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ENSE 374 – Software Engineering Management

MediLocate

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1 Introduction

Imagine a world where booking a medical appointment is as easy as ordering your favorite meal online—no more endless phone calls, no more waiting for days just to get a simple appointment. MediLocate brings this vision to life by developing a web-based application designed to revolutionize how Canadians book medical appointments.

The current process of scheduling appointments can be overwhelming and frustrating. Patients often face long wait times, struggle to connect with clinics, and find it difficult to secure an available slot. MediLocate is here to change that narrative. Our solution cuts through these challenges by offering a simple, intuitive platform where users can effortlessly book appointments online, anytime, anywhere. No more busy signals, no more stress—just a few clicks, and you're set.

With MediLocate, clinics can easily upload their addresses and share their schedules on a weekly, biweekly, or monthly basis, giving patients a clear and comprehensive view of available options. Imagine being able to see the availability of clinics near you at a glance—compare schedules, select the best fit for your needs, and book instantly. Users can log in, browse clinics by location, specialty, or even user reviews, making the process of finding healthcare as personalized as possible.

Our platform supports two types of logins: one for patients who want to schedule appointments and another for medical staff who need to manage their clinic's availability, update their schedules, and share important information with patients. This dual functionality ensures that clinics stay organized, and patients stay informed, all in real time.

MediLocate aims to create a seamless experience that benefits both patients and healthcare providers. By reducing wait times, eliminating communication barriers, and simplifying the entire appointment process, we're making healthcare more accessible, efficient, and stress-free for everyone involved. Whether you're a busy professional, a parent with a hectic schedule, or simply someone seeking timely healthcare, MediLocate is your partner in connecting you to quality care without the hassle.

The following sections will explore the design problem, potential solutions, our final approach, and the overall project management plan.

2 Design Problem

This section has the following two subsections:

Accessing healthcare should be a straightforward process, yet for many Canadians, it is anything but. Despite Canada's universal healthcare system, accessing timely medical care remains a significant challenge. Long wait times, difficulties in booking appointments, and limited clinic availability often mean that patients cannot receive the care they need when they need it. This issue is not just an inconvenience—it can have serious health implications, delaying diagnosis and treatment for many individuals.

2.1 Problem Definition

Link to the 'Business Case'

The healthcare system in Canada is often plagued by accessibility issues. According to recent statistics, there are approximately 2.6 physicians per 1,000 people in Canada, which creates significant pressure on healthcare providers and makes accessing timely care a challenge. Studies show that nearly 30% of Canadians report difficulties in getting healthcare when they need it, and around 20% of patients experience delays that can exceed a week just to see a family doctor. This mismatch between the supply of healthcare services and the demand from patients leaves many people frustrated and, at times, unable to access essential care.

These accessibility issues have far-reaching effects on the health and well-being of Canadians. Long delays in obtaining healthcare can result in the worsening of medical conditions, increased anxiety, and decreased quality of life. People in rural and remote areas face even greater challenges due to the scarcity of healthcare facilities nearby, making it difficult to access even basic medical care without extensive travel. Additionally, the administrative burden placed on clinics by managing appointments manually adds inefficiencies and increases the likelihood of scheduling errors, further complicating the situation.

The lack of efficient scheduling also means that clinics face challenges in managing patient loads, leading to overbooked or underutilized resources. This inefficient system impacts not only patients but also healthcare providers who struggle to organize their time and offer timely services, which can ultimately lead to burnout and reduced quality of care.

2.2 Project Charter

Link to 'Project Charter'

3 Solution

An engineering design is iterative in nature!

In this section, we provide an account of some of the solutions our team brainstormed to implement the project. During our brainstorming sessions, we considered multiple approaches, each with different features and potential constraints. Some solutions lacked specific desired features, while others did not fully satisfy all the identified constraints. The iterative nature of engineering design helped us refine these ideas until we reached the final solution that best balanced all requirements.

MediLocate was conceived to bridge the gap in healthcare accessibility by providing a comprehensive platform where clinics can efficiently manage their availability while allowing patients to book appointments with ease. By offering a centralized system for clinic schedules, MediLocate will help reduce wait times, improve the efficiency of healthcare services, and ensure patients have access to the care they need when they need it.

3.1 Solution 1

One of the first ideas we explored as part of our brainstorming process was to create a platform that would allow clinics to upload and manage their schedules with a high degree of flexibility. This meant clinics could choose to update their availability on a weekly, biweekly, or monthly basis, depending on their preferences and operational needs. The aim was to offer patients an accurate and up-to-date view of appointment slots, thereby providing them with a clear and transparent picture of availability. This level of visibility would enable patients to proactively find open appointments that fit into their schedules, ultimately giving them more control over their healthcare journey.

From the patient's perspective, this solution seemed highly beneficial because it empowered them to take charge of their healthcare needs, reducing the hassle of calling clinics or dealing with inconsistent information. However, upon closer examination, we realized that this approach, while promising, was lacking some essential features that are crucial for providing a comprehensive and streamlined healthcare experience. One major shortcoming was the absence of automated reminders, which play a critical role in minimizing missed appointments and ensuring that patients do not overlook their scheduled visits. This feature is particularly important in healthcare, where missed appointments can lead to delays in treatment and impact patient outcomes.

Additionally, our initial solution did not include integration with electronic health records (EHR). EHR integration is vital because it allows healthcare providers to have immediate access to patient histories, which helps them make informed decisions quickly and enhances the overall quality of care. For patients, having their appointment bookings integrated with their health records means a smoother, more cohesive experience, where their healthcare journey feels interconnected rather than fragmented. Without these features—automated reminders and EHR integration—the platform would fall short of delivering the kind of seamless, efficient experience that both patients and clinics require. Thus, while our initial concept was strong in its transparency and user empowerment aspects, it ultimately needed additional functionality to truly meet the needs of a modern healthcare system.

3.2 Solution 2

As our team continued to brainstorm potential solutions, we identified another approach that could significantly improve the user experience of finding and booking clinic appointments. This solution involves leveraging the Google Maps API to display clinics around the user’s current location. Instead of presenting users with a simple list of clinics one by one, our idea is to use an interactive map that provides a visual overview of all nearby clinics. This approach would make

it easier for users to quickly see what options are available around them, enabling them to make informed decisions based on proximity and convenience.

The interactive map would allow users to view multiple clinics at once, along with details such as address, operating hours, and available services. By integrating this functionality, we aim to offer a more intuitive, visual method for finding healthcare services, catering to the diverse needs of our users. Users can zoom in and out to see various areas, click on clinic markers for more information, and even get directions—making the entire experience more efficient and user-friendly.

Another key aspect of this solution is our focus on future accessibility improvements. Our vision is to make healthcare accessible to all, regardless of physical ability. To achieve this, we are planning to incorporate features such as text-to-speech, which would read aloud clinic details for users who have visual impairments or reading difficulties. Additionally, we are considering other assistive functionalities designed for individuals with different accessibility needs. These features would help us ensure that the platform is inclusive and welcoming to everyone.

While this solution presents a promising step forward in enhancing usability, it comes with its own set of challenges. Integrating the Google Maps API will require managing data dynamically to reflect real-time availability and precise location information, which could introduce complexities in terms of maintaining accuracy and reliability. Furthermore, the accessibility features we envision, such as text-to-speech and other assistive technologies, will require additional development time and resources, and may need specialized testing to ensure their effectiveness.

3.3 Final Solution

Our final implemented solution prioritizes a streamlined, efficient, and user-friendly approach to clinic management and appointment booking. Recognizing the need for simplicity and accessibility, we chose to forgo the integration of Google Maps, opting instead to organize clinics by their respective cities: Regina, Moose Jaw, and Saskatoon. This method provides a clear and intuitive navigation experience, allowing users to quickly locate clinics based on their geographic preferences.

Each clinic is displayed with comprehensive details, including its name, address, and a representative image, ensuring users have all the necessary information at a glance. This visually appealing and organized interface eliminates potential confusion and allows patients to focus on their healthcare needs without being overwhelmed by unnecessary complexities.

This approach enhances the overall user experience by making it easier for patients to identify and select clinics that align with their proximity, preferences, and requirements. By categorizing

clinics by city, we ensure that users can access healthcare services tailored to their specific location with minimal effort.

Furthermore, our design prioritizes efficiency and accessibility by offering quick access to critical clinic information, such as available appointment slots. This empowers users to book appointments seamlessly through a straightforward and professional platform. By reducing navigation time and eliminating the learning curve associated with map-based interfaces, our solution ensures that users of all technical skill levels can benefit from our platform.

In addition, the simplicity of our implementation allows for scalability and future enhancements. As new clinics are added or updates are made, they can be incorporated seamlessly into their respective city categories without disrupting the user experience. This adaptability ensures that our platform remains relevant and continues to meet the evolving needs of patients and healthcare providers alike. By focusing on clarity, simplicity, and usability, our final solution represents a significant improvement in clinic management and appointment booking systems. It balances functionality with ease of use, delivering a platform that is not only professional and visually engaging but also highly effective in connecting patients with the healthcare services they require.

The third solution is superior to the first two because it effectively balances simplicity, efficiency, and scalability while addressing the shortcomings of the earlier approaches. The first solution, while transparent and empowering for users, required clinics to manage flexible schedules, adding significant administrative complexity. Additionally, it lacked essential features like automated reminders and EHR integration, which are critical for a seamless healthcare experience. On the other hand, the second solution, though innovative with its use of the Google Maps API for clinic discovery, introduced technical challenges such as maintaining real-time data accuracy and added a learning curve for users unfamiliar with interactive maps. It also required significant development resources for advanced accessibility features, delaying deployment. In contrast, the third solution adopts a streamlined approach by categorizing clinics by cities, providing users with an intuitive and visually appealing interface that simplifies navigation and decision-making. It avoids the complexities of map integration while ensuring reliable access to clinic information like names, addresses, and representative images. This design is inclusive, caters to users of all technical abilities, and allows for future scalability, making it a practical and effective platform for clinic management and appointment booking.

3.3.1 Components

What components you used in the solution? What is the main purpose of using individual component? Provide a block diagram (with a numbered caption, such as Fig. 1) representing the connectivity and interaction between all the components.

In our solution, we utilized a range of components, which we structured following the **Model-View-Controller (MVC) architecture** to ensure a modular and organized system. The MVC design pattern was instrumental in dividing the project into three interconnected parts: **Model**, **View**, and **Controller**, each serving a distinct purpose and allowing for scalability, maintainability, and clarity in development.

Model

The **Model** represents the data layer of the application. In our project, the Model was responsible for handling all interactions with the database. Using **JavaScript** with **Mongoose**, a powerful Object Data Modeling (ODM) library for MongoDB, we created schemas to define the structure of the data stored in the database. These schemas were used to model key entities, such as users, clinics, appointments, and availabilities, each with their specific attributes and relationships. For instance, the User schema captured fields like `name`, `username`, `password`, and optionally `medicalId` medical professionals. The Model's primary purpose was to provide a structured and consistent way to interact with the database, ensuring that data could be created, read, updated, and deleted efficiently. By abstracting database operations, the Model safeguarded the data layer and ensured seamless integration with other parts of the application.

View

The **View** represents the presentation layer of the application, handling how data is displayed to users. In our project, the View was implemented using **Express.js**, a fast and minimal web application framework for Node.js, in conjunction with **EJS (Embedded JavaScript Templates)**. The View dynamically rendered each page of the website, enabling a personalized and interactive experience for users. For example, after a user logged in, their data (such as their username or email) was passed from the Controller to the View and displayed dynamically on the home page. The use of EJS allowed us to embed JavaScript logic directly into HTML templates, providing flexibility in rendering dynamic content based on user actions or database data. This ensured that the user interface remained responsive and up-to-date, reflecting changes in real-time, such as booked appointments or available clinics.

Controller

The **Controller** acts as the intermediary between the Model and the View, orchestrating the flow of data and logic. In our project, the Controller consisted of various routes defined using **Express.js**, which handled user requests and responses. For instance, when a user attempted to log in, the Controller verified their credentials by querying the database via the Model. Upon successful authentication, it redirects the user to the appropriate View (e.g., the home page). Similarly, the Controller managed routes for signing up, booking appointments, and viewing

availability. This component was central to ensuring the smooth navigation between pages and proper interaction between the user interface and the data. By separating logic into distinct routes, the Controller ensured that the application remained well-organized and easy to debug.

Languages and Tools

- **JavaScript**: The primary programming language used throughout the project, ensuring consistency across all components. JavaScript's versatility allowed us to implement both server-side logic (Controller and Model) and client-side functionality (dynamic rendering in the View).
- **Node.js**: Enabled server-side execution of JavaScript, providing the runtime environment for Express.js and other backend operations.
- **Express.js**: Served as the framework for defining routes and managing HTTP requests and responses, forming the backbone of the Controller and View components.
- **Mongoose**: Used in the Model to interact with MongoDB, allowing us to define schemas and handle data with ease.
- **EJS**: Empowered us to create dynamic HTML templates in the View, seamlessly integrating JavaScript to render content dynamically based on user interactions and database queries.
- **MongoDB**: The database solution for storing and retrieving structured data, such as user profiles, clinic details, and appointment records.

Purpose of the Components

- The **Model** ensured robust and efficient data management, abstracting database complexities and providing a clear interface for data manipulation.
- The **View** delivered a user-friendly interface, dynamically adapting to user input and presenting relevant information clearly and efficiently.
- The **Controller** connected the Model and View, facilitating smooth communication between the data and presentation layers while managing the application's core logic and routing.

By leveraging the MVC architecture and these tools, our solution was able to maintain a high degree of organization, scalability, and user engagement. Each component worked in harmony, ensuring a seamless and effective clinic management and appointment booking system.

3.3.2 Features

Link to Features of our solution '[Final Solution features]'

3.3.3 Environmental, Societal, Safety, and Economic Considerations

Our engineering design took into account various **environmental**, **societal**, **economic**, and other constraints to ensure that our solution was not only practical and efficient but also contributed positively to its users and society at large. Below is an explanation of how these considerations influenced our design choices and their broader implications.

Environmental Considerations

While the direct environmental impact of our platform is minimal as it is a digital solution, its ability to streamline clinic management and appointment booking indirectly reduces environmental burdens:

- **Reduction in Paper Usage**: By digitizing clinic operations, such as scheduling and record-keeping, our platform eliminates the need for physical paperwork. This contributes to reducing paper waste, which aligns with sustainable practices in healthcare.
- **Minimized Travel**: By categorizing clinics by city and providing clear availability information, patients can plan their visits more efficiently, reducing unnecessary trips to clinics. This helps lower carbon emissions associated with transportation.

Societal Contributions

Our solution was designed with a strong focus on **societal benefits**, aiming to improve healthcare access and inclusivity:

- **Improved Access to Healthcare**: By organizing clinics by city (e.g., Regina, Moose Jaw, Saskatoon), we ensure that users can easily locate healthcare services near them. This is particularly beneficial for patients in underserved areas where finding clinics can be challenging.
- **Inclusivity and Accessibility**: Our design ensures a user-friendly interface that is accessible to individuals of all technical skill levels. Patients can navigate the platform effortlessly, enabling even those with limited tech literacy to book appointments and access critical healthcare services.

- **Time Efficiency**: Providing users with clear availability and booking options minimizes time spent searching for clinics or making calls. This benefits both patients and clinics by reducing bottlenecks in appointment scheduling.
- **Healthcare Empowerment**: The platform encourages patients to take control of their healthcare journey by providing transparency and convenience, fostering a healthier and more informed society.

Economic Considerations

Economic constraints and decisions played a critical role in shaping the design of our platform:

- **Cost-Effectiveness**: We prioritized open-source tools and frameworks such as **Node.js**, **Express.js**, **MongoDB**, and **EJS** to minimize development costs while maintaining high functionality and scalability. This allowed us to deliver a robust solution without incurring significant expenses.
- **Future Scalability**: The simplicity of our solution allows for the easy addition of new clinics or features without substantial redevelopment costs. This ensures that the platform remains economically viable in the long term.
- **Minimized Operational Costs for Clinics**: By providing a streamlined digital solution, we reduce the administrative burden on clinics, allowing them to save on operational costs, such as manual scheduling or additional staffing.
- **Affordable for Users**: The platform is designed to be free or low-cost for end-users, ensuring accessibility regardless of economic status, thereby addressing a societal need for equitable healthcare.

Reliability and Safety

We prioritized reliability and safety in the design and implementation of the platform to ensure a secure and trustworthy user experience:

- **Data Security**: Sensitive user data, including personal and medical information, is stored securely using encrypted communication protocols and robust authentication mechanisms, such as **passport.js** for login and session management.
- **Error Handling**: Comprehensive error handling was implemented across all components to ensure smooth functionality and reduce the risk of failures, such as incorrect scheduling or data corruption.

- **Scalability and Resilience**: The use of the **MVC architecture** ensures modularity and maintainability, allowing the system to handle increased traffic or additional clinics without compromising performance.
- **Ease of Use**: The platform's intuitive design reduces the likelihood of user errors, ensuring a safe and reliable experience for patients and clinic staff.
- **Testing and Validation**: Extensive testing was conducted to validate the platform's reliability under various conditions, including high user traffic, invalid inputs, and unexpected scenarios.

Positive Contributions

Our design contributes positively to both society and the healthcare ecosystem:

- It promotes equitable access to healthcare by simplifying clinic discovery and appointment booking, especially for individuals in underserved communities.
- It reduces inefficiencies in healthcare management, saving time and resources for both patients and clinics.
- By fostering transparency and convenience, it strengthens the relationship between patients and healthcare providers, contributing to improved health outcomes.

3.3.4 Limitations

While our design offers significant benefits in streamlining clinic management and appointment booking, it is important to acknowledge certain limitations and constraints that impact its scope and performance. These limitations can be broadly categorized based on economic, regulatory, reliability, sustainability, ethical, and societal factors, along with specific project constraints.

Economic Factors

One key limitation is the reliance on open-source tools and frameworks to keep development costs low. While cost-effective, this choice limits the availability of premium features or advanced functionalities that could enhance the platform, such as integrated video consultations or advanced analytics. Additionally, clinics that adopt the platform might incur costs for training staff or upgrading their systems to align with our solution.

Regulatory Compliance (Security and Access)

Our platform handles sensitive personal and medical information, making regulatory compliance a critical constraint. While efforts have been made to secure user data through

encrypted storage and authentication mechanisms, ensuring full compliance with data privacy regulations (such as HIPAA or PIPEDA) would require further investment in advanced security infrastructure. Additionally, the risk of unauthorized access or data breaches remains a limitation that requires continuous monitoring and updates.

Reliability

The reliability of the platform heavily depends on accurate and timely updates from clinics. Real-time availability is contingent on clinics consistently managing their schedules in the system, and any lapse in this process could lead to misinformation for users. Furthermore, as the platform scales to handle more clinics and users, server load and downtime could become challenges without adequate infrastructure upgrades.

Sustainability and Environmental Factors

Although the platform reduces paper usage and travel emissions by digitizing appointment bookings, its reliance on cloud-based infrastructure has an environmental footprint. The energy consumption of data centers powering the system is a factor that cannot be ignored when considering the solution’s sustainability.

Ethics

Ethical concerns related to fairness and accessibility also present a limitation. For instance, the platform currently categorizes clinics by city, which might inadvertently disadvantage clinics located on city outskirts or in rural areas. Additionally, while we strive to ensure equitable access, individuals without internet access or digital literacy may still face barriers to using the platform.

Societal Impacts

The societal impact of the platform is inherently positive, but limitations remain. The pilot phase restricts the platform to clinics in Regina, Moose Jaw, and Saskatoon, which excludes users and clinics from other regions. This limits the solution's overall reach and societal benefit during its initial deployment.

Project-Specific Constraints

- **Limited Geographic Scope**: The platform is restricted to clinics in Regina, Moose Jaw, and Saskatoon, which limits its usability for users outside these areas.
- **Data Accuracy Dependence**: Real-time availability is dependent on clinics accurately and regularly updating their schedules, which poses a risk of outdated or incorrect information.

- **Tight Time Frame**: The development and implementation of the platform were constrained by a tight timeline, which limited the inclusion of additional features, such as expanded city coverage or advanced accessibility options.

4 Team Work

Meeting 1

Link to Meeting Agenda 1 ‘Meeting 1‘

Link to Meeting Minutes 1 ‘Meeting 1’

Link to Project status report 1 ‘Project Status 1’

Meeting 2

Link to Meeting Agenda 2 ‘Meeting 2‘

Link to Meeting Minutes 2 ‘Meeting 2’

Link to Project status report 2 ‘Project Status 2’

5 Project Management

Link to Milestone-based Schedule ‘Milestone-based Schedule’

Gantt Chart ‘Gantt Chart’

6 Conclusion and Future Work

- Our project successfully delivered a streamlined and user-friendly platform for clinic management and appointment booking, categorized under the **Model-View-Controller (MVC) architecture**. By leveraging **JavaScript**, **Express.js**, **EJS**, and **MongoDB**, we developed a reliable and scalable solution tailored to meet the needs of clinics and patients in Regina, Moose Jaw, and Saskatoon. The platform provides a visually appealing and intuitive interface that simplifies the process of locating clinics, accessing critical information, and booking appointments. This design has demonstrated its potential to improve healthcare accessibility, enhance efficiency, and empower users to take control of their healthcare journey.

- However, while the solution achieved its primary goals, certain limitations remain. The platform is geographically restricted to the three pilot cities and heavily relies on accurate and consistent data updates from clinics. Regulatory compliance, such as aligning with privacy laws like HIPAA or PIPEDA, requires further development to ensure robust data security. Additionally, the reliance on cloud-based infrastructure has an environmental impact, and users without digital literacy or internet access may face challenges in using the platform.

- To address these limitations and enhance the platform, we propose several recommendations for future design improvements. Expanding the geographic scope beyond the pilot cities will ensure broader accessibility and societal impact. Integrating advanced features such as real-time data synchronization and automated reminders will improve user experience and reduce errors in clinic schedules. Further, optimizing the system's energy efficiency and adopting sustainable hosting solutions can reduce its environmental footprint. Lastly, incorporating more advanced accessibility features, such as text-to-speech and simplified navigation for less tech-savvy users, will ensure inclusivity and equity for all.

- In conclusion, while our solution successfully lays the groundwork for a transformative healthcare platform, future iterations focused on scalability, inclusivity, and compliance will ensure that it continues to evolve and meet the needs of an expanding user base. With these enhancements, the platform has the potential to make a lasting positive impact on healthcare accessibility and efficiency.

Link to '[Lesson Learned Report]'

7 References

- Use the IEEE reference style.
- Do not put any reference if it is not cited in the text.

8 Appendix

If you want to provide an additional information, use this appendix.