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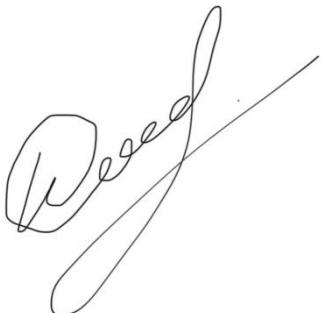


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ABSTRACT

Fashion recommendation systems which offer customized ideas have become more common as a result of the growing impact of fashion. Even so, it can be difficult for internet consumers to locate apparel that suits their unique body shapes and sizes. This study investigated challenges faced to customers when they shop for fashion online using a mixed-methods requirement elicitation methodology. The suggested method does away with manual input by using computer vision technology to automatically record body dimensions. Clothes tailored to each user's specific proportions is dynamically shown thanks to the integration of 3D modeling. Providing a smooth, customized purchasing experience is the goal. The technology-enabled solution attempts to close the gap between online fashion products and the different fitting demands of clients by utilizing body-type and preference-specific technologies.

Additionally, this study explores the potential of assistive technologies through the examination of image classification, parsing, and processing methods. These technologies present an opportunity to enhance both the accuracy and efficiency of the system. Fashion recommendation algorithms play a crucial role in delivering precise and tailored product suggestions. The envisioned approach seeks to significantly enhance the online shopping experience for customers by refining the clothing selection process. The primary goal is to empower consumers to make informed apparel choices quickly and effortlessly, ultimately enhancing their overall satisfaction with online shopping experience.

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ABBREVIATIONS

ABBREVIATION	EXPLANATION
AI	Artificial Intelligence
ML	Machine Learning
API	Application Programming Interface
GDPR	General Data Protection Regulation
OOD	Object Oriented Design
OOP	Object Oriented Programming
SDGP	Software Development Group Project
UI	User Interface
UX	User Experience
UML	Unified Modelling Language
FR	Functional Requirements
NFR	Non Functional Requirements
OOAD	Object Oriented Analysis and Design
SSADM	Structured System Analysis and Design Method
AR	Augmented Reality
CLI	Command Line Interface

CHAPTER 1: INTRODUCTION

1.1 Chapter Overview

Before moving on to more in-depth research, this introductory chapter will concentrate on gathering the necessary data for the system. Nevertheless, it will also provide us with an overview of the project, its background, requirements for achieving the solution, and details regarding its scope, both inside and outside the system.

1.2 Problem background

The fashion industries are undergoing a transformative shift towards enhancing the online shopping experience, and our project aims to address a significant gap in this domain by introducing a dynamic and personalized plugin for a clothing website. The plugin is designed to revolutionize the way users interact with and visualize outfits online, providing a unique and tailored experience. The “wow factor” in our project comes from the combination of cutting-edge technologies (AR) with personalized features that address common pain points in online clothing shopping. It introduces a level of interactivity and realism that goes beyond traditional online shopping experiences, offering users a novel and engaging way to explore and choose outfits.

Magnitude of the problem:

Online apparel shopping often presents challenges for customers, particularly in envisioning how a particular outfit will look on their body. The lack of personalized and interactive platforms contributes to a disconnect between the online shopping experience and the real-world fit and appearance of clothing items. This issue is exacerbated by the fact that individuals come in diverse body shapes, sizes, and skin tones, making it challenging to create a one-size-fits-all online shopping solution. In a comprehensive study conducted by Stöcker, Baier, and Brand (2021), the reasons behind fashion returns were examined, revealing critical insights from the customers' perspective and the dynamic nature of return patterns in online fashion retail. The research, published in the Journal of Business Economics, disclosed that a substantial 87.1% of respondents cited "Item does not fit" as the primary reason for returning purchased items. Additionally, 45.9% expressed dissatisfaction with the item, stating "I do not like this item," while 41.6% acknowledged ordering multiple sizes to facilitate a choice. Further contributing to the return dynamics were reasons such as 21.0% finding the received items "not

as described" and 4.2% making additional purchases for home consideration due to promotional measures. These findings underscore the challenges faced by consumers in accurately assessing the fit and appeal of online clothing purchases, emphasizing the need for innovative solutions, such as the proposed plugin, to mitigate these common issues and enhance the overall online shopping experience (Stöcker, Baier, & Brand, 2021, <https://doi.org/10.1007/s11573-021-01032-1>).

Example Scenarios:

Consider a scenario where a user is browsing a clothing website to find the perfect outfit for a special occasion. Despite finding an outfit that appeals to them, uncertainty about how it will complement their unique body shape and skin tone prevents them from making the purchase. This hesitation often leads to missed opportunities for the online retailer and frustration for the customer.

Furthermore, imagine a user with a specific event in mind, such as a night party or an important interview. They may struggle to navigate the vast array of available options and envision how each outfit would suit the occasion. This lack of guidance can be overwhelming and time-consuming.

The Problem Statement:

The problem identified is the absence of a personalised, interactive, and immersive online shopping experience that addresses the individuality of users in terms of body shape, skin tone, and occasion. Existing online platforms fail to provide adequate tools for users to visualize and assess how clothing items will look on their unique physique, leading to increased instances of dissatisfaction and returns.

Considering these challenges, our project proposes a solution through the development of a plugin that incorporates three key features: body measurement analysis, skin tone selection, and occasion-based outfit recommendations. By integrating Augmented Reality (AR) to generate personalized models showcasing the outfits on the user's body type, our solution aims to bridge the gap between the virtual and physical aspects of online shopping.

By addressing this significant problem, our project seeks to enhance the online shopping experience, reduce return rates, and contribute to a more sustainable and customer-centric fashion industry. The incorporation of innovative technologies and personalized features sets our plugin apart, providing a "wow factor" that promises to revolutionize the way users engage with online fashion retail.

1.3 Problem Statement

Many people find it challenging to find clothing products that fit their distinct body types and preferences when they purchase online. We are in the midst of creating an advanced method to handle this continual issue. This technology is made to efficiently choose and suggest clothes alternatives that are customized to each person's unique body type, shape, and preferred color. The system's creative methodology integrates advanced Augmented Reality (AR) technology together with plugins. Our goal is to transform online buying by utilizing these cutting-edge techniques. Users will have access to a customized recommendation system that may offer clothing alternatives based on their unique body types, shapes, and favored colors thanks to these plugins and augmented reality technologies.

Our main objective is to help consumers through the internet by offering them a simple, effective solution to the widespread problem of having trouble finding clothes that precisely match their own physical characteristics and preferred styles. By providing personalized recommendations, this approach aims to improve the entire shopping experience and eventually change how people find and choose clothes online.

1.4 Proposed Solution

Our main goal is to create an innovative plug in for clothing websites using cutting edge AR technology together with WooCommerce and Shopify plugins. With the help of this cutting-edge function, you can measure your body precisely, finding out things like your waist, hip, breast, and shoulder length. The system uses this information to intelligently propose the customer's body type as rectangle, hourglass, or pear based on their body type. The next step in customization is to provide outfit recommendations based on each customer's unique body type. Our system has an innovative function that measures the customer's skin tone in addition to physical parameters.

Using this knowledge, color suggestions for clothes are made that suit the wearer's skin tone and improve the whole look of the outfits. Next adding a unique function that goes above and beyond standard customization we can identify the event the customer is buying for, such as a meeting, wedding, or other special occasion. By using this information, the system suggests outfits that go well with the event, making sure the customer feels and looks their best. Basically, our inclusive plan is to completely transform the online buying experience through the seamless integration of technology. The project includes not only the essential elements of precise measurements and body type recommendations, but also personal style, occasion specific requirements, and color balance, resulting in a genuinely customized and delightful shopping experience for the customer.

1.4.1 Problem Definition

We are humans, So the humans have different body shapes. We have fashion requirements that means we need clothes to wear. Just we are in a busy lifestyle, so we have no time to shop physically. Then we must choose only shopping through the web. But is it impossible sometimes because there are some issues like frustration and dissatisfaction. Customers frustration and dissatisfaction at not being able to find clothing that truly fits their unique body shapes and sizes is a persistent obstacle in the fashion industry.

Clothing that doesn't fit right can make people feel uncomfortable, make them feel less confident, and make retailers get more returns. The fashion industry faces constant difficulties with product fit and customer satisfaction. The trouble that many individuals have in finding shops that really accommodate their body shapes. So, the size and the quality is the main issue. According to "Forrester research" the product return rate is about 35%. This is very high, and it might be 40% after years.

1.4.2 Problem Boundary

This creative project aims to combine the powerful ecommerce platforms such as WooCommerce and Shopify with cutting edge technology, specifically AR (Augmented Reality). The main goal is to provide an advanced plug-in function for clothing websites that goes over typical online buying experience. By taking specific body measurements from customers, such as shoulder length, hip size, waist size, and breast size, we want to improve their customized experience. Based on these measures, the customer's body type such as pear, hourglass, or rectangle can be suggested allowing for the creation of clothing suggestions that are specific to their body type.

Our plug in will go beyond customization and into the aesthetics by employing AR technology to capture the customer's skin tone. After that, the system will cleverly recommend outfits in colours that go well with the wearer's skin tone, making the choice pleasant and eye catching. We also want to launch another cutting-edge function that allows customers to choose the event such as wedding, meeting, or any other kind of gathering for which they are buying clothes. By using this data, our system will select outfits that are suited for the given situation while still respecting your personal sense of style.

Even with our project's outstanding potential, we must define a problem boundary that limits the extent of our work. This barrier is purposefully drawn to keep out problems with product quality, delivery transport, and other small problems. We only work on improving and streamlining the suggestion and shopping process. By focusing on these specific areas, we want to focus our efforts and resources on solving issues that occur during the customizing process, avoiding any possibility of confusion or replacing our main objectives.

We solve difficulties in taking accurate body measurements, analyzing them to provide customized body type ideas, and producing specialized clothes suggestions within the parameters of our project. Our priority is to provide the best possible experience for both customers and sellers, with a focus on easy communication with Shopify and WooCommerce.

Reducing unnecessary problems allows us to focus more on improving essential features, which improves e-commerce. Personalization is the foundation of our strategic decision-making process, which uses customer information to provide helpful recommendations. Our project is positioned as a forerunner in the transformation of online fashion retail due to its purposeful focus on providing a customized, realistic, and enjoyable shopping experience.

1.4.3 Examples in the Solution

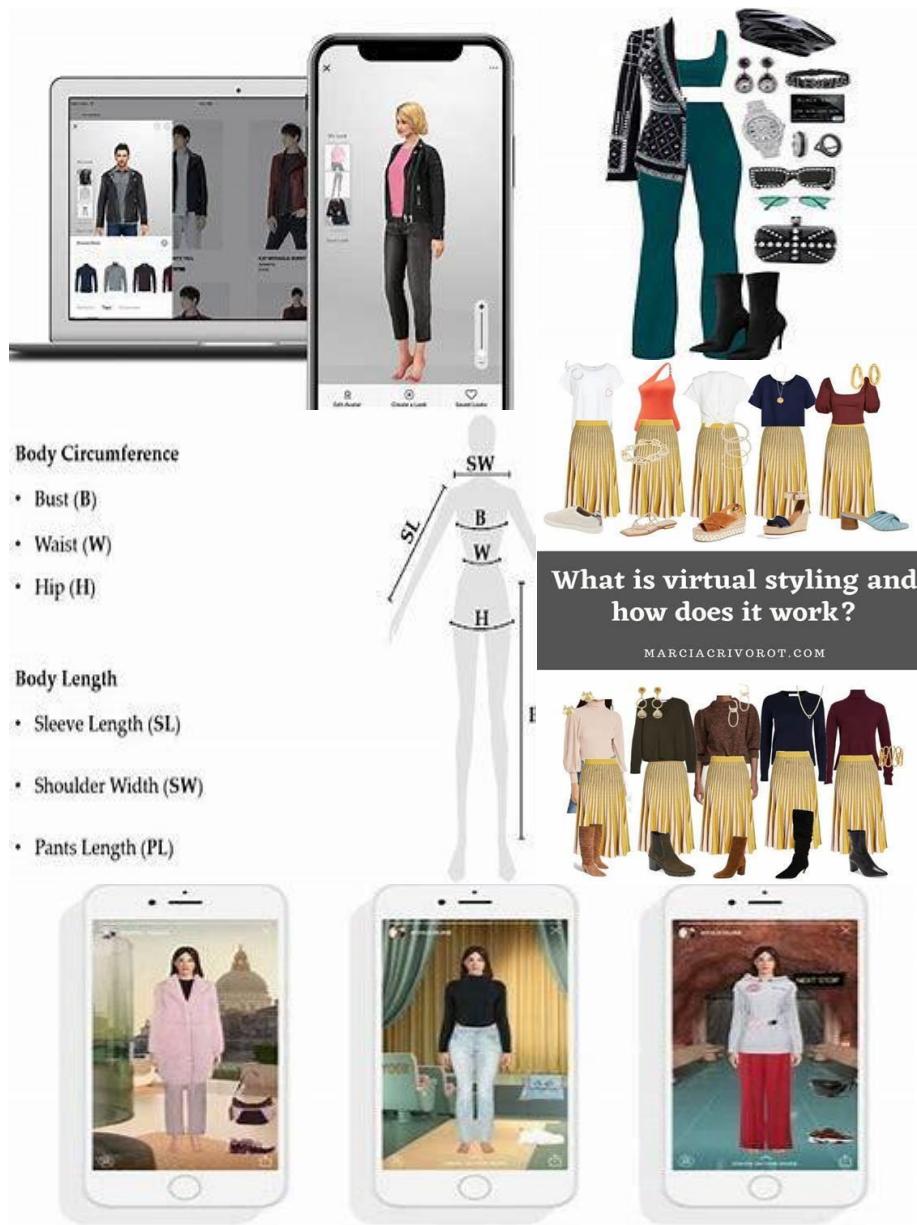


Figure 1: Examples in the solution (self-composed)

There are the some examples ,

1. Recommendation Engine
2. Virtual fitting rooms
3. 3D Avatar Customization
4. Size recommendation
5. Virtual styling

1. Recommendation engine:

Improves customer experience by using ai to provide personalized options depending on user preferences and behaviours.

Ex: “1822 Denim” company provides personalized size and fit recommendations.

2. Virtual fitting rooms:

Virtual fitting rooms use augmented reality (AR) technology to allow users virtually try on clothes. Customers may make confident online purchases without having to physically fit clothes by seeing how they fit and appear on their computer screens.

Ex: “Knix” company created a virtual fitting room to provide a fitting service to client online.

3. 3D Avatar Customization:

Users can personalize their 3D avatars to create unique digital versions of their bodies for online try-ons. This improves fit accuracy for prediction and offers a more interesting buying experience.

Ex: “Nesting Olive” company allows clients to create their personalized 3D avatars.

4. Size recommendation:

According to a customer's body measurements or previous purchases, size recommendation systems use methods to identify the best size. This limits the possibility of returns because of size problems.

Ex: “Amazon” suggests the best fit clothing based on customers body measurements.

5. Virtual styling:

Personalized clothing and fashion suggestions based on personal tastes are provided by virtual styling services. Customers may visually see several looks and pairings while getting professional style advice matched to their own favours and tastes.

Ex: “StyleMyMind” offering virtual styling consultations and outfit suggestions.

1.4.4 Attempted solutions

To change the whole fashion system, modern technologies and methods are being used to address the issues of customer discontent and poorly fitting products in the business. These solutions focus on addressing the fundamental causes for dissatisfaction, improving the overall online shopping experience, and enhancing the size and quality of clothing. Among the most important plans are:

- Advanced body type identification:

Introducing modern size technology, like 3D body scanning and AI driven algorithms, allows for more accurate and customised sizing suggestions for customers.

- Virtual fitting room experiences:

Reducing the risk of customer dissatisfaction by providing virtual try on experiences that allow customers to check out how products will fit and look at their unique body types before making a purchase.

- Body measurements input:

Certainly, an essential part of solving the problem of misfitting clothes in the fashion industry is using correct body measurements in the solution. These solutions focus specific body measurements to improve the accuracy of sizing suggestions, reduce the possibility of clothes that are too small, and make online shopping for customers a better experience.

- Skin tone questionnaire:

We can reduce the risk of customer dissatisfaction by providing a skin tone facility that allows customers to check out how products will look on their unique skin color types before making a purchase.

- Customer feedback integration:

We can develop our software day by day by getting customer feedback and can see continuous improvement based on real user experiences.

- Clothes recommendation:

Using AI powered engines to analyze preferences and trends for personalized recommendations. Improving the buying experience, decreasing dissatisfaction, and encouraging style experimentation. This solution makes use of machine learning to align with customer preferences for a great online experience. The feature adapts to shifting preferences thanks to integrated feedback and evolving technology, which improves the fashion retail landscape.

Through bringing together these methods, the suggested solutions aim to change the fashion industry, reduce customer dissatisfaction, and increase total satisfaction with virtual shopping experiences; in the end, these efforts want to control the increased number of product returns and develop an effective change of customer confidence.

1.5 Aim

The research's objective is to create a virtual fitting room plugin for a website that recommends clothes. It is made especially for Shopify and can cater to a wide range of target users.

People these days want to save time, so they utilize online systems most of the time. However, because of past failures and experiences, people don't trust online systems, so we're trying to change that by providing comprehensive satisfaction systems for online consumers. for them to save time and provide better results.

1.6 Project Scope

1.6.1 In-scope

- Users will have the ability to create an account on the shopping website.
- The plugin will show a dialog box asking the user to retrieve data or use the same data saved before.
- Getting body measurements, skin tone and occasion type.

1.6.2 Out-scope

- The plugin will not have the ability to compensate for wrong measurement inputs.
- When the user encounters the dialog box and utilizes previously saved data, but there have been alterations in the user's body measurements leading to an inaccurate body type and outfit recommendation, the plugin lacks the capability to correct or adjust for such changes.

1.7 Rich Picture Diagram

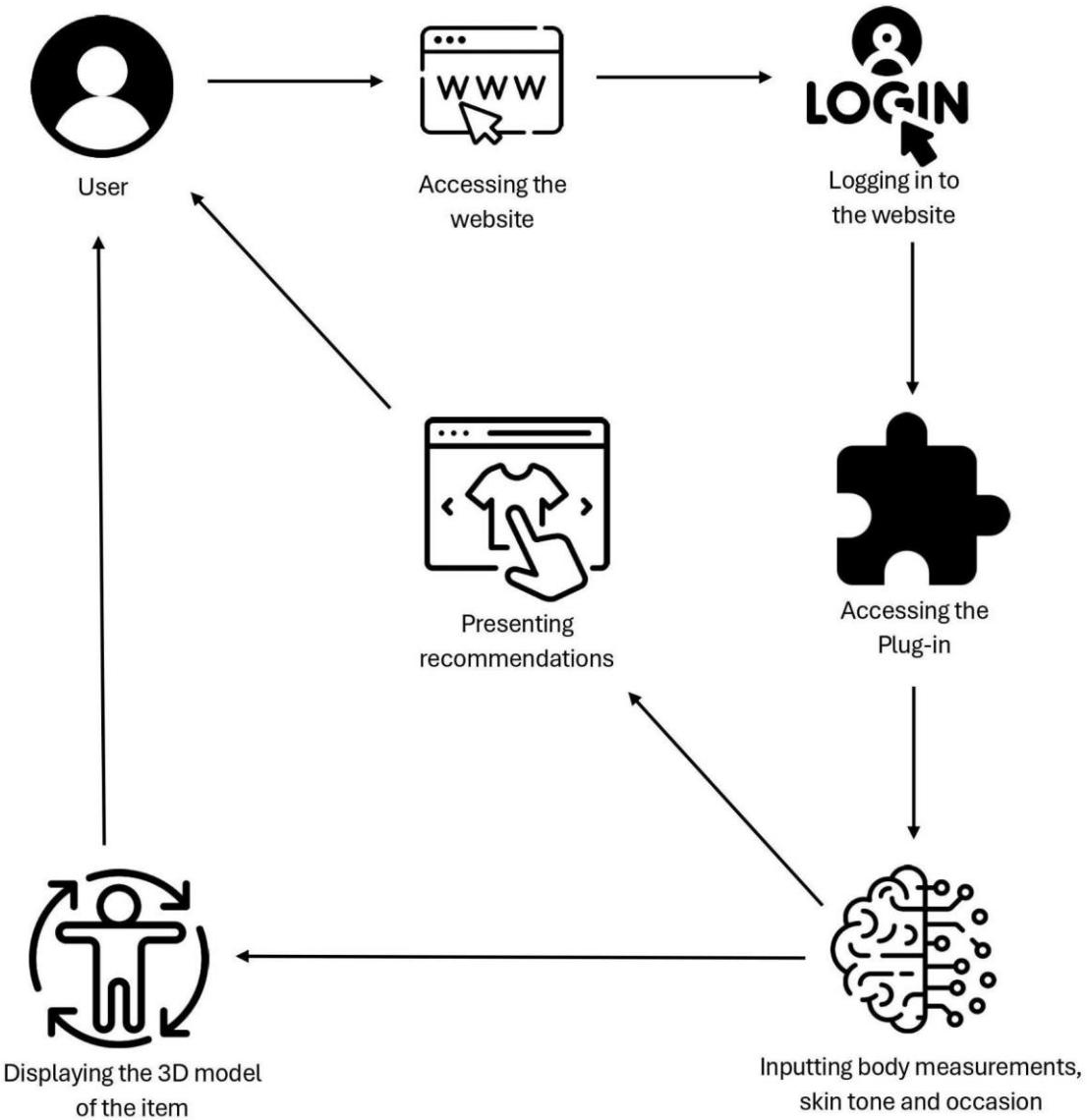


Figure 2: Rich Picture Diagram

1.8 Resource requirements

1.8.1 Hardware requirements

A project integrating augmented reality (AR) technology into a Shopify platform fashion recommendation system may have different hardware needs depending on a number of variables, such as the intricacy of the AR features, the size of the system, and the particular technologies employed. In this project Machine Learning also have big part. Then we need high performance hardware. Mainly need below hardware requirements:

- Development Machine:

A laptop or desktop we need with sufficient RAM. Processing power and enough storage to run development tools and IDEs.

Ex -: I5 or higher multi-core processor, 8GB+ RAM, 500GB+ Hard SSD

- Smart Phone:

Smartphones with AR capabilities for use AR feature and to get measurements. Need a good camera with at least 8 MP+. Because when user giving measurements need to be clear.

- Router

We need a router to connect to the internet. Because this plugin is running through the online shopify platform.



Figure 3: Hardware Requirements (Self Composed)

1.8.2 Software requirements

This detailed explanation ensures an in-depth understanding of the technologies and their responsibilities within the integration of fashion recommendation with augmented reality into the Shopify platform by outlining the software requirements and the step-by-step methodology involved in each part of the project. In this project we need to know there is a seamless connection between recommendation engine and Shopify platform. Software requirements are given according to 4 main points.

Software requirements	
1.) Back-end	The backend technology selection revolves around Python for integration with the frontend with Flask, alternatively using Node.js with Express if needed. Flask for Python and Express for Node.js are optional framework.
Framework:	Flask (Python) or Express (Node.js) Optional
Libraries:	Pandas, NumPy, scikit-learn TensorFlow - Recommendation algorithms parts (Using ML)
	Flask-RESTful - Simplifying REST APIs creations with Flask setups. Flask-SQLAlchemy - Supporting efficient database management. Flask-CORS - Extension for Cross-Origin Resource Sharing in Flask application.

2.) Front-end:	Frontend development is based on HTML, CSS, and JavaScript, enhanced by the Shopify Embedded App SDK for user interactions. React.js for dynamic interfaces and Shopify-specific frameworks are suggested to this project.
	Framework: React.js and shopify development frameworks
	Libraries: Bootstrap or Tailwind CSS - styling, responsive and visually appealing frontend (UI) design. jQuery - DOM manipulation and event handling.
3.) AR Implementation:	JavaScript is good for AR. Js and other frameworks or Vuforia AR platform with Unity.
	Framework: JavaScript with AR.js/A-Frame C# (Using Unity)
	Libraries: AR.JS - Creating AR experience on the web. Three.js - More complex 3D rendering and interactions in AR.
4.) Additional Tools and Considerations	Shopify Plugin Creation Shopify's embedded App SDK to integrate the recommendation system into shopify plugin. Shopify platform is giving this for shopify developers. Also, we needed shopify store to apply this plugin.
	IDE Selection Visual Studio Code and JetBrains' IntelliJ IDEA(Optional). These tools are helpful for combined different languages processes to run in one project.
	Version Control Git - Version control and for collaboration GitHub -Repository Hosting
	Communication Tool Google Meet, Microsoft Teams - Communicate with team members.

	Project Management Tool	Trello for Task Tracking and project management
	3D Modelling Tool	Photogrammetry can create 3D models using 2D images taken from different angles. This can be used to store clothes details to use in the process of virtual fitting room.

Table 1 : Software Requirements and Frameworks/ Libraries

1.8.2.1. Software Overview

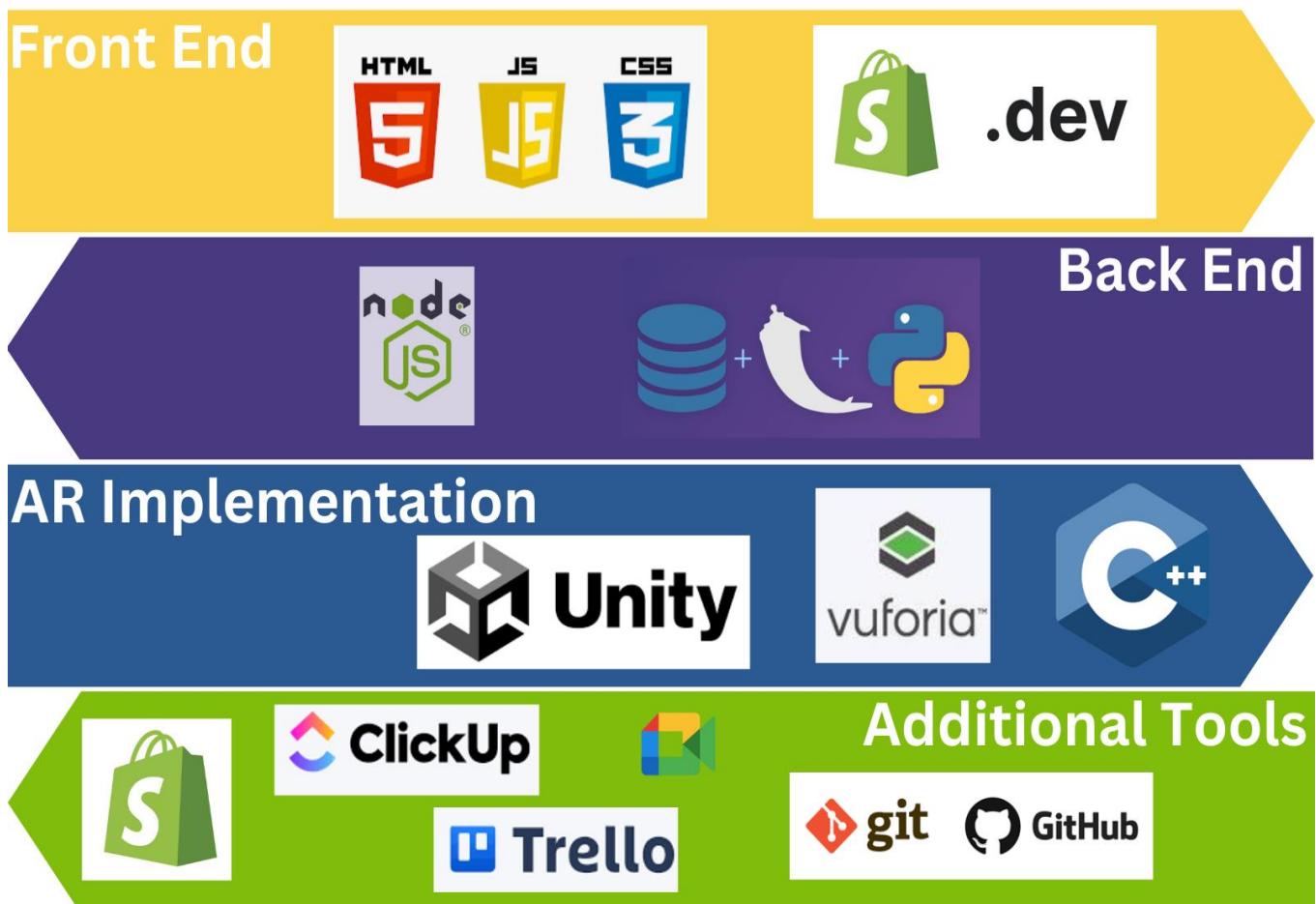


Figure 4: Software Overview (Self Composed)

1.9 Business model canvas

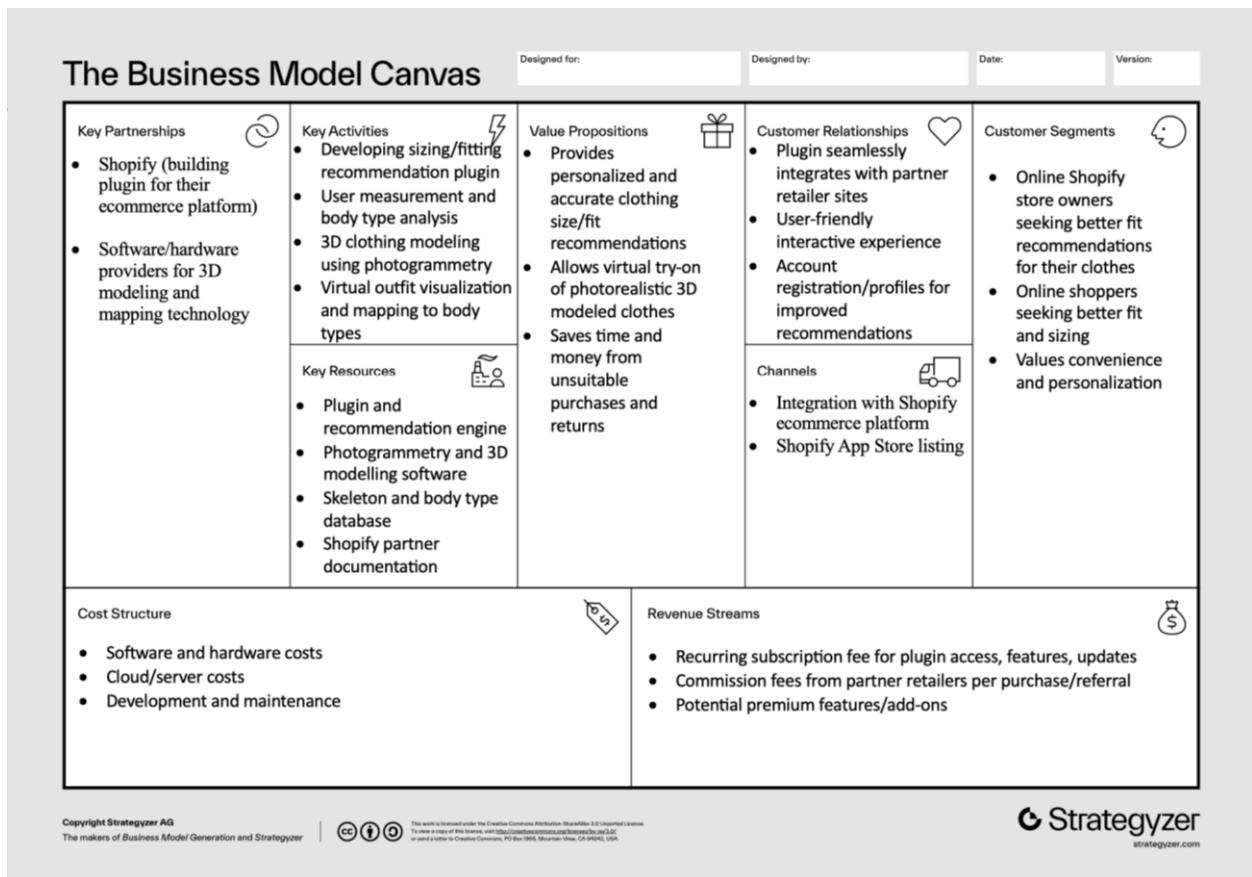


Figure 5: The Business Model Canvas

Models are used as tools for creating visual artefacts within software development phases such as specification of client requirements, software design, documenting the implemented solution etc”(Ljubica,2019,p15). A business model canvas is a visual chart with elements describing a company’s key partnerships, key activities, value propositions, customer segments, key resources, channels, cost structure and revenue streams which allows to visualize and assess how these components interact with the system.

1.10 Chapter Summary

This section is summarized in the chapter to provide readers with a thorough overview of the work. Those that use e-commerce systems encounter a plethora of issues. Our goal is to identify these kinds of issues and provide better solutions so that customers may purchase new clothing with confidence. The chapter therefore covers the following topics: problem description, research gap, project aim, project scope, rich picture diagram, research objectives, and problem with comparison chart for aim solutions. The resource requirements for the implementation are covered as above at the end of the chapter.

CHAPTER 2: EXISTING WORK

2.1 Chapter Introduction

This chapter elaborates on the project scope and requirements needed to develop the product. We compare existing solutions, delve deeper into competitor solutions, and discuss rough implementation plans and the tools and technologies that will be used. The previous chapter provided an overview of project scope and requirements. Establishing the optimal strategy for product implementation is the aim of this conversation. In addition to providing a more thorough review of this chapter for the project, the final strategy that was chosen will also be explained.

2.2 Existing Work

This section conducts a thorough assessment of available products and technologies that are associated with the suggested online shopping plugin solution. Considering that this project combines new approaches, it is difficult to find exact equivalents in the market. Nevertheless, essential functionalities are evaluated in similar options and research to identify gaps and differentiation factors.

The objective of the suggested plugin is to improve the virtual shopping experience by incorporating features such as suggestions, 3D visualization, and personalised body model fitting. Achieving this involves utilizing various capabilities including recommendation engines, creating 3D models, employing simulation and overlay technologies, and implementing body mapping techniques. Although there are plugins available that enable basic virtual try-on using 2D overlays or simple 3D rendering, none of them offer the comprehensive range of advanced features that are planned for this plugin. Although certain companies provide recommendation services separately, they do not combine them with immersive simulation customised to users' individual body shapes. Previous studies have investigated ideas such as photogrammetry and body scanning, but not specifically with the intention of enhancing consumer e-commerce.

There are several existing applications, such as BODI.ME Mirrorsize, hiploose, Virtusize, and TUREFIT. Benchmarking revealed limitations related to personalization and accuracy in current market options. The following table presents a summary of important comparative aspects between the existing solutions and the suggested approach. This evaluation verifies the distinctive nature of this endeavour, which aims to integrate state-of-the-art capabilities to enhance the simulated shopping experience.

2.2.1 Comparison of the existing solutions in the domain

No table of figures entries found.	3DLOOK	Mirrorsize	Virtusize	Proposed Solution
Recommendation Engine	X	X	X	X
Virtual Try-On	X			X
Body Shape Matching	X	X	X	X
Body Measurement Tracking	X			X
Fit Analysis	X	X	X	X
Shared Virtual Closet				X
3D Avatar Customization				X

Table 2: Comparison of the Existing Solutions in the Domain.

2.2.2 Uniqueness of the proposed solution

The proposed plugin offers a distinctive solution by integrating advanced methods such as photogrammetry and body mapping for creating 3D models, along with personalised recommendation functions. This unique combination enables it to deliver an optimised and customised online shopping experience. Unlike any other existing solutions, it encompasses a comprehensive range of features that aim to perfectly meet customer requirements and preferences, ensuring maximum satisfaction and convenience.

The plugin revolutionises various aspects to address major issues in online clothing shopping. By utilising 3D simulation technology based on photogrammetry, it enables users to visualise outfits from all perspectives and ensures accurate fitting, surpassing the limitations of 2D approximations. Moreover, advanced matching algorithms exclusively match clothing items to personalised avatar models created from individual body scans.

Furthermore, the plugin's accurate 3D visualisation differs from conventional e-commerce websites. Custom models made based on each person's measurements and preferences minimise the probability of receiving items that are ill-fitting or that are stylistically mismatched. This reduces the time-consuming returns and exchanges that result from doubts about the appearance and fit of clothing.

The plugin aims to assist shoppers and retailers by utilising advances in immersive visualisation and tools. Customers benefit from assured choices, and retailers benefit from a more seamless shopping experience with fewer returns and exchanges. By presenting personalised models based on user preferences and body types, the visualisation accuracy reduces wrong decisions and uncertainty. For both the consumer and the retailer, preventing uncertainty results in extraordinary convenience and satisfaction.

2.3 Tools and Implementation plan

2.3.1 Tools and Techniques

2.3.1.1 Tools selection

- Basic development and version control:

For the basic development process an IDE like IntelliJ will be used and to assist with the version control Git and Github will be used.

- User measurement capture:

For capturing accurate body measurements using the phone camera, Computer vision library tensorflow will be used which is capable of robust image processing allowing for precise measurement extraction from image capture. (TensorFlow, n.d.)

- Machine Learning Model for Body Shape Prediction:

TensorFlow was considered for developing the machine learning model responsible for predicting the user's body shape and with the help of datasets the body shape will be predicted to help recommend the clothing items.

- Color Palette Selection:

The selection of the color palette that matches their skin tone, the user can pick the color palette from a user-friendly color picker interface developed with the use of web development technologies HTML, CSS and JavaScript making it an interactive and visually appealing selection option.

- Outfit Recommendation Engine:

With the help of collaborative filtering and representation learning algorithms the outfits will be recommended to the user based on their preferences with the help of TensorFlow to build the system and Shopify API to integrate it with the Shopify store.

- 3D Model Generation:

For generating 3D models based on user measurements and recommended clothing items blender is used which is a 3D computer graphics software. This will help generate a 3D model of a human based on the user measurements.

2.3.1.2 Outfit Recommendation approach

The outfit recommendation approach mainly depends on the user's body type, skin tone and the occasion the user is planning on wearing the outfit.

- Body shape analysis: Utilising machine learning algorithms like collaborative filtering and representation learning the body shape of the user will be determined based on their measurements.
- Skin tone matching: With the help of color science principles to match recommended clothing colors with the user's skin tone the outfit recommendation is enhanced. The user will be presented with a color palette to choose the most accurate skin tone.
- Occasion based filtering: The main goal being the outfit recommendation being personalised the user can input the occasion which the system will use to present the user with the perfect outfit.



Figure 6: Free Vector Blogger Review (freepik, 2020)

By integrating these techniques, the outfit recommendation approach aims to provide tailored suggestions that not only fit the user's body shape but also harmonise with their skin tone and suit the intended occasion.

2.3.1.3 Combination of ML algorithms, rule-based approaches

Most existing recommendation systems are based on the purchase history of the customer, up and coming trends etc.... but in that system it lacks personalization. To increase the customer satisfaction it is important to understand individual preferences which increases the e-commerce profits. It is tough to develop a fashion recommendation model based on the body type due to the requirement for a large training dataset. To make it a success a deep learning model for categorising fashion item images is required through collaborative filtering and representation learning.

The machine learning algorithm collaborative filtering gathers user preferences from a large number of users to predict a user's preferences, hence collaborating. Collaborative filtering in fashion recommendation can be item based or user based. Item based collaborative filtering suggests items based on how similar their characteristics are to those of users, whereas user based collaborative filtering bases recommendations in the preferences of users with similar tastes (Koren, Bell and Volinsky, 2009). This algorithm will be used in the LUXE plugin to

determine the body shape of the user based on their measurements and to recommend users outfits based on their body shape, skin tone and the occasion they are planning on wearing the outfit to.

The representation learning algorithm takes data and turns it into a compact, meaningful representation to extract the underlying structure. This algorithm can be used to encode users and items into continuous vector representations in the context of fashion recommendation (Chen et al., 2021). The algorithm is helpful to train a machine learning model to identify the body shape of the users and identify which outfit suits the relevant body types. Or a pre trained model like AlexNet can also be used for the same purpose (Saxena, 2021).

2.3.2 Implementation plan

2.3.2.1 Shopify Plugin integration

2.3.2.1.1 Shopify API

The Shopify's API acts as a bridge between the fashion recommendation system and the e-commerce store on the Shopify platform. Basically, when the user engages with the plugin, behind the scenes the Shopify's API is connecting the plugin with the store presenting the user with recommendations based on the user preferences in real time. (Shopify, n.d.)



Figure 7: Shopify API Integration (EComposer, 2023)

2.3.2.1.2 Plugin integration with the platform

The integration of the plugin with the Shopify's e-commerce platform is effortlessly done with the help of the Shopify's API, forming a connection that goes both ways in retrieving and showcasing the fashion items. Beyond the technical partnership, the plugin is creative enough to carefully connect the user with the e-commerce store through the Shopify's API showcasing the recommendations that are tailored to the user's needs taking the retail experience to a new level. (Shopify, n.d.)

2.3.2.2 Front-End Development

As for the development of the front end of the plugin, the typically used web technologies like HTML, CSS and JavaScript will be used. In addition to that Shopify Polaris alongside react will be used which is a design system created by Shopify. It can be used to develop a consistent and cohesive user interface for the plugin. (Shopify, n.d.)

Polaris includes the following features:

- Design guidance: Guidance on accessibility, colours, typography, spacing, naming and actionable language.
- Components: Building blocks that are reusable which are made of interface elements and styles.
- Tokens: Named CSS values that represent design decisions.
- Icons: Icons that are designed focused on commerce and entrepreneurship.
- Patterns: Repeatable solutions to common UX problems in specific scenarios.

2.3.2.3 Back-End Infrastructure

The basic functionality of the back end in this scenario is handling data processing, machine learning model deployment and communication with the Shopify API. To achieve this, the Shopify CLI (command line interface) will be mainly used alongside Node.js. The Shopify CLI makes it easier to develop extensions for the platform and automate many common development tasks. (Shopify, n.d.)

Features of the Shopify CLI:

- Create new apps using app templates.
- Generate app extensions.
- Builds the app and creates a tunnel to test it out on a development store.
- Deploys the app extensions.

2.4 Chapter Summary

This chapter summarizes the available products and technologies that are associated with the plugin. The plugin incorporates many features, and they leverage technologies such as recommendation engines, creating 3D models, overlay technologies and many more. Although some plugins allow basic virtual try-on, none of them provide the advanced features that are planned to be included in this specific plugin. Therefore, this chapter compares the aspects between the existing solutions and the suggested approach. Need to get idea about what are the functional requirements(FR) and non functional requirements(NFR),then this chapter is helpful for that. It also discusses the uniqueness of the proposed solution by emphasizing its integration of advanced methods like photogrammetry and body mapping for 3D model creation. Finally, this chapter illustrates the tools and techniques used for the implementation of the plugin and approach taken for the recommendation of the outfits.

CHAPTER 3: METHODOLOGY

3.1 Chapter Overview

The project is relevant to the problems that we are facing using the online clothing industry. And our suggested solution includes Shopify and WooCommerce plugins with augmented reality technology (AR) to create a cutting edge plugin for clothing websites. In order to provide customised outfit recommendations. This plugin measures the customer's bodies, makes recommendations for body types, takes skin tone into account, and decides the purpose of the outfit. In response to the ongoing problem of customers being dissatisfied with clothes that fit badly. Our solution makes use of modern technology to improve the online shopping experience by offering accurate size, virtual try on experiences, and personalised style advice. Our goal is to change the fashion industry by integrating feedback from customers continuously, reducing returns, and increasing confidence among consumers.

3.2 Research Methodology

Research philosophy

Research philosophy is the view of the best methods to gather, evaluate, and use facts regarding a phenomenon. It has the potential to influence the kinds of research questions presented, the procedures followed for gathering and analyzing data, and the interpretation of study findings.

Research philosophies inform teams' methodology choices, and it is important to recognize that they are not mutually exclusive. Many times, researchers combine different points of view, which encourages thoughtful solutions to problems. Because of its adaptability, approaches may be customized to meet the objectives of individual studies, resulting in a strong framework that provides insightful information within a given context.

In light of this, it is crucial that researchers understand how their own research philosophy's function and apply them to their work. Depending on the situation, researchers may use multiple philosophies in their work.

Therefore, the philosophy used in this project will be pragmatism because it is the most appropriate and focuses on finding practical solutions to real-world issues. Therefore, it provides a clear and concise understanding of our project.



Figure 8 Paradigms Compare

Research methodologies

Research methodology simply refers to the practical “how” of a research study. More specifically, it’s about how a researcher systematically designs a study to ensure valid and reliable results that address the research aims, objectives and research questions. (derek jansen, 2020)

There are different types of methodologies that we can learn about such as qualitative, quantitative and mixed method.

Quantitative research method

Quantitative research is the process of collecting and analyzing numerical data. It can be used to find patterns and averages, make predictions, test causal relationships, and generalize results to wider populations (Bhandari, 2020) Interviews, observations, and open-ended surveys are examples of non-numerical data that is referred to as qualitative data. It is possible to comprehend any specific issue through qualitative research.

Qualitative research method

Qualitative research involves collecting and analyzing non-numerical data (e.g., text, video, or audio) to understand concepts, opinions, or experiences. It can be used to gather in-depth insights into a problem or generate new ideas for research. Qualitative research is commonly used in the humanities and social sciences, in subjects such as anthropology, sociology, education, health sciences, history, etc. (Bhandari, 2020)

Among the most popular qualitative techniques are the following:

Observation: it is about everything you have seen, heard, or come across

Interviews: one-on-one discussions in which questions are directly asked of individuals.

Focus groups: posing queries and fostering conversation among participants.

Surveys: distributing forms with blank spaces for questions.

Mixed method research

Mixed methods research combines elements of quantitative research and qualitative research in order to answer your research question. Mixed methods can help you gain a more complete picture than a standalone quantitative or qualitative study, as it integrates benefits of both methods.

Mixed methods research is often used in the behavioural, health, and social sciences, especially in multidisciplinary settings and complex situational or societal research. (Bhandari, 2020) Combination techniques Research can be used to find detailed information, investigate links between variables, and address related questions.

	Quantitative	qualitative	Mixed method
Method of gathering information	Surveys and experiments are used to gather data.	To collect data, it conducts observations and interviews.	It combines interviews and surveys.
Methods of analysis	Statistical analysis	It makes use of content or theme analysis.	It employs both kinds of analysis.
Designing	It performs planned and organized designing.	It has an engaging and adaptable design.	blend of fluid and structured design
Advantages	Accuracy and applicability	comprehensive comprehension	thorough understanding
Disadvantages	Insufficient depth	Inability to be generalized	requires knowledge and takes a lot of time.

Table 3: Comparison of the Research Methodologies

Due to its flexibility, many benefits, and combination of qualitative and quantitative methods, mixed method research methodology will be used for this study. The above-mentioned examples will be taken into consideration.

3.3 Development Methodology

Software Development Life Cycle(SDLC) use to structure the implementation/development process of a software. This shows you stages, tasks need to do and deliverables required for each phases of software development structure. This is useful to get the idea about how to develop the whole project and what you need to do at different stages. There are various life cycle models which have a unique approach to managing the software development process. These are some common software development life cycle models.

Model	Description	Pros	Cons
Waterfall	Sequential stages, Linear approach	<ul style="list-style-type: none"> • Easy to handle. • Clear Structure • Defined phases clearly 	<ul style="list-style-type: none"> • Low flexibility to do changes after phase completed. • Late feedback
Agile	Continuous improvement, Adaptable and Iterative	<ul style="list-style-type: none"> • Flexibility is higher. • Adapting to changing requirements. • Continuous feedback. 	<ul style="list-style-type: none"> • Scope sometimes can creep. • Less documentation
Spiral	Iterative model combining elements of prototype methodologies and waterfall.	<ul style="list-style-type: none"> • Iteration and prototyping both allowed. • Emphasises risk management. • Suitable for complex projects. 	<ul style="list-style-type: none"> • Hard to manage. • May require higher cost and time.
V-Model (Verification and Validation Model)	Extension of waterfall method.	<ul style="list-style-type: none"> • Clear structure, traceability and documentation. • Can get a proper idea in every stages clearly. 	<ul style="list-style-type: none"> • Low level flexibility and adaptability.

Table 4 Comparison between Development Methodology

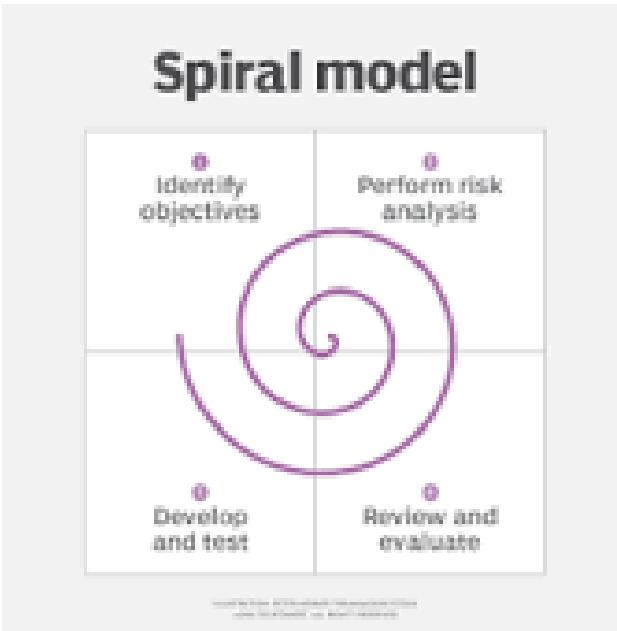


Figure 9 Spiral Model



Figure 10 Waterfall Model

According to all these points Agile methodology proves exceptionally beneficial in crafting a fashion recommendation Shopify plugin. It has around adaptability, collaboration, and iterative development, seamlessly fitting the high-speed environment of e-commerce and the ever-evolving fashion landscape. Implementing Agile enables the development team to promptly address shifting requirements, integrate valuable customer feedback, and guarantee the plugin meets the ever-changing demands of Shopify merchants and customers within the dynamic e-commerce platform.

- **Adaptability:**

Agile methodology's flexibility enables accommodating evolving requirements, ensuring the plugin evolves alongside swiftly changing fashion trends and user preferences in the e-commerce realm.

- **Customer-Centric Approach:**

Places strong emphasis on continuous customer feedback and involvement. This ensures the plugin aligns closely with the needs of Shopify shop owners and customers.

- **Iterative Development:**

Agile's iterative nature allows developing the plugin incrementally. This enables continuous enhancement, early delivery of crucial features, and the prioritisation of high-value functionalities.

- **Collaborative Teamwork:**

Agile fosters collaboration among team members, cultivating a culture of transparent communication and shared responsibility. This facilitates quicker decision-making and effective problem-solving.

- Early and Continuous Delivery:

Agile promotes delivering a functional product in incremental stages, facilitating early testing, feedback incorporation, and refinement. This expedites deployment and reduces the plugin's time-to-market.

- Risk Mitigation:

Regular reviews and retrospectives in Agile allow early identification and resolution of issues, thereby minimising project risks.

- Enhanced Quality:

Focus on manageable iterations ensures sustained attention to quality, guaranteeing that the plugin meets necessary standards and expectations.

Then here Agile Methodology using Scrum Framework for this project.

Below clipart will give you an idea.

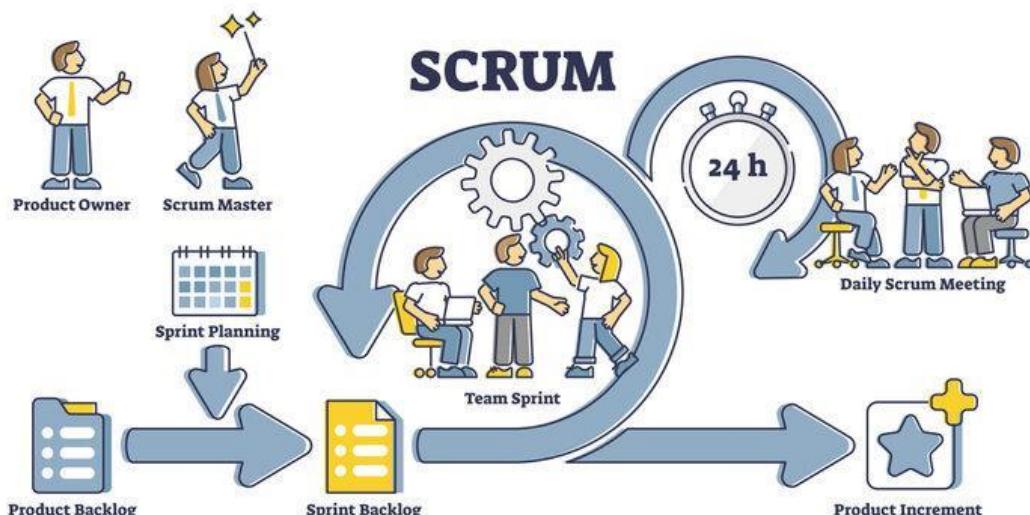


Figure 11 Scrum Process

3.4 Design methodology

Choosing a design process for a project, like integrating a fashion suggestion system into the Shopify platform, depends on several criteria, such as the complexity of the project, team expertise, and particular project requirements. The **Structured Systems Analysis and Design Method (SSADM)** and **Object-Oriented Analysis and Design (OOAD)** are two widely used design approaches. Design methods are organised frameworks that help in software development. They achieve this by methodically defining requirements and developing process blueprints for software development. The design process is greatly aided by these approaches, which also guarantee a methodical approach to software development chores and set the groundwork for a successful project's execution.

Brief introduction about SSADM and OOAD:

1.) Structured System Analysis and Design Method (SSADM)

The typical waterfall-based approach that focuses on stages analysis and designing. Logical and Structured techniques used to do system design and analysis parts.

Specifications: Requirements/logical system/physical system specification and design are sequential operations.

Advantages: Structured and clear detailed in stages. Well-defined deliverables at each stage. Suitable for pre well understood and stable requirements used projects.

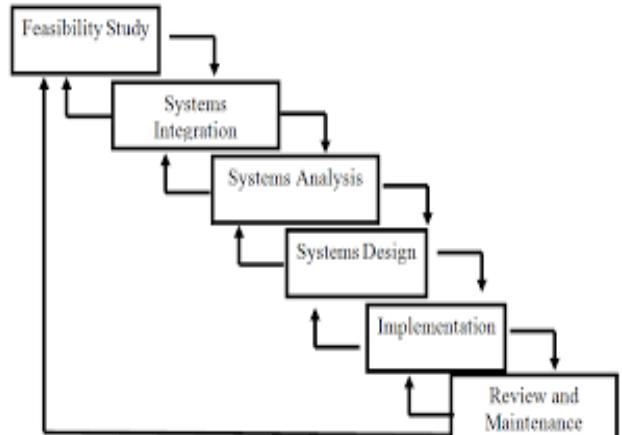


Figure 12 SSADM Structure

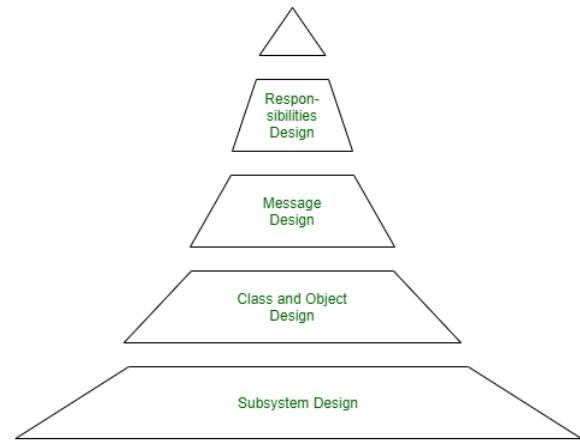
Disadvantages: Less responsive for changing requirements and may need stable documentation and formalisation.

2.) Object-Oriented Analysis and Design (OOAD)

Based on object-oriented programming principles, concentrate on simulating software as an assembly of interacting objects.

- **Specifications:**

Recognize objects, classes, relationships, and interaction between objects. Sequence diagram, class diagram and use-case diagrams use as methods.



The Object Oriented Design Pyramid

Figure 13: Object Oriented Design Pyramid

- **Advantages:**

Better reusability, more accurate representation of real-world systems and ability to changes through inheritance and encapsulation.

- **Disadvantages:**

Need to have a proper knowledge about OOAD concepts and use that accurately.

Features	SSADM	OOAD
Method	Structured & Sequential	Object-oriented & iterative
Concentrate on	Stages analysis and design	Object, classes, interactions, and models
Flexibility	Low Level	More adaptable to changes
Documentation	Pre needed proper formalisation and documentation.	Emphasises modelling and visual representation.
Suitability	Stable requirement projects	Project needing scalability and flexibility.
Learning flow	Easy to understand traditional techniques.	Required knowledge about OOP concepts

Table 5 SSADM and OOAD Comparison

Design Methodology Selection:

The selection between SSADM and OOAD depends on the project environment, requirement, and team members capacity. For a project like implement a recommendation system plugin for shopify stores, **Object-Oriented Analysis and Design (OOAD)** is the suitable design methodology. This project runs through on Shopify platform. Shopify platform is a dynamic e-commerce environment. OOAD allows flexibility, scalability and adapting to the changes better than other methods. And in this projects always updating the database and other features. Through OOAD can give more quality effort to the process because this method based on object-oriented concepts. That process is very suitable for handle this project as a developer.

3.5 Project Management Methodology

Project management plays a major part in achieving objectives with plans and expectations. A project can be more effectively organised into streamlined, structured stages by using a project management approach. However, there is no singular project management methodology perfectly suited for every project type. It is essential to have an in-depth knowledge of commonly used project methodologies and their differences in order to determine which approach is best for your project. Developers should become familiar with methodologies, since projects can vary depending on several variables, including the project's domain, scope, schedule, resources, and solution-finding strategy. Waterfall and Agile are two common approaches, each with particular characteristics.

The Waterfall methodology is a linear process that moves projects through different phases one after the other. Projects with well-defined requirements and a fixed scope are best suited for it. The Waterfall methodology makes sure that every stage is finished before going on to the next by emphasising careful planning and documentation. When the project's requirements are well understood from the start, this approach can be effective.

Conversely, Agile approaches place a higher value on adaptability and flexibility. Agile emphasises teamwork and iterative development, enabling ongoing project improvement. Agile development methodologies respond quickly to feedback and changing requirements. This methodology works well for projects with constantly shifting requirements or uncertainties. Within Agile, there are several popular methodologies, including Scrum, Kanban, and Scrumban.

- Scrum:

Scrum is a framework that encourages collaboration, transparency, and adaptability. It is particularly effective for projects with rapidly changing requirements. Scrum divides work into sprints, short time frames typically lasting between one and four weeks. The team plans and executes the work during these sprints, with regular meetings and reviews. Scrum promotes self-organisation and focuses on delivering value in each iteration.

- Kanban:

Kanban is a visual project management methodology that emphasises continuous flow and limiting work in progress. The Kanban board visualises tasks on columns, representing the different stages of work. The team pulls tasks from one column to the next, maintaining a steady workflow. Kanban ensures that the team stays focused and reduces bottlenecks by setting work limits for each stage.

- Scrumban:

Scrumban is a hybrid approach that combines elements of Scrum and Kanban. It allows teams to benefit from the flexibility of Kanban while retaining some structured elements from Scrum. Scrumban can be useful when transitioning from Scrum to Kanban, or when there is a need for more structure in a Kanban-style workflow.

The development team opted for the agile methodology, the Scrum framework to oversee the online shopping plugin project. Their decision was based on the project's innovative scope and the importance of incorporating user feedback on an ongoing basis. They chose agile due to its structured yet flexible approaches to iterative progress.

Scrum offers sprints to prioritise features and maintain regular communication with stakeholders for reassessment. This allows for the adjustment of requirements based on testing and learning during the development process. The daily scrum meetings facilitate coordination for intricate tasks such as constructing recommendation algorithms and designing 3D simulations intended for the plugin.

The online tool ClickUp was selected in order to implement agile concepts, facilitate virtual coordination, and monitor progress. ClickUp offers agile-style management features such as customizable workflows, boards, assistance with sprint planning, and analytics to improve team productivity. Integrations enable connection with other essential software development tools. Overall, ClickUp enables iterative work and ensure alignment on priorities. The development team gains agility through the utilisation of Scrum, and ClickUp. This combination facilitates structured sprints and continuous flow optimization. By employing this integrated agile approach, the team can effectively address new insights and challenges through gradual improvement to meet the changing needs of users. This adaptable framework provides maximum flexibility while still maintaining planning and coordination in order to create inventive solutions.

3.6 Team Work Breakdown Structure (WBS)

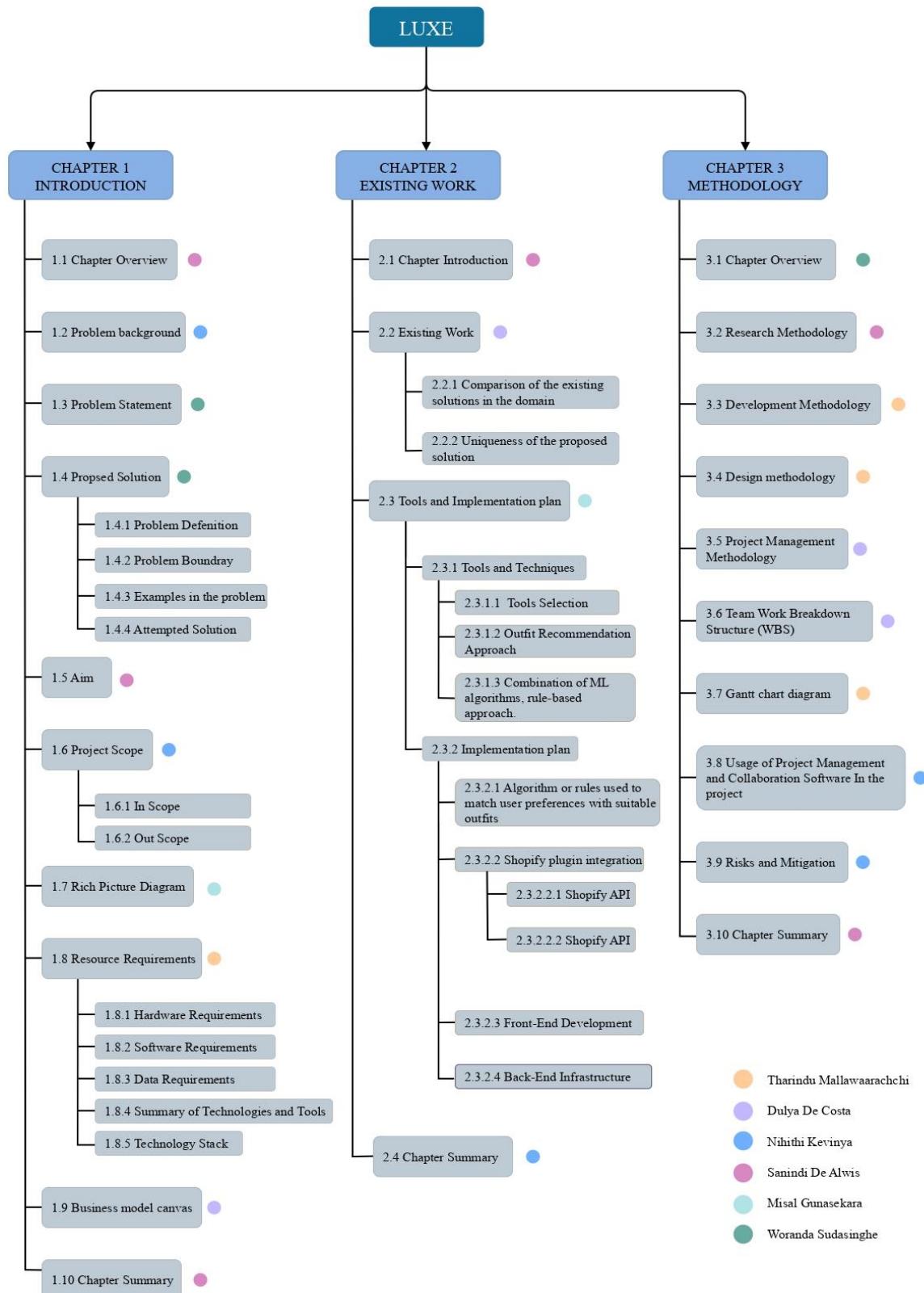


Figure 14: Team Work Breakdown Structure

3.7 Gantt chart diagram

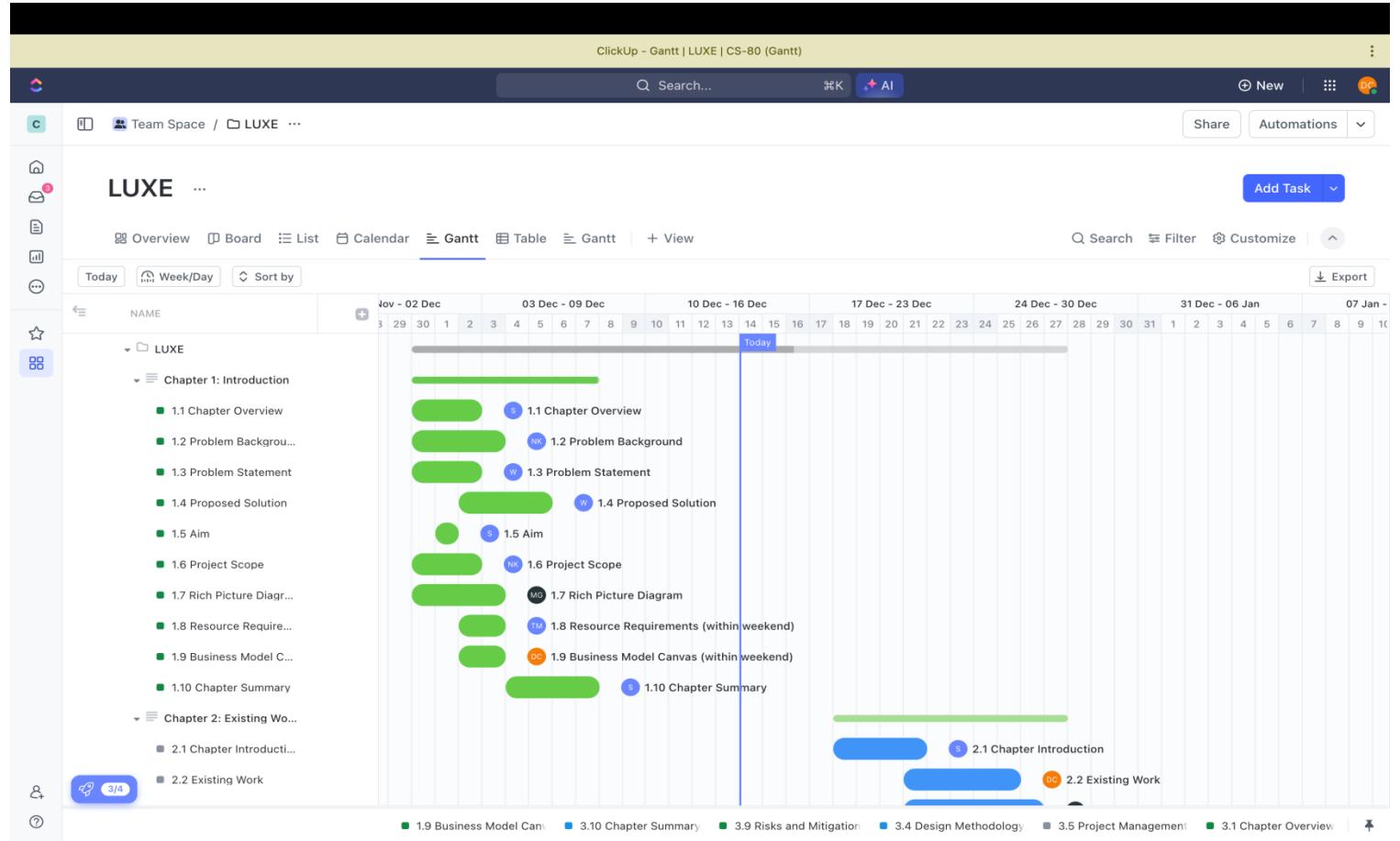


Figure 15 Gantt Chart Part 1

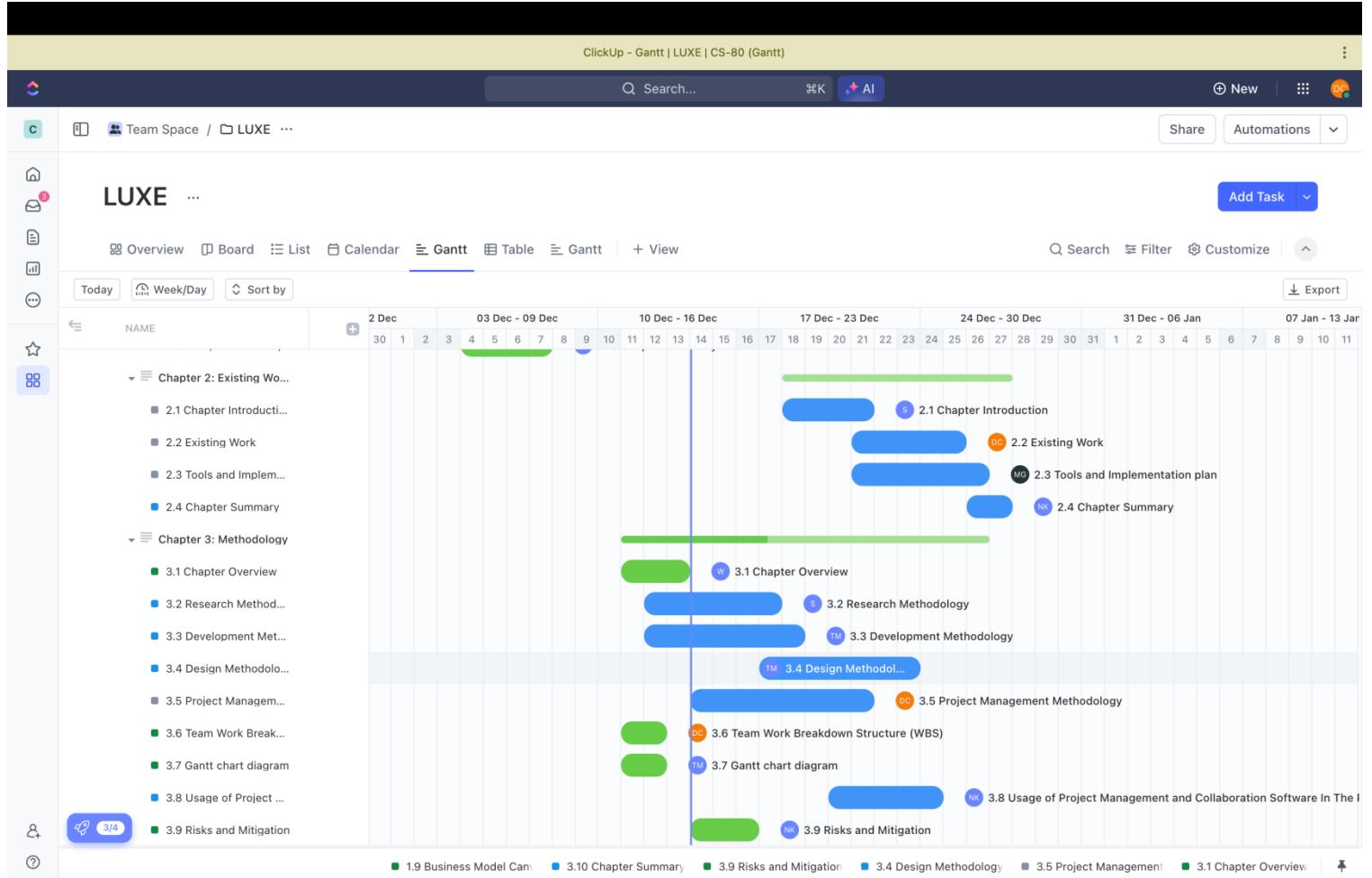


Figure 16 Gantt Chart Part 2

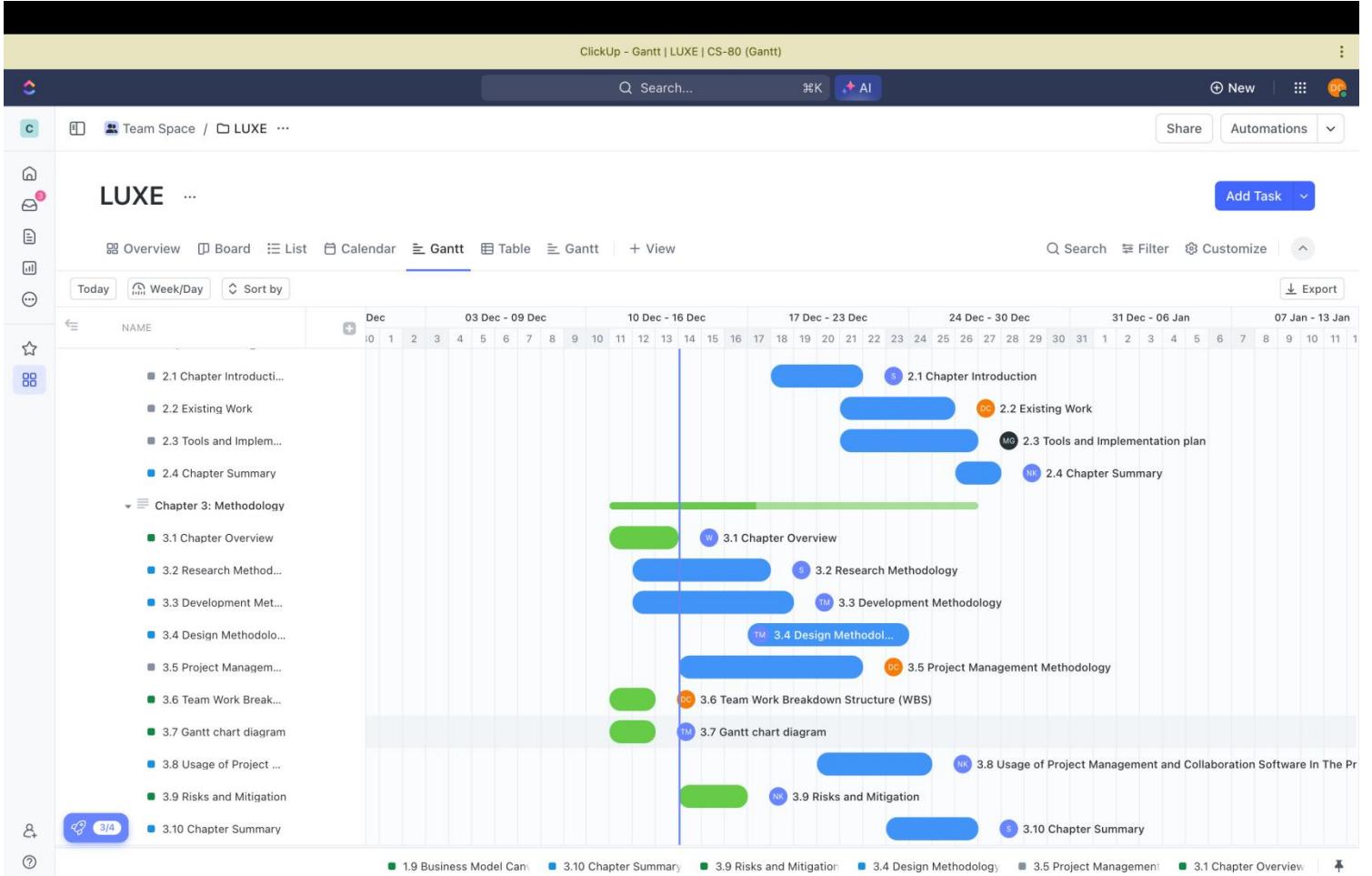


Figure 17 Gantt Chart Part 3

3.8 Usage of Project Management and Collaboration Software In the project

3.8.1 ClickUp

ClickUp is a project management software, and its task management features provides users with a durable and user-friendly system for organising their project work.

The screenshot shows the ClickUp interface for the 'LUXE' workspace. The top navigation bar includes 'Search...', AI integration, and 'New' buttons. The left sidebar has icons for Home, Team Space, LUXE, Overview, Board, List (selected), Calendar, Gantt, Table, Gantt, View, Share, Automations, and Help.

The main area displays a list of tasks under 'Chapter 1: Introduction'. The tasks are:

Name	Assignee	Due date	Priority	More
1.1 Chapter Overview	S	Dec 2	P	...
1.2 Problem Background	NK	Dec 3	P	...
1.3 Problem Statement	W	Dec 2	P	...
1.4 Proposed Solution	W	Dec 5	P	...
1.6 Project Scope	NK	Dec 2	P	...
1.8 Resource Requirements	TM	Dec 3	P	...
1.9 Business Model Canvas	DC	Dec 3	P	...
1.10 Chapter Summary	S	Dec 7	P	...
1.7 Rich Picture Diagram	MG	Dec 3	P	...
1.5 Aim	S	Dec 1	P	...

At the bottom, there are sections for 'TO DO' (0 tasks) and a legend for task status: 1.9 Business Model Can., 3.10 Chapter Summary, 3.9 Risks and Mitigation, 3.4 Design Methodology, 3.5 Project Management, 3.1 Chapter Overview.

Figure 18 Click up Works Space

3.8.2 Google Meet

Google meet is a video communication service developed by Google. It has many features such as accompanying chat and screen sharing which makes it easier for the team members to collaborate. Additionally, users are able to join the video conference directly from Gmail or Google Calendar, so there is no need to download the app.

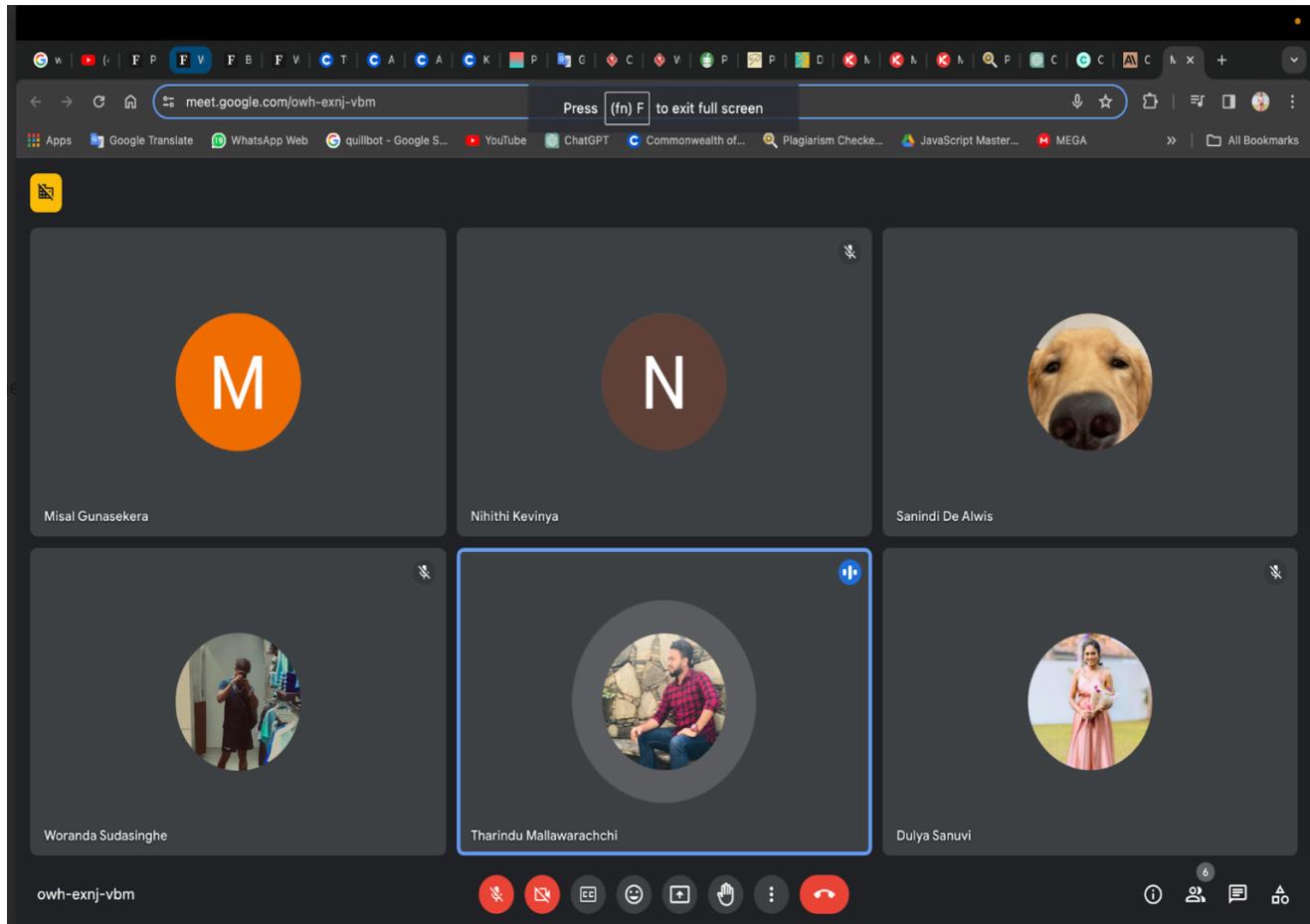


Figure 19 Google Meetings Proof 1

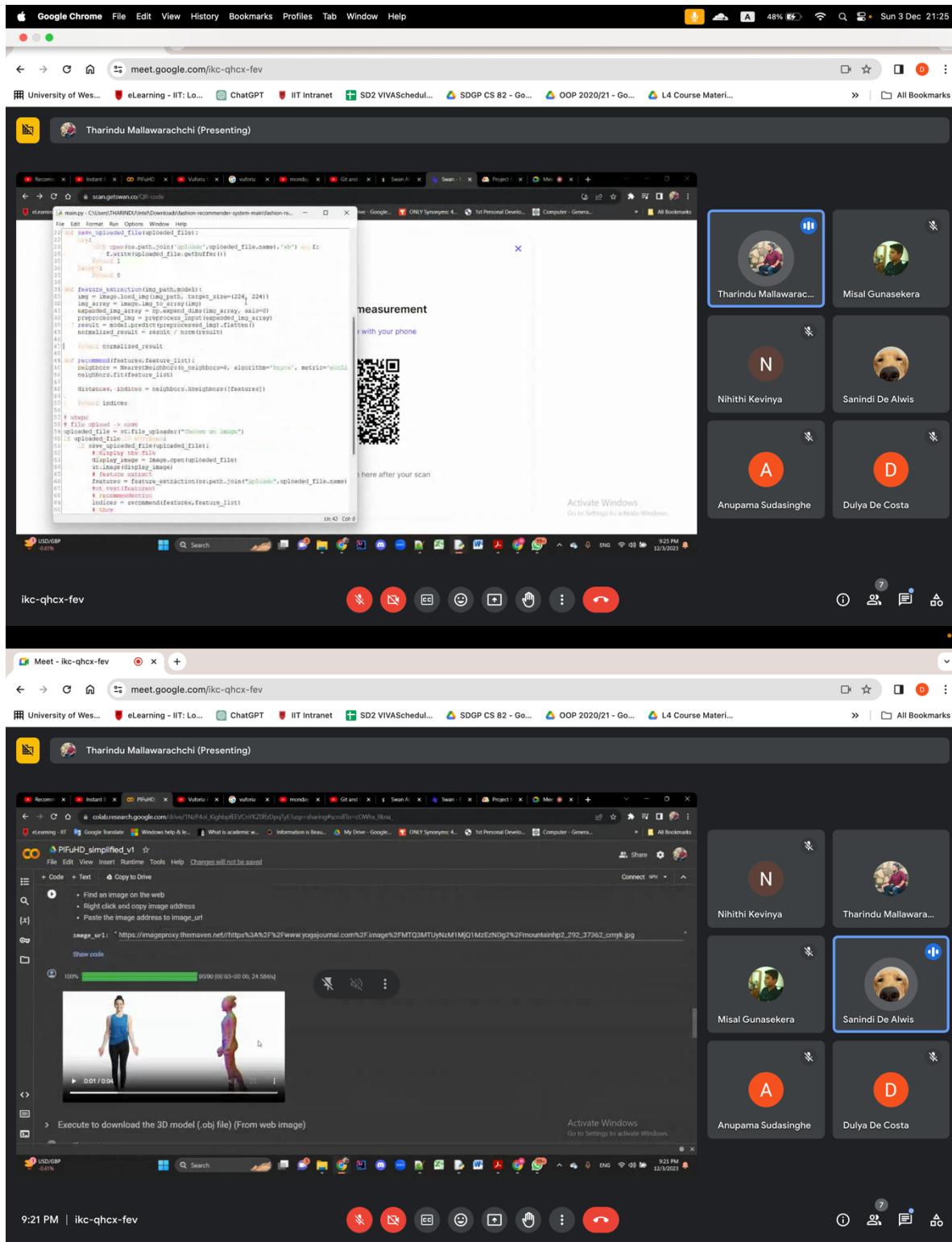


Figure 20 Google Meeting Proof 2

3.8.4 Google Calendar

Google calendar is a time management and scheduling calendar service developed by Google. It has many features such as creating and editing events, setting reminders for events and adding event location which will keep the project on track and ensure the punctuality of the team members.

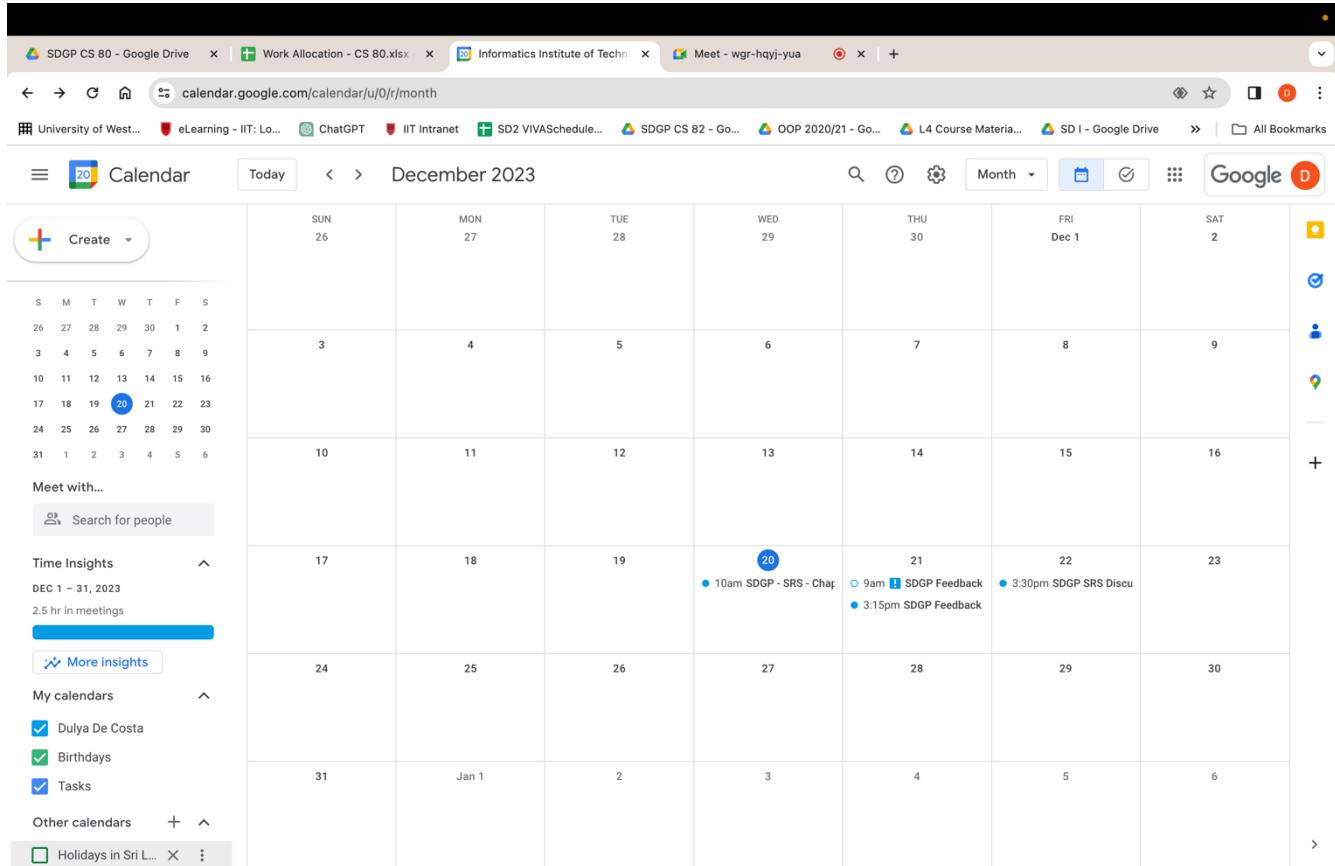


Figure 21 Google Calendar

3.9 Risks and Mitigation

Risk Item	Severity	Frequency	Mitigation Plan
Personal issues impacting the performance of team members	High	Medium	<ul style="list-style-type: none"> Communicated about the issues faced by the team members and made proper arrangements.
Difficulty in adhering to deadlines	High	Medium	<ul style="list-style-type: none"> Setting realistic schedules and regularly monitoring the work of all team members.
Market acceptance	Medium	High	<ul style="list-style-type: none"> Conducted market research to understand the current trends and customer preferences of clothing items. Conducted surveys to understand what the customers would prefer to experience from our plugin.
Compatibility issues	High	Medium	<ul style="list-style-type: none"> Test the plugins across a variety of devices, browsers, and operating systems.
Troubles in finding the right technology.	High	High	<ul style="list-style-type: none"> Seeked assistance and advice from senior professionals and experts. Conducted thorough research on technologies to identify the optimal solution for our plugin.

Table 6: Risks and Mitigations

3.10 Chapter Summary

Every methodology used for this project is described in this chapter. This chapter included a concise introduction at the beginning. Nevertheless, this chapter will finally discuss all the approaches used for each project phase, such as project management, design, development, and research. Every methodology includes a concise introduction that highlights pertinent topics, identifies the most widely or practically applicable methodologies in the relevant phase, and identifies the best medical practices that are used to the project. Research philosophy is pragmatism, and mixed methods research was selected as the research methodology while object-oriented design was selected as the design approach. For this project, agile development is utilising the Scrum Framework. Additionally, there is a team breakdown structure that breaks down themes in this project. It includes a Gantt chart, screenshots from meetings, screenshots from ClickUp, and, last but not least, a Google calendar. Finally, in this chapter, the optimum mitigation plan has taken into account both risk and migration.

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APPENDIX

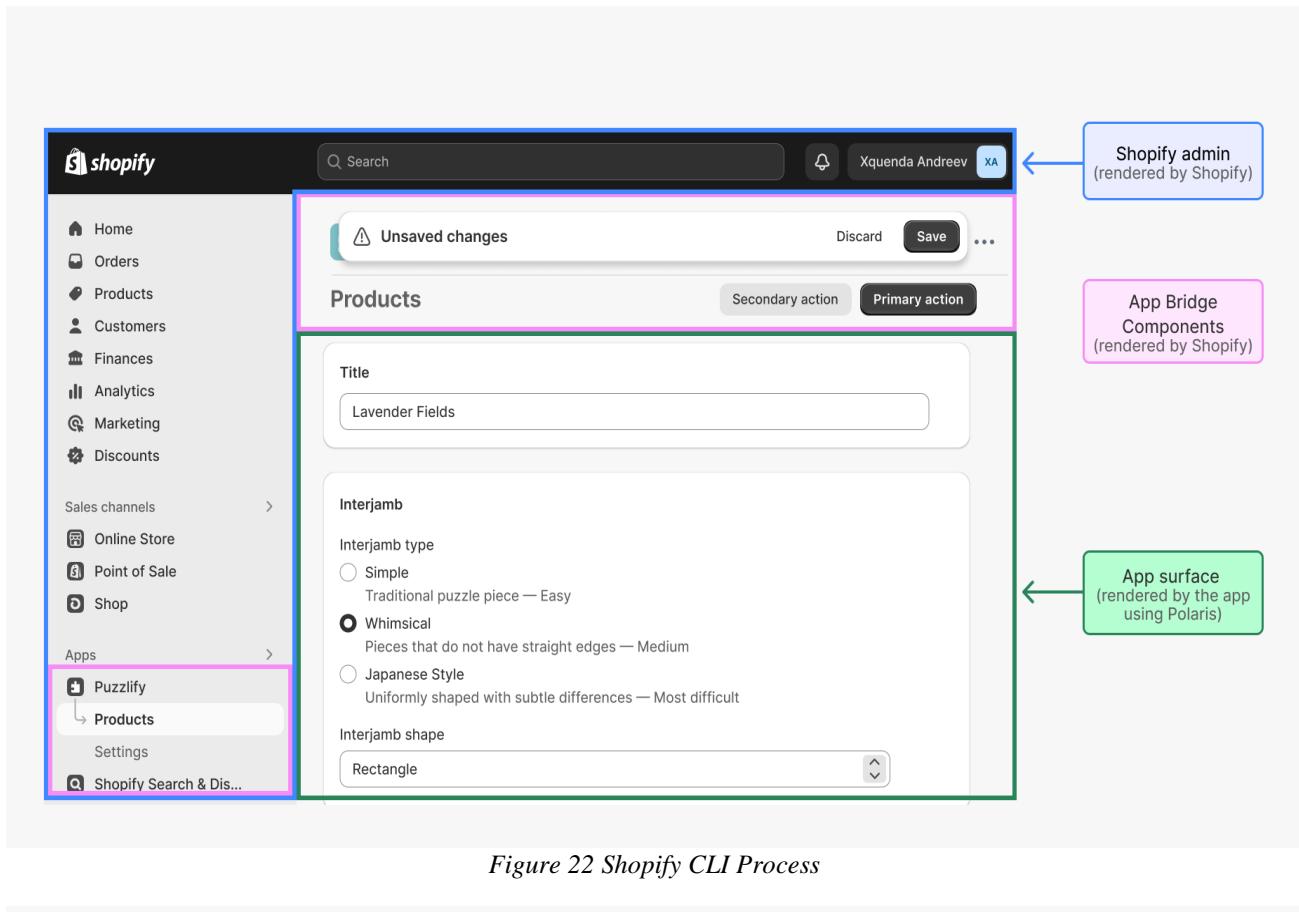


Figure 22 Shopify CLI Process

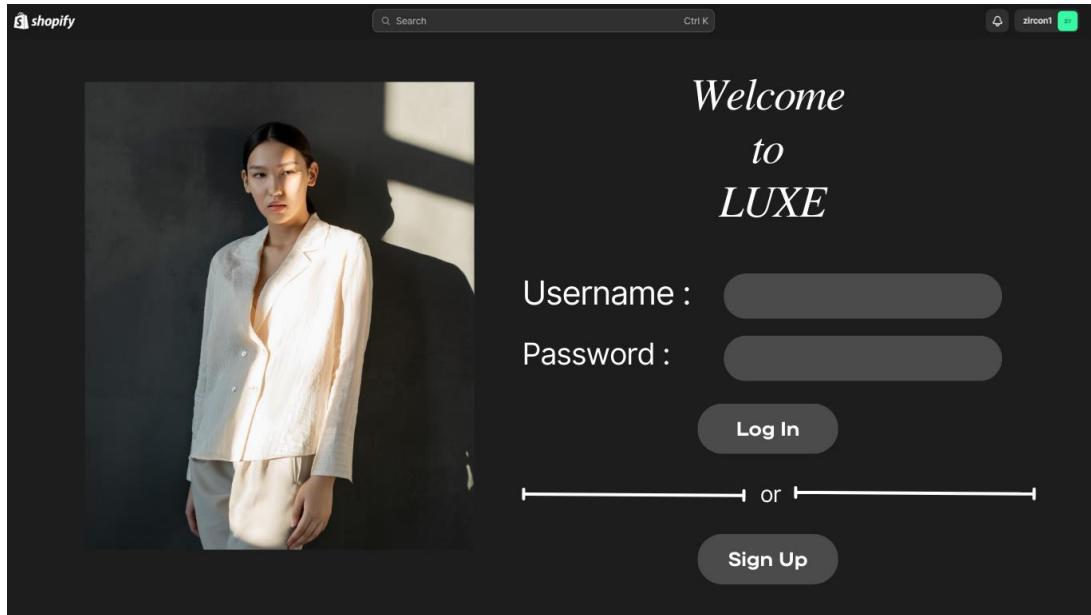


Figure 24 Welcoming UI

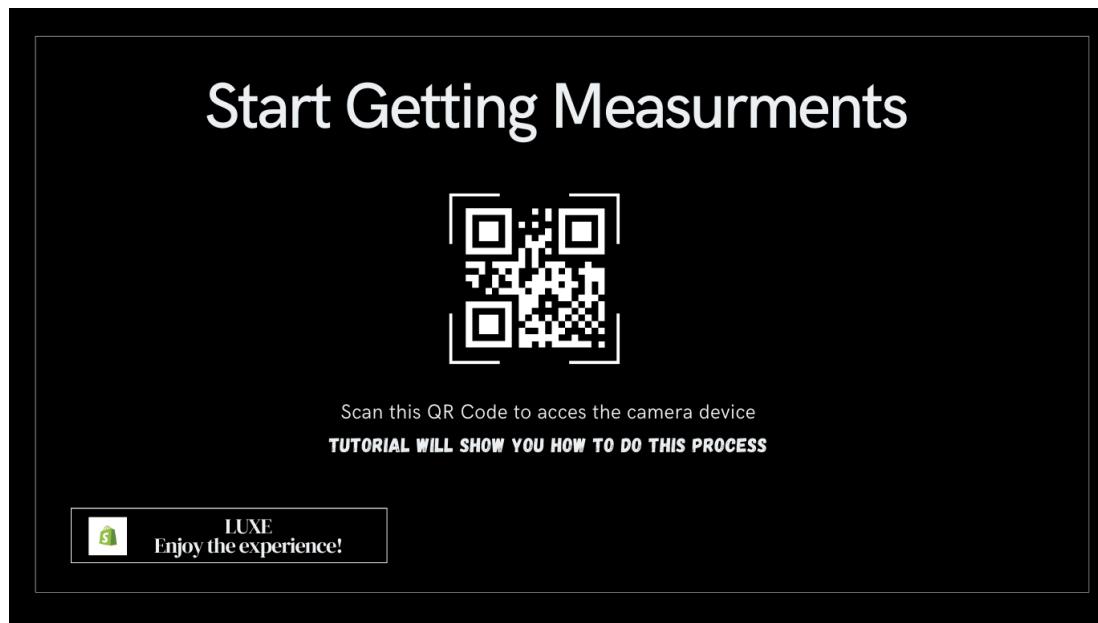


Figure 23 Scanning UI

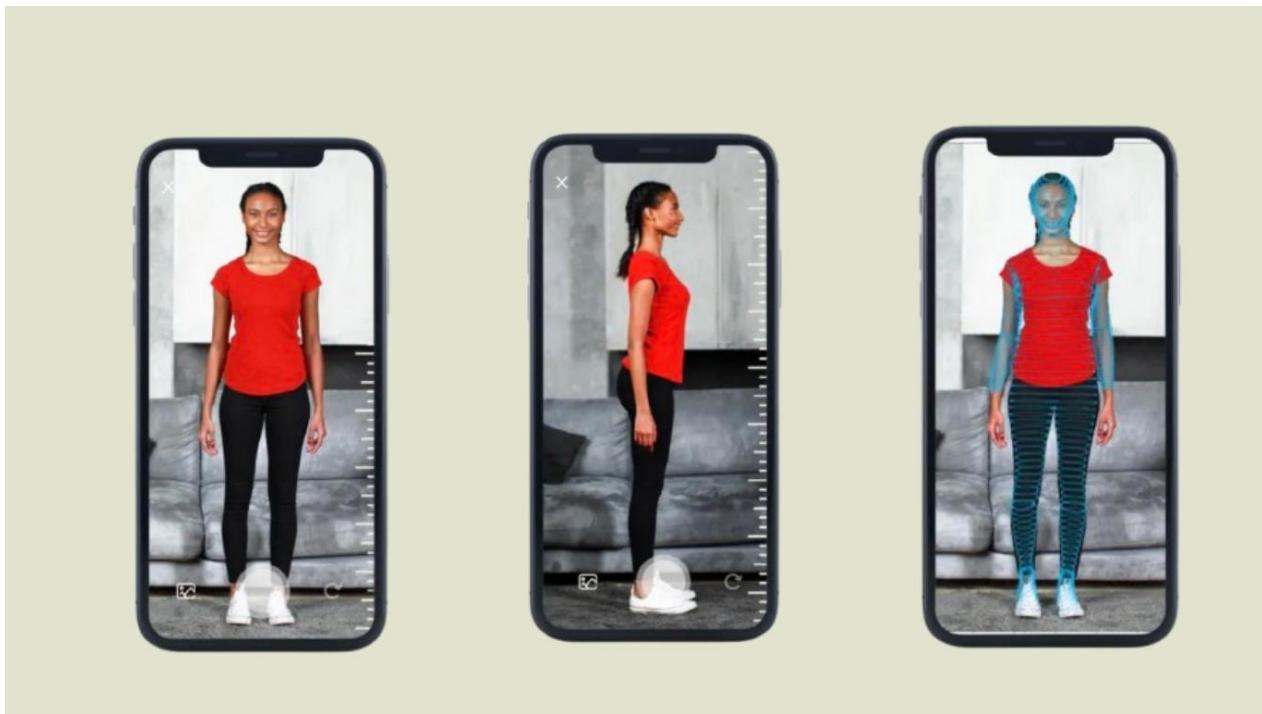


Figure 25 Getting Body Measurements through AR

HEIGHT	5' 6"	GENDER	MALE	SKIN COLOUR	MALE
WEIGHT	65 Kg	AGE	22	BODY TYPE	22

Mary Jane

BODY CIRCUMFERENCE

BUST(B)	US 8
WAIST(W)	US 4
HIP(H)	BLACK

BODY LENGTH

SLEEVE LENGTH(SL)	US 8
SHOULDER WIDTH(SW)	US 4
PANTS LENGTH	BLACK

DONE

Figure 26 Registered Customer User Profile UI

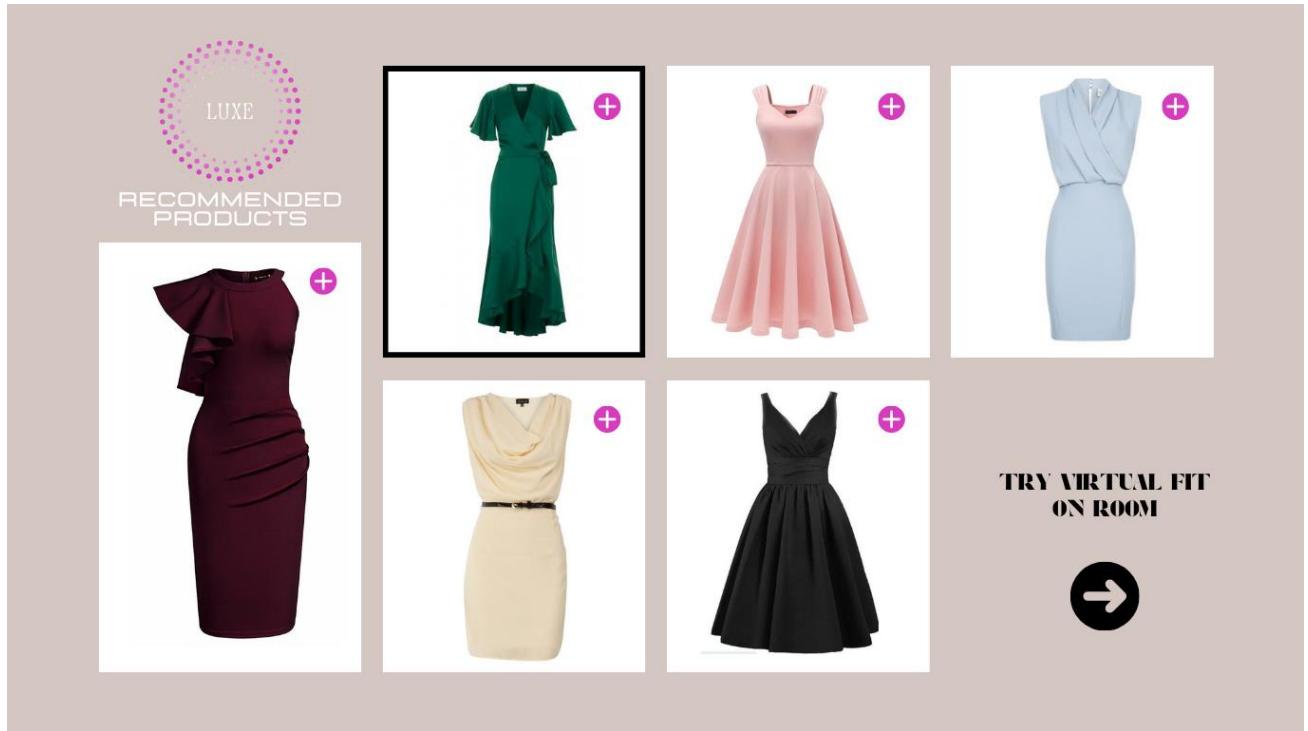


Figure 27 Recommending Outfits UI

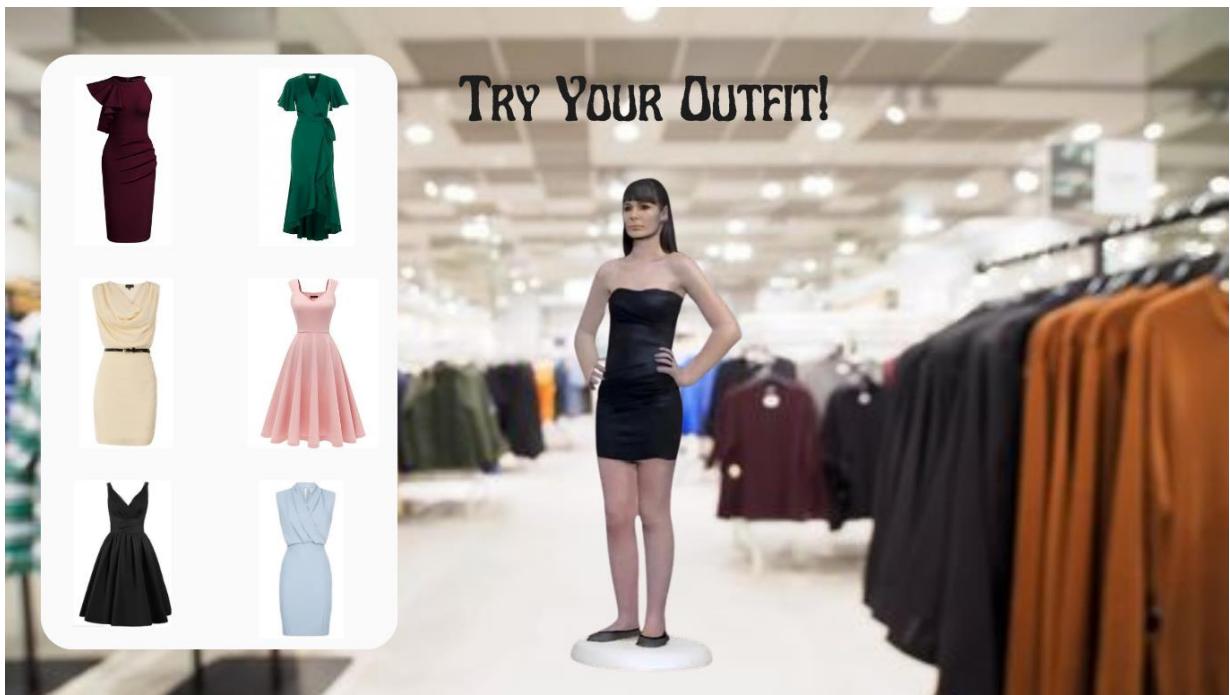


Figure 28 Virtual Fit On Room