ENHANCING PRODUCTIVITY AND RISK MANAGEMENT IN VEGETATION MANAGEMENT USING AI AND ML

A PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF

MASTER OF DESIGN
IN
VISUAL COMMUNICATION

SUBMITTED BY
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CANDIDATE'S DECLARATION

I, Snehanshu Bindal, Roll No. - 2k22/MDCV/08, student of M.Des (Department of Design), hereby declare that the project dissertation titled "Vegetation Management" which is submitted by me to the Department of Design, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Design, is original and not copied from any source without proper citation. This work has not previously formed the basis of the award for any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

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CERTIFICATE

I hereby certify that the Project Dissertation titled "Vegetation Management" which is submitted by Snehanshu Bindal, Roll No. 2k22/MDCV/08, Department of Design, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Design, is a record of the project work carried out by the student under my supervision. To the best of my knowledge, this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

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Place: Delhi

Snehanshu Bindal

ABSTRACT

Vegetation management is an important task in the energy sector that is concerned with ensuring the safety and reliability of power supply by maintaining clearance around power lines. However, vegetation management suffers from challenges such as low productivity, lack of real-time data, and inadequate risk management. This dissertation seeks to address these challenges by using technology and indicators to improve vegetation management productivity and risk management.

This dissertation explores the UX design challenges faced by vegetation management in the energy sector. The research delves into the users, their goals, and the company's objectives, aiming to identify the pain points in the current design and propose potential solutions.

The study was based on a live project that I was working on during my internship, where I analyzed work processes, identified gaps and proposed solutions. The study employs a qualitative research approach, using semi-structured interviews and observations with users and stakeholders to gather data. It was discovered that technology, like smart dashboards, make it easier for contractors to record and track work progress, and for managers to monitor and assign tasks on the go; it was found to be potentially more productive. Additionally, metrics such as percentage of work scheduled, trees cut, distance from the poles, hours logged, and budgets provide real-time insight into the progress and performance of vegetation management tasks.

This paper proposes a task-centric approach that emphasizes task completion and risk mitigation. This approach involves using real-time data to identify high-risk areas, prioritize work, and allocate more budget and resources to mitigate those risks and provides a comprehensive view of your vegetation management operations and enables effective decision making.

Based on the themes identified, visual explorations were conducted to create potential design solutions that addressed the identified pain points. These explorations included wireframes, prototypes, and mockups that incorporated user feedback and iterative design practices.

The results of this dissertation provide valuable insights into the UX design challenges faced by IVMS and offer potential solutions to improve the user experience of the products. This research contributes to the field of UX design by presenting a case study of a technology company in the energy sector and the unique challenges they face in providing AI-powered solutions for vegetation management.

Overall, the results of this paper highlight the potential of technologies and indicators to improve productivity and risk management in vegetation management. The proposed solution will help vegetation management companies optimize operations, reduce risk and improve power supply reliability.

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CHAPTER 1: INTRODUCTION

1.1 ABOUT AIDASH

AiDash is an artificial intelligence (AI) and machine learning (ML) company that provides solutions that automate and streamline asset management for industries such as electric utilities, gas utilities, energy, water and wastewater, transportation and mining.

Fig. 1 AiDash's Logo

(Source:https://www.aidash.com/)

The company's technology uses satellite, drone imagery and other data sources to monitor and analyze assets such as power lines, pipelines and solar panels. This allows businesses to identify problems before they become major and to perform more efficient maintenance and repairs.

AiDash also offers vegetation management solutions, which can be a big problem for utilities and other industries with large infrastructures in rural and remote areas. AiDash uses AI and ML algorithms to identify areas where vegetation is encroaching on power lines and other assets, helping businesses prioritize and plan maintenance work accordingly.

Overall, AiDash's technology helps businesses reduce downtime, increase efficiency, and improve safety while reducing costs and environmental impact.

1.2 About the Project

1.2.1 Intelligent Vegetation Management System

AiDash's Intelligent Vegetation Management System (IVMS) is an AI-powered solution that helps utilities and other companies manage vegetation around their infrastructure more efficiently and effectively.

IVMS uses high-resolution satellite imagery to identify areas where vegetation encroaches on power lines, pipelines, or other assets. The system then applies AI algorithms to analyze the data and provide detailed insights into vegetation growth patterns such as type, height, density and proximity to assets.

IVMS can also predict vegetation growth rates and potential risks to future assets. Based on these insights, the system creates a prioritized list of areas that need immediate attention to help the organization plan and optimize maintenance activities. It also enables organizations to monitor the effectiveness of their vegetation management activities over time and adjust their approach as needed. This helps utilities and other companies reduce costs and minimize the environmental impact of their vegetation management activities.

In summary, IVMS provides a comprehensive solution for managing vegetation around critical infrastructure, enabling organizations to improve safety, reduce downtime and improve efficiency.

1.2.2 About my role

I had been fascinated by the use of AI and machine learning, their uses and their effects on the general audience since my 3rd year, and I made sure to have a few projects on the same to get a better understanding.

AiDash has been a great opportunity for me to explore and know more about the workings and usage of AI and ML. This helped me understand how data collection and the recommendation system work on a deeper level along with many other soft skills such as critical thinking, problem-solving, and adopting a healthier outlook towards reaching out and asking for help.

My role at AiDash included but was not limited to in-depth User Research, low-fidelity wireframing, high-fidelity wireframing, understanding the nuanced concepts of vegetation, its management and exactly how and where IVMS was helping in bridging the gap between the user and their requirements.

1.2.3 My Journey with IVMS

I was assigned to work on the Intelligent Vegetation Management System. IVMS uses high-resolution satellite imagery and artificial intelligence (AI) algorithms to detect vegetation growth and condition around power lines, and other critical infrastructure. The system analyzes satellite imagery to identify areas of vegetation that pose potential risks to infrastructure. Based on the data, IVMS gives recommendations to the users as to when the vegetation should be pruned, trimmed or removed along with the risk associated if the recommendations are not followed.

To know more about the product, and understand its full capabilities, I started by looking through the information resources compiled by our team manager, Senthil, and then through all the other documentation which were provided to me by my mentor, Athira. Throughout my journey, they were very helpful and ready to answer all of my questions, queries and brainstorm with me on any of the ideas and suggestions that I had.

1.3 Approach

The process that I followed majorly was iterative and reiterative, getting all the feedback I can along with brainstorming the behavior of the various interactions happening within the screen.

My approach towards all my tasks after getting the brief was -

Re-write the brief in my own words

1. Make on-paper components and iterations
2. Translate the same on screen to understand the layout
3. Make high-fidelity prototypes
4. Get feedback

Chapter 2

Literature Review

2.1 Vegetation Management

2.1.1 What is Vegetation Management

Vegetation management is the process of maintaining and controlling vegetation growth in areas that may interfere with the proper functioning of infrastructure or pose a safety hazard.

In the context of utility companies, vegetation management usually refers to the management of vegetation near power lines, transformers, and other electrical equipment. Power outages, electrical fires, or other safety hazards can occur if trees or other plants get too close to power lines.

Vegetation management activities may include trimming or pruning trees, removing shrubs or other undergrowth, and applying herbicides to control the growth of certain plant species.

Fig. 2 ‘Directional pruning’ involves strategically trimming trees to keep the trees alive while also ensuring the utility poles and lines around them keep operating.

(Source: https://www.mosaic51.com/technology/advances-utility-vegetation-management-and-inspection/)

The goal of vegetation management is to minimize the environmental impact of these activities while maintaining a safe and reliable power supply. Effective vegetation management requires careful planning and coordination between utility companies, landowners, and local governments. It is important to balance the need for a safe and reliable power supply with the need to protect natural habitats and maintain the beauty of the surrounding landscape.

New technologies, such as AI-powered vegetation management systems, are helping utilities and other businesses improve the efficiency and effectiveness of their vegetation management activities while minimizing environmental impact.

2.1.2 Who manages the vegetation

Vegetation management is typically the responsibility of the organization or entity that owns or operates the infrastructure in question. For example, utility companies are responsible for managing vegetation around power lines, and pipeline companies are responsible for managing vegetation around pipelines.

Vegetation management is often performed by specialized teams or contractors trained in the proper techniques of pruning, trimming, and removing vegetation. In some cases, companies can also use technologies such as satellite imagery and artificial intelligence to identify areas of vegetation that need attention and optimize their vegetation management efforts.

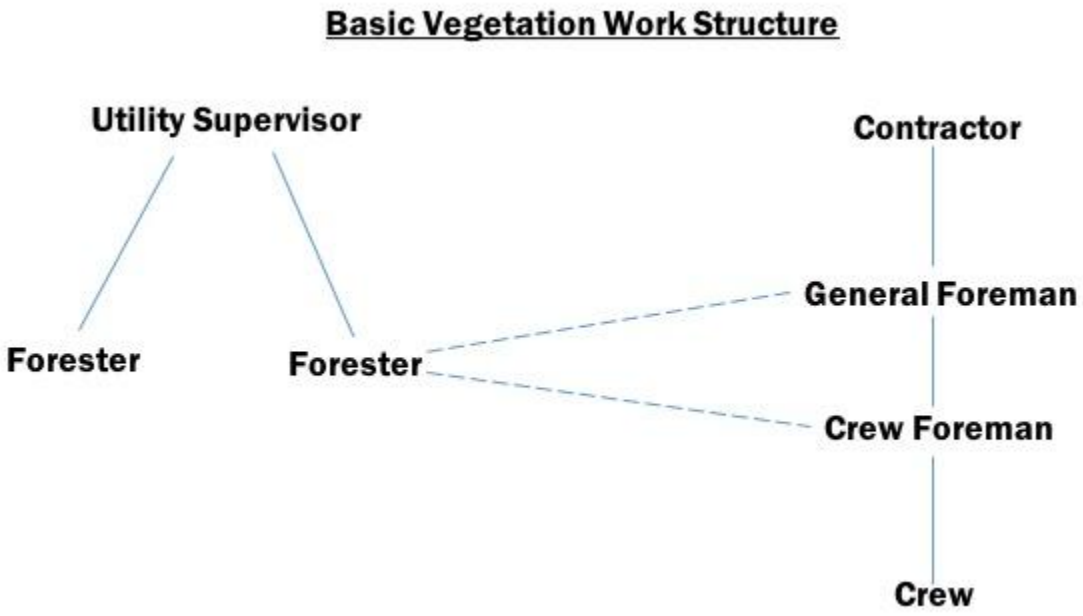


Fig. 3 Vegetation management work structure during task execution
(Source: https://gsiworks.com/a-rookies-guide-to-vegetation-management/)

In addition to businesses and contractors, local governments and municipalities can also be involved in vegetation maintenance efforts. For example, city and county officials may be responsible for managing vegetation along highways and public parks.

Ultimate responsibility for vegetation management rests with the organization or entity that owns or operates the infrastructure in question. Effective vegetation management requires careful planning, expertise and commitment to promoting safety, reliability and environmental sustainability.

2.1.3 Role of a Vegetation Manager

A vegetation manager is responsible for overseeing the vegetation management program of a particular organization or body. This may include utility companies, pipeline companies, transportation companies, and other companies that own or operate critical infrastructure.

A vegetation manager's primary responsibility is to properly manage vegetation around critical infrastructure to prevent disruption and reduce the risk of damage or failure. This includes developing and executing vegetation management plans, coordinating with contractors and professional teams, and overseeing the use of technologies such as satellite imagery and artificial intelligence to optimize vegetation management efforts.

Vegetation managers are also responsible for ensuring compliance with regulations and standards related to vegetation management. We can work closely with regulators and stakeholders to ensure that vegetation management practices meet or exceed required standards.

Vegetation managers not only manage vegetation around critical infrastructure, but they may also be responsible for promoting environmental sustainability and biodiversity. This includes encouraging the use of native plants and minimizing the use of herbicides and other chemicals.

Overall, the vegetation manager's role is to ensure the safe and reliable operation of critical infrastructure by managing vegetation in a responsible, sustainable and effective manner. This requires a deep understanding of vegetation management practices, legal requirements, and the latest vegetation management techniques and techniques.

2.2 Need for Vegetation Management

One of the main reasons for the need for vegetation management is the risk of damage to critical infrastructure. Trees and other vegetation can grow rapidly and, if left unchecked, can disrupt power lines, pipelines, and other infrastructure. This can lead to breakdowns, leaks, and other types of damage that are costly to repair and can pose a public safety hazard. Vegetation management practices such as pruning, trimming and removal help prevent vegetation from impacting critical infrastructure, reduce the risk of damage and ensure safe and reliable operation of infrastructure.

In addition to reducing the risk of damage to critical infrastructure, vegetation management is also essential to ensuring public safety. Trees and other vegetation that are too close to highways and railroad tracks can block the driver's view and lead to accidents and injuries. In urban areas, dense vegetation provides breeding grounds for mosquitoes and other pests, increasing the risk of disease transmission. Vegetation management practices such as mowing and trimming help ensure that vegetation does not pose a threat to public safety.

Furthermore, good vegetation management practices help promote environmental sustainability. Trees and other plants play an important role in regulating the Earth's climate by absorbing carbon dioxide from the atmosphere. By carefully managing vegetation around critical infrastructure, companies can reduce their carbon footprint and contribute to efforts to combat climate change. Additionally, vegetation management practices such as mulching and soil covering help prevent erosion, preserve soil nutrients, and promote healthy plant growth. This helps maintain healthy ecosystems and promote biodiversity.

Another reason for the need for vegetation management is to comply with regulations and standards. Many utilities and other businesses are subject to regulations and standards related to vegetation management. Effective vegetation management helps ensure compliance with these requirements and minimizes the risk of fines and penalties.

In summary, vegetation management is essential to ensuring the safety and reliability of critical infrastructure, protecting public safety, promoting environmental sustainability, and maintaining compliance with regulations and standards. . Good vegetation management practices such as pruning, pruning, and removal help prevent vegetation from impacting critical infrastructure, reduce the risk of damage, and help ensure safe and reliable operation of infrastructure. increase. By carefully managing vegetation around critical infrastructure, companies can reduce their carbon footprint, promote biodiversity and maintain healthy ecosystems for future generations.

2.3 Vegetation Management and environment preservation

Vegetation management is an important part of infrastructure maintenance and management, including controlling and maintaining vegetation growth in areas that may interfere with the proper functioning of infrastructure or pose a safety risk. Good vegetation management practices are important not only for maintaining the safety and reliability of critical infrastructure, but also for protecting the environment and promoting sustainability.

One way vegetation management is linked to environmental protection is the conservation of natural habitats. Well-managed vegetation helps maintain natural habitats for wildlife, including birds, insects, and other species. By carefully selecting and managing vegetation in areas close to critical infrastructure, companies can protect natural habitats and promote biodiversity. In this way, we can maintain healthy ecosystems and contribute to the conservation of biodiversity.

In addition to protecting natural habitats, vegetation management also helps maintain soil and water quality. Vegetation management practices such as mulching and soil covering help prevent erosion and protect soil nutrients. This helps maintain soil quality and promote healthy plant growth while minimizing the environmental impact of vegetation management

activities. Trees and other plants absorb carbon dioxide and other pollutants from the air while regulating water flow and filtering pollutants from the soil. By carefully managing vegetation in areas close to critical infrastructure, businesses can maintain healthy air and water quality.

In addition, trees and other plants play an important role in mitigating the effects of climate change by absorbing carbon dioxide from the atmosphere. By carefully selecting and managing vegetation in areas close to critical infrastructure, companies can reduce their carbon footprint and contribute to efforts to combat climate change. Vegetation management also helps reduce the energy required to maintain infrastructure. Trees and other plants can provide shade and regulate temperature, reducing the need for energy-intensive cooling systems.

Effective vegetation management practices are also essential to maintaining compliance with vegetation management regulations and standards. Many utilities and other businesses are subject to regulations and standards related to vegetation management. Effective vegetation management helps ensure compliance with these requirements and minimizes the risk of fines and penalties.

In summary, vegetation management is an important aspect of environmental protection. By carefully selecting and managing vegetation in areas close to critical infrastructure, companies can protect natural habitats, protect soil and water quality, and combat climate change. In addition, effective vegetation management practices also help reduce the amount of energy required to maintain infrastructure and comply with regulations and standards. Overall, good vegetation management practices are critical to promoting sustainability and preserving the environment for future generations.

Chapter 3

Problem Identification

3.1 Extracting Themes of Focus

After reading through the compiled documentations, and mapping the user journey through the product, I had the following questions highlight several key themes related to vegetation management relevant to the current version of the IVMS:

- Real-time vegetation management plan adjustment and progress tracking
- Access to the latest information on work plans and priorities
- Identify and resolve delays or obstacles in vegetation management projects
- Communication with vegetation contractors and managers regarding work planning and implementation
- Monitoring weather conditions for crew safety and task planning
- Track crew and equipment availability to optimize work schedules
- Prioritize urgent and important tasks and alert on unfinished tasks
- Impact, Risk, OH Line Miles, Budget Forecasts and Forecasts
- Manage deferred important tasks and suggest new deadlines, contracts, or plan splits
- Tracking customers in need and their resolution
- The value of her SAIDI and SAIFI indicators for task escalation and utility users
- Minimize communication gaps for efficient decision-making, escalation and mitigation
- Identify critical planning areas and communicate to users
- Criticality and Priority in Circuit Criticality and Risk
- Prompt users to take recommended actions based on historical data and context
- Provide Direct Touchpoints to Make Widgets, KPIs, and Data Points Actionable
- Indicators and KPIs for informed decision-making in vegetation management
- Indicators and KPIs required to develop a vegetation management plan.

3.2 Problem Statement

Based on the themes of focus, following were some of the problem statements I boiled everything down to pertaining to vegetation management and IVMS:

- Current vegetation management systems lack real-time adjustments to priorities and changing conditions, resulting in delayed treatment of critical areas.
- Vegetation managers do not have up-to-date information on work schedules and priorities, making it difficult to make the necessary adjustments to ensure work is completed on time and meets safety and quality standards. is.
- Vegetation management project delays and failures are not recognized in time, increasing project costs and missed deadlines.
- The lack of clear and consistent communication between vegetation contractors and utility vegetation managers creates mismatched priorities and specifications, impacting work schedules and resource allocation.
- Weather conditions are not effectively monitored, causing crew delays and safety concerns. Crew and equipment availability is sub-optimal, causing delays due to lack of resources.
- Urgent and important tasks are not properly prioritized, delaying the completion of more important and less urgent tasks.
- Lack of forecasting and forecasting capabilities for impacts, risks, circuits, OH line mileage, budgets and weather.
- Delayed critical tasks are not managed effectively, deadlines are missed, and costs increase. Completion of vegetation management activities is delayed due to ineffective tracking of problem customers and their resolution.
- The value of the SAIDI and SAIFI metrics is not fully understood and utilized, resulting in missed opportunities to escalate tasks and improve efficiency.
- Communication gaps in utilities lead to delayed decision-making, escalation and mitigation.
- Areas that are important to the plan are not effectively communicated to the user when the plan is created, thus missing the opportunity to address those areas.

- Current definitions of circuit criticality do not fully account for a circuit's current risk, thus misaligning priorities and resource allocations. Users are not prompted to effectively take recommended actions based on historical data and current conditions, resulting in lost opportunities to improve resource allocation and work efficiency.
- Direct on-screen touchpoints are not effectively used to make widgets, KPIs, and data points more actionable, resulting in poor user engagement and missed opportunities for efficiency .
- Missing metrics and her KPIs to help vegetation managers make more informed decisions to keep their plans healthy.
- The metrics and his KPIs required for planning are not readily available, delaying planning and reducing efficiency.

Chapter 4

User Research and Research Methodology

4.1 Methodology and Approach

4.1.1 Methodologies followed

1. **Interviews**: Interviews are a qualitative research method that involve one-on-one conversations with users to understand their experiences, attitudes, and behaviors in more depth. Interviews can be conducted in person or remotely, and can be structured or unstructured depending on the research objectives.
2. **Usability testing**: Usability testing involves observing users as they interact with a product or service to identify usability issues and areas for improvement. Usability testing can be conducted in person or remotely, and can involve task-based or exploratory testing.
3. **Analytics**: Analytics involve collecting and analyzing data about user behavior and interactions with a product or service, typically through website or app tracking tools. Analytics can provide insights into user behavior and preferences, but may not provide a complete picture of user needs or attitudes.

4.1.2 Approach followed

1. **Design thinking**: Design thinking is a human-centered design approach that involves empathizing with users, defining the problem, ideating solutions, prototyping and testing, and iterating based on feedback.
2. **Contextual inquiry**: Contextual inquiry is a research methodology that involves observing users in their natural environment to understand their behaviors and needs. This approach is useful for understanding how users interact with products or services in real-world settings.
3. **Competitor Analysis**: Competitive analysis is an assessment of the strengths and weaknesses of current and potential competitors. This analysis provides both an offensive and defensive strategic context to identify opportunities and threats.
4. **UX Audit**: A UX (User Experience) audit is a process of evaluating the usability, accessibility, and overall user experience of a website, application, or product. The objective of a UX audit is to identify areas for improvement and provide recommendations to enhance the user experience.

   The process of conducting a UX audit involves the following steps:

   a. **Define the scope**: The first step is to define the scope of the audit, which includes identifying the specific areas of the product or service that will be evaluated. This may include the user interface, navigation, content, functionality, and accessibility.
   b. **Gather data**: The next step is to gather data about the product or service being audited. This may include reviewing existing user research, conducting new research through user testing, analyzing analytics data, and reviewing the product or service documentation.
   c. **Evaluate the user experience**: Once the data has been gathered, the next step is to evaluate the user experience of the product or service. This may involve using heuristics or best practices to identify areas of strength and weakness, and evaluating the product or service against established standards or benchmarks.

d. **Identify areas for improvement**: Based on the evaluation, the next step is to identify specific areas for improvement. This may include usability issues, accessibility concerns, or opportunities to enhance the overall user experience.
e. **Develop recommendations**: The final step is to develop recommendations to address the areas for improvement. This may include changes to the user interface, navigation, content, or functionality, as well as recommendations for improving the overall user experience.

Overall, a UX audit is a valuable tool for identifying areas of a product or service that can be improved to enhance the user experience. It can help organizations to identify specific areas for improvement and develop actionable recommendations to enhance the user experience and improve user satisfaction.

4.2 Discovery Calls with CSM

To get a detailed understanding of the problems identified, my team members included me in some discovery calls with the customer success managers to validate the same:

- The top goals include percentage of work planned, trees removed, miles worked, hours logged, hazard trees, and budget.
- They suggest keeping track of high-risk mile/segment, and differentiating between active, assigned, and unassigned plans.
- Monthly and annual reviews should be done with metrics such as miles worked, assigned, planned, unplanned, etc.
- The note also mentions the need for a filter and trigger warning for completed vs. to be completed tasks.
- Ensuring managers use IVMS, knowing metric data, and being task-centric are important for removing risk and allocating budget.
- Lastly, notifications and time vs. completion should be monitored.

Chapter 5

Need Statement

A comprehensive dashboard is needed to enable field contractors to efficiently manage devegetation and maintenance operations while providing real-time insights to field managers, vegetation managers, and overhead managers. The dashboard should track key metrics such as percentage of work scheduled, trees removed, miles driven, hours recorded, high-risk segments, and budget. It should provide yearly and monthly toggle views, trend analysis, and filtering down to the region level. The dashboard should also enable AD HOC task management and trigger alerts to ensure timely task completion. Finally, the dashboard should be integrated with her IVMS to ensure managers are using the system and provide real-time data insights to enable risk management and budget allocation adjustments.

Chapter 6

Conceptual Development

6.1 Explorations

Blockers and Opportunities while Mapping the Journey

Fig. 4 Identifying the blockers in the User Journey

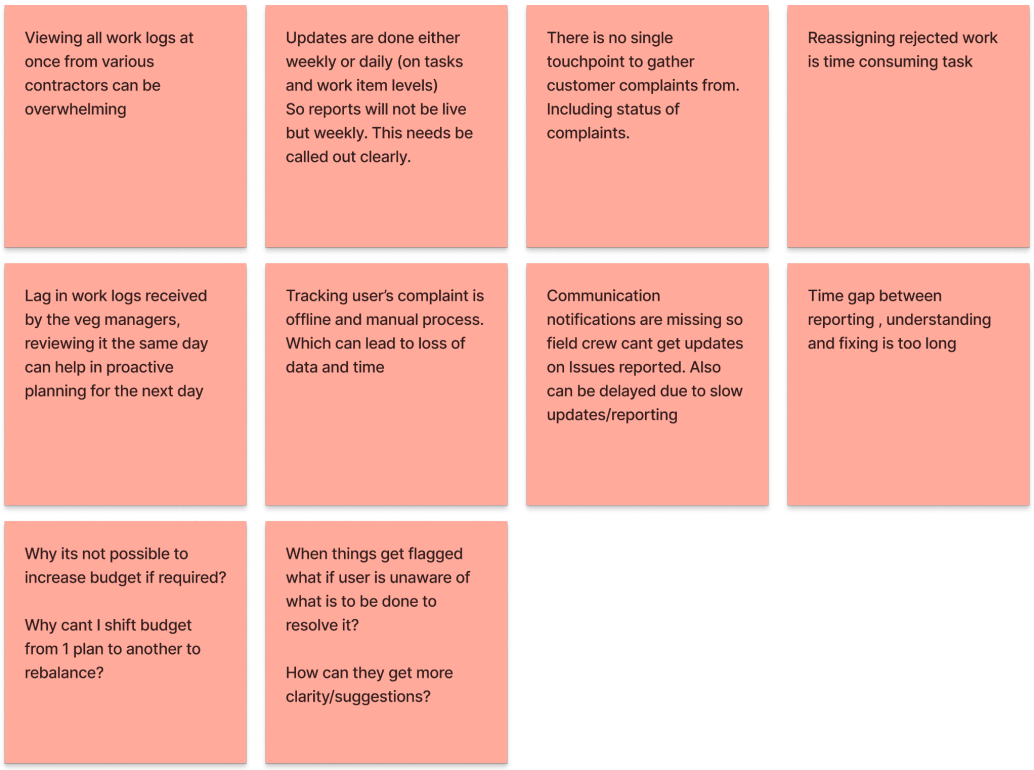


Fig. 5 Identifying the blockers in the User Journey

Fig. 6 Identifying the Opportunities

Biography

Reuben Parrish has been working as a Vegetation Manager for over a decade.
On a daily basis, he provides his services and audits accounts, focusing on KPI. When there's a problem, he always prefers to deal with it personally.
He wants the system to be easy and intuitive so he can easily find solutions.

Need

- View important/Key business metrics like - outages, SAIDI, SAIFI, and O&M budgets
- View suggested schedule for trimming based on scenarios and risks
- Manage Adhoc task request

Frustration

- Harm caused by grow-in risk and hazard
- Lack of detailed view for KPI, assets
- Inefficient tracking of tasks, track progress

Motivation

- To improve the overall efficiency and oversee operations of the utility
- Functionality to prioritise trimming based on impact to reduce the risk
- Condition based management

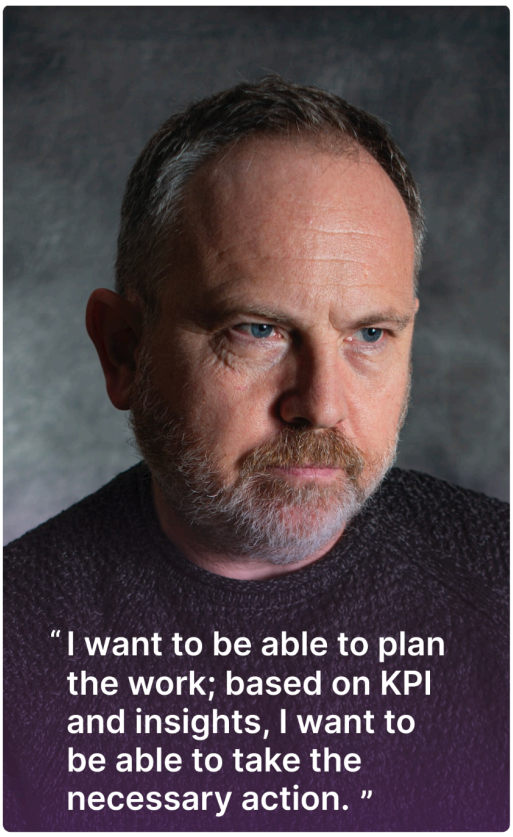


Fig 7 User Persona

Fig. 8 User Stories extracted from the persona identified

Chapter 7

Results and Discussions

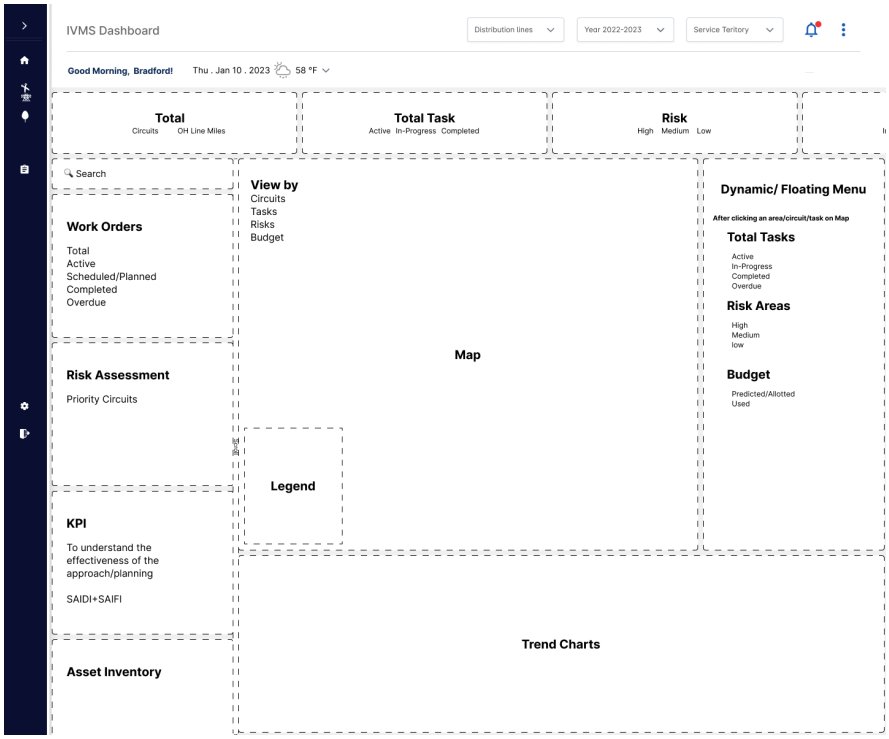
7.1 Selection of Concepts

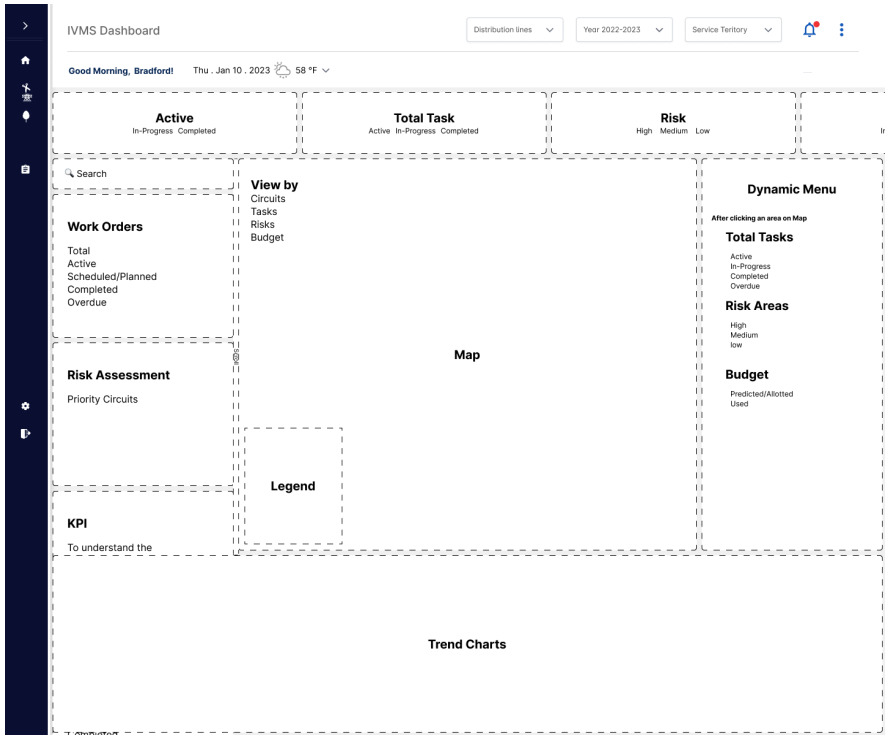
Out of many themes that were identified during the explorations and discussions, it was decided that it's best to move forward the following:

- Better visibility of the network
- Increasing user engagement by introducing recommendations to preserve the health of the region/network
- Introducing an overview section as a homepage, which has more functionality than a regular dashboard

These themes were chosen in order to upgrade the existing version of the product in ways that it adds more functionality and value for the user, and hence increase the user engagement.

Based on these, I came up with some low fidelity wireframes





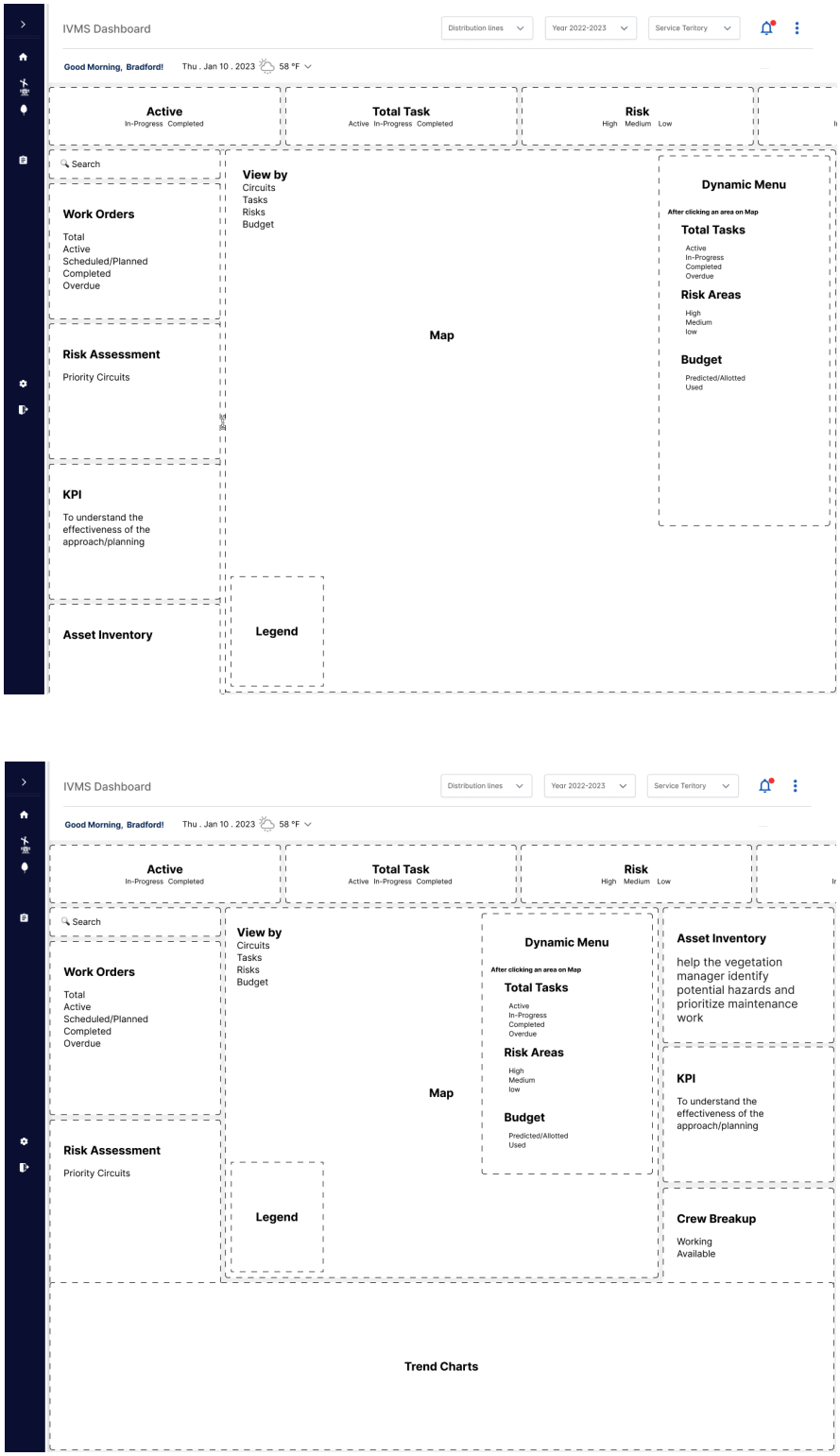


Fig. 9 Low Fidelity Explorations based on the research

Some components that I explored extensively were:

Map

I explored a Map centric approach as it was something that would definitely give the user a complete view of the network; where all the work is being done, where all these places lie on the map, their proximity to each other, etc., can be easily explored if the map was given an appropriate space.

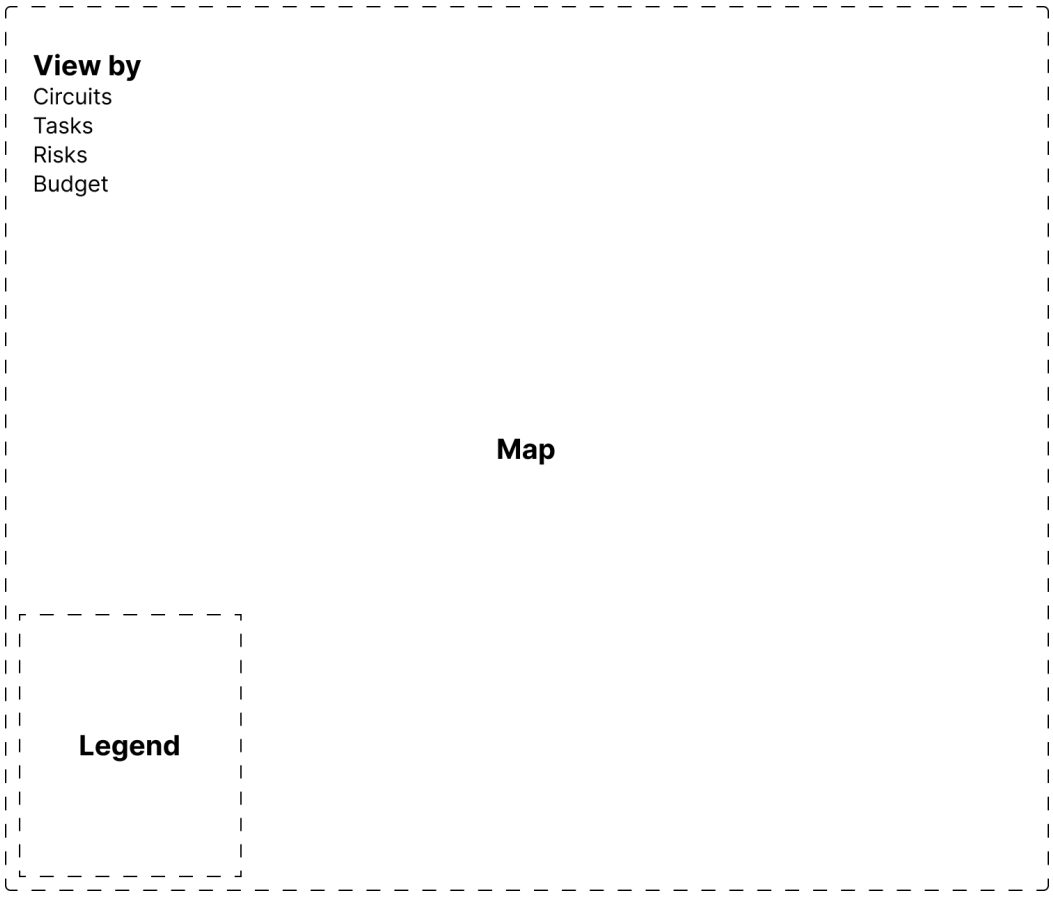


Fig. 10 Map

Top Panel

Fig. 11 Top Panel

Top panel in my designs included work KPIs that would summarize the progress of the active plans, total land covered, tasks completed, risk mitigated, overdue tasks that might pose a big threat, so that the Vegetation Manager, or Utility Supervisor can make informed decisions.

Dynamic Floating Menu

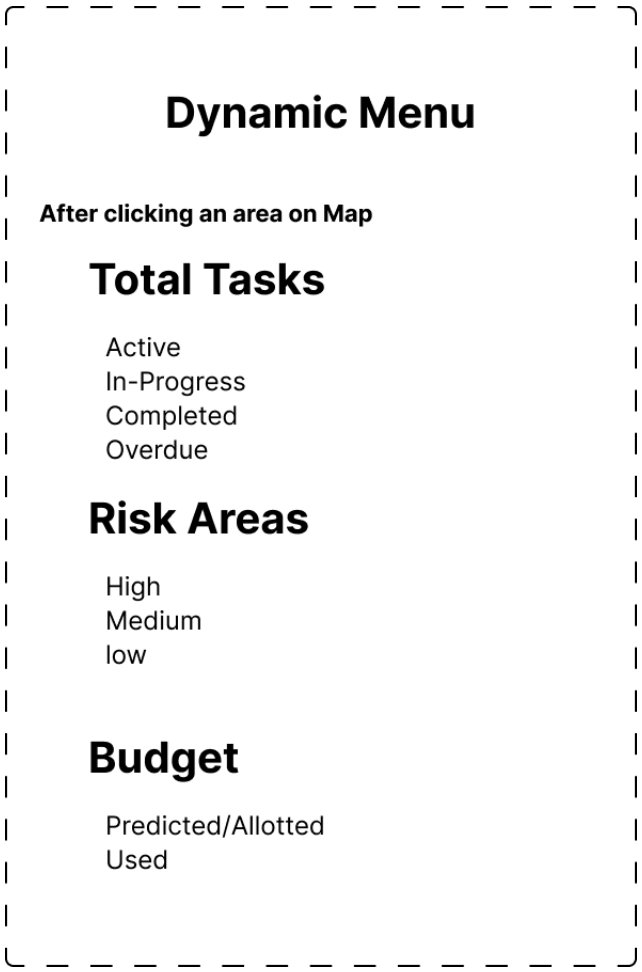


Fig. 12 Dynamic Floating Menu

This dynamic menu is a part of the map, whenever the user would click on any active area, or any circuit, they would see this card, and understand how the selected entity is performing.

7.2 Going Forward

After these explorations were discussed in the team, it was found that the approach was something that can be implemented as it covers most of the the concerns and opportunities that were discussed.

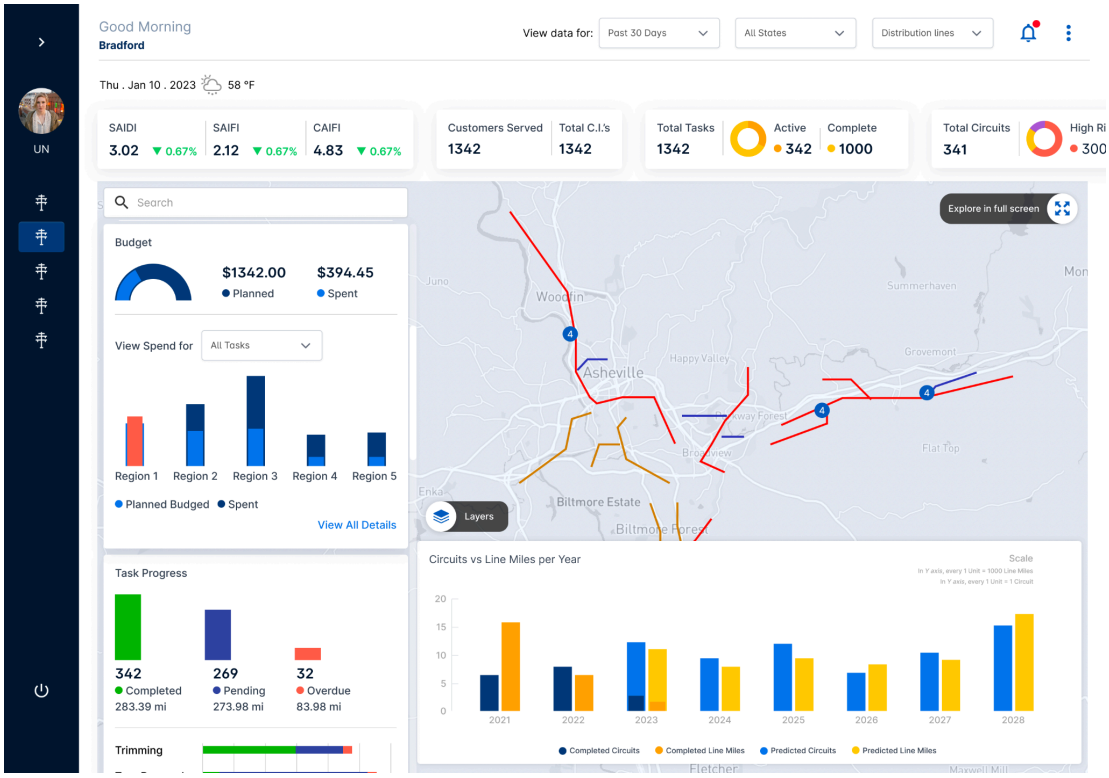


Fig. 13 High Fidelity Exploration

7.3 Learnings

- **Understanding the problem statement**: It is important to clearly understand the problem statement and the goals of the stakeholders before conducting any research.
- **User-Centered Design**: A user-centered design approach is crucial to ensure that the end product meets the needs of the users.
- **Data-Driven Approach**: A data-driven approach to design ensures that the product is designed based on real data and metrics, and not just assumptions.
- **Collaborative Approach**: Collaborating with stakeholders, users, and cross-functional teams can help identify pain points and generate better solutions.
- **Iterative Design Process**: The iterative design process allows for continuous feedback and improvements, leading to a better end product.

Conclusion

Based on the discussions, it has been evident that vegetation management is a crucial aspect of any industry that involves the management of natural resources. Poor vegetation management practices can lead to adverse effects such as power outages, wildfires, and environmental degradation. However, with the help of technology, there are innovative solutions that can be implemented to improve vegetation management practices.

The use of AI and machine learning algorithms in vegetation management systems can help to identify high-risk areas, predict potential hazards, and improve overall efficiency. Moreover, the integration of mobile applications and real-time monitoring tools can enable contractors to be more productive and facilitate more effective communication between managers and contractors.

The dissertation delved into the various themes and problems identified during the research process, including the need for asset/performance level information, the importance of identifying high-risk areas, and the need for better metrics to measure productivity. Additionally, the dissertation explored the visual explorations made during the research, which will demonstrate the various design solutions that can be implemented to improve vegetation management practices.

Overall, the discussions highlighted the need for a more integrated and technology-driven approach to vegetation management. The implementation of such solutions can help reduce costs, increase efficiency, and mitigate potential risks associated with poor vegetation management practices.