.

5) Comparison of Providers Performance using Comments Sentiment

This area chart visualizes the comparison of comment types (positive, negative, and neutral) received by each dentist-hygienist pair over time. It provides a clear picture of how each pair has been performing, based on the feedback from patients. By tracking this data across multiple years, the clinic can assess the individual and collective performance of each pair and identify patterns in patient satisfaction. The chart helps pinpoint specific pairs that may need further training or adjustments in their practices to improve the quality of care and service, as reflected by patient comments. Additionally, the chart can highlight successful teams, allowing the clinic to recognize and replicate best practices. This visual analysis aids in making targeted decisions for continuous improvement in patient care and satisfaction.

6) Word Cloud

A word cloud was generated from the comments provided in the surveys to help visualize the key areas where the clinic performed well and where improvements could be made. The size of each word in the cloud reflects the frequency with which it appeared in the comments, making it easier to identify the most commonly mentioned aspects of the clinic's service. This can reveal both positive feedback, such as "friendly," "professional," or "comfortable," as well as areas that might require attention, such as "wait time," "communication," or "pain management."

In Power BI, the word cloud can be further refined using filters based on sentiment (positive, neutral, or negative) and by specific years or months. This functionality allows the clinic to drill down into specific time periods, providing more focused insights into how patient perceptions have changed over time or how certain aspects of service have improved or declined. This dynamic feature makes it easier for the clinic to make data-driven decisions aimed at enhancing patient care and satisfaction, based on direct feedback from patients.

1. RESULTS

The analysis of patient satisfaction surveys collected from Longworth Dental-Bowmanville between 2019 and 2024 provided significant insights into patient experiences, clinic performance, and areas for improvement. The results are categorized into key themes derived from the data:

1. Trends in Patient Satisfaction

**Positive Overall Ratings**: Survey responses showed an upward trend in satisfaction over the five years, especially in areas like treatment options, greeting quality, and overall patient comfort. Most average ratings consistently scored above 9, indicating strong performance in these domains.

**Impact of the Pandemic**: 2020 exhibited a dip in ratings, particularly for waiting room satisfaction and provider performance, likely reflecting operational challenges during the COVID-19 pandemic. Subsequent years saw recovery and stabilization.

1. Provider Performance

**Hygienists as Key Drivers of Satisfaction**: Correlation analysis revealed a strong positive relationship (correlation coefficient: 0.68) between hygienist performance and patient comfort during appointments. This highlights the critical role of hygienists in shaping positive patient experiences.

**Distribution of Provider Ratings**: Ratings for both dentists and hygienists were predominantly clustered between 9 and 10, signifying general satisfaction with provider performance. However, a small fraction of low ratings identified areas for targeted improvement.

1. Qualitative Feedback Insights (Sentiment Analysis):

**Positive Comments**: Highlighted attributes like professionalism, friendliness, and clinic cleanliness.

**Negative Comments**: Common issues included dissatisfaction with wait times, financial communication, and appointment delays. Specific keywords like "billing," "time," and "uncomfortable" frequently appeared in negative sentiments.

**Neutral Comments**: Typically contained routine feedback without strong opinions.

**Word Cloud Analysis**: Key positive terms such as "friendly," "professional," and "clean" stood out, whereas negative terms like "waiting" and "billing" pointed to areas needing attention.

1. Engagement Trend

**Increased Survey Participation**: The number of surveys with qualitative comments increased from 26 in 2020 to 165 in 2024, reflecting greater patient willingness to share detailed feedback. However, surveys without comments remained significant, indicating scope for improving engagement through survey design.

**Feedback Engagement Patterns**: Over time, a larger proportion of patients opted to provide comments, indicating an increasing value placed on qualitative feedback.

1. Correlation Analysis

**Key Satisfaction Drivers**: Strong correlations were observed between treatment option satisfaction and the likelihood of referrals (correlation coefficient: 0.55).

Greeting quality and overall satisfaction, underlining the importance of first impressions.

**Weaker Correlations**: Factors like waiting time showed weaker correlations with overall satisfaction, suggesting these may be secondary concerns for patients.

1. Interactive Dashboard Insights

The Power BI dashboard provided actionable insights through dynamic visualizations:

**Trends Over Time**: Line charts revealed performance improvements post-pandemic.

**Provider Comparisons**: Bar and area charts enabled detailed analysis of dentist-hygienist pairs, identifying high-performing teams and areas for improvement.

**Sentiment Distribution**: Clustered bar charts showed annual shifts in positive, neutral, and negative feedback. While the positive comments gradually increased from 60 in 2019 to 149 in 2024, the negative comments persisted suggesting the need to improvements.

**Word Cloud Visualization**: The Word Cloud visualization offers a clear representation of the recurring themes found in patient comments. The analysis of the word cloud reveals that negative comments predominantly contain terms such as "finance," "painful," "waiting time," and "uncomfortable." These words indicate common pain points for patients who may have had unpleasant experiences during their visits. Such negative feedback highlights key areas where the clinic could improve its services, such as addressing patient concerns about financial aspects, reducing wait times, and improving patient comfort during treatment.

1. SUGGESTIONS FOR IMPROVEMENT

Based on the detailed analysis of patient satisfaction surveys, the following suggestions are proposed to address identified challenges, enhance patient experiences, and sustain high standards of care at Longworth Dental-Bowmanville.

1. Improvement in Financial Communication

**Transparent Billing Practices**: Implement clear and detailed billing policies that outline all costs upfront. This can reduce patient dissatisfaction related to unexpected charges.

**Proactive Discussions**: Encourage staff to discuss treatment costs and payment options before appointments, ensuring patients are well-informed.

**Digital Tools**: Introduce online tools or mobile apps that provide real-time estimates for procedures, making financial communication more accessible and efficient.

1. Reduction in Waiting Times

**Enhanced Scheduling**: Use predictive analytics to optimize appointment scheduling and minimize wait times. Allocate adequate buffer periods to manage delays effectively.

**Queue Management Systems**: Introduce digital queue tracking systems that inform patients of expected wait times, reducing frustration.

**Staff Allocation**: During peak hours, allocate additional resources or extend working hours to manage patient flow better.

1. Encouraging Comprehensive Feedback

**Survey Design Optimization**: Redesign surveys to make them more engaging and user-friendly. For instance: Use a mix of closed and open-ended questions to capture both structured ratings and qualitative feedback.

Include optional sections for specific feedback areas, allowing patients to focus on aspects most relevant to their experience.

**Incentivization**: Offer small incentives, such as discounts on future visits or entries into a prize draw, to encourage more patients to complete surveys.

**Real-Time Feedback Collection**: Provide digital kiosks or mobile-friendly survey options at the clinic for immediate post-appointment feedback.

1. Focus on Training and Professional Development

**Communication Skills Training**: Provide regular workshops for dentists, hygienists, and administrative staff on effective patient communication, emphasizing empathy and clarity.

**Handling Negative Feedback**: Train staff to address patient concerns proactively and resolve complaints efficiently, fostering trust.

**Performance Monitoring**: Use dashboard insights to identify staff members with recurring negative feedback and provide targeted coaching.

1. Enhanced Patient Comfort During Visits

**Waiting Area Upgrades**: Invest in improving the ambiance and amenities of the waiting room, such as comfortable seating, entertainment options, and refreshments.

**Personalized Experiences**: Provide tailored care by maintaining detailed patient profiles, including preferences and prior feedback, to create a more personalized experience.

1. Streamlining Appointment Management

**Online Booking Enhancements**: Enhance the clinic’s online booking system to include real-time availability updates, appointment reminders, and rescheduling options.

**Pre-Appointment Communication**: Send patients reminders about documents or preparations needed for their visit to avoid last-minute delays.

1. Leveraging Technology for Continuous Improvement

**Real-Time Analytics**: Implement systems to monitor survey feedback in real time, enabling immediate action on patient concerns.

**Sentiment Analysis Integration**: Automate sentiment analysis on survey comments to track emotional trends and address negative sentiments promptly.

**Predictive Analytics**: Use historical data to predict future satisfaction trends and proactively address potential issues.

1. Building Patient Relationships

**Regular Follow-Ups**: Establish a practice of following up with patients after treatments to ensure satisfaction and gather additional feedback.

**Patient Engagement Initiatives**: Host informational events, newsletters, or workshops to educate patients on oral health, creating a stronger sense of community and trust.

1. Data Accessibility and Scalability

**Survey Data Structuring**: Restructure survey variables during data storage to enhance accessibility and streamline analysis. Use scalable cloud storage solutions for better management and automation.

**Dashboard Customization**: Expand the Power BI dashboard with additional filters and visualizations tailored to specific user roles, such as management or operational staff.

1. Addressing Recurring Negative Sentiments

**Focused Interventions**: Identify patterns in negative feedback (e.g., billing, waiting times) and target these areas with actionable solutions.

**Patient Communication Channels**: Introduce a feedback resolution portal where patients can report issues directly, ensuring their concerns are addressed promptly.

By adopting these suggestions, Longworth Dental-Bowmanville can address persistent challenges, elevate patient satisfaction, and create a robust system for continuous improvement. These recommendations emphasize a data-driven and patient-centric approach, ensuring both operational excellence and positive patient outcomes.

1. FUTURE ASPECTS

The "Dental Analysis" project offers numerous opportunities for future advancements to enhance the quality of patient care, improve operational efficiency, and leverage data for predictive insights. Below are the potential areas of growth and innovation:

1. Cloud-Based Data Management

**Scalability**: Transitioning the survey database to cloud platforms (e.g., AWS, Azure) can accommodate growing data volumes as the clinic expands.

**Automation**: Automate data integration processes, such as scraping, storage, and reporting, to reduce manual intervention and ensure real-time data updates.

**Data Security**: Implement advanced security protocols on cloud platforms to ensure HIPAA compliance and protect patient confidentiality.

1. Real-Time Feedback and Analytics

**Instant Sentiment Monitoring**: Enable real-time sentiment analysis of patient comments, allowing the clinic to address concerns immediately and improve patient experiences dynamically.

**Dashboard Enhancements**: Expand the interactive Power BI dashboard to include real-time metrics, such as patient flow and satisfaction trends during operational hours.

1. Predictive Analytics and AI Integration

**Patient Satisfaction Forecasting**: Utilize machine learning models to predict satisfaction scores based on historical trends, seasonal patterns, and provider performance.

**Appointment Optimization**: Develop AI-driven tools to optimize appointment scheduling, minimizing wait times and maximizing resource utilization.

**Targeted Interventions**: Predict patient dissatisfaction triggers and proactively implement corrective measures, such as personalized communication or improved amenities.

1. Personalization of Patient Experience

**Tailored Recommendations**: Use patient data to provide personalized treatment recommendations, enhancing trust and satisfaction.

**Customized Surveys**: Introduce dynamic surveys that adapt questions based on patient history, visit type, or previous feedback to gather more relevant insights.

1. Enhanced Visualization and Reporting

**Granular Insights**: Develop detailed visualizations focusing on specific demographics, treatment types, or satisfaction factors to better understand patient needs.

**Mobile Dashboards**: Create mobile-friendly versions of the Power BI dashboard for on-the-go access by clinic staff and management.

1. Integration with Other Healthcare Systems

**Electronic Health Records (EHR**): Link patient feedback data with EHR systems to provide holistic views of patient experiences and outcomes.

**Multi-Clinic Analysis**: Expand the framework to analyze feedback across multiple locations, enabling broader insights into organizational performance.

1. Advanced Patient Engagement Tools

**Chatbots and Virtual Assistants**: Deploy AI-based chatbots to address patient queries, collect feedback, and schedule appointments efficiently.

**Gamification of Surveys**: Introduce gamification elements, such as reward points or leaderboards, to motivate patients to provide detailed and constructive feedback.

1. Training and Development Analytics

**Provider Performance Tracking**: Use feedback data to assess and improve individual provider performance through targeted training programs.

**Behavioral Insights**: Leverage sentiment analysis to provide insights into interpersonal factors influencing patient satisfaction, guiding behavioral improvements.

1. Expanding the Scope of Feedback

**Social Media Monitoring**: Extend sentiment analysis to social media and online reviews, capturing a broader spectrum of patient opinions.

**Video Feedback Analysis**: Allow patients to submit video feedback, which can be analyzed using AI tools for richer emotional and content analysis.

1. CONCLUSION

The "Dental Analysis" project successfully demonstrated the transformative potential of data analytics in enhancing patient care and operational efficiency at Longworth Dental-Bowmanville. By systematically analyzing survey data collected over five years (2019–2024), the study identified critical insights into patient satisfaction, provider performance, and areas for improvement.

The findings highlighted strong patient loyalty, particularly with hygienist care, and consistently high satisfaction ratings in treatment quality and patient comfort. However, challenges such as financial communication, appointment scheduling, and waiting room management emerged as key areas requiring targeted interventions. The integration of advanced sentiment analysis, correlation metrics, and dynamic Power BI dashboards ensured a comprehensive understanding of patient feedback, empowering the clinic to make data-driven decisions.

Through interactive visualizations and detailed qualitative feedback analysis, the project emphasized the importance of adopting a patient-centric approach in healthcare. Real-time insights from the dashboard and sentiment analysis provided actionable strategies for addressing recurring concerns and enhancing overall patient satisfaction.

Looking ahead, the project offers a robust foundation for future growth, including cloud-based data management, real-time analytics, and predictive modeling. These advancements, combined with a commitment to continuous improvement, can position Longworth Dental-Bowmanville as a leader in innovative, patient-focused care.

In conclusion, the "Dental Analysis" project reaffirms the value of leveraging data to drive operational excellence and improve patient outcomes. By addressing identified challenges and building upon existing strengths, the clinic can achieve sustainable growth and maintain high standards of dental care.

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