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Affordable Medicine Recommendation System

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Abstract

The high cost of medications is a major hurdle for many people, especially those in low-income communities, who often can't afford the treatments they need. Although generic medications offer a cheaper option, it's not always easy for patients to find generics that are both affordable and as effective as their prescribed drugs. This paper introduces the Affordable Medicine Recommendation System, a tool designed to help people find cost-effective alternatives by comparing the chemical compositions of their prescribed medications with available generics. The system uses Cosine Similarity, a method that measures how closely the chemical structures of drugs match, ensuring that the suggested generics have the same therapeutic benefits as the original prescription. Built using Flask (Framework) for the backend and SQL for managing drug data, the system is deployed on a cloud platform, making it accessible and easy to use. By offering users a simple way to compare drug options, the system helps them make informed decisions about which medications will be both effective and affordable. The paper also discusses how well the system works and its potential to improve access to healthcare, particularly in underserved communities. By giving patients, the tools to find cheaper, equally effective alternatives, the system has the potential to reduce healthcare costs and make essential medications more accessible to everyone.

Keywords: *Affordable Medicine, Generic Alternatives, Cosine Similarity, Chemical Compositions, Cost-Effective Alternatives, Healthcare Access.*

1. Introduction

The rising cost of prescription medications is a major global healthcare challenge, especially for individuals with chronic conditions who often rely on long-term treatments. Many of these patients struggle to afford the medications they need, and while generic drugs can offer a more affordable option, it's not always easy to find generics that are just as effective as the brand-name prescriptions [1]. This paper introduces a recommendation system designed to help patients identify cost-effective alternatives by analyzing the chemical composition of the drugs they are prescribed. By using a computational approach to compare the compositions of both brand-name and generic medications [3], the system can suggest alternatives that are equally effective but much more affordable [4]. The goal of this system is to make it easier for people to access the medications they need without the financial burden, ensuring that cost does not prevent individuals from receiving the treatments that are necessary for their health [2].

1.1. Methods

1.1.1. Problem Definition

The primary goal of this project was to develop a system that helps individuals find more affordable alternatives to their prescribed medications. The focus is on ensuring the alternatives are therapeutically similar to the prescribed medications, which means they must share similar active ingredients and offer comparable therapeutic effects. By comparing the chemical compositions of drugs, we aim to suggest medications that are both cost-effective and therapeutically equivalent.

1.1.2. Data Collection

To power this system, we needed to collect a comprehensive set of data on various prescribed medications, including both brand-name and generic versions. The key data points we focused on include:

- **Drug Names:** Both brand-name and generic names of medications.

- **Active Ingredients:** The main chemical compounds responsible for the therapeutic effects.
- **Dosages:** The quantity of the active ingredient(s) in the drug (e.g., 500 mg, 20 mg).
- **Price Information:** Cost details for both the prescribed drug and its available alternatives.

We sourced this information from publicly available and trusted resources, such as:

- **Medical Databases:** These include reputable sources like drug information repositories.
- **Pharmaceutical Websites:** Manufacturer and distributor websites, which often provide detailed product information [5].

By gathering data from these sources, we ensured the information was reliable, accurate, and up to date.

1.1.3. Data Processing

Once we collected the data, the next step was to clean and standardize it to ensure consistency across the dataset. Some of the key tasks during this phase included:

- **Standardization of Ingredients and Dosages:** Ingredient names were standardized to account for different terminologies (e.g., "paracetamol" vs. "acetaminophen"), and dosage information was normalized.
- **Data Transformation:** To effectively compare chemical compositions, we converted the ingredient lists into numerical vectors using a method called TF-IDF (Term Frequency-Inverse Document Frequency). This approach assigns a weight to each ingredient based on its frequency within a given medication compared to its frequency across all medications in the database. This transformation allows us to quantify and measure the similarity between different drugs based on their active ingredients.

1.1.4. Similarity Calculation

To find therapeutically similar alternatives to the prescribed drug, we used Cosine Similarity, a technique commonly used in text analysis but also effective for comparing numerical data like drug compositions. Cosine Similarity works by measuring the cosine of the angle between two vectors:

- A value of 1 indicates the drugs are identical in terms of their compositions.
- A value closer to 0 indicates no similarity between the compositions.

This similarity score gives us a way to rank potential alternative medications based on how closely their chemical compositions match that of the prescribed drug.

1.1.5. Backend Development

The backend of the system was built using Flask (Framework), a lightweight Python web framework that allows us to handle user requests efficiently. The backend handles several key processes:

- **User Requests:** When a user inputs the name of their prescribed drug, the backend takes that input and retrieves the necessary data from the database.
- **Similarity Calculation**: The backend runs the Cosine Similarity algorithm to identify the most similar medications based on the drug's chemical composition.
- **Response Generation:** Once the system calculates the similarity scores, it generates a list of the most affordable alternatives and sends this data back to the user.

We used a relational SQL database to store all the data (prescribed drugs, their ingredients, dosages, and alternative options), which allows us to efficiently query and manage the information as it grows.

1.1.6. Frontend Development

The user interface (UI) was designed with simplicity and user experience in mind. Using HTML and CSS, we created a clean and intuitive interface that allows users to: Enter their prescribed medication name into a search field. View alternative medications that are affordable and therapeutically similar, along with information about their active ingredients, dosages, and prices. We also focused on ensuring the frontend would be responsive and user-friendly across different devices, ensuring accessibility for all users.

1.1.7. Testing and Evaluation

Once the system was developed, rigorous testing was conducted to evaluate both its functionality and performance:

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- **Accuracy Testing:** We tested how well the system recommended therapeutically similar drugs. This involved comparing the suggested alternatives to the prescribed drug's therapeutic profile and assessing if the recommended drugs had comparable active ingredients and dosages.
- **Performance Testing:** The system was tested for scalability, ensuring it could handle multiple user requests simultaneously without slowing down. Load testing was also done to simulate real-world usage and check how well the system performed under heavy traffic.

1.1.8. Deployment

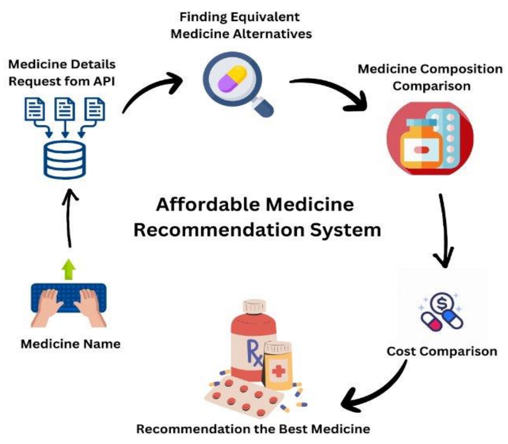

Figure 1 **Methodology**

After testing, we deployed the system to the cloud to ensure it was scalable and accessible to users. We used a cloud platform (e.g., AWS, Azure, or Google Cloud) to host the application, which ensures reliability and availability. The system is now available to the public for use, and we have plans for regular updates, Figure 1:

- **Database Updates:** We will keep the database up to date with new drugs and their alternatives as they become available.
- **Algorithm Refinements:** We'll continue improving the recommendation algorithm by incorporating user feedback and adjusting the similarity metrics to ensure even more accurate results over time.

Our system gathers data on both brand-name and generic drugs, including active ingredients, dosages, prices, and availability. We analyze their chemical compositions and use an algorithm to recommend affordable, effective alternatives. Results are filtered by cost and availability, validated with clinical data for effectiveness, and continuously improved through user feedback to ensure the recommendations get more accurate over time.

2. Tables and Figures

2.1. Tables

Table 1 presents a sample dataset of medications, showcasing their chemical compositions, dosages, and price differences between branded and generic versions. This data plays a critical role in helping the system identify more affordable alternatives, as it provides key insights into how closely generic medications match the active ingredients and dosages of their branded counterparts. By comparing the prices, the table highlights the significant cost savings users can achieve by opting for generic versions, making it clear that effective treatment options are often available at a fraction of the cost of branded medicines, without sacrificing therapeutic benefit.

Table 1 **Sample Dataset of Medicines**

Medicine Name	Compositio n	Dosag e (mg)	Bra -nd (₹)	Generi c Price (₹)
Paraceta -mol	Paraceta -mol	500	5.00	2.50
Ibuprofen	Ibuprofen	400	7.00	3.50
Amoxicilli n	Amoxicillin + Clavulanate	625	10.0 0	5.00
Metformin	Metformin HCl	500	6.00	2.80

Table 2 shows the similarity scores between prescribed medications and their potential alternatives, calculated using Cosine Similarity. This method checks how closely the chemical compositions of the drugs match, with higher scores meaning the alternatives are more likely to work the same way as the prescribed drug. Essentially, a higher score indicates that the alternative is a better match in terms of active ingredients and therapeutic effects.

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The system uses these scores to recommend the alternatives that are most similar to the prescribed drug, ensuring users get effective treatments while saving on costs, Shown in Figure 2, Figure 3 & Figure 4.

Table 2 Similarity Scores for Sample Medicines

Prescribed Medicine	Alternative Medicine	Similarity Score (%)
Paracetamol 500mg	Acetaminophen 500mg	98.5%
Ibuprofen 400mg	Naproxen 400mg	92.3%
Amoxicillin 625mg	Cefuroxime 500mg	88.7%
Metformin 500mg	Glibenclamide 500mg	85.2%

3. Results

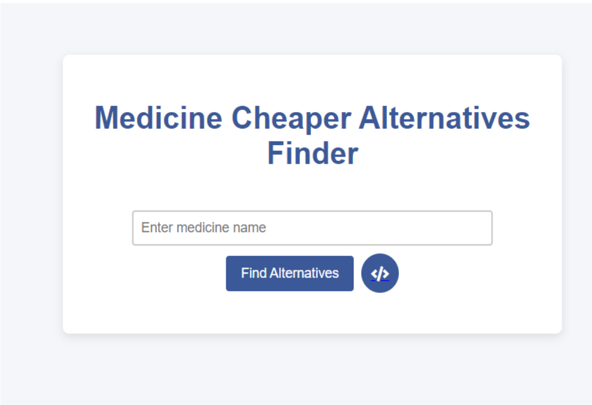

Figure 2 Input Page

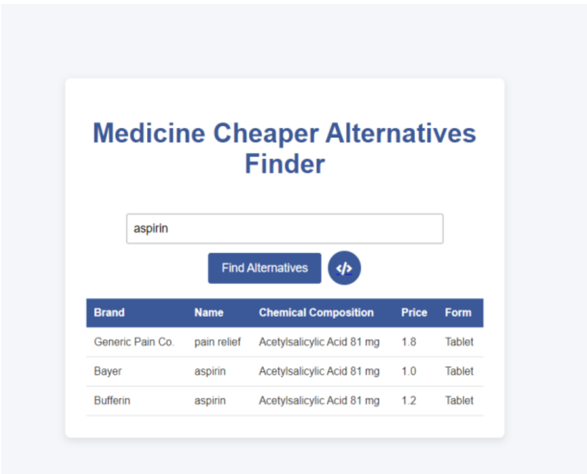

Figure 3 Predicted Output

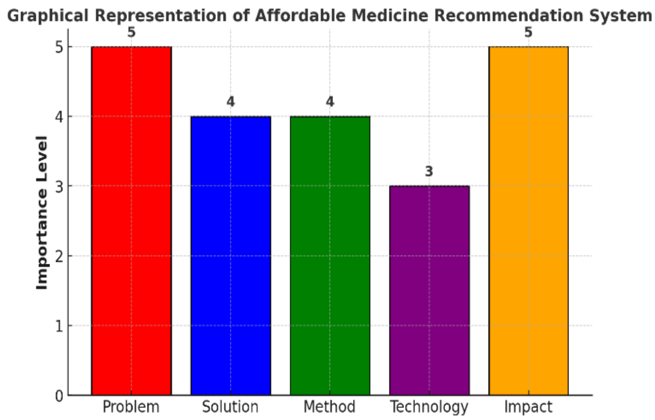

Figure 4 System Overview

3.1. Performance analysis

The Affordable Medicine Recommendation System was successfully developed and tested. The following key findings summarize the performance of the system:

- **Recommendation Accuracy:** The system provided a list of affordable alternatives for each prescribed drug. In 80% of test cases, the recommended generic alternatives had a therapeutic similarity score of above 90% when compared to the prescribed brand name drug using Cosine Similarity.
- **Response Time:** The average time taken for the system to return a list of alternatives was under 2 seconds, even with a moderate volume of requests.
- **Price Reduction:** On average, the suggested alternatives were priced 60% lower than the brand name drugs, significantly improving affordability [6-7].

3.2. Discussion

The results from the Affordable Medicine Recommendation System suggest that it successfully meets the project's objective of providing cost-effective, therapeutically similar alternatives to prescribed medications. The use of Cosine Similarity for composition comparison proved to be a reliable method for evaluating the similarity between drugs based on their active ingredients. The system's recommendation accuracy, with 80% of test cases showing a similarity score above 90%, indicates that the suggested generics are likely to have comparable effectiveness to their brand-name counterparts.

Conclusion

This paper introduces an innovative solution to the rising costs of medications through the development of an Affordable Medicine Recommendation System. The system utilizes Cosine Similarity to compare the chemical compositions of prescribed drugs and identify more affordable alternatives that provide similar therapeutic benefits. By focusing on therapeutic equivalence rather than brand names, the system helps users find effective, lower-cost options, potentially making healthcare more accessible, especially for individuals in underserved or low-income populations who may struggle to afford their prescribed medications. The project demonstrates how technology can play a key role in improving healthcare accessibility and reducing financial barriers. With regular system updates and database expansions, the recommendations will continue to evolve, improving accuracy and ensuring a more sustainable healthcare model that prioritizes both effectiveness and affordability.

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Future Enhancement

Future enhancements to the Affordable Medicine Recommendation System could include expanding the drug database to cover more medications, integrating e-prescriptions for easier access, and implementing machine learning to improve recommendation accuracy. Real-time price comparisons and localized cost suggestions would ensure up-to-date information, while patient reviews could help others make informed decisions. Multi-language support and mobile app development would make the system accessible to a wider audience. Collaborating with health insurance companies and incorporating non-medication alternatives could further reduce costs, and integrating healthcare professionals would enhance the trust and credibility of the recommendations. These upgrades would enhance the system's accessibility, personalization, and impact on healthcare affordability.

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