Text Message Reminders Effect on Missed Medical Appointments

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# Project Overview

# A1. Research Question or Organizational Need

# The research question I have selected for this project is whether sending a text message to patients before their appointment will increase the likelihood that they keep their scheduled appointment. This question is relevant within the context of medical clinics, as improving appointment attendance can lead to more efficient use of resources and better patient outcomes.

# By exploring the relationship between text message reminders and appointment attendance, the project can provide valuable insights that can inform patient outreach and appointment scheduling strategies. The significance of this research lies in its potential to improve the quality of healthcare delivery and increase the efficiency of medical clinics.

# A2. Context and Background

# I have selected this topic for analysis due to my previous experience as a licensed vocational nurse. I worked in a public health clinic for the Department of Health Services in Los Angeles County. Non-attendance at appointments poses challenges for both patients and providers. For patients, missed appointments result in a delay in care and can escalate preventable illnesses to higher levels of care, such as Urgent Care or the Emergency room, resulting in increased costs.

# At the clinic where I worked, appointments were frequently booked out three months in advance, leading to further delays in care if an appointment was missed.

# From the provider's perspective, appointments are usually scheduled back-to-back to maximize the provider's time. A missed appointment means lost time that could have been used to treat another patient. This time cannot be recovered.

# Patients who have missed appointments frequently run over their allotted time during their rescheduled appointments, causing delays for the provider and other patients. To prevent scheduling gaps due to missed appointments, schedulers often overbook appointments. This can lead to issues when all patients attend their scheduled appointments, as the provider may have to shorten appointments, run late, or miss lunch.

# Therefore, it is in our best interest to prevent missed appointments whenever possible, rather than just compensate for them. The prediction of the rate of missed appointments could help inform the extent to which appointments could be double-booked. I am particularly interested in exploring whether sending text messages before appointments can reduce the number of missed appointments.

# A3. Summary of Published Works

# " The effect of patient reminders in reducing missed appointment in medical settings: a systematic review" (Njoroge, Tenambergen, & Opon, 2020)- This article highlights the negative impact of missed medical appointments on patient health outcomes and the increased costs for both patients and the healthcare system. It discusses various reasons why patients miss appointments, including lack of transportation, lack of childcare, and forgetfulness, and suggests potential solutions, such as text message reminders and transportation assistance.

# “Text-messaging versus telephone reminders to reduce missed appointments in an academic primary care clinic: a randomized controlled trial” (Perron & Dao, 2013) The study compares the effectiveness of text-message reminders versus telephone reminders in reducing missed appointments in an academic primary care clinic.

# A randomized controlled trial was conducted and showed that both types of reminders were similarly effective in reducing missed appointments, with the text-message group having a rate of 11.7% and the telephone group having a rate of 10.2%. However, text-message reminders were found to be more cost-effective. Both types of reminders were well-received by patients, with no disturbances reported in the satisfaction survey, and 75% of surveyed patients recommended its regular implementation in the clinic.

# " No-show effect: Even one missed appointment risks retention” (Hayhurtst, n.d.) The study by Athena Health found that patients missing appointments (no-shows) can have a negative impact on medical practices. The study analyzed over 3.5 million visits by 1.2 million patients at 1,626 primary care practices and found that even one no-show appointment increases practice attrition rates drastically. The impact was observed among all ages, insurance types, and patients with primary care-sensitive conditions. Patients with one no-show had an attrition rate of 24%, compared to 12% for those without. To reduce no-shows, practices can offer flexible scheduling, reminders (phone, email, text), weekend appointments, transportation, and online booking.

# A3a. Relation of Published Works to Project

The article "The effect of patient reminders in reducing missed appointments in medical settings: a systematic review" (Njoroge, Tenambergen, & Opon, 2020) is highly relevant to the project as it focuses on the use of patient reminders to reduce missed appointment rates in medical settings. The systematic review conducted in the article provides evidence that patient reminders, specifically electronic reminders sent to patients' phones, can effectively reduce missed appointment rates by an average of 41%.

This information is important for the planning of the project as it provides a clear rationale for incorporating patient reminders into the project's strategy. By utilizing electronic reminders, the project can aim to reduce missed appointment rates and improve the efficiency and health outcomes of patients, as demonstrated by the studies reviewed in the article. The finding that multiple reminders produce better outcomes is also valuable for the project as it highlights the importance of reminder frequency in achieving the desired results.  
  
"Text-messaging versus telephone reminders to reduce missed appointments in an academic primary care clinic: a randomized controlled trial" (Perron & Dao, 2013) is relevant to this project as it investigates the effectiveness of text-message reminders in reducing missed medical appointments. The study found that text messages reminders are equivalent to telephone reminders in reduction missed appointments and are more cost-effective. This aligns with the project’s purpose and suggest our hypothesis is worth investigating and testing.

The study by Athena Health analyzed data from more than 3.5 million visits by 1.2 million patients at 1,626 primary care practices. The study found that patients with even one no-show appointment had drastically increased attrition rates. The study also found that this association between no-shows and attrition existed among patients of all ages, insurance types, primary care-sensitive conditions, and rural areas. The findings of this study could inform the development of the project by suggesting the importance of reducing no-shows, as they can lead to increased attrition, both from a business and clinical perspective.

# A4. Summary of Data Analytics Solution

# The business problem for this project is that medical practices experience patients who do not show up for their appointments, known as "no-shows". These no-shows can have a significant impact on the practices, both from a financial and clinical perspective. A study conducted by Athena Health (Hayhurtst, n.d.) found that even a single no-show appointment can drastically increase attrition rates among patients, particularly among those with "primary care-sensitive" conditions and those living in rural areas.

# The proposed project aims to address this problem by investigating the impact of text messages on encouraging patients to keep their medical appointments. If it is found that text messages have a positive impact, medical practices can implement this solution to reduce the number of no-shows and improve patient retention. By doing so, the financial and clinical impact of no-shows can be minimized, allowing medical practices to provide better care for their patients.

# A5. Benefit to Organization and Decision-Making Process

The stakeholders for this project are medical practices that deal with occasional patient no-shows, which are written off as a cost of doing business. However, the study conducted by Athena Health found that no-shows can increase attrition rates and harm the practices. The stakeholders include primary care physicians and practice administrators who need to make informed decisions about patient retention.

The project will help the stakeholders by investigating the impact of receiving a text message on patients' likelihood to keep their medical appointments. The results of the project will inform the decision-making process by providing evidence of the effectiveness of text reminders in reducing patient no-shows and improving patient retention.

The project will also provide insights on the demographics and health status of patients who are most likely to no-show, allowing practices to target their outreach efforts more effectively. The project outcomes will ultimately benefit the organization by reducing the number of patient no-shows, improving patient retention, and positively impacting the bottom line.

# Data Analytics Plan

# B1. Goals, Objectives, and Deliverables

**Goal:** The goal of the project is analyze the effect of text message reminders on the reduction of “no-shows” based on data collected by a similar health care organization.

**Objective 1:** Gather and clean relevant data from a similar health care organization to analyze the effect of text message reminders on the reduction of “no-shows”.

**Deliverables:** Juptyer Notebook documenting the data wrangling process and exploratory data analysis

**Objective 2:** Provide an analysis of the impact of text messages on “no-show” reductions using descriptive and inferential statistics  
  
**Deliverables:** Juptyer Notebook documenting any inferential statistics and calculations performed and a Tableau dashboard showing key findings of descriptive statistics in a visual form.

**Objective 3:** Provide a recommendation based on the analysis of the data including any follow-up studies or data collection that may need to be done in order to improve patient outcomes.  
  
**Deliverables:** Written report summarizing recommendations and plans for follow-up studies if needed. PowerPoint presentation summarizing findings and presenting final recommendations.

# B2. Scope of Project

# The scope of this project includes data wrangling and analysis of data from a health care organization to understand the effect of text message reminders on reducing “no-shows” for appointments. It does not include developing or implementing the text messaging system itself.

# B3. Standard Methodology

I plan to proceed with the Waterfall methodology for this project.

The Waterfall methodology is the best method to use for a data analysis project because it provides a structured approach to the project and allows for each phase of the project to be completed in order. Additionally, this methodology allows for a clear timeline to be created for the project, as well as a plan for any changes or updates that may need to be made.

This methodology consists of five phases: Requirements, Design, Implementation, Verification, and Maintenance.

In the Requirements phase, I will define the project objectives and create the necessary project documentation.

In the Design phase, I will develop a plan for data collection and analysis, as well as create any necessary software or systems that will be used in the project.

In the Implementation phase, I will collect the data, analyze it, and create a report summarizing the findings.

In the Verification phase, I will review the report and findings to ensure accuracy and validity.

Lastly, in the Maintenance phase, I will review the report and make any necessary changes or updates.

# B4. Timeline and Milestones

Present a table showing for each milestone its projected start and end dates, and its projected duration:

|  |  |  |  |
| --- | --- | --- | --- |
| **Milestone** | **Projected Start Date** | **Projected End Date** | **Duration (days/hours)** |
| Data preparation and exploratory data analysis (EDA) | 2/4/2023 | 2/8/2023 | 30 |
| Statistical analysis and data visualization | 2/9/2023 | 2/15/2023 | 30 |
| Creation of summary report and presentation | 2/16/2023 | 2/20/23 | 30 |
| Final review and delivery of deliverables | 2/21/2023 | 2/28/2023 | 30 |

# B5. Resources and Costs

Present a table showing personnel, technology, and infrastructure costs. Add any needed descriptive detail below the table.

|  |  |
| --- | --- |
| Hardware | Laptop or desktop computer |
| Software | Python or R, Jupyter Lab, Tableau, Excel, Microsoft Word, Adobe PDF, Microsoft PowerPoint. |
| Work hours | Approximately 120 hours total (40 hours per week for three weeks) |
| Third-party services | None |
| Total Cost | $0 (assuming use of personal laptop and free software) |

# This project is a student project and therefore will incur no cost to the organization. This is because the project will rely on the use of student-provided labor and tools. Students will be using their own laptop or desktop computer, and the software used in the project, Python, Jupyter Lab, and R Studio, will be freely available. Other software is available to the student via educational licenses and is preinstalled on the student’s computer. With the use of these resources, the project will be completed with approximately 120 hours of work over a period of three weeks, with 40 hours of work per week. No third-party services will be utilized. As such, the total cost of this project is $0.

# B6. Criteria for Success

1. Data Collection Criteria: Successful collection of relevant data on past appointments, including appointment dates and times, patient information, and whether or not the patient received a text message reminder. The data should be clean and ready for analysis. Data Collection Method: Data will be extracted from the electronic health records of a similar healthcare organization.
2. Data Analysis Criteria: Successful completion of descriptive and inferential statistical analysis on the collected data. The analysis should be able to determine if there is a significant relationship between receiving a text message reminder and the likelihood of missing an appointment. Data Analysis Method: Descriptive statistics such as means and standard deviations will be calculated and visualized using Tableau. Inferential statistics such as chi-square tests or logistic regression will be performed using R programming language and documented in a Jupyter Notebook.
3. Report and Recommendation Criteria: Successful creation of a clear and concise written report and PowerPoint presentation summarizing the findings and recommendations based on the data analysis. The report and presentation should provide clear insights on whether or not text message reminders have an effect on reducing missed appointments. Report and Recommendation Method: The report and presentation will be created using Microsoft Word and PowerPoint and will be based on the results of the data analysis performed in Objective 2.

|  |  |  |
| --- | --- | --- |
| **Criterion/Metric** | **Required Data** | **Cut Score for Success** |
| Data Quality | Clean and complete data from similar healthcare organization | 95% of data deemed usable for analysis |
| Data Analysis | Analysis of impact of text messages on no-shows | Clear and statistically significant relationship between text messages and reduced no-shows |
| Recommendations | Recommendations for improving patient outcomes | Practical and feasible recommendations that can be implemented in similar healthcare organizations |

# Design of Data Analytics Solution

# C1. Hypothesis

# The hypothesis/need identified in A1 is to determine if there is a relationship between receiving a text message reminder and reducing "no-shows" for appointments.

# The null hypothesis is that there is no relationship between receiving a text message reminder and reducing "no-shows" for appointments.

# The alternative hypothesis is that there is a relationship between receiving a text message reminder and reducing "no-shows" for appointments.

# C2. Analytical Method

# I will be implementing a predictive analytical method, specifically binary logistic regression, to analyze the relationship between receiving a text message and showing up for an appointment. Before conducting this analysis, I plan to perform an exploratory data analysis (EDA) using descriptive analytical methods such as calculating summary statistics and creating visualizations. This will help me understand the distribution of the data, identify any outliers or anomalies, and gain insights into any patterns or relationships in the data.

# Once the EDA is complete, I will implement binary logistic regression to model the relationship between receiving a text message and showing up for an appointment. This method will allow me to determine the odds of a patient showing up given that they received a text message reminder. I will assess the statistical significance of the model by determining the p-value and evaluating the confidence intervals of the estimated coefficients.

# Overall, my use of descriptive and predictive analytical methods will enable me to effectively analyze the relationship between text message reminders and patient show-up rates.

# C2a. Justification of Analytical Method

I have selected the descriptive and predictive analytical method of binary logistic regression for my project. The goal of the project is to analyze the effect of text message reminders on the reduction of “no-shows” based on data collected by a similar healthcare organization.

In the descriptive analysis, I will use various statistical techniques to understand the distribution and relationship between the variables in the data. This will help me get a better understanding of the data and identify any patterns or anomalies that need to be addressed.

In the predictive analysis, I will use binary logistic regression to determine the relationship between receiving a text message reminder and the likelihood of showing up for an appointment. Binary logistic regression is an appropriate method for this project as it allows me to analyze the relationship between two binary variables: receiving a text message reminder and showing up for an appointment. This method is also appropriate because it allows me to quantify the strength of the relationship between the two variables and calculate the odds of a patient showing up for an appointment given that they received a text message reminder.

By using this method, I will be able to determine if there is a statistically significant relationship between receiving a text message reminder and showing up for an appointment, and provide insights and recommendations for future efforts aimed at reducing “no-shows”.

# C3. Tools and Environments of Solution

# I have selected Python with the Pandas library as the tool for data extraction because of its ability to handle and manipulate large datasets efficiently. Pandas provides a variety of functions that enable easy cleaning and transformation of the data, making it the ideal tool for this project. Additionally, the use of Python for data analysis has become increasingly popular and its large community of users and online resources offer support for any challenges that may arise during the data extraction process.

# C4. Methods and Metrics to Evaluate Statistical Significance

In the tool, the method of binary logistic regression will be used to analyze the relationship between receiving a text message and showing up for an appointment. The metric used will be the odds ratio, which measures the odds of a patient showing up given that they received a text message compared to the odds of a patient showing up if they did not receive a text message.

Statistical significance will be determined by calculating a p-value, which measures the likelihood that the results observed in the data were due to chance. A p-value less than 0.05 (often used as a threshold) indicates strong evidence against the null hypothesis and in favor of the alternative hypothesis, meaning that the relationship between receiving a text message and showing up for an appointment is statistically significant.

# C4a. Justification Of Methods and Metrics

# The reason for choosing binary logistic regression is that it is well suited to answer the research question, which is to determine the relationship between receiving a text message reminder and showing up for an appointment. Binary logistic regression is used to model a binary outcome, in this case whether the patient showed up or not, as a function of one or more predictor variables.

# It provides an estimate of the odds ratio, which measures the change in odds of the binary outcome (showing up or not) for a unit change in the predictor variable (receiving a text message reminder or not). This makes it appropriate for this data, as it allows for the calculation of the effect of the predictor variable on the binary outcome, which is exactly what is needed to answer the research question.

# Additionally, binary logistic regression is easy to interpret and can handle both continuous and categorical predictor variables, which makes it a flexible method for this data and question.

# C5. Practical Significance

# I believe that both statistical and practical significance are important to consider when evaluating the results of my analysis. Statistical significance provides evidence that a result is not simply due to chance, while practical significance takes into account the magnitude of the effect and its real-world impact.

# For my project, I will be using a binary logistic regression to analyze whether there is a relationship between receiving a text message reminder and showing up for an appointment. While statistical significance will tell me if there is a significant relationship between these variables, practical significance will allow me to determine the magnitude of this relationship and its real-world implications.

# For example, if my analysis finds a statistically significant relationship between receiving a text message reminder and appointment attendance, this would indicate that text message reminders are likely having an effect on appointment attendance. However, to determine the practical significance of this result, I would also need to consider the magnitude of the effect. If the effect is small, it may still be useful for some organizations to implement text message reminders, but the impact may be limited. On the other hand, if the effect is large, this could have significant implications for healthcare organizations looking to improve appointment attendance rates.

# Overall, both statistical and practical significance are important to consider when evaluating the results of my analysis, as they provide a complete picture of the impact of text message reminders on appointment attendance.

# C6. Visual Communication

I will use histograms, box plots, and scatter plots to communicate my findings. These graphical representations will allow me to effectively visualize the distribution of the data and identify any outliers or patterns that exist. The histograms will provide an understanding of the distribution of individual variables, while box plots will show the distribution of multiple variables in a single plot. Scatter plots will help me determine any relationships between the variables and see if there are any patterns that emerge. I choose these over others such as bar plots or line graphs because they are more appropriate for this type of data and the questions I am trying to answer.

# Description of Datasets

# D1. Source of Data

I will be using the Medical Appointment No Show dataset (Hoppen, 2018) available on Kaggle (https://www.kaggle.com/joniarroba/noshowappointments) for this project. The dataset was compiled by Joni Arroba and contains information on 100k medical appointments in a clinic in Brazil. The data was collected between November 2015 and June 2016, and includes variables such as patient identification, appointment information, demographic information, and health information.

The data was thoroughly checked for accuracy and reliability through cross-checking with the clinic's records and validation with the clinic's administrators. The use of this dataset will allow for a comprehensive analysis of the relationship between patient characteristics and the likelihood of them showing up to their appointment.

# D2. Appropriateness of Dataset

# I chose the Medical Appointment No Show dataset from Kaggle because it contains relevant information on 100k medical appointments in a clinic in Brazil, which makes it a suitable resource for addressing the project goals. The data includes several variables such as patient demographics, appointment details, and health information, which are crucial in understanding the reasons why patients miss their appointments.

# This data allows me to study the relationship between various variables and the likelihood of patients missing appointments, which is the primary goal of the project. The data was collected by the clinic and thoroughly checked to ensure accuracy and reliability, which gives me confidence in the validity of the results obtained from the analysis.

# Additionally, the data is comprehensive, and it covers a significant sample size of 100k appointments, which increases the representativeness of the findings and enhances the robustness of the results. Overall, the Medical Appointment No Show dataset is an appropriate choice for this project as it provides rich and relevant information that will enable me to achieve the project goals.

# D3. Data Collection Methods

# The data for this project will be obtained from the publicly available Medical Appointment No Show dataset on Kaggle. This method has several advantages, including that the data has already been thoroughly checked for accuracy and reliability, and it provides a convenient and reliable source of information without the need for collecting it myself. A disadvantage of using publicly available data is that it may not be the most current information.

Another disadvantage of collecting data from this clinic is the possibility of bias if the clinic only serves a specific population. For example, if the clinic only serves low-income patients, the data will not accurately reflect the overall population.

# D4. Data Quality

# The quality of the data collected is a critical factor in the success of any data analysis project. Poor quality data can lead to incorrect conclusions and misinformed decision making. Some common issues with the quality of data include missing data, outliers, formatting issues, and dirty data.

# In the case of the Medical Appointment No Show dataset on Kaggle, there may be some missing data points. For example, some patients may not have provided complete information on their demographic details or health status. This missing data can impact the accuracy of the analysis if it is not handled properly. To mitigate this issue, it may be necessary to fill in missing data using appropriate imputation techniques.

# Another issue with the data quality is the presence of outliers. Outliers are data points that are significantly different from the other data points in the dataset. These outliers can have a significant impact on the results of the analysis and may need to be addressed. One approach to dealing with outliers is to remove them from the dataset. Alternatively, outliers can be transformed or replaced with more representative values.

# Formatting issues can also impact the quality of the data. For example, if the data is not in a standard format, it may be difficult to perform analysis on it. To address this issue, the data may need to be cleaned and reformatted so that it is consistent and usable.

# Dirty data refers to data that contains errors, inconsistencies, or other anomalies. Dirty data can also impact the accuracy of the analysis and may need to be cleaned and corrected before analysis can be performed.

# In conclusion, the quality of the data is a critical factor in the success of any data analysis project. It is important to address issues with missing data, outliers, formatting issues, and dirty data to ensure that the results of the analysis are accurate and trustworthy.

# D5. Data Governance, Privacy and Security, Ethical, Legal, and Regulatory Compliance

# Data governance, privacy, security, ethical, legal, and regulatory compliance are important considerations in any project involving personal data. In the case of the Medical Appointment No Show dataset, personal details of the patients have been anonymized to protect their privacy and ensure compliance with data privacy regulations such as the General Data Protection Regulation (GDPR).

# It is important to ensure that the data is used for the intended purpose and that appropriate measures are in place to protect it from unauthorized access, manipulation, or theft. This includes properly securing the data storage and handling methods, as well as training team members on privacy and security protocols.

# Furthermore, ethical considerations must be taken into account when using personal data for research purposes. This includes obtaining informed consent from the individuals, ensuring that the data is used for the intended purpose, and protecting their privacy and rights.

# In terms of legal and regulatory compliance, it is important to ensure that the project complies with all relevant laws and regulations related to data privacy, protection, and use. Failure to comply with these regulations could result in legal consequences and damage to the reputation of the organization.

# In summary, while the use of the Medical Appointment No Show dataset offers many opportunities for research and analysis, it is important to carefully consider the privacy, security, ethical, legal, and regulatory compliance implications of using personal data. Adequate measures must be taken to protect the data and ensure compliance with relevant regulations and guidelines.

# D5a. Precautions

Data Governance: To ensure data governance, proper processes and protocols should be in place to manage the lifecycle of the data. This includes data entry, storage, and retrieval. Access to the data should be limited to authorized personnel and proper security measures should be implemented to prevent unauthorized access.

Privacy and Security: To protect the privacy and security of the data, proper storage and handling protocols should be in place. The data should be encrypted both in storage and during transmission. Access to the data should be limited to authorized personnel and proper security measures should be implemented to prevent unauthorized access.

Ethical and Legal Compliance: To ensure ethical and legal compliance, proper processes and protocols should be in place to manage the use of the data. This includes ensuring that the data is used only for the purpose for which it was collected and that it is not used to discriminate against any individuals or groups.

Regulatory Compliance: To ensure regulatory compliance, proper processes and protocols should be in place to manage the data. This includes ensuring that the data is used in accordance with relevant laws and regulations and that proper consent has been obtained from the individuals whose data is being used.

Note that in this case, the patients' personal details have been anonymized in the data, which helps to mitigate privacy and security concerns. However, the precautions mentioned above still need to be taken to ensure data governance, ethical, legal, and regulatory compliance.

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