ANKARA UNIVERSITY
ENGINEERING DEPARTMENT

FINAL PROJECT
Clothing Size Matcher

Quality Management EEE0309

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INTRODUCTION

In recent years, the way people shop has undergone a significant shift towards e-commerce. With the rise of the internet and the proliferation of smartphones, it has become easier than ever for consumers to shop online from the comfort of their own homes.

E-commerce offers several benefits for both consumers and businesses. For consumers, shopping online can be more convenient than physically going to a store. It allows them to shop at any time of day, from any location, and they can easily compare prices and read reviews before making a purchase.

For businesses, e-commerce provides a wider reach, as it allows them to sell their products to customers all over the world. It also allows them to collect data on their customers, which can be used to personalize the shopping experience and improve their marketing efforts.

Despite the many benefits of e-commerce, it also has its challenges.

One of the challenges of shopping for clothing online is finding the right size. Clothing sizes can vary significantly between different brands and even within the same brand, making it difficult to know what size to order. This can lead to frustration for consumers, as they may have to go through the process of ordering, returning, and reordering multiple times before finding the right fit. In addition to the inconvenience of having to return and reorder, this can also lead to additional costs for both the consumer and the business. Consumers may have to pay for shipping fees for returns, and businesses may have to pay for the cost of processing returns and restocking items.

In this project, we will try to fix one of the most daunting problems experienced in the e-commerce sector.

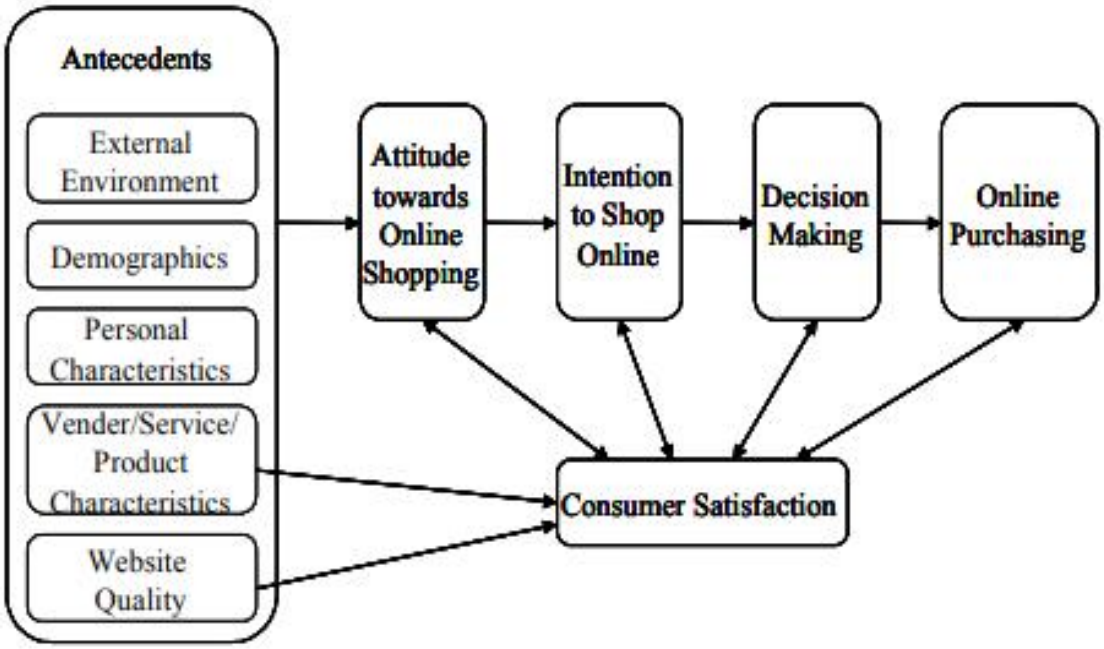
DISCUSSION

To fix this important issue, we have proposed a system that can predict the size of clothing one will need based on personal parameters (e.g., age, sex, height, weight) with an acceptable accuracy rate.

The system will offer interactive sizing tools that allow consumers to input their measurements and receive recommendations for the best size to order. These systems will use algorithms to recommend the best-fit size.

There are a number of issues creating this system. Size detecting for bodies is challenging and measurement devices may not work properly due to their accuracy. However, the system will

improve itself by taking further knowledge like height, weight, age, hip and midsection shapes, bra size, preferred garment fit, and favorite size for a definite company to improve accuracy of size recommendation because demographic factors affect our shopping affects.[1]



Researc

h Model of Consumers' Online Shopping Attitudes and Behavior

This article aims to synthesize the relevant existing literature on consumer attitudes toward and behaviors related to online shopping based on an analytical literature review. This study makes an effort to do so in order to paint a complete picture of the state of this subfield, identify its deficiencies, and suggest areas for further investigation. [2]

Possible Problems of the system

1. The measurement errors

As the proposed system will work on the data the customers provided about themselves. It is prone to measurement errors. These errors can occur due to using different measurement devices or people's inability to measure their size.

2. Reluctancy of Customer for giving away personal information

Customers feel invaded if asked to provide personal information about their body shape.

Market Analysis

Factors of Consumer Satisfaction

There are a number of factors that can affect consumer satisfaction when shopping for clothing online. Some of these factors include:

1. Fit: One of the most important factors for many consumers is whether the clothing fits well. Poor fit can lead to dissatisfaction, as consumers may need to go through the process of returning and reordering items until they find something that fits.

2. Quality: Consumers expect clothing to be of good quality and to hold up to wear and tear. If clothing is of poor quality or arrives damaged, it can lead to dissatisfaction.
3. Price: Price is often a factor in consumer satisfaction, as consumers want to feel that they are getting good value for their money. If clothing is overpriced or not of good value, it can lead to dissatisfaction.
4. Delivery: Consumers expect their orders to arrive in a timely manner, and any delays or issues with delivery can lead to dissatisfaction.
5. Returns and exchanges: The process of returning or exchanging items that don't fit or meet expectations should be easy and hassle-free. If the process is difficult or not customer-friendly, it can lead to dissatisfaction.
6. Customer service: If consumers have questions or issues with their orders, they expect to be able to easily contact customer service and receive helpful and timely assistance. Poor customer service can lead to dissatisfaction.

Overall, consumer satisfaction when shopping for clothing online is influenced by a combination of fit, quality, price, delivery, returns and exchanges, and customer service. By addressing these factors, businesses can improve the shopping experience for their customers and increase satisfaction.

E-commerce Return Rates by Industry

A quarter of all consumers return between 5% and 15% of the items they buy online. Ecommerce returns happen across all industries. More than a quarter of retailers have seen a rise in the number of online-purchased items being returned by a customer.

Choices	I return over 50% of what I buy online	I return between 30-50% of what I buy online	I return less than 30% of what I buy online	I return between 5-15% of what I buy online
Responses	7.92%	16.69%	18.11%	24.91%

Figure 3: Customers product return habits. Source: ReBOUND Returns Consumer Survey 2020

Automotive retailers are the most likely to have customers return an online purchase, followed by apparel retailers and home improvement and houseware brands. Shoppers that purchase an item using a credit card are more likely to return it, while those buying with a debit card are the least likely.

Return Rate by Retail Category

Retail Category	Blended Return Rate [1]
Apparel	12.2%
Auto Parts	19.4%
Beauty	4.3%
Department Stores	11.4%
Drug/Pharmacies	1.6%
Footwear	9.1%
Hard Goods	3.8%
Home Improvement	11.5%
Housewares	11.5%
Sporting Goods	7.6%
Survey Average [2] [3]	**10.6%**

Return Rate by Payment Type

Original Payment Type	Blended Return Rate [1]
Cash	12.69%
Credit Card	22.78%
Debit	7.04%
Other	13.90%

(1) Payment type rates derived from a 2019 analysis of 40,000 stores in the specialty and general merchandise retail segments. Appriss Retail reviews data direct from anonymous ecommerce and POS T-Logs—so all returns, exchanges, on-line returns, employee sale returns, and other refund scenarios are considered to build a blended return rate.

Basic Return Reasons

Our aim is to decrease returns for clothing since it is mostly used in Online shopping [3]. The reasons for return can be based on a variety of things:[4]

1. Incorrect size: One of the most common reasons for returning clothing is that it doesn't fit properly. This can be due to the sizing being off or the consumer ordering the wrong size.
2. Quality issues: Consumers may return clothing if it is of poor quality or arrives damaged. This can include issues such as holes, stains, or other defects.
3. Wrong item: Sometimes, the item that is received may not be the one that was ordered. This can be due to a mistake on the part of the business or a miscommunication between the consumer and the business.
4. Changed mind: Consumers may return clothing simply because they changed their mind or decided they didn't like the item once they received it.

Reducing returns can be beneficial for e-commerce businesses in several ways. It can help them save money by reducing the cost of processing returns, improve customer satisfaction by making the return process easier and more hassle-free, and improve their data analysis by identifying patterns and trends that may indicate issues with their products or shopping experience. Additionally, reducing returns can help businesses better manage their inventory and more accurately predict their stock needs. By focusing on improving the quality of their products, providing accurate sizing information, and streamlining the return process, e-commerce businesses can minimize the number of returns and improve customer satisfaction.

Competition

The area is highly populated with competitors. In this section, the competitors will be analyzed. One of the biggest names in this business is Kiwi sizing [5]. Kiwi Sizing offers size charts and custom size recommenders. The system works on e-commerce sites that are integrated with shopify.com.

Another competitor in business is “Fit Finder”[6] developed by a company named fitAnalytics. Their system uses a machine learning algorithm to measure how good clothing of a size will fit. [7]

ALTERNATIVE APPROACHES

An augmented reality system currently used by companies to visualize products on consumers’ bodies to show color, size and quality can be used to do the task. An augmented system will use users’ cameras to take a video and apply a filter that will make it look like that individual is wearing the product instead. The major drawback of this approach is that it requires a big amount of computation and memory.

We focus on more simple and effective ways to achieve customer satisfaction on Online Shopping.

FORMULATION

SOLUTION

As we explained in the analysis section, the problem we want to solve is the mismatch of clothing sizes, which leads to a high rate of returns (30%) for Turkish customers. This is a waste of time and money for companies. While shopping online in Turkey, the most common problem is the mismatch of clothing sizes. In this project, we focused on this problem and developed a solution - a system - to provide an easy interface and algorithm for people to easily shop online.

The second problem we focused on is the high rate of returns. In traditional commerce, the return

rate is 9%; in e-commerce, it is 30%. When analyzing e-commerce statistics from the past ten years, it is found that among the reasons for returns in online buying, 20% are due to delivery damage, 23% are due to delivery errors (size mismatch), 22% are due to product images that do not match expectations, and 35% of returns are due to people wanting new clothes or showing off on social media. [9]

When some people want to publish a new post on social media, they just buy a new piece of clothing and, after taking pictures, return it thanks to the free returning facilities of e-shopping companies, according to hurriyet.com.tr.
In order to fix this problem, we propose a system that can estimate how good clothing will fit a certain individual.
Let us explain how the system works; The system uses a matching algorithm to match the size of the customer's body to the size of the clothing, and we have introduced new terms to the return policy. In detail, a customer who bought clothing with a 90% size match will not be able to return the item. This will have a significant impact on the return rate. Additionally, this system will store the customer's information in a database for future purchases, so that customers do not have to enter their information repeatedly. There is a deviation rate, which refers to the deviation from the size match. This is calculated using an equation based on measurements.

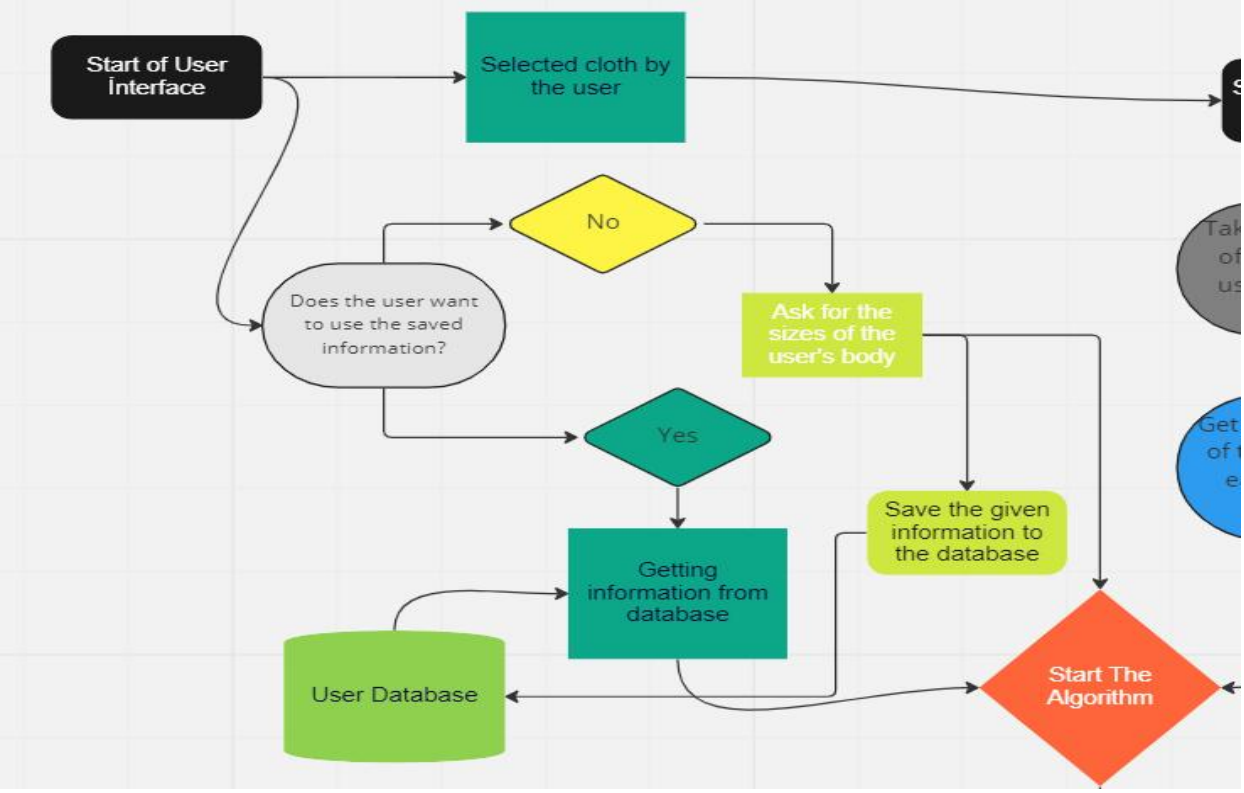
Here is the equation that we are using for the calculation;

$$\text{Deviation Rate}=\{((|User1 - Store1|)/\text{User1})x100+\ldots+((|User5 - Store5|)/\text{User5})x100\}/5$$

When people enter a wrong data to the algorithm, the equation will deflect and this

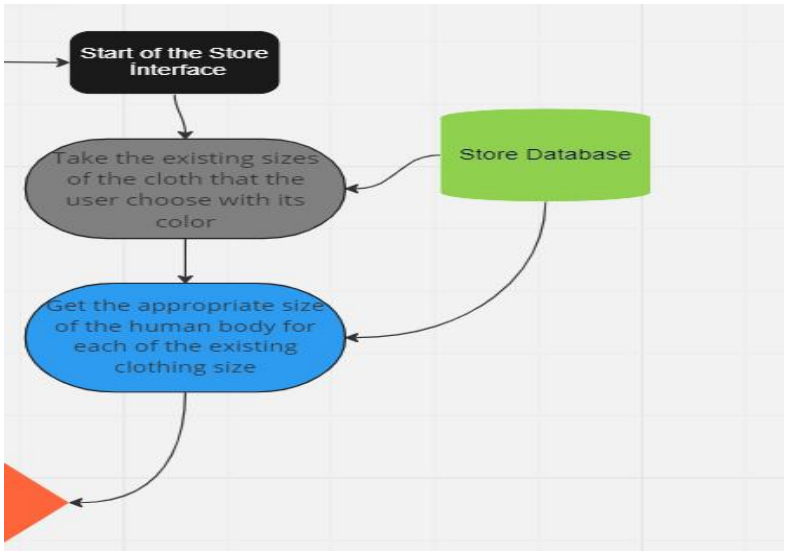
will affect the cloth. So, we determine a deviation rate so that the customer have are turning right when the cloth sent deflected because of the deflections in the
calculation.

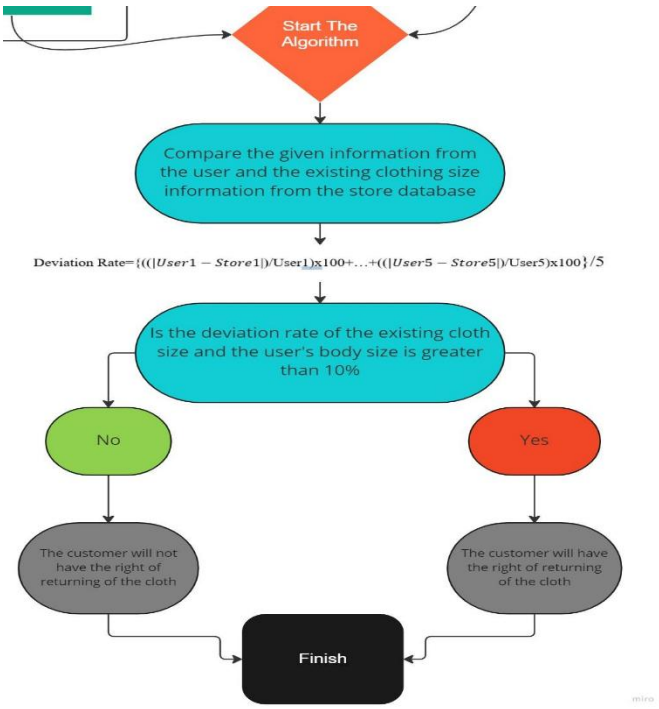
So, we have a flowchart to simplify and explain the system visually.



Here in this part of the flowchart the customer has two options. If he shops before, he will be able to use saved information and select this option ,or if he or she is using this system for the first time or if there are some changes with his or her body sizes, she or he will enter his body measurement (height, weight, shoulder size, bust size, waist size, hip size). Before every shopping activity, the algorithm asks the user to use the saved information in the database. So that, if the customer realizes a change with the size of the body, he or she will refuse using the saved information and entering new size information.
While operating with saved information, the algorithm will use a user database. This database include all the pre-measured information as explained before.
The all information that is collected by our system will be sent to the algorithm part to be processed. This process will be continuous. This is the store part of the flowchart.

When the store produces new clothes, they will enter the required size information for every body size and so that the algorithm can compare the size information from user and store. For example, when a store produces a T-shirt, they will enter the size information (height, weight, shoulder size, bust size, waist size, hip size). When a user chooses a T-shirt and the color of the T-shirt, the algorithm will run and compare the sizes.





Here, this system compares two pieces of information: one from the user and the other from the store database. The algorithm then calculates a deviation rate. To clarify, the deviation rate is a rate calculated using the arithmetic average of the difference between body size and clothing size. After this process, we determined a limit of 10% for the deviation rate. If the deviation rate is greater than 10%, the customer has the right to return the clothing. However, if the rate is less than 10%, the customer loses the right to return the item. After implementing these terms, the return rate drops significantly. Both the customer and the store will benefit from this application.

For example, suppose a person named Can wants to buy a T-shirt. After he enters the application, the application will ask for the size information if he has no information in the database and when Can enter the size information, the application will save this information to the database.

Otherwise, the application asks if Can wants to use the saved information or if he needs to enter new information due to possible changes in his body (gaining or losing weight). Now, let's assume that Can has saved information for height=180 cm, weight=78 kg, shoulder size=110 cm, bust size=95 cm, waist size=78 cm, and hip size=90 cm. When he runs the application, the application asks if he wants to enter new information, and he realizes that he has gained weight and decides to enter new information.
The user enters their height (180 cm), weight (82 kg), shoulder size (112 cm), bust size (95 cm), waist size (82 cm), and hip size (93 cm) after measuring themselves. On the other side of the system, the store has four different sizes of clothing available: S, M, L, and XL (it is assumed to be only four sizes for the purpose of this example, as there are often many sizes available in real life). For size S, the following measurements are given: height (176 cm), weight (76 kg), shoulder size (102 cm), bust size (86 cm), waist size (76 cm), and hip size (91 cm). For size M: height (180 cm), weight (84 kg), shoulder size (112 cm), bust size (95 cm), waist size (82 cm), and hip size (93 cm). For size L: height (184 cm), weight (87 kg), shoulder size (116 cm), bust size (100 cm), waist size (86 cm), and hip size (100 cm). For size XL: height (188 cm), weight (93 kg), shoulder size (122 cm), bust size (105 cm),

waist size (91 cm), and hip size (105 cm). Now, the deviation rate for each size will be calculated for Can's size information according to the formula.

- For the S size: (|180-176|/180) x100 + (|82-76|/82) x100 + (|112-102|/112) x100 + (|95-86|/95) x100 + (|82-76|/82) x100 + (|93-91|/93) x100 = 6.23%
- For the M size: (|180-181|/180) x100 + (|82-84|/82) x100 + (|112-112|/112) x100 + (|95-95|/95) x100 + (|82-82|/82) x100 + (|93-93|/93) x100 = 0.499%
- For the L size: (|180-184|/180) x100 + (|82-87|/82) x100 + (|112-116|/112) x100 + (|95-100|/95) x100 + (|82-86|/82) x100 + (|93-100|/93) x100 = 4.926%
- For the XL size: (|180-188|/180) x100 + (|82-93|/82) x100 + (|112-122|/112) x100 + (|95-105|/95) x100 + (|82-91|/82) x100 + (|93-105|/93) x100 = 10.198%

According to the measurements, the algorithm will prefer the medium sized T-shirt because the smallest deviation rate calculated for medium one, but if there is no medium size of the clothes in the stock and Can wants to buy the cloth for some reasons, algorithm will prefer L size and if the L size is finished then the algorithm will prefer the S size with the right of return but if the S size is finished too, and Can wants to buy the XL size, he can't return the cloth because the deviation rate of the XL size is higher than 10%. This restriction exists in order to reduce the numbers of returns. The deviation rate proportion may be decrease to around 5% for higher accuracy

IMPLEMENTATION

The environment-based approach to testing lets teams test their applications in a real-world environment.
A test environment is a software and hardware configuration that allows test teams to operate test cases. In other words, it lets test implementations with configured hardware, software and network.
The list of activities by test environment management function includes:

1. Maintenance of a central repository with all updated versions of test environments.
2. Test environment management according to the demands of the test team.
3. According to new requirements creating new environments
4. Monitoring of environments
5. Update/delete old test environments
6. Investigating environmental problems
7. Coordination down to problem resolution.

Testing is necessary for developers to provide a quality end product. It prevents errors while making sure everything is working as it should.

SOFTWARE DEVELOPMENT ENVIRONMENTS

Test environment supports test execution with hardware, software and configured network.
Test Bed provides you have enough data set up before you start the testing.

It also ensures that the team is aware of the kind of data required as well as if the data needs to be provided by other teams.
In the study, we first took the height and weight data as input. During the bed testing phase, it was understood that this would cause major problems in determining body measurements. In addition to these data, shoulder size, chest size, waist size, hip size were added. With this data, the error rate decreased.
Software Development Environments:

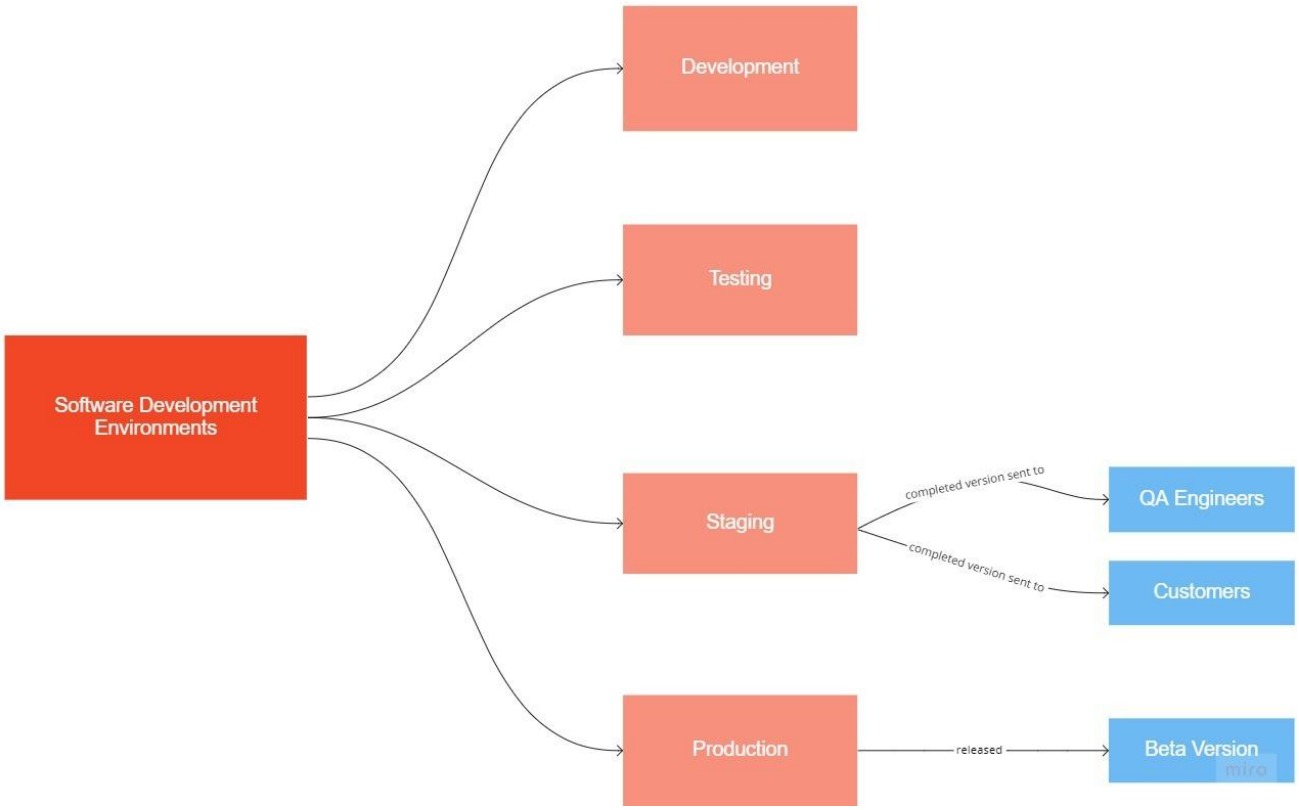


Figure: Sections of Software Development Environments [10]

There are four types of software development environments:

- Development
- Testing
- Staging
- Production

Development	➢ It is used by Dev Teams to develop new features and make change requests.
	➢ No client data
Testing	➢ It is used by QA engineers to test different software versions and features.

	➢ No client data.
Staging	➢ It is used by QA engineers and/or clients for UAT based on production size data sets.
	➢ Limited production data.
Production	➢ It is used by clients (live). Hosted in cloud infrastructures or data center servers.
	➢ Full production data.

Table: Types of Software Development Environments

Development

It is used to develop new features and make changes. It is the main branch of a software application. At this stage, code writing has begun. [11]

Testing

It is used by engineers to test different software versions, features. Following are the key areas of setting up the testing environment:

- Test Data
- Database Server
- Browser
- System & applications
- Network
- Hardware that includes Server Operating System

Staging

It is used for the software build process before it is migrated to the production environment.

The software that was deemed correct during the testing phase was further tested, and a few suitable options were selected. The completed version was then sent to engineers and customers before the product was released. Sample clothing items were added to this temporary application. Customers can enter their body measurement information in the app, choose an outfit, and receive a recommendation for an outfit based on their appropriate body size. This is just an application to test whether the application is functioning correctly.

Production

It is a production environment where new updates or builds are moved to production for end users. The most appropriate software and application form selected and accepted in the staging environment is made into a beta version and released. Beta version means an application prepared for beta testing to try out the experimental features of the application before it is released. Users can

download and try it as if it is a real application, thanks to the feedback about the deficiencies, the program is developed from this stage and finalized.

Testing Environment
An environment where you can test any modification or correct errors before pushing them to the final version.
It is considered best practice to have multiple test environments.
A development environment is a testing environment, most likely a whiteboard for developers to make modifications and unit test the code.
The test environment is focused on testing individual components.
Staging Environment
The staging environment is also considered a test environment. It is booked for QA or software testers.
It is also considered a copy of the production environment. It hosts a live version of an application.
The staging environment focuses on testing the entire application.

Table: Differences between Testing Environment and Staging Environment

Untested software cannot be released, even for beta testing purposes. Testing such as unit, integration, performance and load testing should be performed in an environment that imitates real user conditions.

- A test environment provides exact feedback on the quality and behavior of the application under test.
- A test environment helps developers by providing a special environment for them to isolate code and confirm the behavior of an application.
- The test environment allows QA's to determine errors, incompatibilities and other issues. Once errors are identified, testers and developers can easily modify data without affecting real users.
- Finally, a test environment acts as a complete copy of the production environment and ensures that the test results are assured.

REFERENCES

1. Online Shopping Behavior : Demographics' Influence on Online Travel Article in Indian Journal of Marketing · June 2017 from https://www.researchgate.net/publication/318262610_Online_Shopping_Behavior_Demographics'_Influence_on_Online_Travel
2. Zhang, Ping and Li, Na.(2002, August). Consumer Online Shopping Attitudes and Behavior: An Assessment of Research. Paper presented at Americas Conference on Information Systems, Dallas. Retrieved from https://www.researchgate.net/publication/2557074_Consumer_Online_Shopping_Attitudes_and_Behavior_An_Assessment_of_Research
3. https://www.statista.com/forecasts/997235/returns-of-online-purchases-by-category-in-the-us
4. https://www.shopify.com/enterprise/ecommerce-returns
5. https://kiwisizing.com/
6. https://www.fitanalytics.com/fit-finder
7. https://www.vox.com/2019/10/17/20898585/sizing-fit-prediction-clothing-bodyscan-made-to-order
8. https://www.kigili.com/bedenini-bul/
9. https://www.linkedin.com/pulse/online-al%C4%B1%C5%9Fveri%C5%9Fte-iade-oranlar%C4%B1-firmalara-ciddi-maliyet-y%C3%BCz%C3%BCak/?originalSubdomain=tr
10. https://miro.com/app/board/uXjVP4xsn-c=/
11. https://www.softwaretestingmaterial.com/test-environment/#types-of-software-development-environments