

Woodpecker: Using AR to design 3D models for a commercial website

by

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*Project report (CSE499) submitted in partial fulfillment of the
requirements for the degree of*

Bachelor of Science in Computer Science and Engineering

Under the supervision of

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**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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DECLARATION

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I declare that this project report entitled *Woodpecker: Using AR to design 3D models for a commercial website* is the result of my own work except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Dedicated to
my loving Mother

– *Nowshin Tabassum*

ABSTRACT

Nowadays, the present generation tends to be dependent on 3D viewing as a form of a better preview as a whole. AR helps with the preview of products or experience services within a specific environment and time and furthermore, it makes the users more interested. After that, it helps the user with the decision to purchase and provides a customer-friendly and easy, and convenient buying experience to the users. Overall, AR allows the user to get a better visualization of the selected product and allows the user to make a precise decision, and ensures that the user has no remorse. This paper showcases how the following system can view the furniture in 3D, that particular furniture will be created with the help of a tool called "Blender" and will be shown through AR and will be provided with the necessary and required information regarding the specific furniture. Because of AR, the system provides the user with a better 360 view of the product and helps with the visualization which shows a demonstration of the furniture in our home, and then the user will be able to make an accurate decision. AR in this system basically helps the user in viewing the product from a different perspective.

Keywords: AR, 3D models, Model-Viewer, Blender.

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Chapter 1

Introduction

1.1 Problem statement

During the 90s, internet technologies drastically evolved and changed society and business throughout the world. In replace of visiting traditional and structural stores, online shopping can be a much more efficient and preferred method of shopping. Along with the evolution of technologies, business offers a much more refined application in terms of user preferences and demand. Thus, companies are improving their website for a better user experience and to make the atmosphere more enjoyable [Visinescu et al. \(2015\)](#).

The use of 3D displays has slowly become more and more frequent. After the pandemic, the preference for shopping physically has slowly reduced and companies are launching their products online with the help of 3D products. It can be observed that the use of 3D displays is slowly becoming more of a trend. 3D displays can make the visualization more realistic and the three-dimensional view can often cover up the errors made by 2D displays, thus these displays overall make the entire experience a lot more enjoyable. 3D displays can help with the characterization of those products and provide details and information and thus making the purchase intention of the product more improved. AR and VR technologies are two of the many methods used for a better and more interactive experience while web browsing [Ya & Xing \(2021\)](#). Houzz is an example of AR technology that enhances the user's experience. Houzz uses the feature of AR to allow the user to view the furniture creatively. When the user enters the app, they can click on the "My Room" button to access the AR feature. This opens the camera and shows the chosen product in 3D. Users also have the option to rotate and resize

the models to showcase the product from multiple views and angles Sandu & Scarlat (2018).

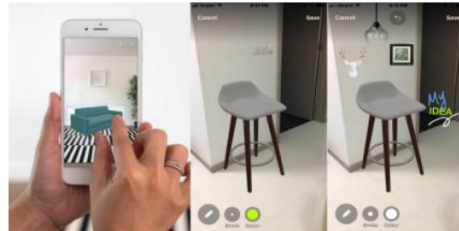


Figure 1.1: AR-based Houzz app

To make this happen, this project focuses on an ongoing system, where the models of furniture will be displayed in 3D and will be shown through AR(Augmented Reality).AR is the latest technology that allows 3D models to be viewed in real life. Here, the 3D models are the initial furniture the user wanted to purchase. Each furniture model will be created with the help of the software called 'blender' and will be displayed on the website. This website helps the users to get a 360-degree view of the user-interested furniture. A phone user can launch the AR code with an AR button that opens the device's back camera and a 3D model pops up in forms of visualization and helps the user see it from a different perspective. This website was constructed to ensure a better experience for online users with the help of 3D displays. Woodpecker's sole purpose is to supply the users with detailed information regarding the furniture in addition to demonstration of the furniture in the home virtually using AR. This would allow users to get a customer-friendly and convenient buying experience.

1.2 Aims, objectives, and Motivation

1.2.1 Aims

There are expected outcomes in this project, the most noteworthy outcome is the feature of AR. Augmented reality has made online shopping much more efficient and easier. From this website, furniture can be demonstrated with the help of 3D models. For a better viewing perspective, AR makes it so that the user can also rotate, zoom in, and zoom out to better visualize. The users can view the object through the phone's back camera. Direct and non-time-consuming purchases can

be made and other built features such as sending messages, and customization are available for the satisfaction of the users. Exploration of previews of interior ideas and designs is also available for the user. For this project, augmented reality plays a vital role in making the experiences of the users much more coherent.

1.2.2 Objective

This website carries a lot of objectives for the future. The notable objectives are as follows:

- 1. To make the users interested in buying the furniture through this interactive website.**

The vibrant color combination, icons, designs, and aesthetic view of the website will catch the attention of the user and make them attracted towards it. This will make the user engage with the website more often.

- 2. To give a customer-friendly and convenient buying experience.**

With the smooth and self-explanatory interactions within the website, the users will have a much more enjoyable experience and will deal with frustration less often.

- 3. To supply the users with detailed information regarding the furniture.**

When viewing any desired furniture, the users will be provided with information such as the description of the product, color, dimensions, and textures.

- 4. To create a 3D representation of each furniture model.**

Every product can be viewed in 3D. The 3D model will be original and created individually with the help of a blender. The user can rotate, zoom in. zoom out, and overall can help the user to visualize.

- 5. To demonstrate furniture in our home virtually using AR.**

When accessing the website, the user can get an opportunity to view the furniture in real life. While browsing the website when the user chooses a particular piece of furniture, that furniture will be viewed after the user clicks on the AR button. After clicking the button, the website will open the back

camera of the phone and the furniture will be in front of the user, from there the furniture will remain still and the user will view that stationary image of the furniture from many angles and perspectives. This AR feature can ultimately create a preview for the user, the preview will clearly show how the furniture would look in the real world.

1.2.3 Motivation

Online shopping created a phenomenon where customers no longer need to drive miles to buy furniture, therefore it slowly became a trend. A Chinese e-commerce marketplace called Taobao, which was ranked number one in china had a huge success with more than 179 million US dollars in profit. This proves that shopping online is a huge trend. But the companies faced a few issues regarding shopping online. Customers would face the grief of regret because of those issues. Due to cramped space, drawers can not be opened. The furniture does not fit into the space that the customer initially desired. To solve this problem, an interactive website to show a preview of the product and how it would look from real life perspective would be very beneficial to the customers. Again, many customers often become disappointed with the furniture's color, quality, or shape, which makes the entire room ugly. But when provided with an AR feature, it gives better visualization and the customer makes a better decision and matches the furniture with its environment [Han & Kim \(2017\)](#).

This website solves all of the previously mentioned issues. This website ensures a convenient, smoother, efficient, and user-friendly exploring experience for the user. That means users can easily use this website to get a pleasing experience. It can also provide the user with details of the product (using a 3D model) from the comfort of home. As this website is entirely online based. Users can get all the information from the house without going out. The web helps users to have a better visualization by using 3D models with a 360-degree viewing perspective. When we generally buy a product we fail to get a detailed view, we can only see the front or side view, for that concern this website will help users to get a 360-degree viewing perspective. Also, for example, it is difficult to design and decorate our home in our mind, to solve this problem AR will be used to see how furniture will look in our home. But the main aim is to engage the users in an interactive way through AR.

1.3 Project Specification

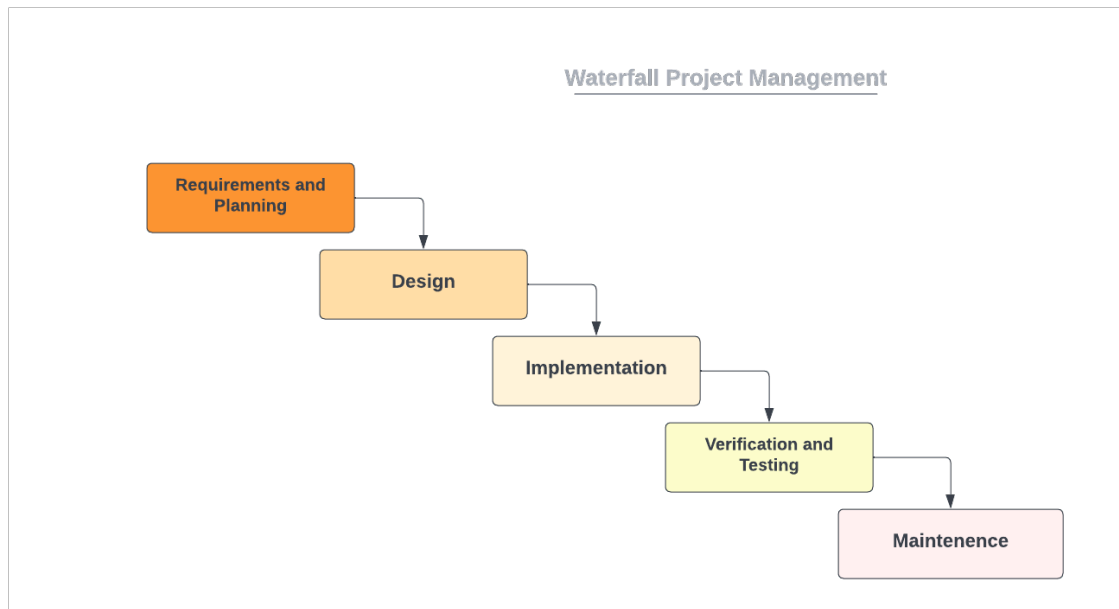


Figure 1.2: Waterfall Model

The waterfall model has been used to show how the process went during the project. As shown in the figure below, there are five steps for the waterfall model. The first step is titled “Requirements and Planning”, which is a thorough planning of what the project should accomplish and all of the required details. The second step “Design” is a solution to all of the requirements. The third step “Implementation” is the execution of the entire project. “Verification and Testing” is testing whether the execution of the project is successful or not. Finally, the last step is “Maintenance” which is any modifications made to minimize any discrepancies regarding the project. Financial planning will be taken to accomplish the goals of the project. Developer costs for hiring will be approximately 15,000 BDT per month, the purchase of licensed and advanced 3D models will be approximately 12,000 per model, and other financial decisions might be taken for the upcoming days of the project to accomplish the goals.

1.4 Report Layout

The Layout of this report is as follows. Chapter 1 is an introduction to the entire project, the motivation, and objectives of the project, what are the expected outcomes, and an overall review of the management and finance regarding the project. Chapter 2 was titled “The Background” which discusses the terminologies and related works. It also describes the comparative study, scope, and challenges of the project. Chapter 3, “Requirement Specification”, discusses the business process mode, collection and analysis of the project, and any other requirements of the whole project. “The Design Specification” is chapter 4 which has discussed the front-end design, back-end design, and UX and application requirements. Chapter 5 named “The Implementation and Testing” briefly discusses the database, implementation, design implementation, test implementations, and test results. The last and final chapter titled “Discussion and Conclusion” is the overall scope of the project and describes what is the outcome of the entire project.

Chapter 2

Literature Review

2.1 Related Works

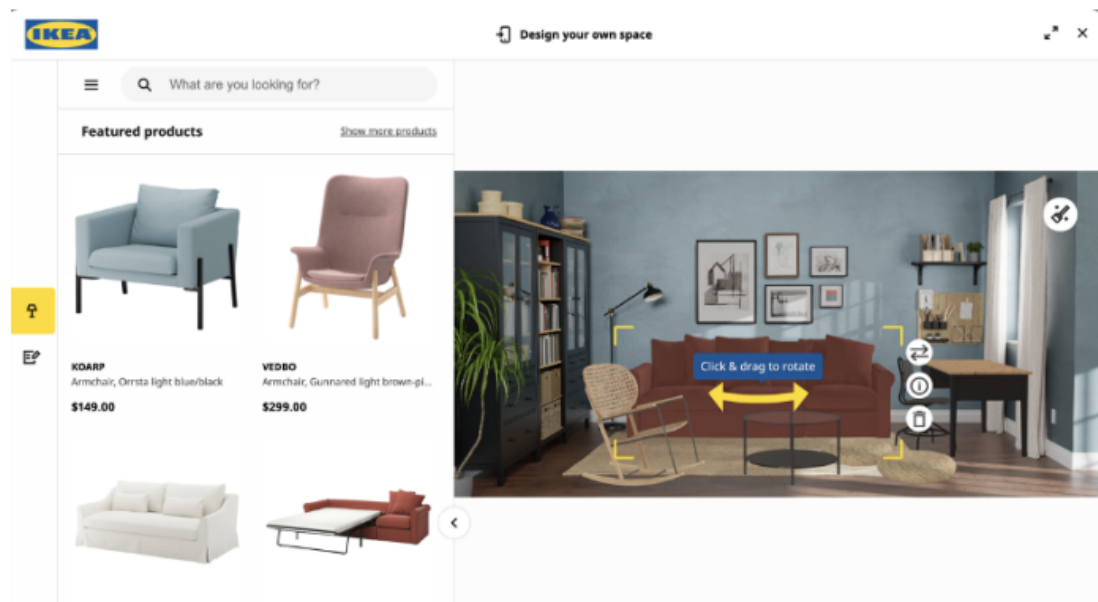


Figure 2.1: IKEA's 3D

There are several related works that are discussed further. The entire system of 3D view in IKEA is discussed by Modak, Kali Charan and Sinha, Kumkum. Users can accurately select products with the help of the feature of placing a virtual object with the intention of simulating the real space, this is why customers are much more satisfied with IKEA. IKEA contains a plethora of features. One of these features is called "design your own space" which allows the user to choose any product and

place it in any preferred position and adjust the placement of the product in a 360 view. But this feature comes with a technical limitation such as not being able to switch between different spaces but in terms of 2D perspective, it does not hamper the user's experience whatsoever [Modak & Sinha \(2019\)](#).

Baruah, Mintu and Panikar developed a mobile application named Deskart with the support of AR and brings a platform for online shopping for furniture. User can get a visualization of the product that he wants to purchase with the help of AR. It also provides reviews and details regarding the product. When the user requests any particular detail then the user can have multiple options. Firstly, the user can get a visualization of the product, can select any one of the preferred objects, and can view that object in 3D. The user has the ability to rotate, move, increase or decrease in size and much more to determine where it fits best. Secondly, the user can be provided with any details of that product such as price, measurements, and even forms of communication. With this method, the user can actually design his whole house and this method makes buying furniture much easier and more efficient [Baruah et al. \(2019\)](#).

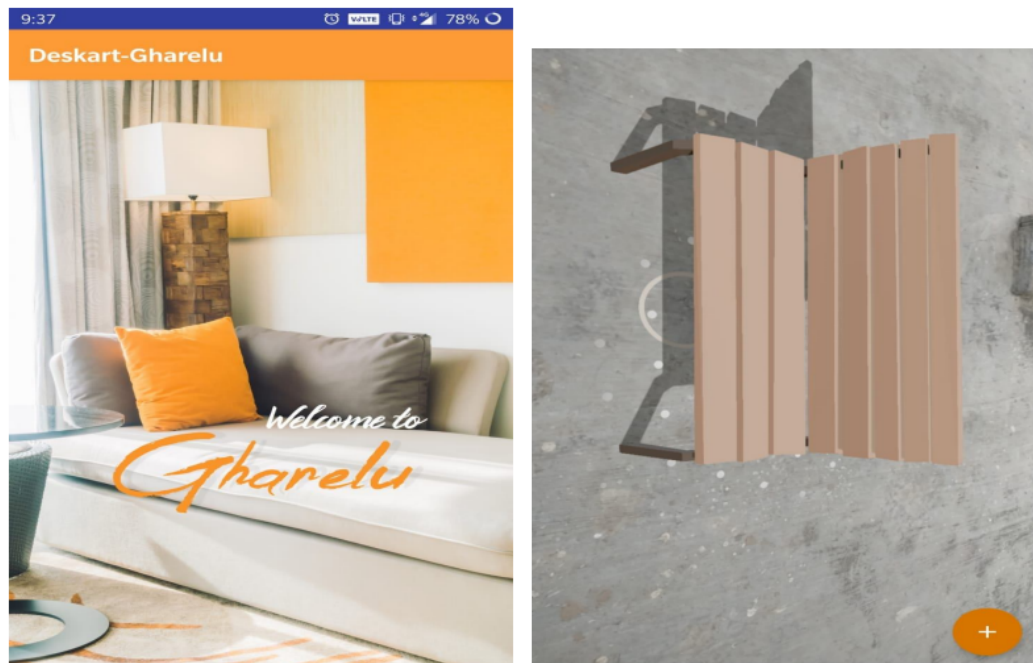


Figure 2.2: Deskart 3D in AR

Reuksupasompon, Peeranut, and Aruncharathorn discussed a system called "AR Development For Room Design". Through this system, a room can be designed with furniture, with the help of AR. The floor plan and QR markers are used for the ability to physically move the furniture within a limited space. With the AR technology, Five white QR markers have been used to indicate the furniture, and a black QR marker is used to indicate the limited yet available space. After all of that, the system will be able to calculate the location of each QR marker and make the corresponding furniture fit within that space, and finally showcase the total layout on the phone's screen as shown in the given figure. [Reuksupasompon et al. \(2018\)](#).



Figure 2.3: AR Development For Room Design

Houzz is an app that is discovered by Sandu, Mihai, and Scarlat and it also uses AR to make the user's experience simpler but more efficient. "View in My Room 3D" is an AR-based feature by Houzz that allows the user to get a visualization of the models of the preferred furniture and other accessories which helps the user to make a much more informed decision when confirming their purchase. When the user enters the app, they can click on the "My Room" button to access the AR feature. This opens the camera and shows the chosen product in 3D. Users also have the option to rotate and resize the models to showcase the product from multiple views and angles. The app comes with another feature that helps the user to post their ideas online and share them with the community [Sandu & Scarlat \(2018\)](#).

Hebbar, Prajna, and Deepa came up with the idea of "The contrivance of Augmented Reality with Interior Designing" where people who find it difficult to get a platform where they can exercise their own ideas of home interior designs and later use that as a reference for their own interior designs. That is why this idea was brought up to resolve this issue, by enabling the user to find their own preferred platform, create their own space, enhance their creativity, and then create a decision

to purchase. The main intention is to scan any room and provide suggestions related to the interior designs of the room. The users will be able to design their own rooms, showcase their tastes and fulfill their needs and receive suggestions. This has made the entire interior design process less time-consuming [Hebbar et al. \(2022\)](#).

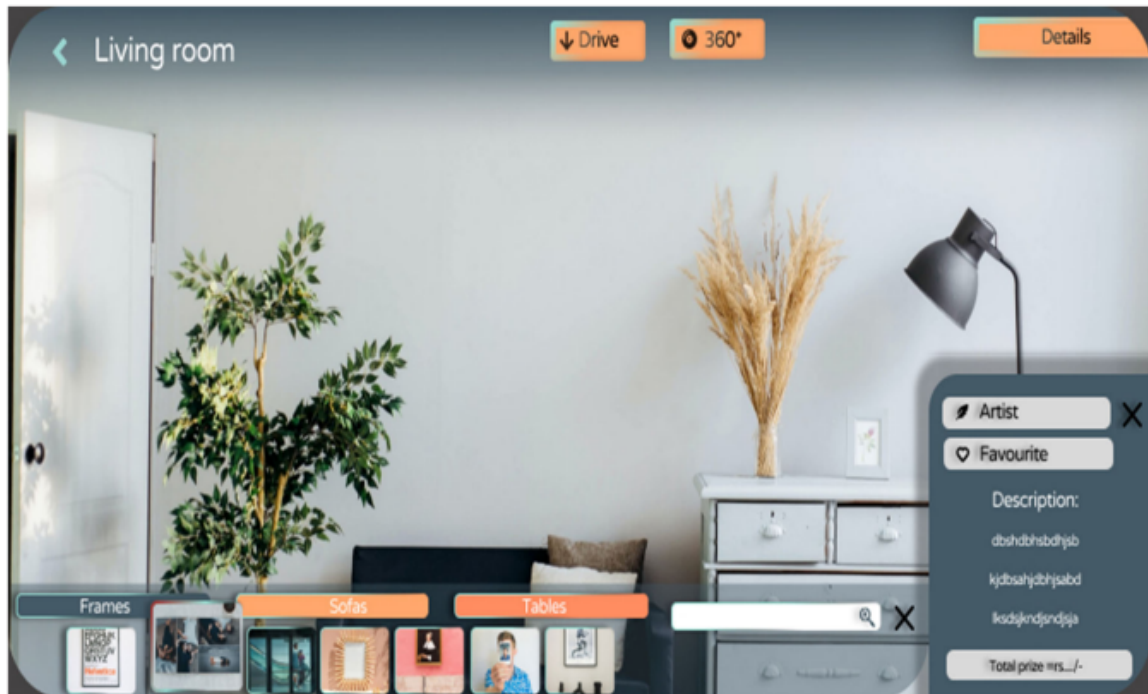


Figure 2.4: The contrivance of Augmented Reality with Interior Designing

Wei, Hongtao and Tang worked on a paper named "Home Environment Augmented Reality System Based on 3D Reconstruction of a Single Furniture Picture". This system's goal is to combine technology that's 3D-based and technology that's AR-based 'to develop a comfortable home environment. Images of furniture with a background are converted into 3D models through this system. The system removes the background of any picture of a piece of furniture and turns it into a 3D model and AR model. This system's main goal is to reconstruct 2D images in 3D and get a 3D model of the furniture. Firstly, the system extracts the furniture from the background with the BCGC algorithm. Then, the system gets the 3D models of the furniture, and to do that a PONet network is used to create the necessary calculations needed to complete the reconstruction. Lastly, the system makes im-

provements and the MF-AKAZE algorithm is used to adjust those improvements and turn them into an AR view [Wei et al. \(2022\)](#).



Figure 2.5: 3D Reconstruction of a Single Furniture Picture

Leiva, Jens Emil, and Klokmoose worked on a project of "Rapido: Prototyping Interactive AR Experiences through Programming by Demonstration" which allows the designer in the AR interface, to record a video, and content regarding sketch. Then animations, rules, and inputs are demonstrated. After that, in the timeline, all previous demonstrations are saved and then a video prototype is created. The prototype later gets tested by the designer in the AR interface. Rapido has a server and two user interfaces. One of the interfaces is a mobile AR interface that is implemented on iOS14 and can be run on an iPad Pro tablet and as a stylus, Apple Pencil 2. ARKit is used to record the video and save spatial information and frames. The rendering of 3D scenes in multiple modes like playback and live modes uses SceneKit. A NodeJS-implemented server runs on the laptop. The connections between the tablet and laptop cause a share of timeline information [Leiva et al. \(2021\)](#).

"Furniture layout application based on marker detection and using augmented reality" was discovered by Khairnar, Khushal, and Khairnar. This application was developed where an object can be tried out by placing a marker in the room, the position of the marker is the desired position of the user for where the object will be placed. By using the fiducial marker detection algorithm, the application detects where the marker is situated and the object that the user chose will be viewed on the webcam. To make this process work the first step a user needs to take is to place



Figure 2.6: Furniture Layout Application

the marker in the user's room. From there, the camera can video stream the object, and then through image capturing and processing, the room will be viewed with the desktop webcam. The position will be calculated after detecting the marker and the object will be placed on the screen with an Augmented display [Khairnar et al. \(2015\)](#).

Chang, Yuh-Shihng, and Hu developed an application with the intention of teaching students invested in interior design. The application is a mobile augmented reality application meaning it uses augmented reality as a feature for the application. Apart from that, the entire learning process has applied John Keller's ARCS (Attention, Relevance, Confidence, and Satisfaction) learning method to validate solutions regarding any issues that arise from the students. Firstly, markers or tags are placed on the 2D interior scenes. Then the camera on the application detects

the marker or tags and a 3D augmented image of the design can be viewed. This process helps the students understand the concept of the structure of the interior space. The students have the opportunity to design different and unique spaces and can evaluate the process which helps the students learn about the concept of interior design through this application [Chang et al. \(2019\)](#).



Figure 2.7: Applying Mobile (AR) to Teach Interior Design Students

Yambao, Jaymark A, and Miranda worked on a report of "Development of Augmented Reality Application for Madeto-Order Furniture Industry in Pangasinana". They discussed on a mobile application named Jasmin's Furniture, where a markerless augmented reality was developed with the intention of expanding furniture-based businesses. This mobile application is where augmented images of products can be viewed without a marker. The objective of this application is to showcase a preview of the product and promote that product for their own businesses. The study focused on developing and designing a website and integrating it into a mobile-based application. A common issue is that the advertised products often do not fit the criteria of the expectations of the users regarding sizes colors etc. That is why AR-based applications are used to solve the mentioned problem to help ease the customer and promote the business's products. The models were developed in Unity 3D, while the Vuforia engine is utilized by AR technology integration. The 3D drawings were recreated using Sketchup software. The integration not only helps in viewing the product, but it also promotes the brand of the furniture in an entirely new perspective of AR view [Yambao et al. \(2022\)](#).



Figure 2.8: Jasmin's Furniture

2.2 Comparative Analysis

As we compared our works with other projects, a few similarities arise when compared. IKEA's 3D allows the user to view any selected product in a 360 view and in terms of woodpecker also has a similar feature of viewing furniture in 3D. In Woodpecker, the user can rotate, move, increase, and decrease in size, and also provides details of the product like price and colors. Also, Deskart-Furniture provides the user with the ability to rotate, resize and move products. Houzz has a button called "My Room" which accesses the AR feature and which opens the camera and views the product through the help of AR, Woodpecker in an IOS browser can also view a product with the help of AR. Jasmin's Furniture helps the user to access AR without any marker and Woodpecker also can access AR without the help of a marker.

When comparing the works, differences can also be seen. IKEA's 3D allows the user to choose any product according to the user's taste, but woodpeckers can not allow the user to choose any product; only a few ranges of particular objects can be viewed in 3D. Woodpecker is a website while Deskart Furniture is an application and this application can provide reviews of products but Woodpecker instead of a review section has a page called FAQ which holds the questions and answers section. AR development for Room Design requires QR markers to be

able to access AR view but Woodpecker does not require any markers whatsoever. Houzz is an application that has the feature to post the users' ideas online and share them with the community but Woodpecker, which is a website, does not have any similar features. Jasmin's Furniture is a mobile application and the models in that application were developed and modeled in Unity 3D but Woodpecker is a website and the models in that website were modeled and developed in Blender. Rapido offers an AR interface, from where users can be able to record a video and content regarding sketches but woodpecker fails to acquire similar features.

2.3 Scope of the Problem

This website would be very capable for the users when launched. Through AR and many other features, this website would be very useful for users. Users will be able to get a better visualization and their decision will be much clearer. The website makes the entire shopping experience of the user much more efficient. The website will be able to showcase the furniture in real life through AR, view the furniture in 3D, and get the detailed information regarding the furniture.

Chapter 3

Methodology

3.1 Business Process Modeling

This business process model focuses on buying a product which helps the investor to examine and observe the model properly. This inevitably becomes useful when the managers share their ideas clearly and quickly. This also makes the procedures of the business easier to understand by organizations. The model is divided into two sections, the customer and the furniture shop itself. Whenever a customer visits the website, they have the opportunity to confirm the order, and that specific and selected order is received by the seller, then the seller verifies the customer's data and checks the store whether the products are available or not. Then there are two conditions, if the product is not available, it will restock and if the products are available then the seller gives the product with charging issues and it helps for financing. At last, after the confirmation of payment, the customer gets the products.

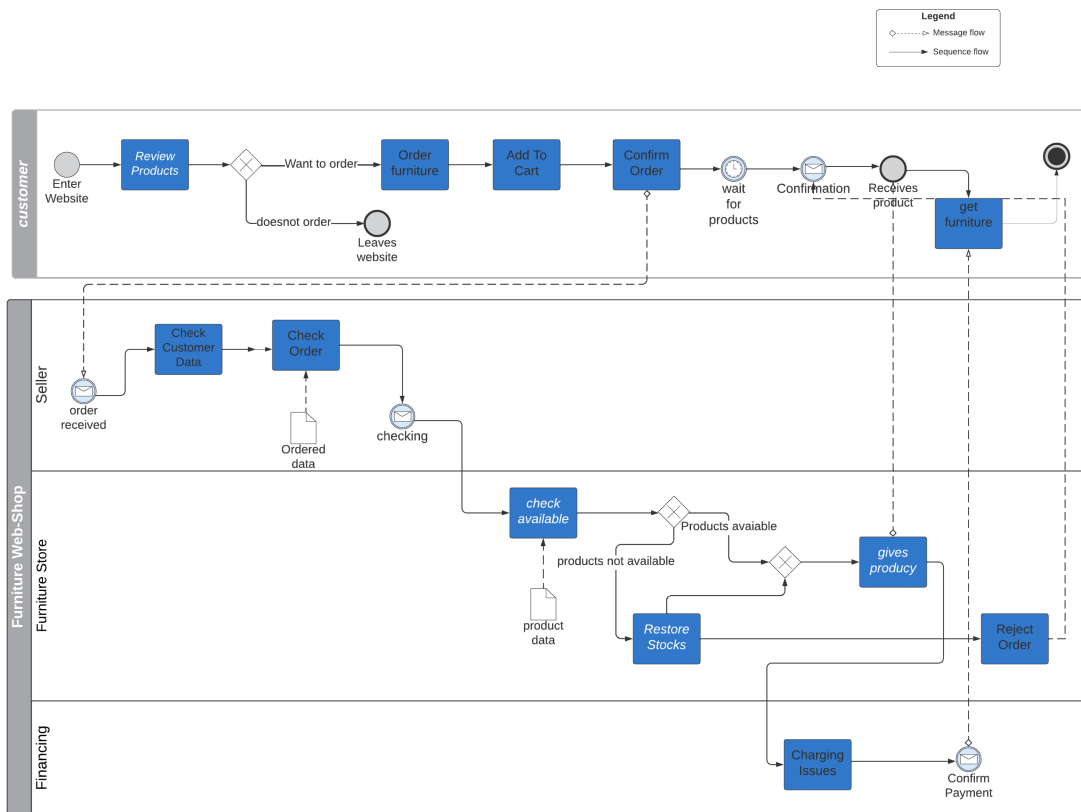


Figure 3.1: Business process model

3.2 Requirement Collection and Analysis

3.2.1 Functional Requirement

Identifier	Priority	Requirement
REQ-1	3	The system will allow the customers to create an account .
REQ-2	2	The system will allow the customers and admin to log in if they already have an account.
REQ-3	2	The system will allow the users to log out whenever they want to.
REQ-4	1	The system will allow the customers to send a message in the contact section for any kind of help or feedback.
REQ-5	3	The system will help the customers to view and access the shopping materials in an organized manner.
REQ-6	3	The system will allow the customers to view the products in 3D to get the interactive features such as zoom in, zoom out and rotate.
REQ-7	3	The system will allow the customers to view the product in AR when the website is opened from google chrome on the phone.
REQ-8	3	The system will allow the user to add to the cart for placing the order.
REQ-9	1	The system will allow the user to explore interior ideas to get the room idea designs.
REQ-10	3	The system will allow admins to view the ordered details of customers.
REQ-11	2	The system will allow admins to respond to the message which is sent by the users.

3.2.2 Non-Functional Requirement

Identifier	Priority	Requirement
REQ-12	2	The system should be compatible with smartphone operating systems (iOS) and computer operating systems (Windows).
REQ-13	3	The system should be easy to use and handle.
REQ-14	3	The system should be able to keep personal user data secure.
REQ-15	2	The system should have smooth transitions.

3.3 Use Case Modeling and Description

The use case diagram shows the relationships among all the Actors and Use Cases. The actors include the user and admin. Some use cases are included and some are extended from the related use cases.



Figure 3.2: Use Case Diagram

Casual Description

UC-1: Create Account - Allows students and instructors to create a new account for accessing the system's information.

Derivations: REQ-1

UC-2: Enter Password - Allows users and admin to enter passwords for verifying themselves.

Derivations: REQ-1, REQ-2

UC-3: Login - Allows users and admin to log in to the system or to create a new account for accessing the system's information.

Derivations: REQ-2

UC-4: Log Out - Allows users and admin to log out of the system whenever they want to.

Derivations: REQ-3

UC-5: Access Shopping Materials Allows users and admin to view the shopping materials.

Derivations: REQ-5, REQ-6

UC-6: Send Message - Allows users to send messages in the contact form if they have any queries.

Derivations: REQ-4

UC-7: View 3D products - Allows the users to view the products in 3D in order to zoom in, zoom out and rotate.

Derivations: REQ-6

UC-8: View in AR - Allows the users to view the product in AR through a phone.

Derivations: REQ-6, REQ-7

UC-9: Add To Cart - Allows the users to add the products to the cart.

Derivations: REQ-8

UC-10: Place Order - Allows users to place and confirm the order.

Derivations: REQ-8

UC-11: Explore Interior Ideas - Allows subject advisors to remove the required study materials.

Derivations: REQ-9

UC-12: View Ordered Details - Allows admin to view the ordered details of furniture.

Derivations: REQ-10

UC-13: View Registered People Allows admin to view the registered people.

Derivations: REQ-10

UC-14: Respond To Chat - Allows admin to respond to the chats from customers or users.

Derivations: REQ-11

3.4 Flow Chart and Logical Data Model

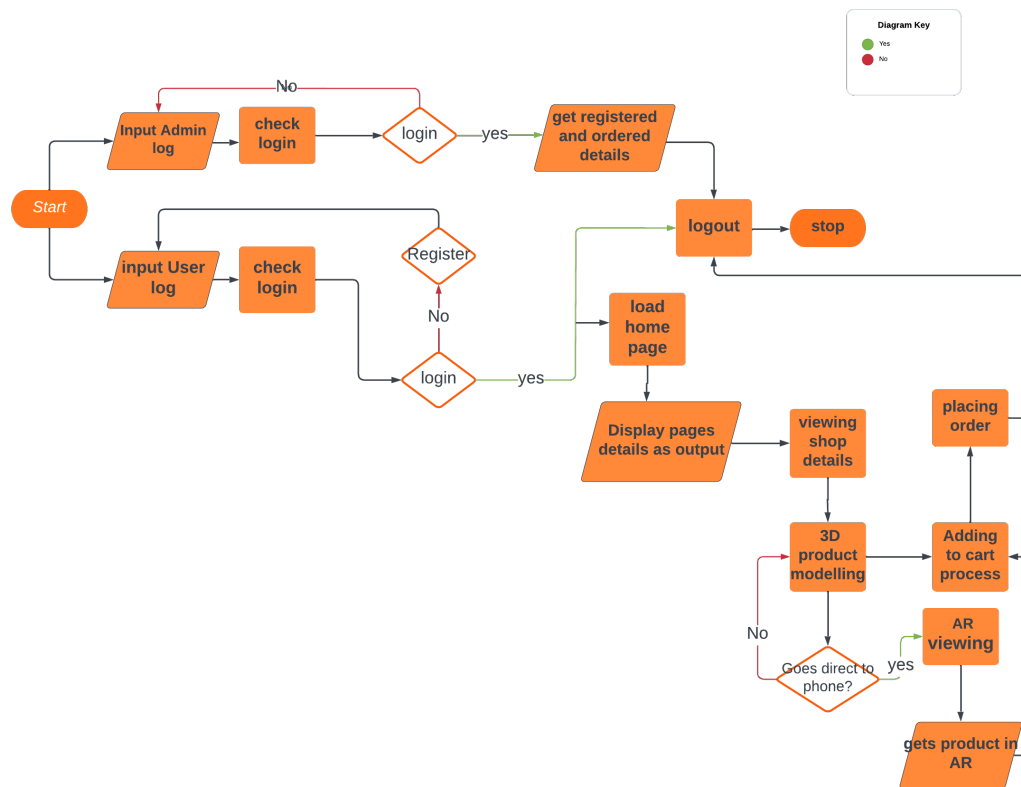


Figure 3.3: Flow Chart of the system

This flowchart diagram showcases the entire procedure of a program. The two users, admin, and user have their own unique features. After the user inputs their

login information, the system verifies the login information. If the login is correct, the home page will be accessed by the user as output and the user can view shop details. And when the user accesses this website from the phone, only then the AR can be viewed and if the user wants to order any product, they can add it to the cart and place an order, and at last, can log out.

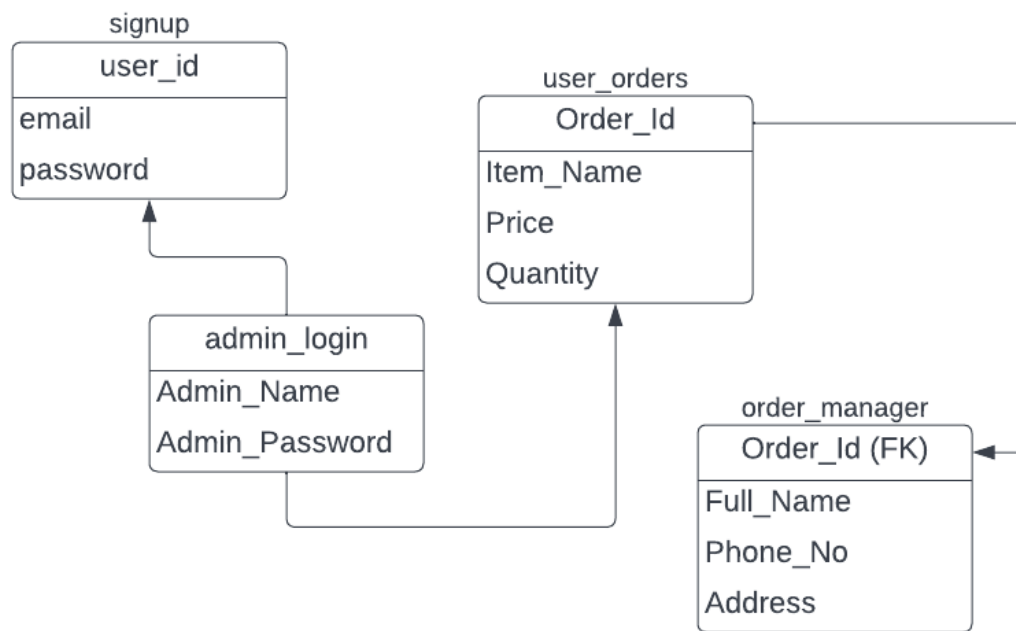


Figure 3.4: Logical Data Model of the system

This logical data model establishes the elements of the structure of data and the relationships between them. There is four entity which is related to the database of the project. The signup table is one of the tables which is for all the users who want to signup to use the website. User orders are the table of what products they want to order. And order manager is the table that is consisted of customers' details, which are saved in the database. The order manager table has the foreign key of the user id. Admin has a table named admin login, where the name and password are fixed in the database.

Chapter 4

Design and Development

4.1 Front-end Design

The name of the website “Woodpecker” is the first thing introduced to the users. Each page was created with the help of web languages like HTML, CSS, and JavaScript. Each page also contains a banner related to that specific page, attracting colors and interactive buttons for the users. “Home”, “Shop”, “About”, “Blog”, “FAQ”, and “Contact” are all situated in the header section of the website. Each section of the header contains its own individual and unique page. After a user has logged in, the user will see this picture.

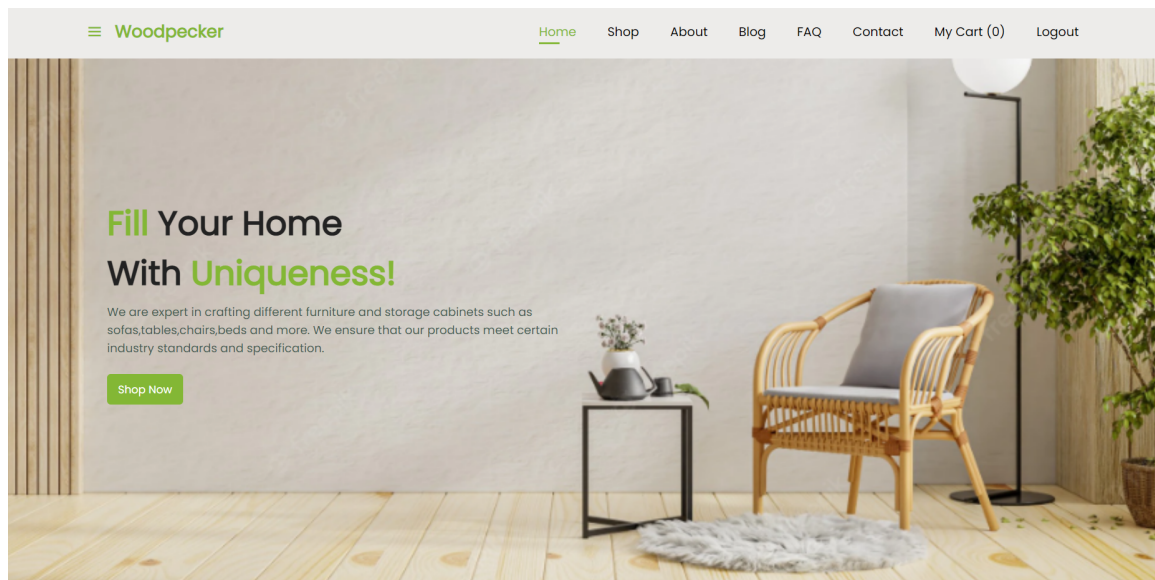


Figure 4.1: Home page

This is the first page of the entire website. The banner indicates the entire furniture theme and it also makes the user feel at home. The color light green has been used to better attract the user and the button “Shop Now” also carries a color that attracts the user. This page also includes a quote “Fill Your Home With Uniqueness” and the purpose of this page is to introduce the users to the entire website of Woodpecker.

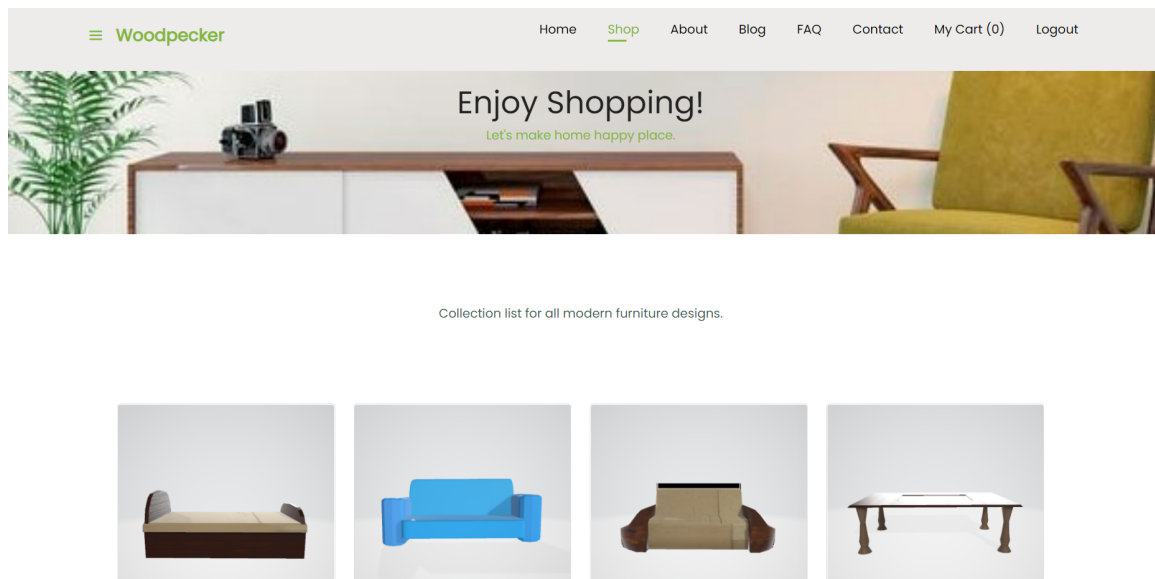


Figure 4.2: Shop page

The “Shop” page is the primary page for the purchase of furniture. The banner at the top shows an attraction towards the product this page offers for you to purchase. “Enjoy Shopping! Let’s make the home happy place” is the quote used on this page for the interaction of users. Products are presented to the users to purchase, side by side. The color “grey” has been used in the background to make the products pop out and the color green has been used on the “Add To Cart” button to make it noticeable to the users.

The “About” page is an introduction to the team that worked for Woodpecker. The banner at the top is used for attraction and the image at the bottom left is another image for the same cause. The quote “Know all the details” is also used. The color black is used for the fonts for a more unique attraction. The page “Blog” is another page of the entire website. For the background, light pink is used and the fonts are all in black. Images on this page are showcasing how the furniture

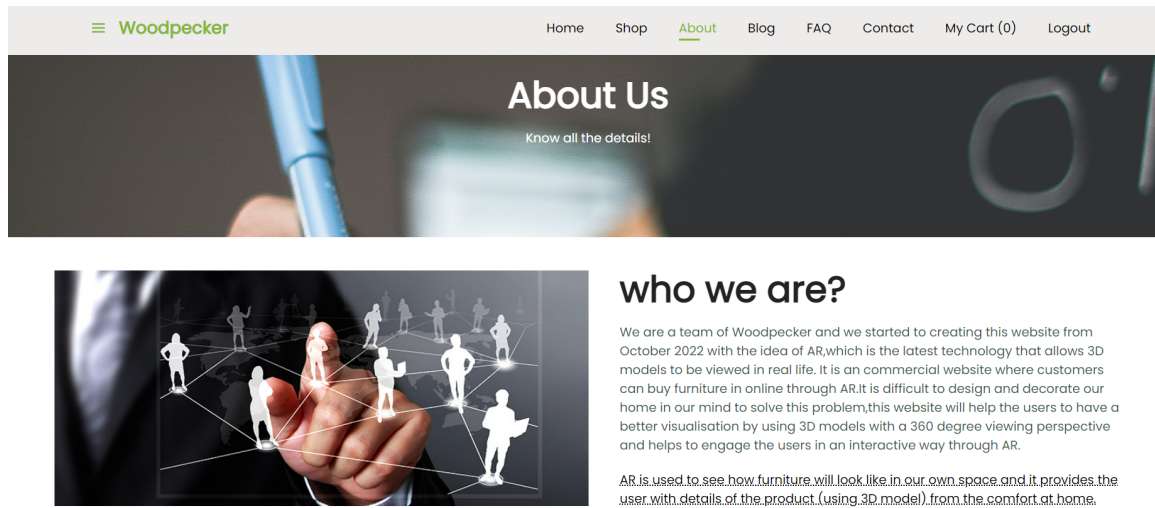


Figure 4.3: About Page

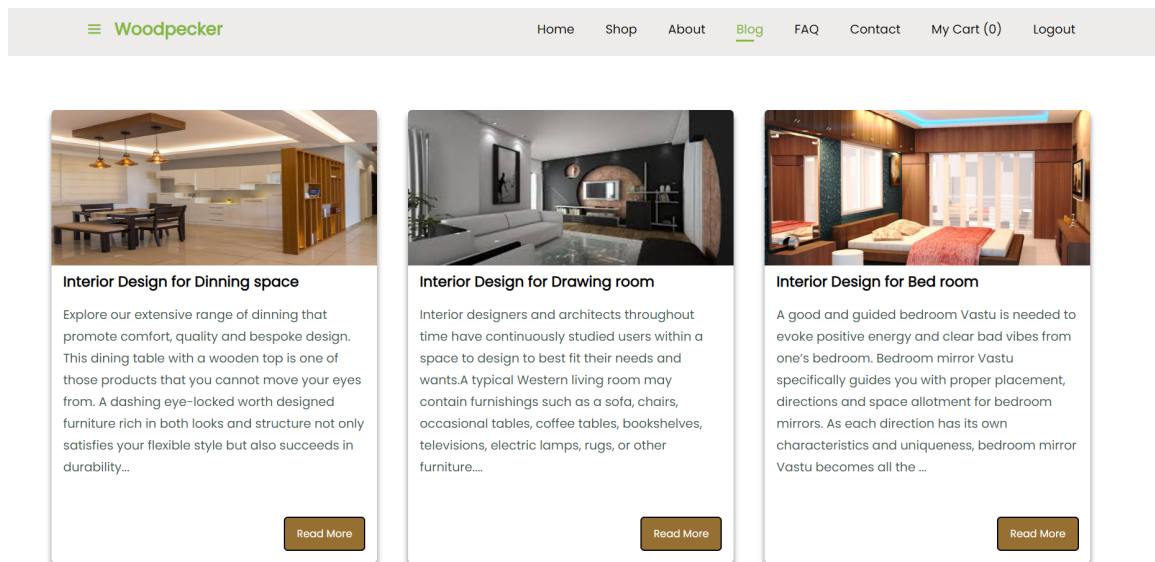


Figure 4.4: Blog Page

would look in real life. Another part of the “Blog” section is the showcase of interior designs for parts of a house. Here images are used to show the design of rooms in the house. After the image, there is a paragraph describing and advertising the interior design. Below the paragraph, there is a button called “Read More” and when the mouse hovers over the button, the color changes.

In the “FAQ” page, a thin opacity of green is used in the background and white

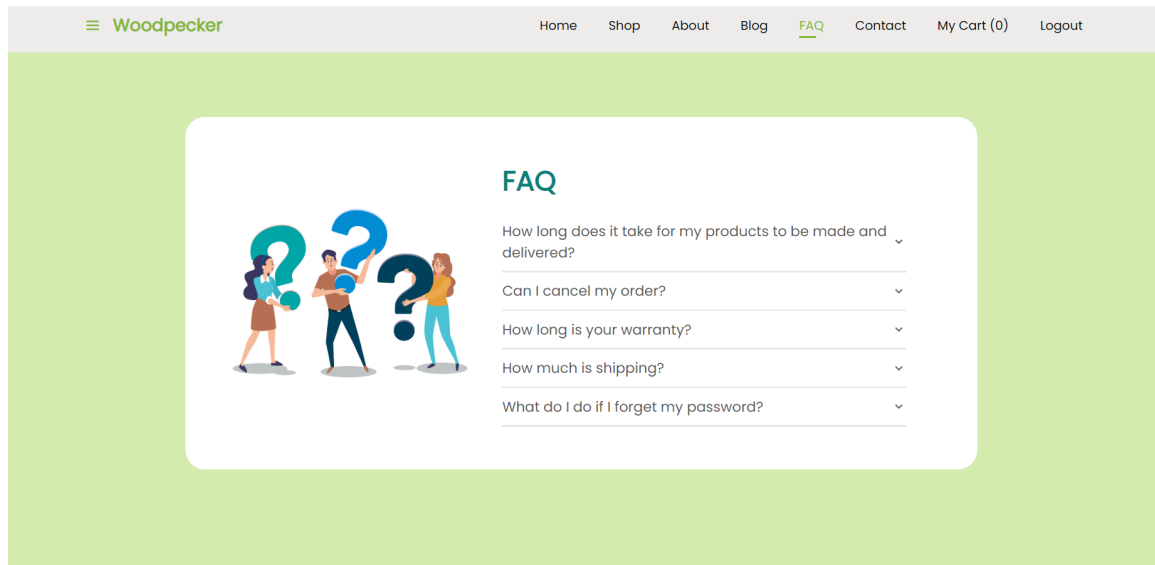


Figure 4.5: FAQ Page

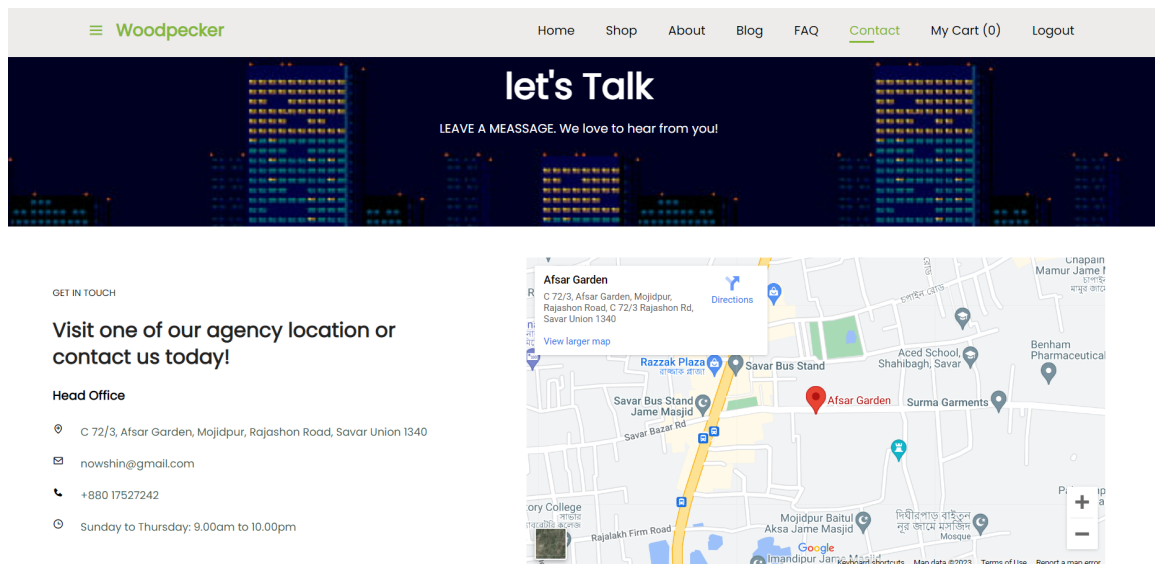


Figure 4.6: Contact Page

in the middle. Questions are situated in that white part. An arrow sign is used beside each question. The “Contact” page has a banner containing a quote, “LEAVE A MESSAGE. We love to hear from you”. On the bottom left side of the page, there is a Pin icon beside the address, a mail icon beside the email, a phone icon beside the number, and a clock icon beside the given availability of time. Also on the

bottom right side of the page, there is a map indicating the location, this feature gives very detailed information to the customer.

4.2 Back-end Design

Any management related to the side of the server is the back-end development. All kinds of databases and management of the website are handled through the back end of the website. In this website, any activities occurring on the front end of the website leave an action behind the website, and the back end of the website deals with those activities. Purchase of any product and login are all dealt with through the back end of the website.

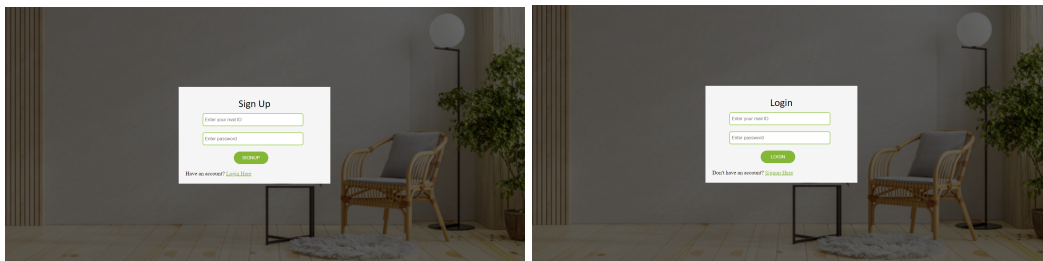


Figure 4.7: Signup and login page for the user

Here, the user needs to Login by typing their mail ID and password. From there, the back end side can access the information provided by the user. If the user does not have an account, he can sign up by clicking on the bottom button “Signup Here”. And when the user needs to Sign up by typing in their mail ID and password from there, the back end side can access the information provided by the user. If the user already has an account, he can log in by clicking on the bottom button “Login Here”. The other user is the admin, they need to log in by typing their admin name and password. From there, the back end side can access the information provided by the admin. The password and admin name has been set in the database, which is fixed.

After the admin logs in, this is the interface in figure 4.9 that is presented in front of the admin. The admin then can view any data such as order ID, customer’s Id, phone number, address, the preferred and purchased item, price of the item, and its quantity. The data is arranged in a table format for an overall better-organized system. The theme color of this interface is black, the philosophical reason behind it

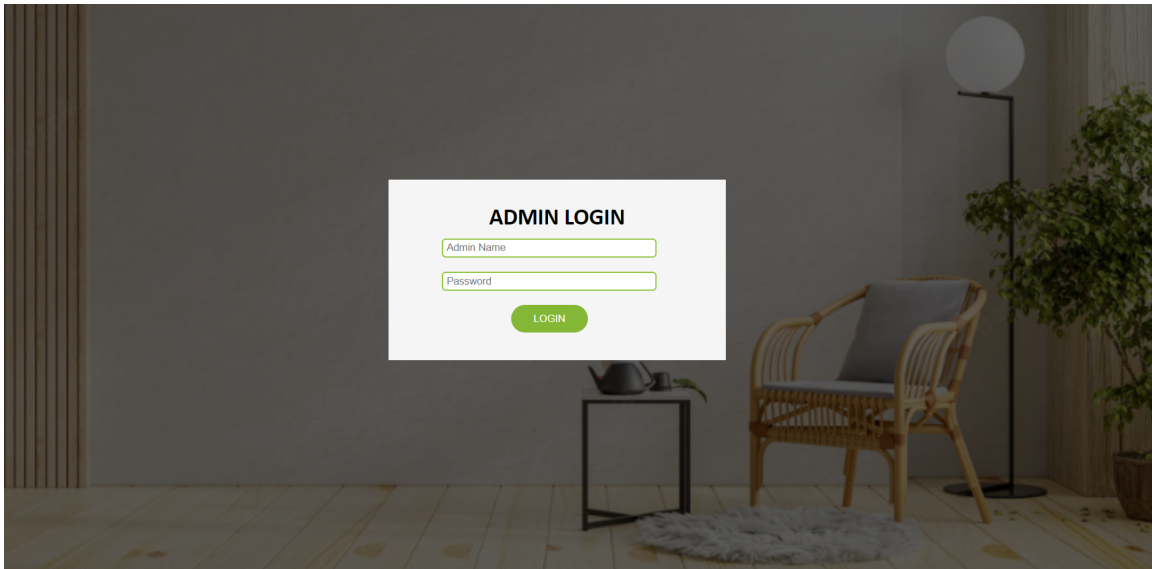


Figure 4.8: Admin Login Page

ADMIN PANEL				LOG OUT		
Order ID	Customer Name	Phone No	Address	Orders		
11	Tabassum Ome	17525252	Savar,Dhaka	Item Name	Price	Quantity
				Chair	1500	1
				Bed	5000	1
12	Akib Rahman	1818245	Lalmatia,Dhaka	Item Name	Price	Quantity
				Dinning Table	7800	1
				Bed	5000	1
13	Wasica Orin	168345	Mirpur-10,Dhaka	Item Name	Price	Quantity
				Chair	1500	1

Figure 4.9: Admin Panel page

is that the entire website and project always go above and beyond, and black refers to the immense number of opportunities provided by the project. The interface has a logout section that offers the ability to log out for the admins.

4.3 Interaction Design and User Experience (UX)

This project holds user experience (UX) which is a process of interactive products that provide relevant and meaningful experiences to the users of that system. In this project, button labels were used for the user to cause interaction and to provide the user with correct and valid information. Images have been used to gain user attention and assist in user interaction. We can use our mouse to access and use any of the interactive buttons when browsing the internet through a desktop and when we are using phones, we can access the same exact buttons but with the help of our physical fingers, and through that we can click any button, zoom in, zoom out and rotate.

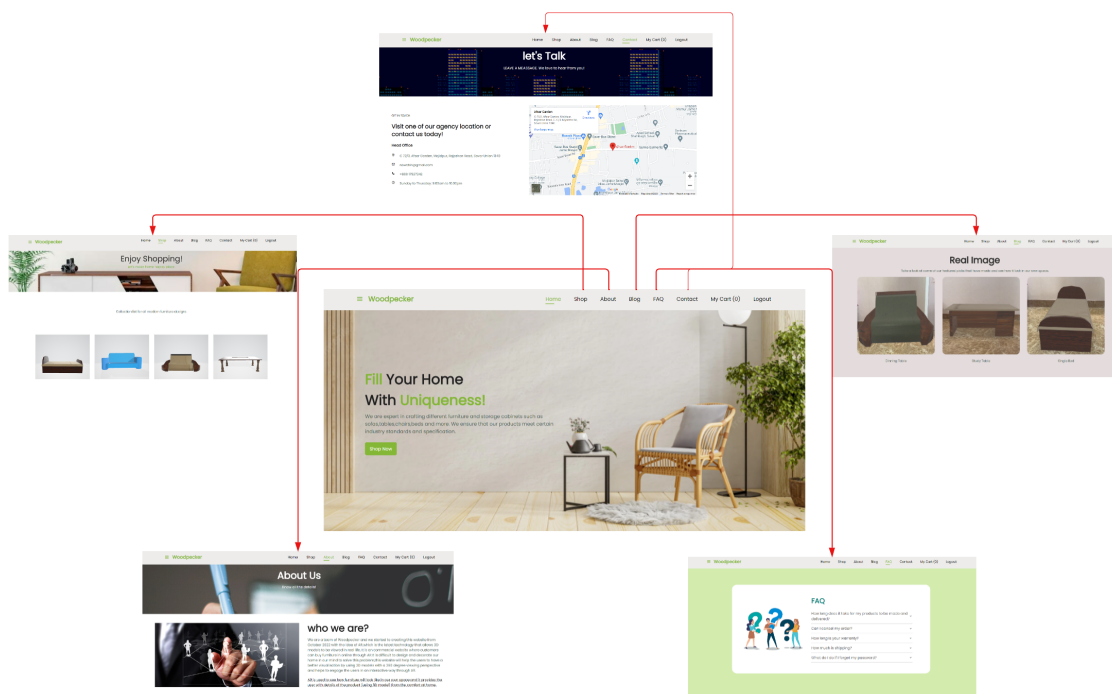


Figure 4.10: Interaction Design for all pages

When the login becomes successful, the user can interact with the home page, which comprises five different pages such as a shop, about, contact, blog, and FAQ. When each of the buttons of each page is clicked, each individual page will be presented to the user.

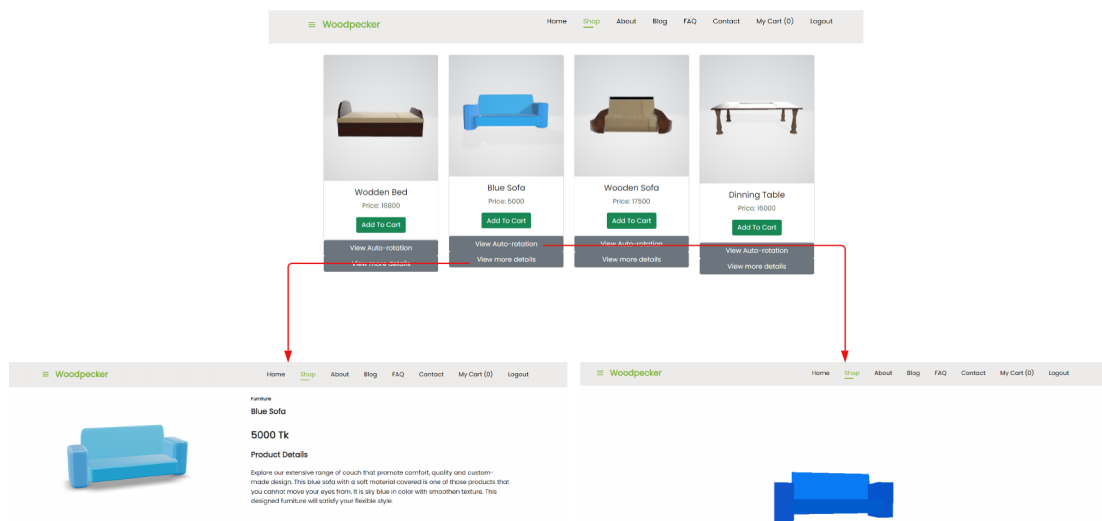


Figure 4.11: UX Design for shop page

This is the shop page in figure 4.11, which holds two different subpages of “view auto rotation” and “view more details”. When the user clicks on the “auto-rotation” button, the user will get a view of the model with the ability to rotate automatically, which provides a user-friendly experience. When the user clicks on the “view more details” button, the user will receive all kinds of necessary details of the products with price, and size and will be provided with information about each texture with the ability to zoom in, zoom out, and rotation with the help of the interaction of user itself.

On the shop page, there is a button called “Add to cart”. When the user interacts with the page and desires to order furniture, the user gets provided with the opportunity to purchase that item by clicking on the button, then a popup message of the item added will appear on the screen. When the user finally makes the decision of which furniture he needs and wants to buy, he can interact with the “My Cart” page. All the ordered products’ details of name, quantity, and price total will be displayed on the page and the user can also remove any individual item with the remove button. Users also can interact with the purchase button, after filling in the necessary and required details of full name, phone number, and address, which concludes the purchase method.

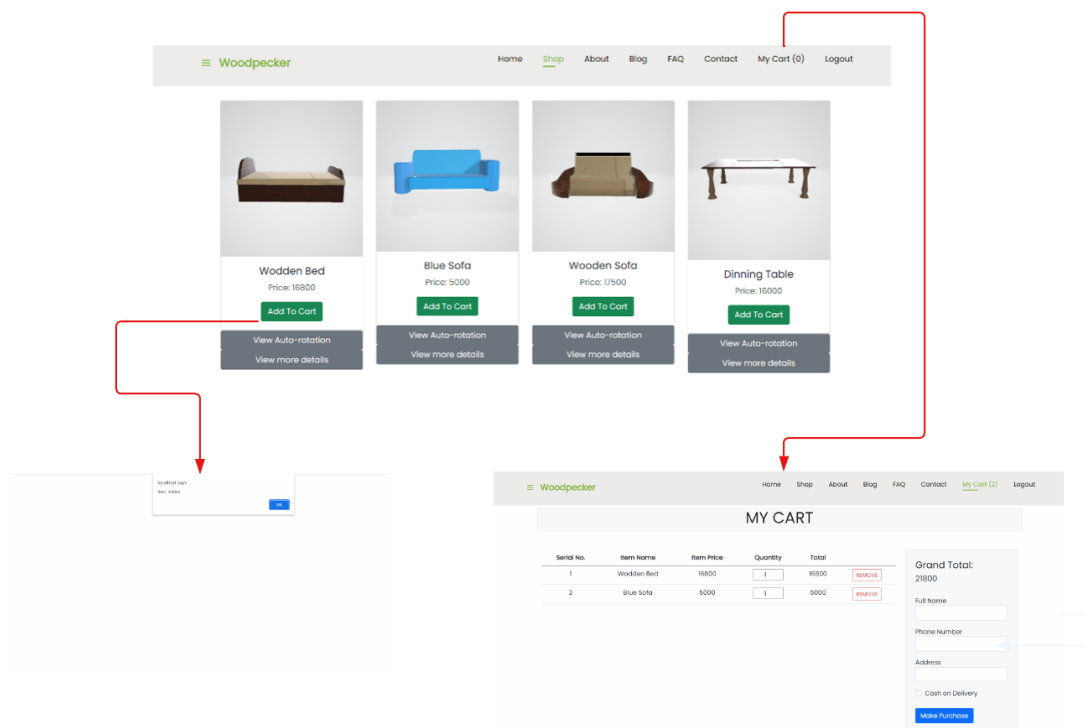


Figure 4.12: UX Design for Cart Page

4.4 Implementation Requirements

During the development of this project, we faced a few requirements. For the coding environment, Visual Studio Code was used. There were a few coding languages used when developing the front end. HTML, CSS, and JavaScript were used for the development. The Home page, Cart page, Contact page, FAQ page, and Blog page were constructed by HTML and CSS. For example, with the help of h1, and h2 tags, the font size of the project was designed. HTML helps in creating the basic structure of sites. The class tags, section tags, and div tags were used provided that CSS styles can be called quickly. To control formatting, presentation, and layout, CSS is used. JavaScript was used in the FAQ section, for example, the feature of clicking the arrow down button, the answers to those asked questions are presented. JavaScript allows the user to implement complex features on the website and it is a scripting language. For the back-end development, PHP is used, for example, the signup and login page for the user and admin was constructed with the help of PHP. All of the

previously mentioned languages were developed in Visual Studio Code. For the database of the project, we used MySQL. MySQL is basically a storage for all of the data of users that signed up, and order details in the format of the table. The main purpose of MySQL is to handle all of the administrative work over the web. For the 3D models, we have used Blender. Blender is software that helps with 3D modeling or animation quickly for users [Aristov et al. \(2022\)](#). 12 unique and creative models and their color and texture have been recreated with the help of a blender.

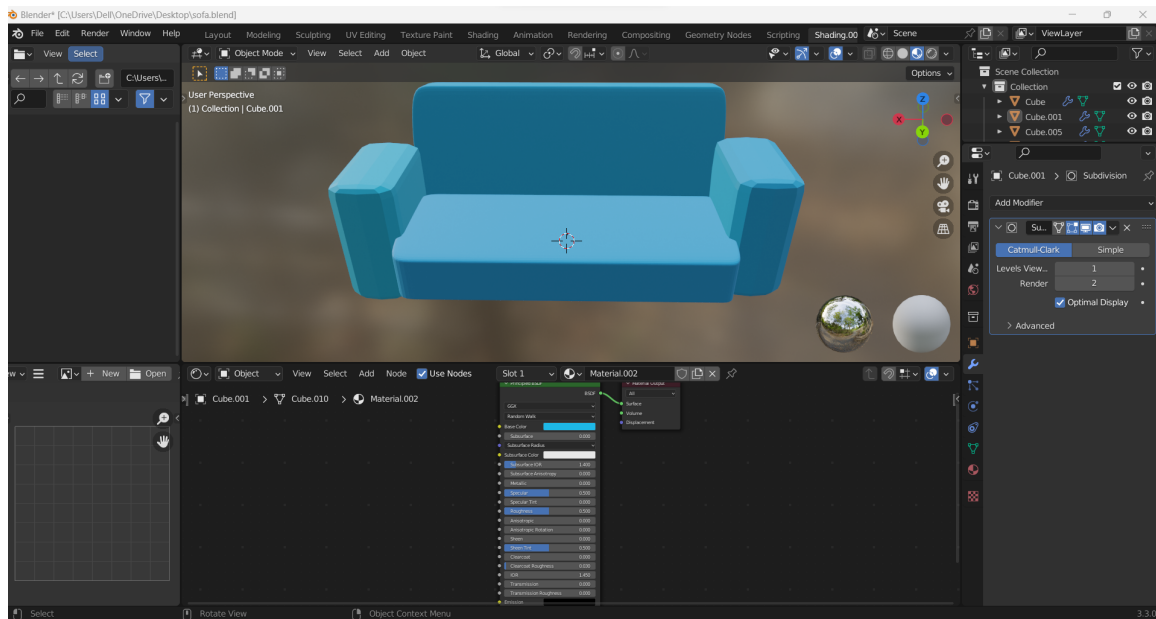


Figure 4.13: Creation of Sofa 3D model in Blender

Chapter 5

Result analysis

5.1 Implementation of Database

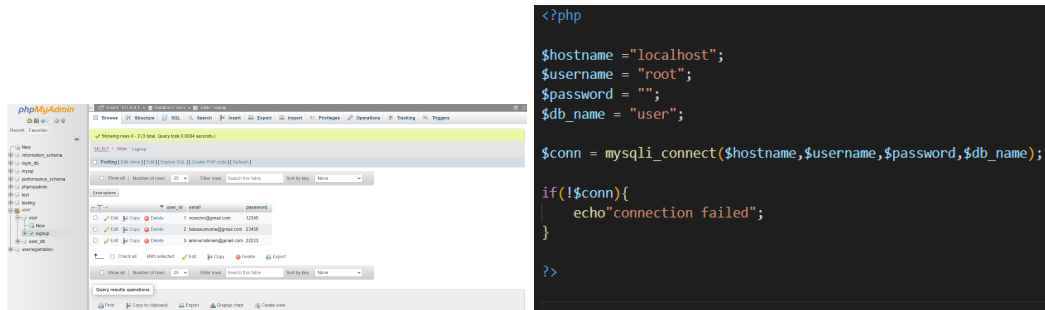


Figure 5.1: Implementation of Signup Table

When a user wants to create an account for the Woodpecker he or she needs to signup with their email and password. The database user has been created with a table named signup, where all the registered data are saved in this table. We had created a connection with the hostname of localhost, username of the root, and database name of the user. When the connection runs successfully it checks with the stored data in the database whether the email and password of the registered user are correct or not. And if it is correct it goes to the home page of Woodpecker.

The database named testing has been created with a table of admin login, where the Admin name and Admin password are given manually so that without that name and password, any user cannot enter the admin panel. We had created a connection with the hostname of localhost, username of the root, and database name of "testing". When the connection runs successfully it checks with the stored

data in the database whether the email and password of the admin are correct or not. The query of the MySQL database is passed with the connection and if the code runs successfully, then it locates on the admin panel page.

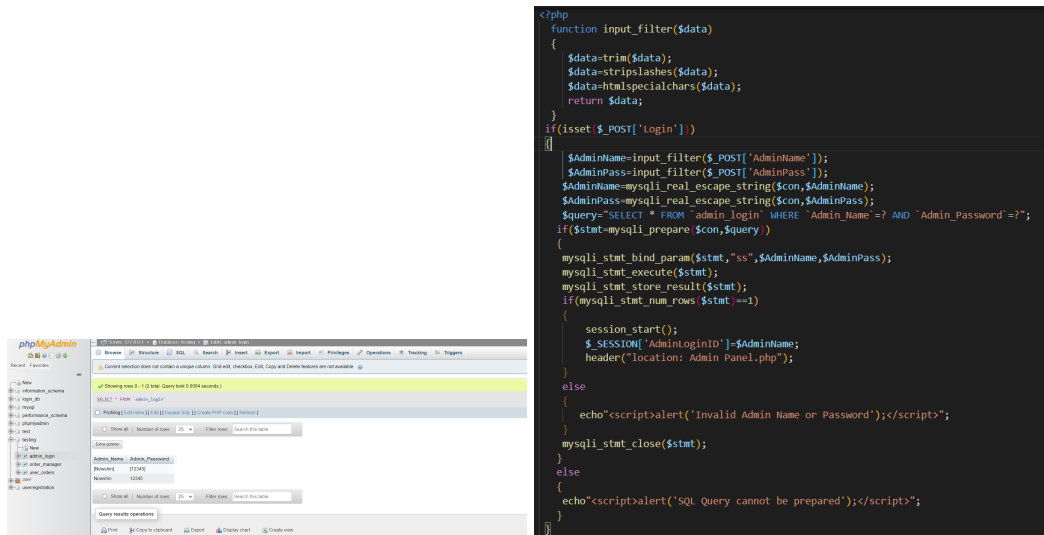


Figure 5.2: Implementation of Admin Login Table

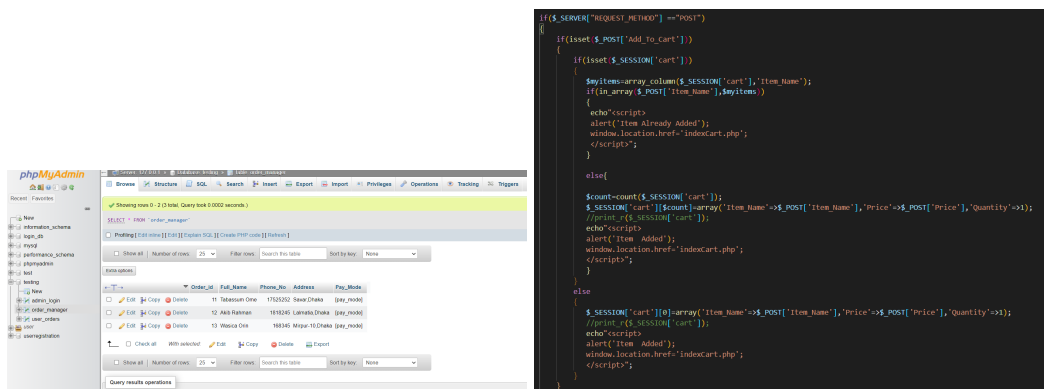


Figure 5.3: Implementation of Order Manager Table

The database named testing has been created with a table of order manager and user orders, where the order manager table holds- the order ID, full name, phone number, and address stored when the user confirmed the order. The user orders have the order ID, item name, price, and quantity, which shows, what type of furniture the customer ordered. The order ID is the foreign key of the user-manager table, the foreign key refers to the primary key of user orders, which established a connection between the data of the two tables.

called by h1,p, and span tag.

```
.navbar li{
  list-style: none;
  position: relative;
}
.navbar li a{
  text-decoration: none;
}
.navbar a{
  font-size: 1rem;
  padding: 10px 20px;
  font-weight: 500;
  color: var(--text-color);
}
.navbar a:hover,
.navbar a.active {
  color: var(--main-color);
}
.navbar a.active::after,
.navbar a:hover::after{
  content: "";
  width: 30%;
  height: 2px;
  background: #83b735;
  position: absolute;
  bottom: -4px;
  left: 20px;
}

.home{
  width: 100%;
  min-height: 100vh;
  background-image: url(images/Cap.PNG);
  background-repeat: no-repeat;
  background-size: cover;
  background-position: right;
  background-attachment: fixed;
  display: flex;
  align-items: center;
}
.home-text h1{
  font-size: 2.7rem;
}
.home-text p {
  font-size: 0.938rem;
  margin: 0.4rem 0 1.8rem;
}
.home-text span {
  color: var(--main-color);
}
.btn{
  padding: 10px 14px;
  background: var(--main-color);
  color: #fff;
  border-radius: 0.3rem;
  font-size: 14px;
  text-decoration: none;
}
.btn:hover{
  background: #8fc53d;
}
```

Figure 5.6: Home Page Implementation with CSS.

For the shop page, a class is given named col-lg-3 and a card class, where the images of each piece of furniture are included with the details, price, and “add to cart” button. At the bottom of each image, there are two subsections of “view auto-rotation” and “view more details” which are designed by a button. After clicking on each button it goes to each page of “sofa3.php” and “sofaAR.php”.

When the view auto-rotation is clicked in Figure 5.8, it opens up a page scripting with three.js, where the GLTFLoader is imported from the GLTFLoader.js files. Also, the scenes and camera are rendered with the WebGLRenderer of setting the window

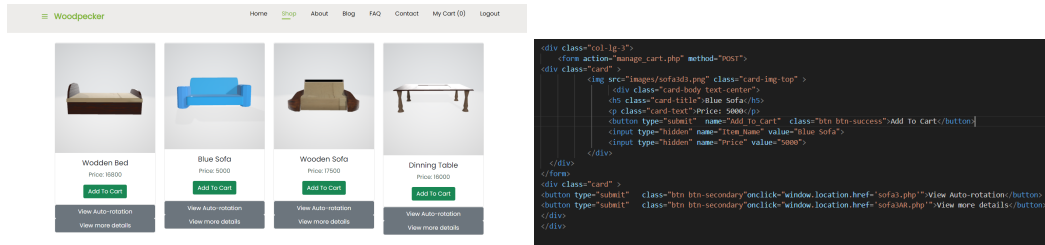


Figure 5.7: Implementation of Shop Page

with inner width and inner height. The 3D model of sofa.gltf is pushed in the loader with the function animate to display the 3D model with automatic rotation.

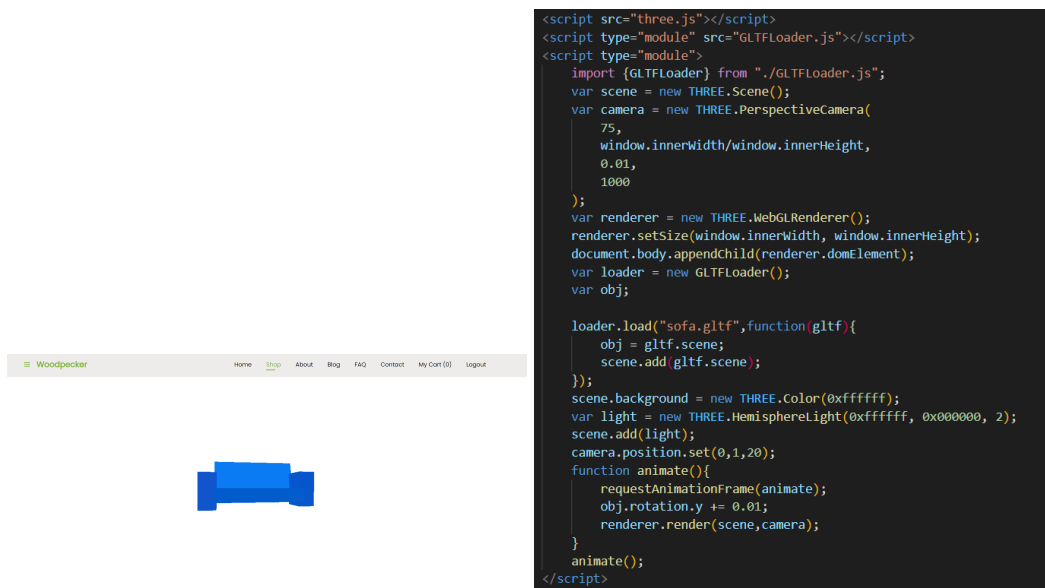


Figure 5.8: Implementation of 3D Model in three.js.

When the view more-details is clicked in Figure 5.9, it opens up a page with the model-viewer tags, where the sofa can be zoomed in, zoom out and rotate by using the mouse. And when we go to this website from the phone, an AR button is displayed by which the sofa is popped by the phone camera. Here we have used a class of “single-pro-details”, where the name of furniture, price, and product details are used with the h,6,h4,h2, and span tags.

The FAQ page in Figure 5.10, described that each of the questions is given and answered individually. We have used the list tag and inside this tag, there is a class called “question-arrow” is used. And inside a class, the arrow is given, so that

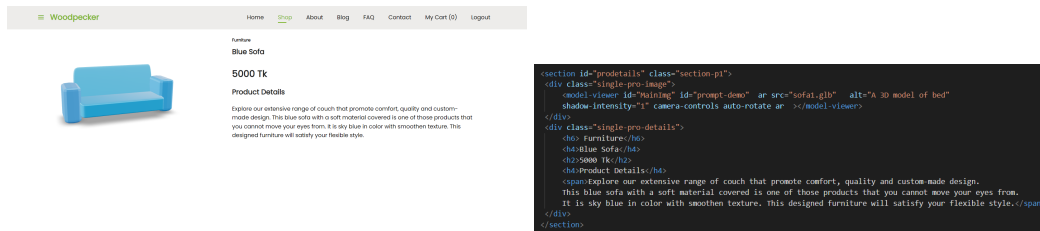


Figure 5.9: Implementation of 3D Model in Model-Viewer.

the user can click it to get an answer. The javascript is used so that the add event listener class can be used with the clicking properties.

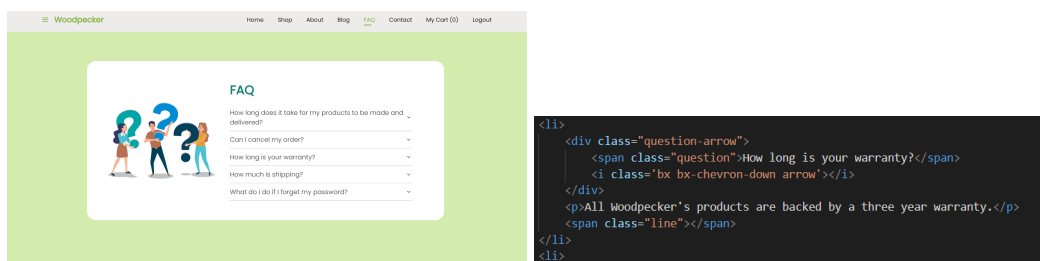


Figure 5.10: Implementation of FAQ Page

5.3 Testing Implementation

Manual testing is a process of test of the software application with the intention of identifying bugs and detecting any issues regarding the running of the software application. When testing, any bugs or issues will be detected and those issues will be later exterminated. There are many different cases of finding out bugs in many circumstances. For example, in the criteria of entering a password, steps were taken to test the program. Procedures cover every possibility and then the expected result will then define whether that feature of the system works or not and how many issues or bugs the program has to face. Then initiatives were taken to fix those issues.

Test Case Identifier: TC-1 Use Case Tested: UC-2 Pass/Fail Criteria: The test will pass if the user successfully enters his password. The test will fail if the user fails to match the entered password. Input Data: Password	
Test Procedure:	Expected Result:
Step 1: User enters invalid user password. Step 2: The user enters a valid user password.	The server denies the login attempt and shows a pop-up message, instructing the user to try again. The server accepts the attempt and takes the user further into the system.

Table 5.1: Test case-1

Test Case Identifier: TC-2 Use Case Tested: UC-1 Pass/Fail Criteria: The test will pass if the user tries to log in to an existing account. The test will fail if the user tries to log in through a non-existing account. Input Data: Password	
Test Procedure:	Expected Result:
Step 1: User enters non-existing Information. Step 2: The user enters his/her existing information.	A pop-up message will appear to request the user to create an account first. The system allows the user to proceed further.

Table 5.2: Test case-2

Test Case Identifier: TC-3 Use Case Tested: UC-2 Pass/Fail Criteria: The test will pass if the Admin enters passcode. The test will fail if the Admin fails to match the entered password. Input Data: Password	
Test Procedure:	Expected Result:
Step 1:The Admin enters an invalid user password. Step 2: The Admin enters his/her existing information.	The server denies the login attempt and shows a pop-up message, instructing the Admin to try again. The server accepts the attempt and takes Admin is further into the system.

Table 5.3: Test case-3

Test Case Identifier: TC-4 Use Case Tested: UC-9 Pass/Fail Criteria: The test will pass if a user is able to add items to the cart. Input Data: Add to cart	
Test Procedure:	Expected Result:
Step 1: The user selects one item and presses add to cart. Step 2: The user selects one item again.	The server verifies the item added and shows a pop-up message, instructing the user that the item is added to the cart. The order is sent to the 'my cart' page in an ordered queue. A pop-up message will appear to inform the item is already placed.

Table 5.4: Test case-4

Test Case Identifier: TC-5 Use Case Tested: UC-9,10 Pass/Fail Criteria: The test will pass if user is able to remove additional items. The test will fail if the user is unable to remove the additional items from the cart. Input Data: Add to cart	
Test Procedure:	Expected Result:
Step 1: The user removes the items added to the cart. Step 2: The user cannot able to remove the items added to the cart.	The server accepts the attempt and a pop-up message is shown that the item is removed and a new cart list is displayed. The server denies the attempt and the existing cart list will be shown.

Table 5.5: Test case-5

Test Case Identifier: TC-6 Use Case Tested: UC-10 Pass/Fail Criteria: The test will pass if the user fills in all details. The test will fail if the user does not fill in the field. Input Data: fill in the data	
Test Procedure:	Expected Result:
Step 1: The user enters the name, phone number, and address to place the order.	The server accepts the attempt and confirms the order and takes the ordered information to the admin.
Step 2: The user does not enter the name, phone number, and address to place the order.	The server denies the attempt and shows a pop-up message, instructing the user to fill out the field.

Table 5.6: Test case-6

Test Case Identifier: TC-7 Use Case Tested: UC-6 Pass/Fail Criteria: The test will pass if the user can send a message via email. The test will fail if the admin cannot receive the message sent by the user. Input Data: Send message	
Test Procedure:	Expected Result:
Step 1: The user sends the message from the contact page.	The server accepts the program and sends it to the admin's email.
Step 2: The user cannot send the message from the contact page.	The server denies the program and the admin cannot able to receive the message of the user.

Table 5.7: Test case-7

All of the test cases mentioned cover the essential classes to ensure the main aspects run smoothly on our Woodpecker website. The test cases clearly show the outcome of the test being passed and the test failing. All the test cases surround the login system mostly which is a vital part to be looked after. There are some test cases for customers who want to purchase any item and for that they have to enter their name, phone number, and address, and without that the server denies the attempt and displays a message on the screen. As we develop our system, we will be adding and adjusting the test cases according to the methods and classes updated.

5.4 Test Results and Reports

Identifier	Test case	Results
Test case 1	User enters a valid user password.	Works successfully.
Test case 2	User enters his/her existing information.	Valid results.
Test case 3	Admin enters his/her existing information.	Works accordingly.
Test case 4	User selects one item and presses add to cart.	Works successfully.
Test case 5	User removes an item that is added to the cart.	Strongly works.
Test case 6	User enters the information to place the order	Gives correct result.
Test case 7	User sends the message from the contact page.	Successful operation.

Table 5.8: All the test results and reports.

Chapter 6

Conclusions

6.1 Social, Legal, Ethical, and Environmental Issues

6.1.1 Impact on Society

The entire project will provide a huge benefit and serve the betterment of the users. The biggest noticeable benefit is that the user has the opportunity to purchase any furniture of preferability with the ease of staying at home. The user can also make a justified decision on the purchase of the product when provided with information related to the chosen product and when offered visualization with the help of AR and 3D models. Brands, Companies invested in furniture can also expand their franchise with the help of this website which brings in financial benefits.

6.1.2 Impact on Environment

This entire project only requires the users to engage with electronic devices. Therefore, apart from the use of electricity, this project is not hampering the environment. But since the users are staying at home, purchasing the products online, and reducing the uses of transportation, the emission of gas from those vehicles will also be reduced and the environment will be a bit safer. All of the wood that will be used in this project will be recycled and trees will be planted for the environment around us.

6.1.3 Ethical and Legal Aspects

The ethical aspect of this project is the values we hold and the values we implement. The offer of a great customer experience is the ethical aspect. Through ethical aspects, trust and loyalty are easily gainable. This project will offer ethical aspects in terms of availability. The user's personal information can not be viewed by others and is secured. The login information is also secured. Even hackers would not be able to access any secured information. With these aspects, the ethics and morality of this project are noticeable and the customers can rely on us.

6.2 Brief Summary

Within this system, we offer AR and 3D views of the products to help users to have a better experience. At first, the user can independently browse through websites and view a huge range of furniture. Due to the AR technology, were able to view our selected product in a 360 view which can clearly showcase the physical positioning of the product in our room. After the user is satisfied with their decision, they have the opportunity to purchase their product. There are a plethora of features for the user that is yet to be discovered. Overall the system helps with the business of other brands related to furniture and promotes and advertises the products to the user and helps them in purchasing the product.

6.3 Future works

This project carries a lot of future scopes with means of development. Currently, the Woodpecker is only a website but procedures will be taken to develop it into an application too. The website on the browser is only compatible with iOS and that's why it will be android compatible in the future. The size scale is also to be implemented as well to get an AR perspective more perfectly and measurements are to be displayed on the side during the preview. For better communication, a live chat is to be developed. Furthermore, steps will be taken to make the website more appealing to the users.

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Appendices (Optional)

Include in the appendices information that could not be included in the formal body of the report because it would disrupt the continuity of the discussion. Background materials, product catalogs, experimental data tables, and extra documentation should be placed in the appendix.