Designing an Online Bidding System for Custom Made T-shirts in Sri Lanka

A dissertation submitted for the Degree of Master of Information Technology

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Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute to the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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This is to certify that this thesis is based on the work of Mr. Jayasinghe M.R. under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

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Abstract

Custom t-shirts market in Sri Lanka does not currently offer an option in the nature of an online marketplace. Individual companies have different offerings and a customer may have to contact vendors separately. This leads to many issues including the inability to compare product and service standards. On the other hand, vendors face great difficulties in finalizing product specifications from customers in order to do costing for the job that eventually leads to wastage in time and effort. This could make the whole process unpleasant for both customers and vendors. As such it was identified that proposing a bidding system where customers and vendors can meet could make win-win situations for both customers and vendors. Accordingly, the vendors would be able to receive finalized specifications required for costing from the customer in one go and at the same time customers would be able to receive quotations from different vendors without a need to contact them individually. Initial information analysis about custom t-shirt manufacturing was done through consulting www.t-shirts.lk, which is a leading entity in custom t-shirt industry in Sri Lanka. It was identified that the over 70% of enquiries received at t-shirts.lk do not get converted into orders, yet the requirement gets fulfilled from elsewhere. Maintaining standardization on custom made t-shirt specifications, encouraging free float of market pricing, assisting customers to find reliable vendors, assisting vendors to reduce difficulties in identifying the finalized product specification required by the customers, encouraging professionalism in the industry through increased service standards were identified as objectives of developing the developing the system. Among other features, the system includes adding of customers, vendors, collar types & fabric types by admin; viewing and adding orders by customers; viewing and bidding for orders by vendors, along with features to obtain valuable reports. Through the bidding system t-shirts.lk could expect income receiving from the online bidding platform from suppliers. The suppliers could be given a monthly/ annual subscription fee to remain in the bidding system. The implementation was done using a number of technologies including Laravel PHP Framework, MySql database Management system, Localhost (XAMP Server) On Windows for the server side, and with CSS, JavaScript, HTML 5 for the client side. The system has been tested through several testing methods namely systems testing, usability testing and user acceptance testing.

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Chapter 1: Introduction

Despite being a tangible product, t-shirts are fast becoming a product that could be sold online, world over. Tshirts could be categorized as readymade t-shirts and custom made t-shirts. Readymade t-shirts contain vendor determined specifications while custom-made t-shirts contain customer determined specifications. Readymade t-shirts are usually possible to be purchased individually if required, while custom-made t-shirts are usually produced in bulk concerning economies of scale in production.

According to [1], in the US Market, online original design t-shirt sales hit 262 million USD in 2015 with the major players namely CafePress Inc., CustomInk LLC, Spreadshirt Inc and Threadless making an estimated 65.8% of industry revenue. It's understood that the industry will further grow with the increasing number of broadband internet connections that creates an increasing number of potential customers.

Even in the Sri Lankan context, there is a rapid development in the IT infrastructure and the Internet penetration. This scenario could positively affect the e-commerce industry in Sri Lanka as a whole as well as online custom made t-shirt industry in specific.

As per [2], the government Sri Lanka's attempt was to increase the internet penetration rate of Sri Lanka from 21.8% in 2016 to 50%. According to [3], Sri Lanka's Internet and email subscriber base including mobile broadband services has been increased 23.6 percent to 3.6 million at the end of the first quarter of 2015 compared to the same period in 2014. It is expected that with the development of the Google Loon project in Sri Lanka that, if become successful, could offer Internet access to the whole country amidst geographical obstacles. Meanwhile, [3] indicates that the number of mobile phones in use at the end of the first quarter of 2015 hit 22.7 million, a 6.2 percent or 1.35 million increase, compared to the same period in 2014. It is further stated in [3] that Sri Lanka's telephone density became 121.2 percent compared to 116 percent in 2014.

As per [4], In 2015, at least one computer is available in 25% of households in the country. That is one out of every four households owns either a desktop or a laptop computer. Overall Computer Literacy reported in 1st half of 2015 for Sri Lanka is 26.8%. The survey results show an increase of 1.7 percentage points from 2014 (1st half) to 2015 (1st half). Computer literacy among the employed population who are aware of computer in Sri Lanka is around 52.7 % in 1 st half of 2015 and the positions such as Senior officials and Managers (71.3%), Professionals (85.0%), Technical and Associate professionals (84.0%) and Clerks and Clerical support workers (88.2%) have higher computer literacy. However, even among the individuals engage in elementary occupations twenty-two percent are computer literate.

Resultant to increased internet penetration, it is observed that the e-commerce in Sri Lanka would gain progress. Being in line with the global trends, Sri Lanka also experiences a growth in the online t-shirt market. There are already more than 10 established names in the custom made t-shirt industry offering end to end solutions for customers compared to a mere 1 or 2 players a couple of years back.

1.1 The Problem

Custom t-shirt production encompasses a multitude of actions from concept development, design development with multiple versions, price comparison by contacting suppliers for multiple versions of the design, determining the product specifications including fabric types, collar types, packaging methods, delivery methods, size charts, size breakdowns and etc. Once is fixed then the production process takes place where some of the steps in the production process being raw material sourcing, building pattern boards, cutting fabric into panels using pattern boards, branding artwork development and printing on cut panels, assembling the cut panels to finish the final garment, trimming, pressing, packing and delivery. In a custom requirement the from the vendors' viewpoint, customization takes place for each and every order and it becomes a daunting task to develop & finalize different product specifications to each and every customer unlike when handling a retail product which has got predefined specifications and would have repeated batch production throughout the year. Vendors have lost focus on the production process as they get busy with liaising with customers in getting product specifications finalized. Most of the customers lack knowledge in production specific parameters and thus would need additional support and time from vendors in adjusting their idea in mind into a production viable production specification. Guiding the customer to the finalized specifications with a minimum amount revision has given vendors an extra burden. A single mistake done in the product specifications received through manual means could lead a huge loss as a production cannot be reversed at the same time a customized product produced in bulk to match with a given customer's branding cannot be utilized

On the other hand, from the point of view of a customer, despite there is a multitude of online vendors in Sri Lanka for the production of custom-made t-shirts, it has become a daunting task for customers to find a fair balance between pricing vs product/service quality, making "value for money", a concept far from reality. There is hardly any standardization over product/service quality, than a bunch of online vendors competing on a particular job mostly based on pricing alone while compromising on other factors. Given the ambiguity in understanding the product & service quality of the tangible product otherwise have been sold offline, customers face

mobility issues in approaching all online vendors individually before placing an order to verify the matter of value for money.

Further, the reliability of an online vendor with regard to the promised vs the actual product/ service levels along with the timelines has been a problematic, discouraging customers to purchase custom t-shirts online according to [1].

In contrary to the customer's viewpoint, from a supply perspective, there is still a considerable number of reputed vendors who have no or least online presence thus failing to seize opportunities in the online market. Gaining access to business leads raised through the internet has become problematic to such vendors.

This situation has eventually caused the online custom made t-shirt industry to receive adverse feedback from the online community hindering the growth of the industry.

1.2 Motivation for the project

The main motivation for the completion of the project is to successfully complete the requirement of the "individual project" to gain the qualification, Master of Information Technology (MIT).

Involvement in this project would result in improving the author's knowledge, coding skills, as well as project writing skills.

Additionally, if the proposed system is in place, the author can suggest a new means for income generation for t-shirts.lk that is through operating an online marketplace, in addition to its current income generation method of direct production of t-shirts.

1.3 Objectives of the project

This system will be developed for Lesova Holdings (Pvt) Ltd (for future potential use) where the researcher is employed at. Lesova Holdings (Pvt) Ltd currently operates www.t-shirts.lk, which is one of Sri Lanka's leading online vendors for custom t-shirt production. The researcher's idea is to convert the MIT project into a commercially viable system at a later stage, with further enhancements surpassing the existing project scope. As such the author is responsible for achieving the following objectives upon completion of the project.

- To create an online marketplace to maintain standardization on custom made t-shirt specifications
- To create an online bidding system where free float of the market pricing is encouraged.

In this bidding system, different vendors can bid for a given customer requirement with pricing details and other information, where the selection of a particular vendor would be at customer's discretion.

- To reduce the difficulties faced by customers in identifying the right vendor for their specific requirement
- To reduce the difficulties faced by vendors in identifying the actual requirement of the customer by means of systematic recording of job specifications
- To encourage professionalism in the industry through increased service standards

1.4 List of deliverables

The following deliverables were expected upon completion of the bidding system.

- To create an online bidding system where customers and vendors can meet
- To provide means for customers to log in and create the job requirement
- To provide means for vendors to login in and bid for job requirements
- To provide means for the customers to evaluate and select a vendor based on the bidding information provided by the vendor

1.5 Scope of the project

The scope of the completed project is as follows.

- The identified features of supplier management, customer management, order posting module and bidding module have been addressed within the project scope.
- For the customers, the system includes login, ability to post jobs, ability to pick a preferred vendor.
- For vendors, the system includes login and ability to bid on jobs posted by customers.
- The platform is limited to cater to custom-made bulk t-shirt requirements.
- Commercial implementation has not been made within the project scope, as such subscription plans module has not been considered.

1.6 Outline of the chapters

The dissertation offers overall clarification about the online bidding system. Outline of the chapters is shown below.

Chapter 2- Analysis

This chapter includes information gathering techniques, explanation of the current system, analysis of similar systems along with non-functional requirements and methodologies.

Chapter 3- Design

This chapter indicates the methodology used for the developed system, modeling the system with various diagrams along with interface designs.

Chapter 4 – Implementation

This chapter includes hardware & software requirements, tools, and technologies used, as well as existing codes.

Chapter 5- Testing and evaluation

This chapter describes the testing techniques, test plans, system as well as client evaluation.

Chapter 6 – Conclusion

This chapter describes the experiences gained through the project along with areas for future recommendations.

Chapter 2: Analysis

2.1 Fact-finding techniques

Fact-finding techniques are instrumental in gathering information about an existing system as well as to identify stakeholder requirements. Wrong fact-finding attempts would result in a different system from the intended system.

2.1.1 Interviews

Interviews are considered a good technique to be conducted individually or as a group in order to gather information through face to face interaction. The interviews were conducted with the Director and the staff.

2.1.2 Record gathering

Records regarding the current system were collected with the view of receiving a better understanding of the existing business model that would assist when designing the interfaces and database structure.

Records collected:

- Order form
- Emails communicated with clients
- Prototypes
- Size charts
- Quotations
- Invoices

2.1.3 Observation

The current business process was observed in order to improve the knowledge of the researcher as well as to gather more information which could assist in building the new system.

2.2 Description of current t-shirts.lk process

The exiting process could be listed as follows.

- Customer enquiry received through email, phone, visit
- Including customer and enquiry details to the CRM (Freshdesk). Freshdesk creates a ticket number to uniquely identify a customer enquiry.
- Developing customer requested computer aided prototype with costing given through quotations for each version and communicating with the customer through email
- Accepting customer order confirmation from the customer with the approval for the finalized artwork, size breakdown as per t-shirts.lk size chart and a copy of the payment slip made to the bank to arrive through email
- Raw material is purchased
- Production is made
- Delivery arranged through courier services across the country

It was observed that more than 70% of the enquiries received do not become orders. Hence, a new platform is proposed for t-shirts.lk where they can work with similar vendors and customers alike.

2.3 Existing bidding platforms

Several international and local platforms inspired the proposed system.
They are namely, www.bidpress.com, www.freelancer.com, www.cafepress.com, and www.print2digital.com.

2.3.1 Introduction to Bidpress.com

Bidpress is a platform that lets customers design custom t-shirts and other apparels and get quotes in real time from top printers in the United States. Through bidpress.com a customer can select a particular garment from an array of products and then customize same. Once customized, the customer can post the job so that he can pick a printer in the U.S based on pricing, delivery time and rating. Once the order is placed with a particular printer, then the customer can receive goods through courier. According to [5] Bidpress attempts to disrupt a $9+ billion industry known for the lack of retail innovation, with more than 85% of orders placed offline along with an online industry dominated by a few large players who would charge

high prices. In addition, Bidpress is geared to save up to 35%, unlike online and offline shops, since printers in their network claim to have extra capacity and are focused on printing at low margins in order to minimize operational idling. A use case diagram for the bidpress.com is shown below as figure 2.1.

Figure 2. 1: Use case diagram for bidpress.com

2.3.2 Introduction to Freelancer.com

Freelancer is a considered a global crowdsourcing marketplace that enables potential employers to post that freelancers could bid to complete. Freelancer.com takes a percentage of the fee charged by the freelancer for a particular job, which can be reduced with paid monthly membership.

The employers can post a project free of charge & invite freelancers to submit bids or browse relevant freelancers in order to make an offer. Chatting with freelancers in real time, comparing proposals and selecting the best alternative and awarding the job is possible with

freelancer.com. Payments can be made upon reaching of the set milestones. The website provides the safety option: GeoTrust 128-bit SSL encryption for transactions. Further, the website has 24/7 customer support. Figure 2.2 indicates the use case diagram for freelancer.com.

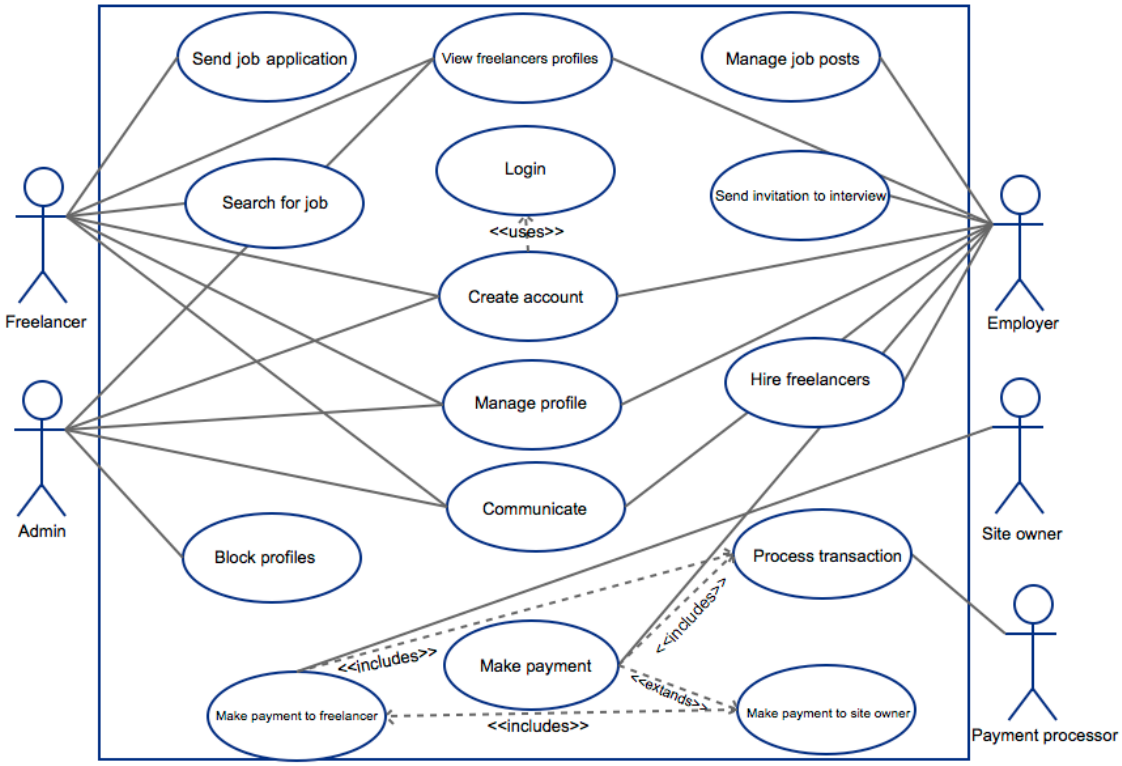

Figure 2. 2: Use case diagram for freelancer.com

Source: [6]

2.3.3 Introduction to Cafepress.com

CafePress.com is an online marketplace offering sellers complete e-commerce services, to independently create and sell a variety of products. On the other hand, the website offers buyers with unique merchandise across various topics. CafePress.com encourages individuals and organizations to create, buy and sell customized merchandise online through the use of print-on-demand and e-commerce services.

2.3.4 Introduction to Print2digital.com

This is a Sri Lankan based design platform where shoppers can select & customize from an array of products, make an online payment and get merchandise delivered to the doorstep.

2.3.5 System comparison matrix

Table 2.1 is a comparison made regarding the functionalities of the currently available systems discussed above.

function/ feature	bidpress.com	Freelancer.com	Cafepress.com	Print2digital.com
Supplier management	Yes	Yes	Yes	No
Customer management	Yes	Yes	Yes	Yes
Subscription plans	Yes	Yes	Yes	No
Order posting module	Yes	Yes	Yes	Yes
Bidding module	Yes	yes	No	No
Communication module	Yes	Yes	Yes	Yes

Table 2. 1 System Comparison Matrix

2.4 Functional requirements

Types of orders are divided into two sections as catalog orders and custom orders. Catalog orders are the type of orders for which the customer has used a t-shirt pattern number and a collar type from the system. Custom orders are the type of orders where the customer would submit all details about a t-shirt without the use of a catalog.

An order (catalog/ custom) submitted by the customer is seen to the admin under "pending" status. If the admin approves the order then it gets the status as “approved” and if the admin rejects the order then it gets the status as “rejected”. A brief listing of the functionalities under each login is shown below.

Admin Login:

The user admin can view and add any kind of a t-shirt or a collar pattern with the requirements submitted by the customers and the name and an image of the pattern can be placed to view by the customers and the suppliers.

- Users – Adding, editing and deleting admin users, customers and suppliers is possible.

- Collar types and t-shirt patterns - Adding, editing and deleting collar types and t-shirt patterns is possible.
- Orders - Viewing, editing, approving or deleting collar types and t-shirt patterns is possible.

Customer login:

The interface for the customer is quite different and user-friendly. Thus the customer can view the system as follows.

- Profile: The customer can view and edit the profile.
- My orders: All orders (custom, catalog) gets displayed with the summarized information.
- Create new order: A catalog or a custom order can be created based on the requirement of the customer.

Supplier login:

Here the suppliers can view both catalog and custom orders received and they can place their bids accordingly.

2.5 Non-functional requirements

Non-functional requirements expected from the system have been listed below.

2.5.1 Usability

Usability is considered the degree to which a software can be used to achieve quantified objectives with effectiveness, efficiency, and satisfaction in a quantified context of use.

- The system should be easy to use by all stakeholders.
- The system must be quickly accessible by all stakeholders whenever needed.
- The system should provide a simple as well as a user-friendly interface along with easy navigation methods to access needed information.

2.5.2 Performance

The amount of work accomplished by the system is listed below.

- All the functions should be available to the user every time the system is turned on
- Key features should be easily accessible in the design layout to ensure fast access and

thereby improve performance.

2.5.3 Reliability

- The system should offer seamless job posting capability with accurate specifications enabling suppliers to do accurate costing.
- The system should notify display bids received from suppliers in a clutter free manner.

2.5.4 Security requirements

- Different access logins should be available for the administrator, supplier, and customer.

2.6 Methodology

System development methodology is considered a framework for planning, structuring and controlling the process of developing an information system. As such, choosing the best matching methodology from different alternatives is an imperative task. Hence, there were several methodologies considered for system development.

2.6.1 Agile methodology over structured methodology for development life cycle

The systems development life cycle (SDLC) is considered a conceptual model that is used in project management that could illustrate the phases involved in developing an information system project, commencing from an initial feasibility study through maintenance of the developed system. It was decided not to proceed with this methodology to manage the life cycle of the system due to unfamiliar technology, unclear user requirement as well as available short time schedule when working only part-time in learning the technology and working on the system. Instead, it was decided to use the agile lifecycle approach have been considered given the limited timeline & cost as well as unclear user requirements.

2.6.2 Object-oriented methodology for coding

As the methodology to develop the code for the system, Object Oriented Methodology has been considered. This methodology offers a modular wise system development is considered under this methodology. Object-oriented approach combines data and processes into single entities called objects. This method has been utilized in developing the system as it makes the process easy by allowing reuse of components in coding.

Chapter 3: Design

3.1 Design overview

This chapter contains the level 0 use case diagram of the proposed system, activity diagram for placing an order, level 1 use case diagram for supplier registration and level 1 use case diagram for order placement.

3.2 Alternative methods

3.2.1 Manual methods

Order details, customer, supplier and pricing details could be maintained in files. These files could be properly labeled for easy reference. Updating order details can be done through a simple document/ spreadsheet format. This method could be simple when the operation is small. When the operation gets complicated, higher amounts of human error, higher need for labour and higher need for micromanagement become unavoidable.

3.2.2 Standalone system

This type of a system could be introduced with the aim of computerizing the manual processes. Thus, all collected data is stored in a data database with easy access enabled along with the ability to generate various kinds of reports. However, such a system would not be able to withstand power failures or system failures.

3.2.3 Web-based bidding system

The proposed system was developed in order to ensure a computerized system with online access. It is a web-based system that facilitates the administrator/ customers and suppliers to log in from anywhere anytime. It also offers user-friendly interface and many other features. Thus the system facilitates a convenient service to all stakeholders with real-time information.

3.3 Use case diagrams for the proposed system

This chapter contains the level 0 use case diagram of the proposed system, activity diagram for placing an order, level 1 use case diagram for supplier registration and level 1 use case diagram for order placement.

3.3.1 Level 0 use case diagram of the proposed system

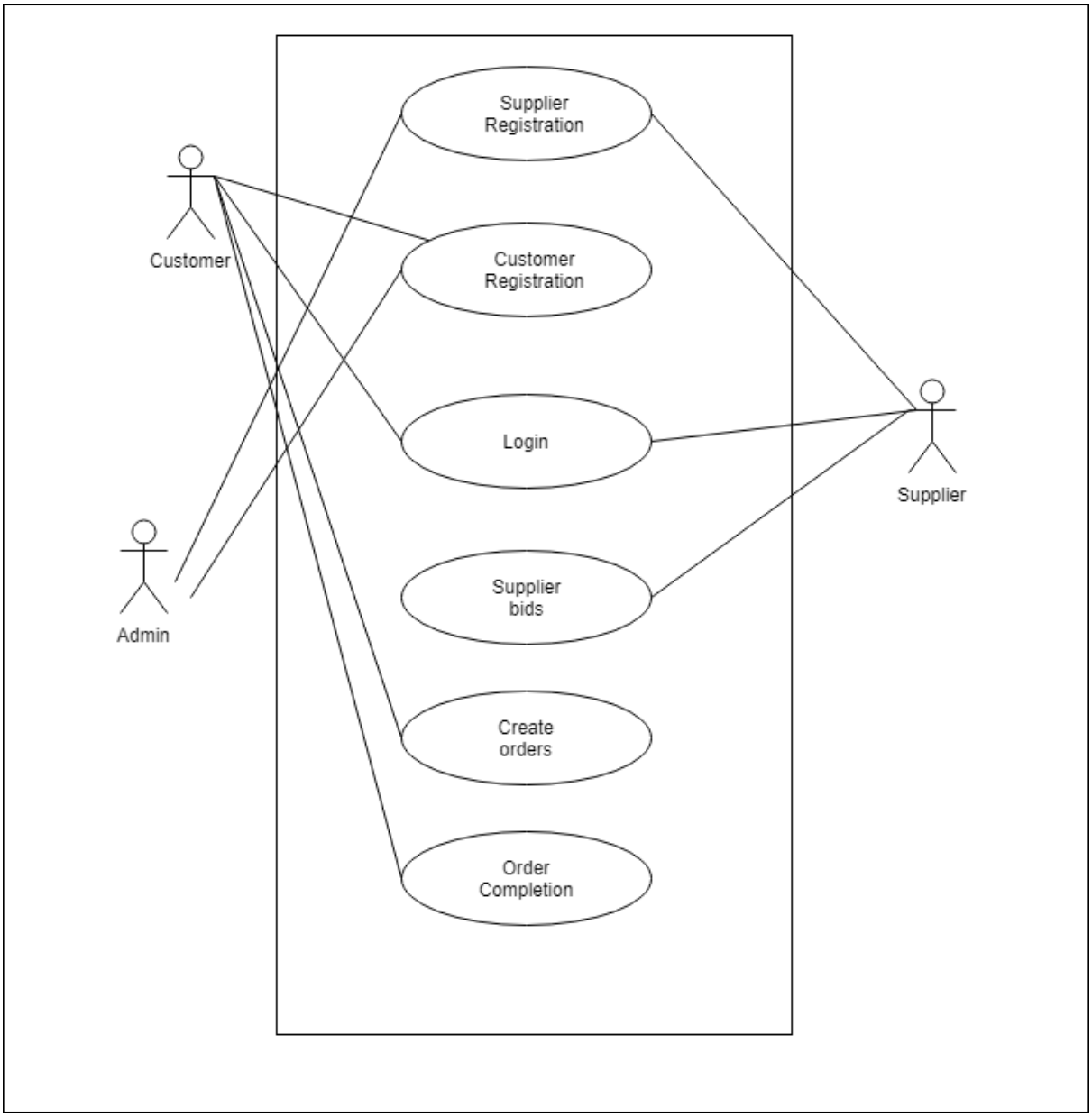

Figure 3. 1: Level 0 use case diagram of the proposed system

Figure 3.1 illustrates the options available in the proposed system. Customers and suppliers can register themselves in the system without the assistance of the admin. Once registered the suppliers and clients can login to the system by using their respective logins. When a customer posts an order, the admin vets the requirement for comprehensiveness and if satisfactory then approves same. Then the suppliers send the bid and the customer selects one supplier based on his/her preference. Then the selected supplier and the customer work together offline to complete the order.

3.3.2 Level 1 use case diagram for supplier registration

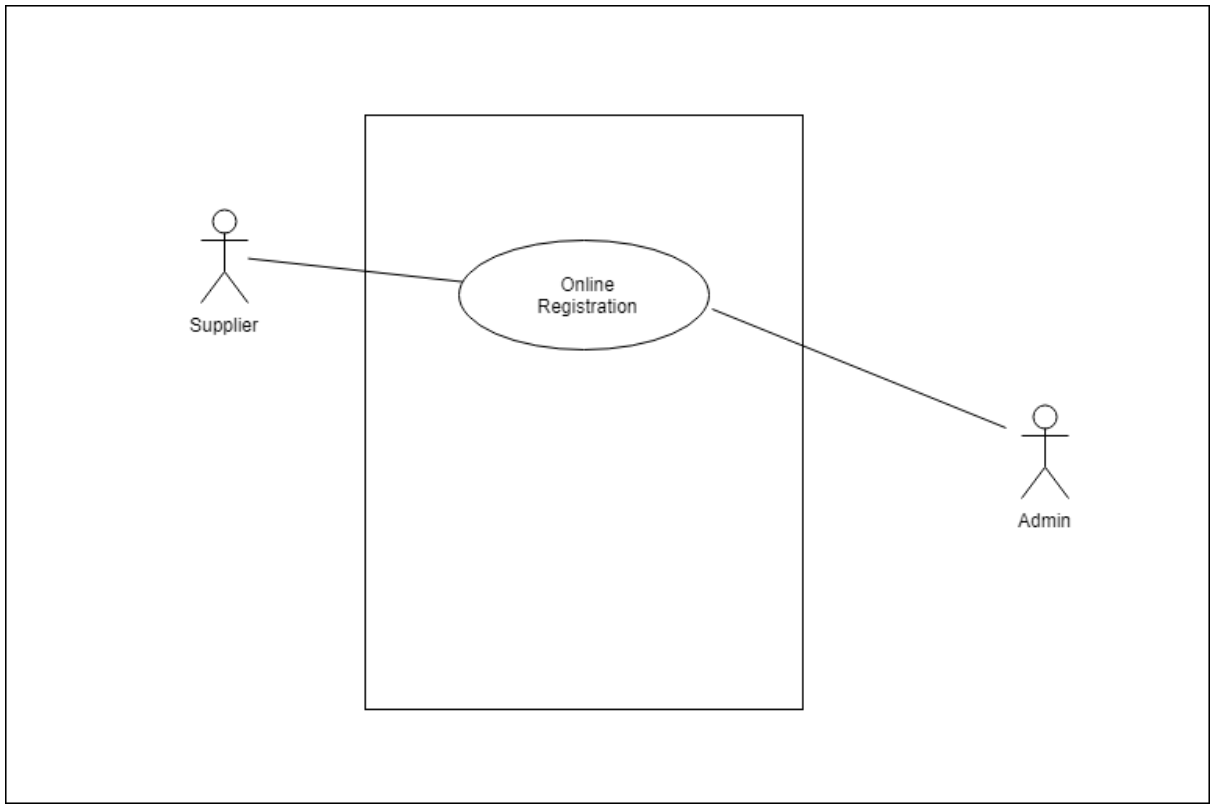

Figure 3. 2: Level 1 use case diagram for supplier registration

According to figure 3.2, the supplier gets himself registered in the system. Then the supplier can log into the system.

3.3.3 Level 1 use case diagram for order placement

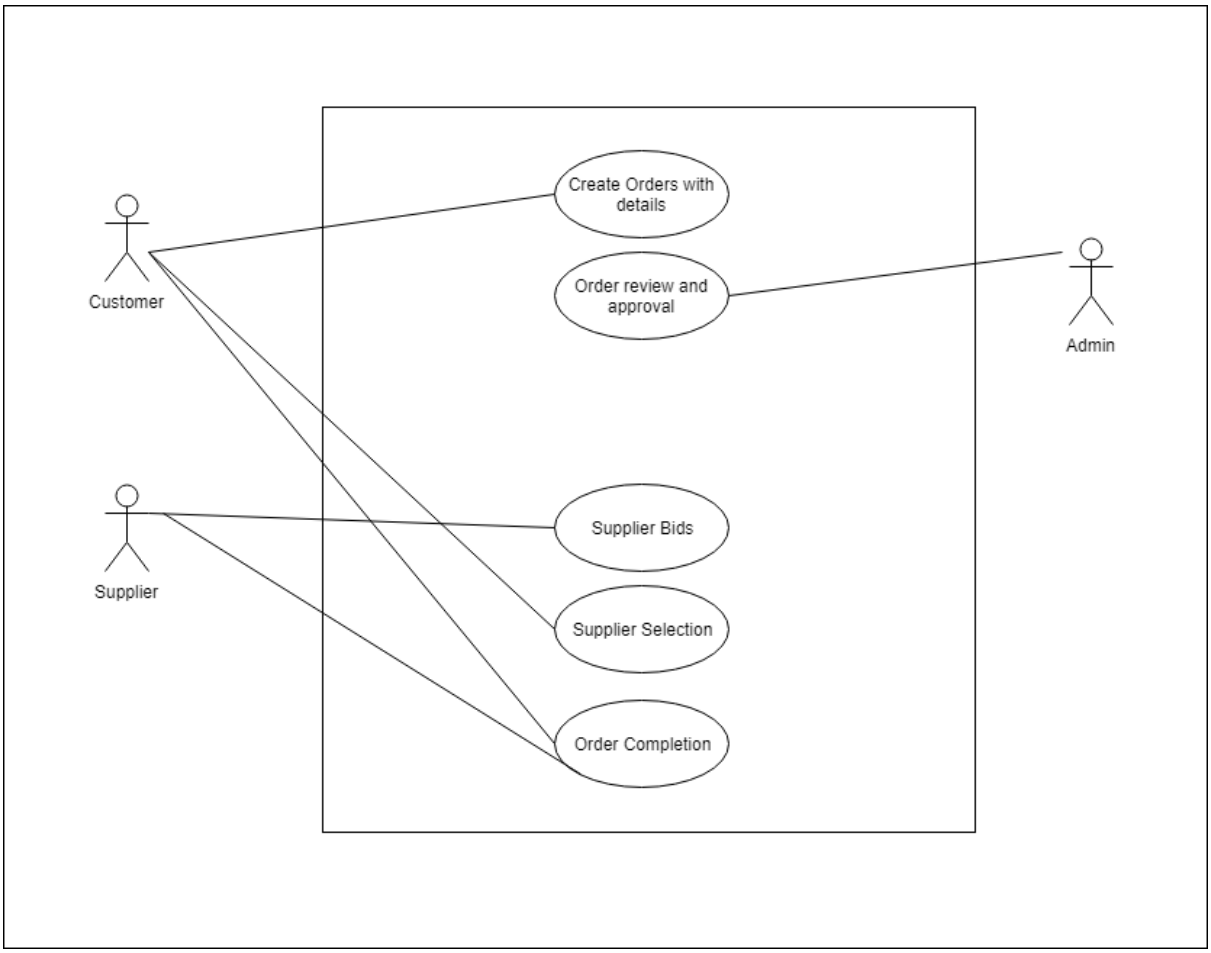

Figure 3. 3: Level 1 use case diagram for order placement

Figure 3.3 indicates the Use Case diagram for placing an order.

3.4 Use case descriptions

3.4.1 Use case description for supplier registration

Use Case Name	Supplier registration
Actor	Supplier
Overview	Supplier getting registered with the system by making a payment, selling products to the customers
Normal supplier registration events	Sending the quotation, sending the purchase order, acceptance of payment, delivering the product

Alternative supplier registration events	Searching for new products, requesting information regarding alternative products
Preconditions	
Postconditions	Selling products

Table 3. 1 Use case description for supplier registration

3.4.2 Use case description for online order placing

Use Case Name	Online order placing
Actor	Customer
Overview	Customer to pick a supplier for the posted job
Normal ordering events	Finalizing the specification, request quotation, ordering products, adding products, updating products
Alternative ordering events	Search for new products, requesting alternative product details
Preconditions	Product information must be in place, supplier information must be in place
Postconditions	Purchase products

Table 3. 2 Use case description for online order placing

Table 3.1 and Table 3.2 indicate the use case description for supplier registration and use case description for online order placement respectively.

3.5 Activity diagram for customer order creation

Figure 3.4 illustrates how the customer orders have been created.

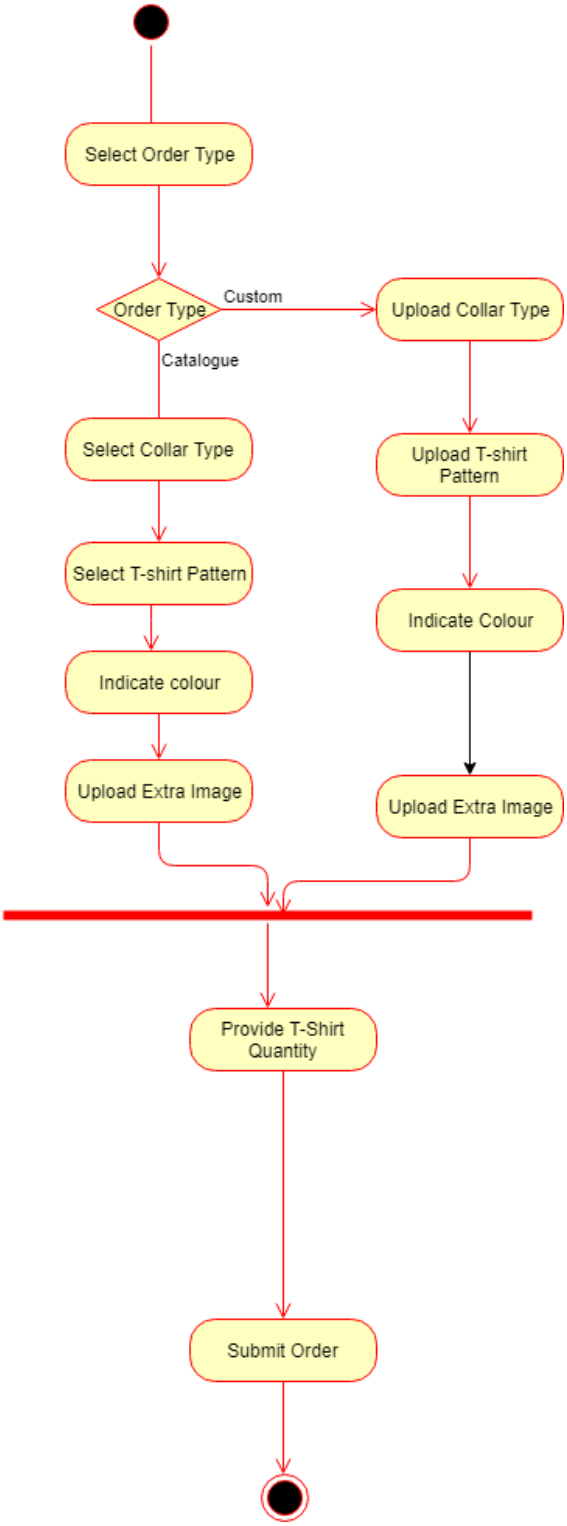

Figure 3. 4: Activity diagram for customer order creation

3.6 Activity diagram for supplier bidding

As indicated in figure 3.5, the customer can first view all kinds of available placed orders and can select an order. And the customer details, other bids, and specifications are available to view in order to submit the bid value. By providing the payment information bid can be submitted by the customer.

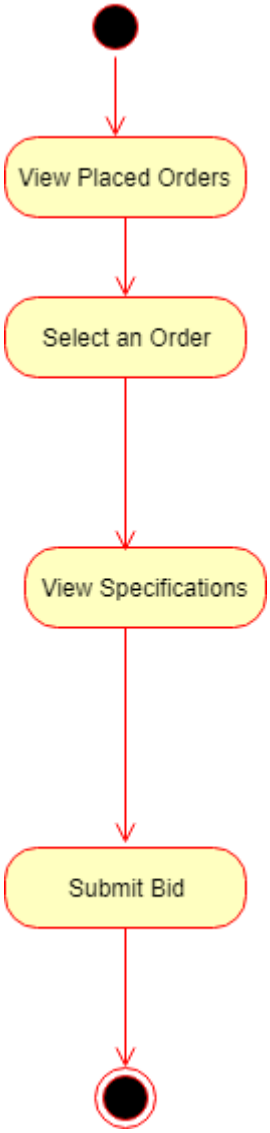

Figure 3. 5: Activity diagram for supplier bidding

3.7 Activity diagram for supplier selection

Figure 3.6 illustrates that the customer can view a list of placed orders, and then a particular order can be selected. By viewing the bids by suppliers, a preferred supplier can be selected in order to assign the order.

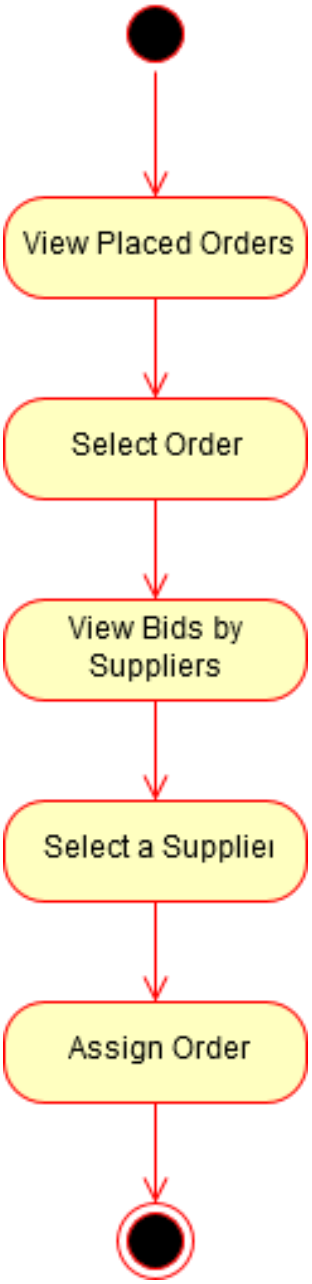

Figure 3. 6: Activity diagram for supplier selection

3.8 Activity diagram for publishing an order

Figure 3.7 indicates how an order can be published. First, an order has to be selected by viewing the placed orders. Then by reviewing the details of the order, the admin can either reject the order if it is in an unsatisfactory level or approve the order if it is in a satisfactory level. If the details submitted by the customer is satisfactory for the vendors to quote for same, then the admin gives the approval or the order is rejected. A vendor can view an order only after that being approved by the Admin.

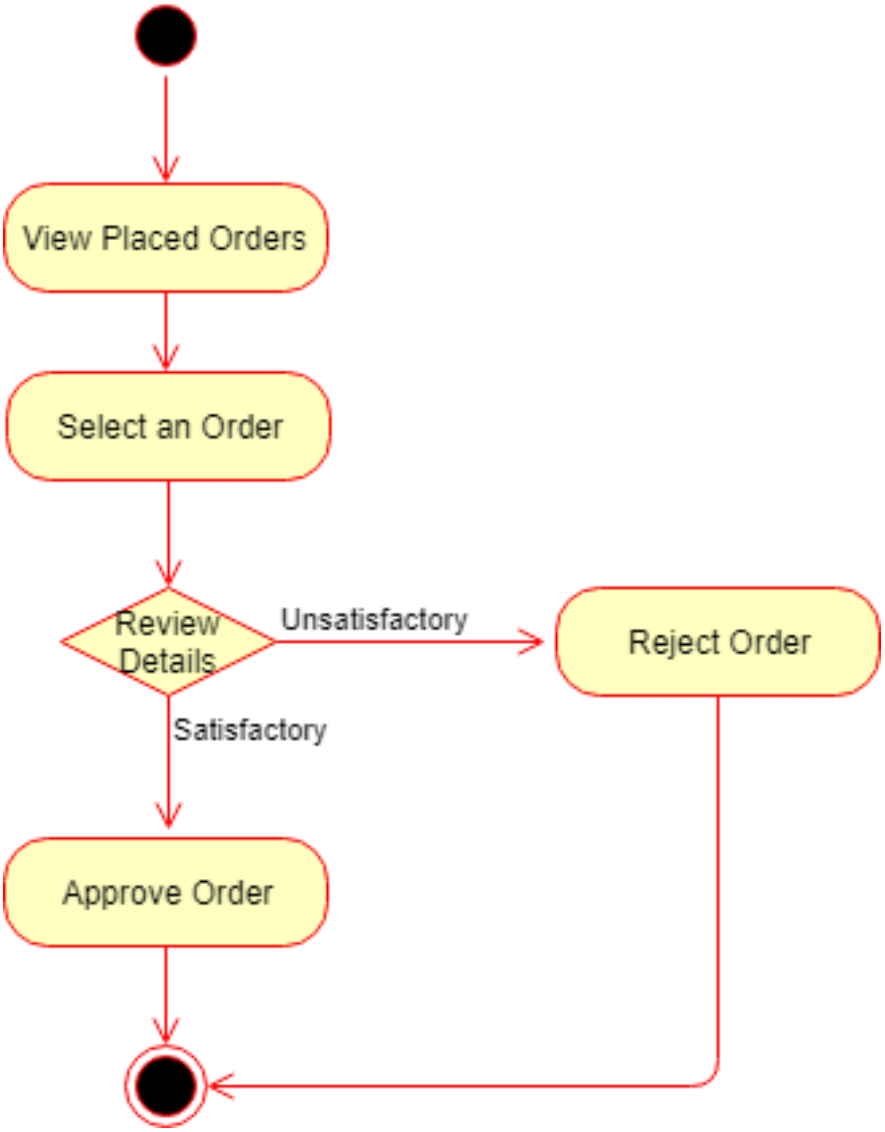

Figure 3. 7: Activity diagram for publishing an order

3.9 Sequence diagram for order processing

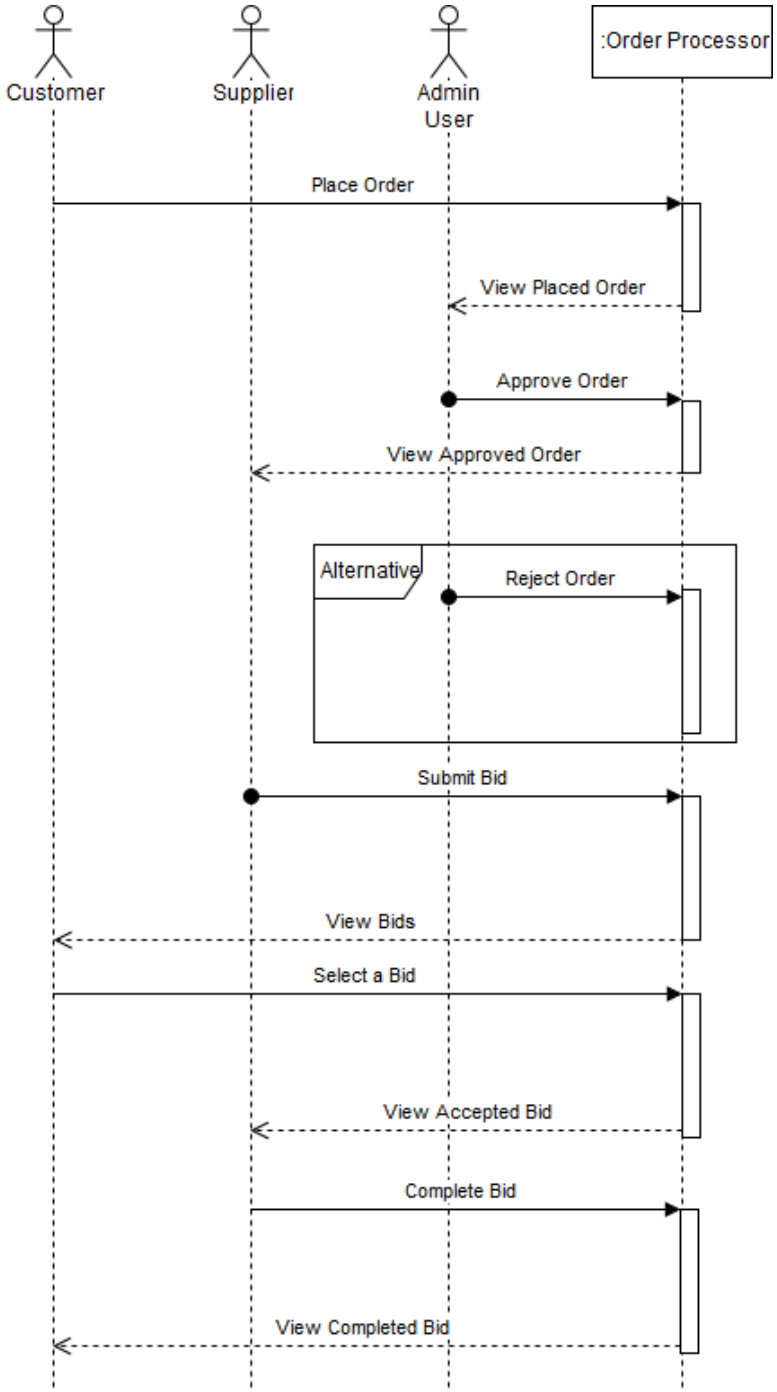

Figure 3. 8: Sequence diagram for order processing

Figure 3.8 shows how the customer, the supplier and the user admin has been involved with the order processing process and it further illustrates the placing of the orders, approving or rejecting the orders and submission and completion of the bids by suppliers.

Chapter 4: Implementation

A short description of the software, tools, and technologies used has been indicated below.

4.1 Languages and frameworks used

Server :

PHP

- Laravel Framework
- MySql database Management system
- Localhost (XAMPP Server) On Windows

Client :

- CSS
- javaScript
- HTML 5

Tools and Softwares Used:

- Atom Text editor
- XAMPP Server Software for Windows

PHP has been used over other languages such as ASP, Perl, and CGI as the server language due to several reasons. Ease of learning, ability to obtain support through online means such as forums, social media, and blogs easily for issues due to the large user base of PHP as PHP is an open source product and level of freedom received to use multiple editors due to PHP being open source scripting language are some of them. Additionally, the ease of use across different operating systems as PHP is not OS specific, PHP being free of charge with no requirement for licenses or royalty fees and ease of finding frameworks due to larger user base could also be listed. Not limiting to those PHP was preferred over other languages due to ease of fixing problems, easier scalability with addition of more servers as projects grow and PHP's ability to call Java and create custom classes as well as the higher speed of PHP due to the fact that PHP is not dependent on a lot of system's resources.

On the other hand, JavaScript has been used as the client side language due to several reasons. Javascript is executed on the client side and thus the web server is released from the strain of allocating bandwidth. Javascript is relatively faster to the end user as the code is executed on the client's computer. This would encourage the users to use the system frequently without a hassle. Additionally, due to Javascript's closeness to the English language, it is relatively easier

to learn.

Laravel is an MVC framework having bundles, migrations, and Artisan CLI. Laravel has a set of tools and an application architecture incorporating many of the best features of frameworks like CodeIgniter, Yii, and ASP.NET MVC. Laravel works an Open Source framework. Laravel saves a lot of time otherwise required to develop a website from scratch. Further, the website built in Laravel is considered secure.

4.2 Module structure diagram of the system

A module structure diagram which illustrates the system is shown below.

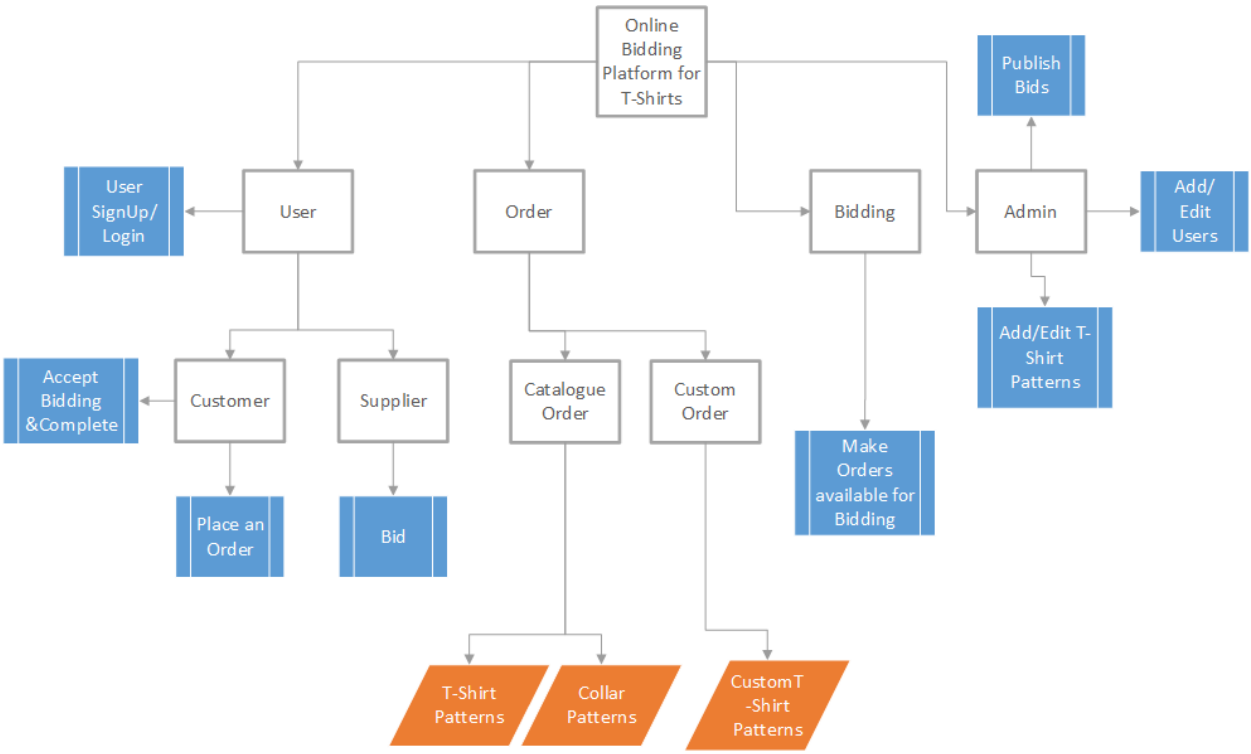

Figure 4. 1: Module structure diagram for the system

According to figure 4.1, four main modules come under the Bidding System which are User, Order, Bidding and Admin modules. These modules further break into sub-modules and subprocesses. The module ‘order’ has two sub modules named ‘catalog order’ and ‘custom order’. The module ‘user’ has two sub modules named ‘customer’ and ‘supplier’. The module ‘user’ manages the user signup/login processes. The sub module ‘customer’ handles the process of bid acceptance and order placement. Further, the module ‘admin’ handles the processes of publishing bids as well as adding/editing and deleting of users.

4.3 User interfaces

Some important areas of the user interface are shown in the screenshots below.

Customer view- Add catalog order:

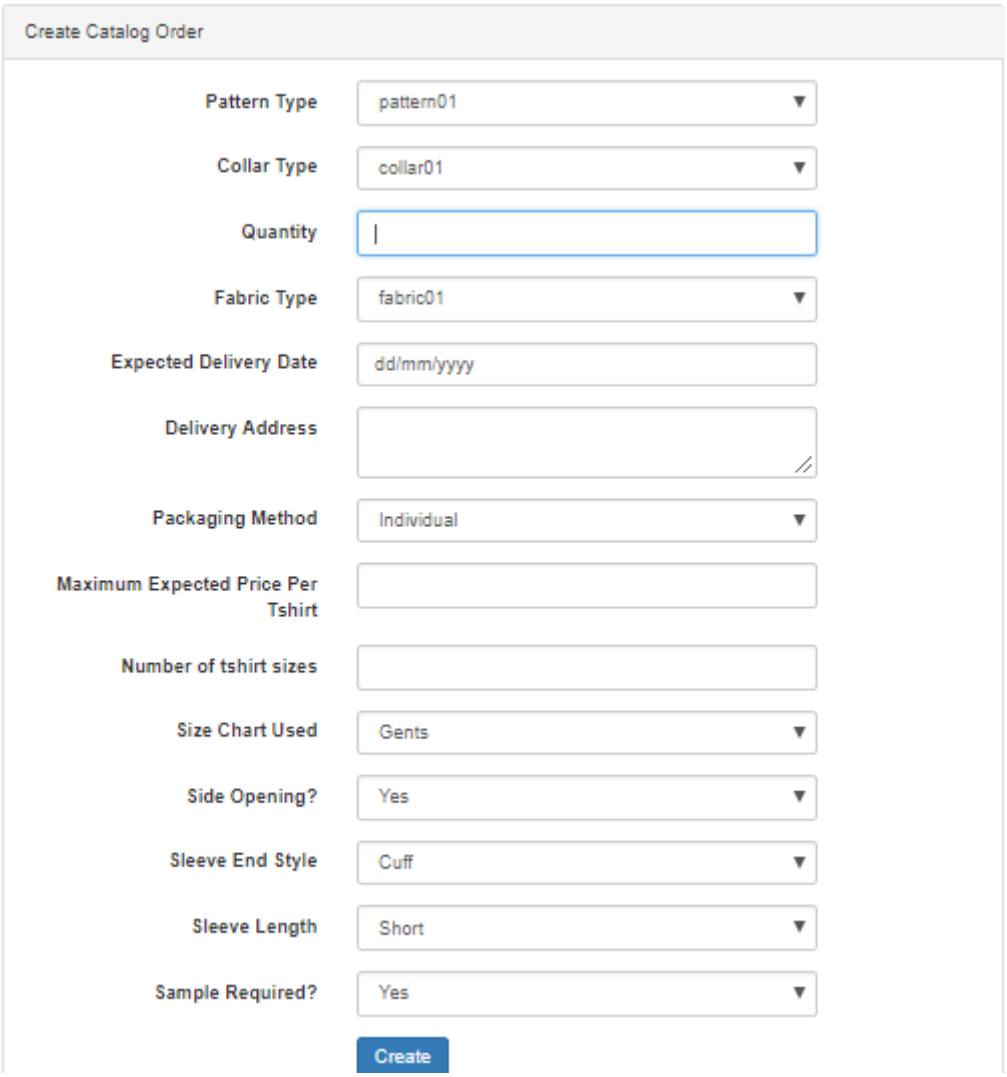

Figure 4. 2: Customer view- Add catalog order

According to figure 4.2, the t-shirt pattern and the collar type are selected from the catalog options. Allocations are available to indicate the quantity required, colour, notes and extra images. Then the order can be submitted.

Customer view- Add custom order:

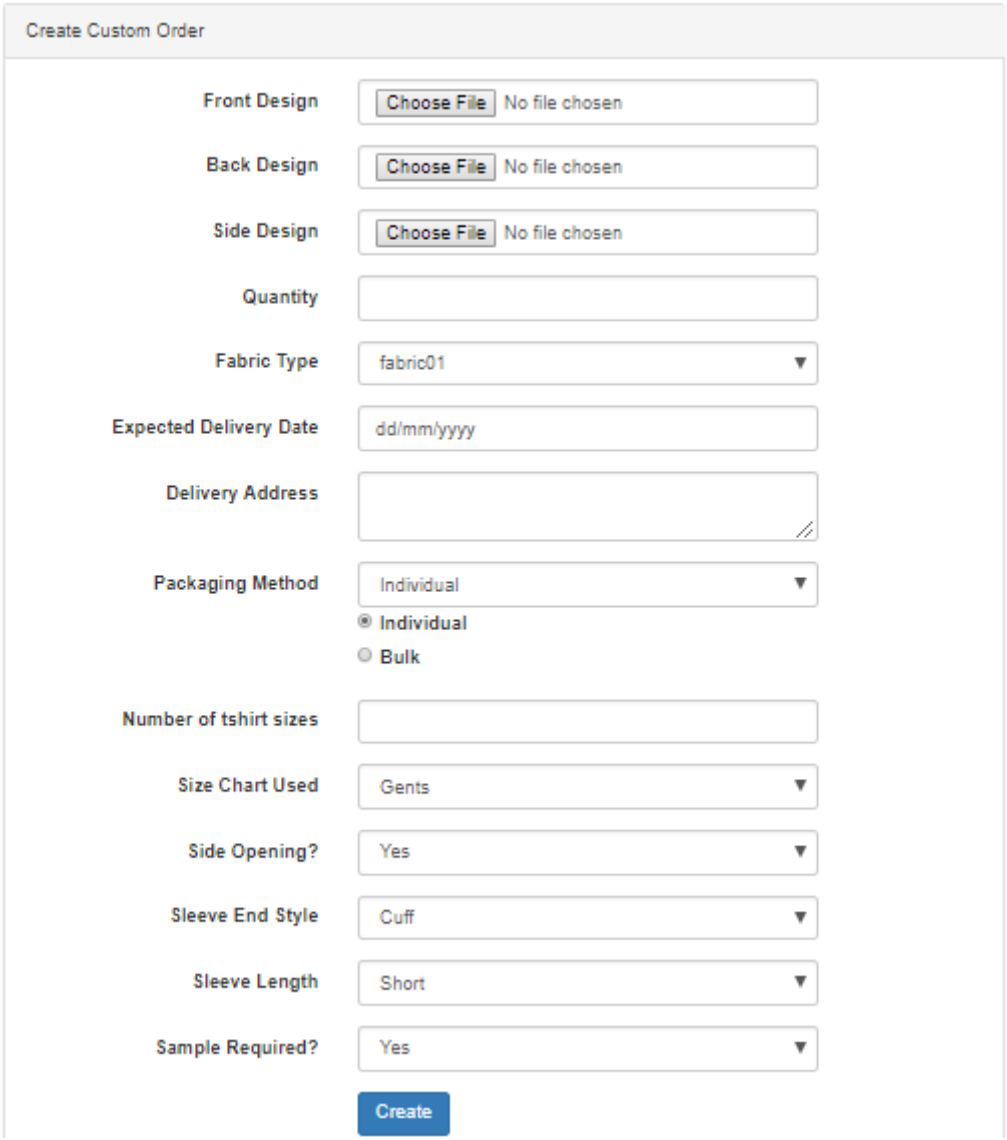

Figure 4. 3: Customer view- Add custom order

As shown in figure 4.3, the t-shirt pattern and the collar type images are uploaded to the system. The quantity required, colour, notes and extra images can be indicated. Then the order can be submitted.

Customer view- Catalog order list:

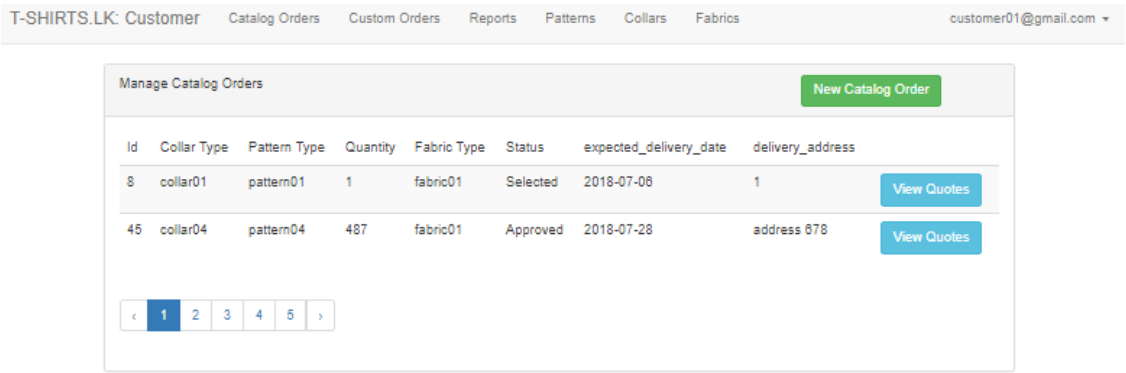

Figure 4. 4: Customer view- Catalog order list

According to figure 4.4, the customer is able to view the list of catalog orders posted by him/her with the details such as the order name, status of the order and the quantity involved.

Customer view- Custom order list:

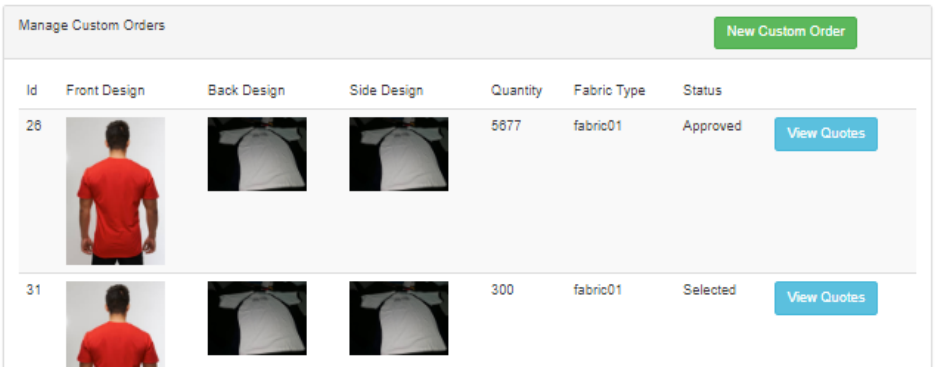

Figure 4. 5: Customer view- Custom order list

Similar to catalog order view, even in the custom order view as shown in figure 4.5, the customer can view the list of catalog orders posted by him/her with the details such as the order name, status of the order, quantity involved and etc.

4.4 Important code segments

The code segments for adding a catalog and custom order by the customer are shown below.

4.4.1 Add catalog order by the customer

```
/**
* Show the form for creating a new resource.
```

```
     *
     * @return \Illuminate\Http\Response
     */
    public function catalogOrderCreate()
        {


        $fabrics = Fabric::all();
        $patterns = Pattern::all();
        $collars = Collar::all();


        return view ('customer.orders.catalog_create')->withfabrics($fabrics)-
>withpatterns($patterns)
        ->withcollars($collars);
    }
```

4.4.2 Add custom order by customer

```
    public function customOrderCreate()
    {
        $fabrics = Fabric::all();
        return view ('customer.orders.custom_create')->withfabrics($fabrics);
    }
```

Though the function “customOrderCreate”, initially, all elements in the model “Fabric” is assigned to a variable called “$fabrics”. Then a view called “customer.orders.custom_create” is returned along with the data obtained for the variable “$fabrics”.

Chapter 05: User evaluation and testing

5.1 Software testing

When a software system is planned and built to satisfy a customer's requirement or as a solution to solve a day to day problem it must be thoroughly tested to ensure its efficient functioning as per the user requirement and design goals. There are a number of testing methods to test different aspects of the system. Following testing methods were used to test this system.

1. Systems Testing - Tests the system functionality as per requirements
2. Usability Testing - Tests the usability of the system
3. User Acceptance Testing - Test how users react when a new system is introduced.

5.2 System testing

Test cases are a set of predefined user behaviors that are expected when a real user is using the system. Each test cases is made to ensure that the functionality is working as per the expectations in each use case.
Following are some of the test cases which the system was tested against. For a list of all major test cases and test results please refer **APPENDIX 1.**

5.3 Test cases

5.3.1 User sign in / sign out and change password process

Table 5.1 indicates the test cases for user sign in / sign out processes as well as for change password process.

Test Id #	**Description**	**Steps**	**Expected Result**
1	At the first interaction, user must be prompted to enter user's credentials.	Visit application URL using a web browser.	A user login screen must be displayed.
2	A valid user can log in.	1 Enter a known correct username and a password. 2 Click login	User successfully login into the system.
3	An invalid user cannot log in	1 Enter a known wrong	An error message

		username and a password. 2 Click login	will be displayed.
4	The user enters a username which is not a valid email address.	1 Enter something which isn't an email address as a username. 2 Click login	An error message will be displayed.

Table 5. 1 User sign in / sign out and change password process

5.3.2 Admin t-shirt pattern management

Table 5.2 indicates the test cases for add, view, edit and delete functions carried out by the admin for collars.

Test Id #	**Description**	**Steps**	**Expected Result**
5	Admin can add a new T-shirt pattern	1 Visit the admin's user interface 2 Click add new link 3 Give a name as Pattern Name 4 Add an image as Pattern Image 5 Click Add Pattern button	The new pattern must get saved in the database.
6	Admin can see a list of patterns he has already added.	1 Visit the admin's user interface 2 Click View All link	A list of patterns will get displayed.
7	Admin can edit an existing pattern	1 Visit patterns list 2 Click edit link for a particular pattern 3 Change pattern name 4 Add a different image as Pattern Image 5 Click Update Pattern button	Pattern changes must get saved in the database.
8	Admin can delete a pattern he added earlier.	1 Visit patterns list 2 Click delete button for a particular pattern 3 Click OK on the popup message.	The particular pattern must get deleted in the database.

Table 5. 2 Admin T-Shirt pattern management

5.4 Usability testing

Usability testing, which is a non-functional testing technique is a measure of how easily the system could be used by the end users.
Having a smooth online functionality for the bidding process was expected through the system. In this chapter, it is discussed how the system user evaluation has been done. The system serves as a bidding platform for custom made t-shirts in Sri Lanka with three modules being the administrator, supplier, and the customer.

5.4 .1 Usability testing plan

The researcher conducted an onsite test using a live version of the system located on the researcher's laptop. Each participant's navigational choices, task completion rates, comments, rating of overall satisfaction, questions as well as feedback were recorded.
There were ten attendees for the usability testing. Each individual session lasted for about 15-20 minutes. 2 of the participants were from the supplier organization category and the remaining 8 participants were from customer category.

However, the test indicated several issues as well.

- Limited option availability in custom designing
- Confusion with minimum and maximum budgeted ranges
- Confusion with order completion timelines
- Confusion with selecting between custom and catalog orders
- Unavailability of an FAQ section
- Unavailability of site navigation index

The following task scenarios were attempted by the participants.

- Task 01: Posting a custom order
- Task 02: Posting a catalog order
- Task 03: Bidding for a custom order
- Task 04: Bidding for a catalog order

5.4.2 Results of usability testing

As per table 5.3, seven of the ten participants completed task 1. Nine respondents completed task 2. All ten respondents completed task 3 and the task 4. The results obtained are shown below.

Task Completion Rates:

Participant no	**Task 1**	**Task 2**	**Task 3**	**Task 4**
1	√	√	√	√
2	-	√	√	√
3	√	√	√	√
4	√	√	√	√
5	-	√	√	√
6	√	√	√	√
7	√	√	√	√
8	√	-	√	√
9	-	√	√	√
10	√	√	√	√
Success	7	9	10	10
Completion Rate	70%	90%	100%	100%

Table 5. 3 Results of usability testing - Task Completion Rates

Ratings for tasks:

Upon completion of the set of tasks, participants were asked to rate the ease or the difficulty of completing the tasks for the following factors:

- **FACTOR 1** - I found it easy to find my way to this specific information from the homepage.
- **FACTOR 2** - While searching for this specific information, I was able to keep track of where I was in the system.
- **FACTOR 3** - I managed to accurately predict the section of the system that contained this specific information.

Answers from each participant were taken as either “yes” or “no” for each of the above factors. The count received as “yes” was taken as the points scored for each factor and the results obtained are shown in figure 5.1 below.

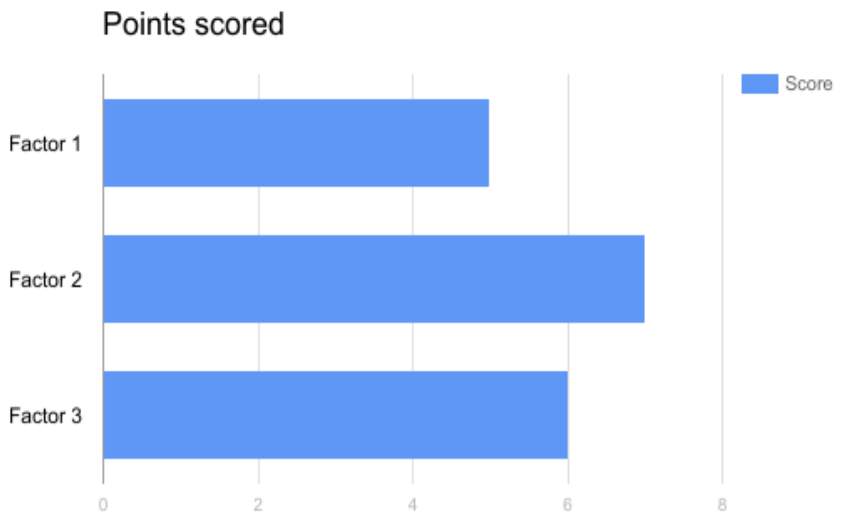

Figure 5. 1: Points Scored

5.4.3 Usability testing conclusion

After analyzing the test scores given on each tested factors, it was decided that overall usability of the system is acceptable at this stage. Further changes were planned and critical issues were fixed before the final deployment on customer premises.

5.5 User acceptance testing

5.5.1 User acceptance testing plan

Few days after system installation, a set of feedback forms were distributed among the users to get their feedback about the system **APPENDIX 2**.

Feedback forms could be submitted anonymously to protect the identity of the reviewer so they can write a critical opinion. Once the feedback forms were collected from the reviewers, feedback data were analyzed **APPENDIX 3**.

Few handpicked feedback forms are available in **APPENDIX 4**.

5.5.2 Overall feedback for user acceptance testing

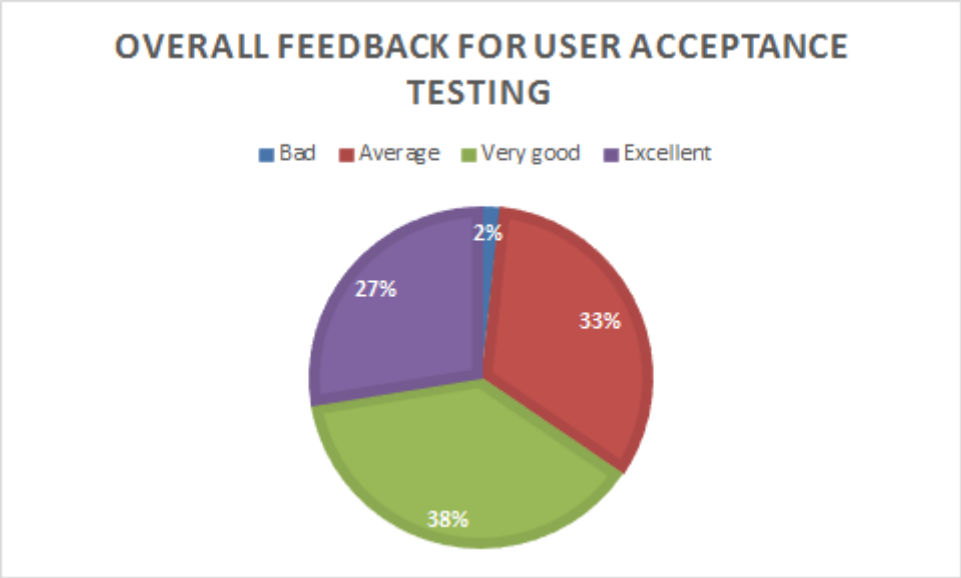

Figure 5. 2: Overall feedback for user acceptance testing

With regard to overall feedback for user acceptance testing, as shown in figure 5.2, the results came for the status ‘bad’, ‘average’, ‘very good’ and ‘excellent’ were 2%, 33%, 38% and 27% respectively.

Chapter 6: Conclusion and future work

The new system has assisted in developing a platform for online job posting and bidding for custom t-shirt requirements in Sri Lanka. T-shirts.lk (admin), customers, as well as suppliers, find it easy to work on a common platform for streamlining the requirements. However, there is a list of areas where further improvements can be made.

6.1 Future enhancements

This system was built considering the requirements received from the client, t-shirts.lk. However, the system can be further improved in multiple ways. The following are amongst the future extensions that could be considered.

Introduction of an advanced design tool:

The current system does not contain a designing tool. Since the product offered is a customized product, having a designing tool could lead to allowing customers to explore the different options possible until they are content with the level of customization done as per their liking. This would, on one hand, increase the number of enquiries becoming orders and on the other hand this could save a lot of time otherwise has to be spent by suppliers in getting the finalized requirements of the customers. It should be noted that it was observed during the initial discussions with t-shirts.lk that costing for a custom requirement gets changed every time customers change their product specifications.

Introduction of online payment facilities:

Online payments are getting popular by the day and customers would thus have multiple payment options in addition to standard physical payment methods. However, it would be initially challenging to decide on the syntax as to how the system gets involved as the middleman to accept payments from customers and then to direct payments to the relevant vendors.

Introduction of shipment tracking system:

While the production work is in progress and once finished goods are in transit, it would be ideal if the interested parties could get real-time tracking information with regard to the order. This will give the customer ease of mind as they get to know that their products will arrive in/on time without a need to manually contact vendors via email, phone or even by visiting.

Introduction of virtual size checker for t-shirts:

Despite the indication of the size chart, customers may still find it difficult to get a comprehensive idea regarding whether the t-shirt sizes fit them well. Having a virtual size checker would certainly add value to the whole experience. Further readings about online virtual size checkers/fit-on rooms would provide inspiration for the type of size checker that may suit this system.

Ability to create, manage and edit invoices, delivery notes and other related documents:

Adding an online invoicing module to the existing system would ensure the clarity in the documentation for both customers and vendors. This could lead to an end to end solution for documentation required specially in corporate purchasing.

Option to conduct online fundraising campaigns:

While discussing with t-shirts.lk it was understood that there is a considerable number of t-shirts being produced for fundraising purposes by different entities. Making the system available to run fundraising campaigns for customers could make the t-shirts.lk more popular as a platform business model.

Expansion of the system to a multitude of custom merchandise:

In addition to t-shirts, the same system could be expanded into other custom product where the customer would get an array of products to select before customization starts. This would lead to more frequent customer engagement with the system.

Addition of social plugins:

Addition of social plugins would enhance the customers to help contribute popularizing the system among their social circles. This reference would remain instrumental as far as the commercial viability of the system is concerned.

6.2 Lessons learnt

Improved practice in critical thinking, planning, organizing, directing and controlling could be obtained through this project. Getting insights into striking a balance between theory and practice was possible while working on the system. Working according to a project timeline was another great learning outcome. Importance of managing timelines, managing pressure under extreme working conditions was also learnt. Improved interpersonal skills while working with different stakeholders would definitely be an advantage when carrying out projects in the

future. Use case diagrams and the like made the development of the system easier as same gave a complete idea about the holistic system. Becoming familiar with a number of software programs was possible as same was used in developing the system. Further, hands-on experience was received regarding conducting usability testing to improve the overall quality of the system.

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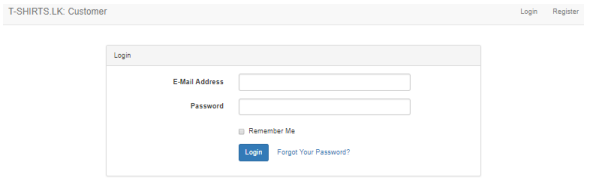
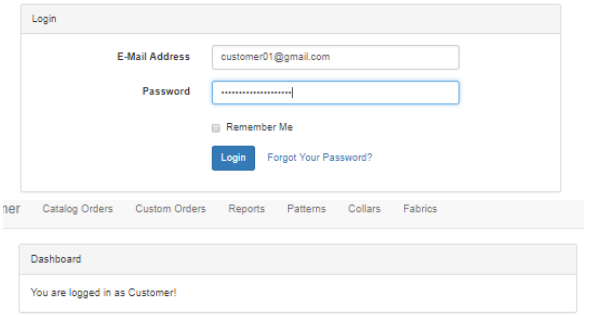
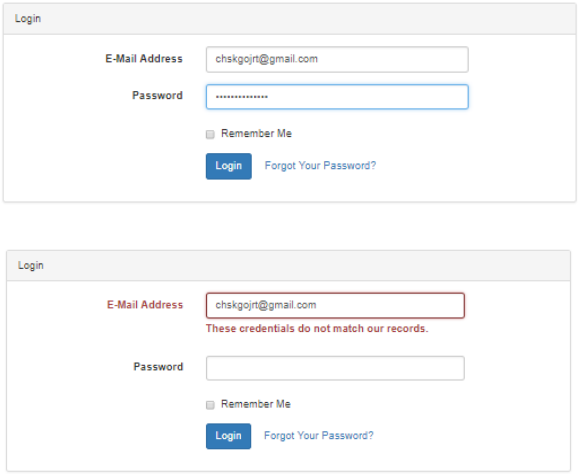
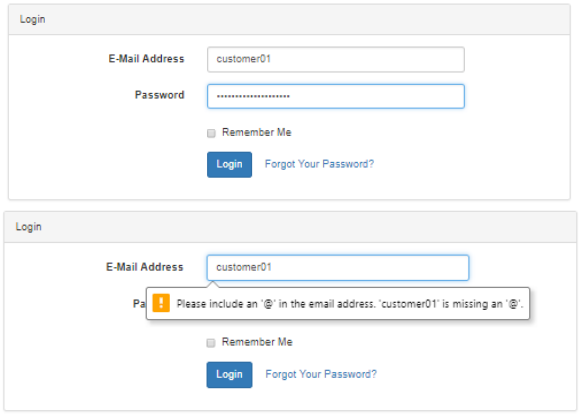
APPENDIX 1: System test cases and test results

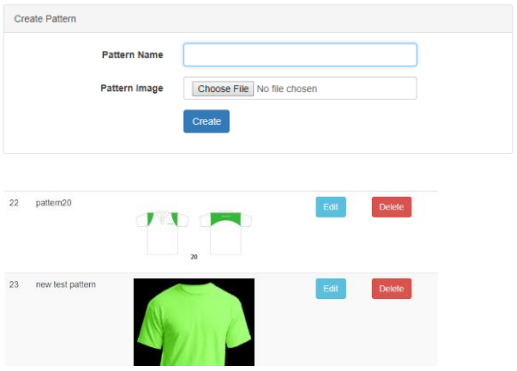
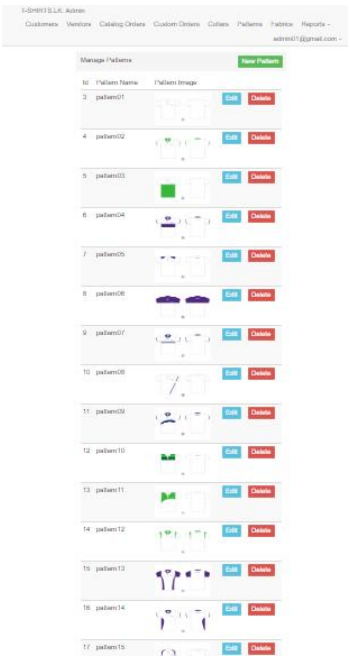
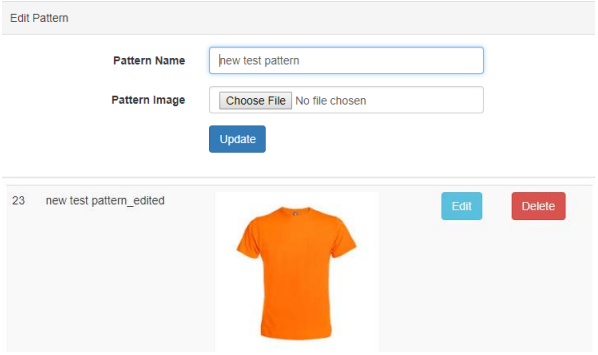
5.2.1 User sign in / sign out and change password process

Test Id #	Description	Steps	Expected Result
1	At the first interaction, user must be prompted to enter user's credentials.	Visit application URL using a web browser.	A user login screen must be displayed.  **STATUS:** **h/Attempt 1: √ SUCCESS**
2	A valid user can log in.	1 Enter a known correct username and a password. 2 Click login	User successfully login into the system.  **STATUS:** **Attempt 1: √ SUCCESS**
3	An invalid user cannot log in	1 Enter a known wrong username and a password. 2 Click login	An error message will be displayed. 

			STATUS: **Attempt 1: √ SUCCESS**
4	The user enters a username which is not a valid email address.	1 Enter something which isn't an email address as a username. 2 Click login	An error message will be displayed.  **STATUS:** **Attempt 1: √ SUCCESS**

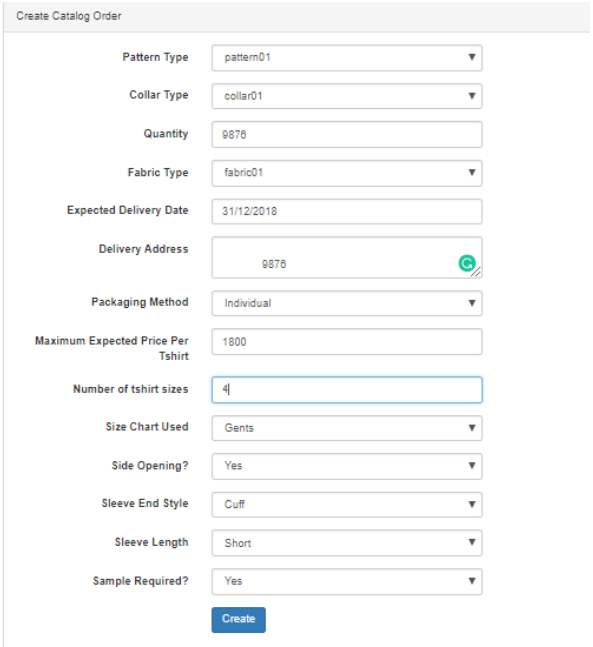
5.2.2 Admin t-shirt pattern management

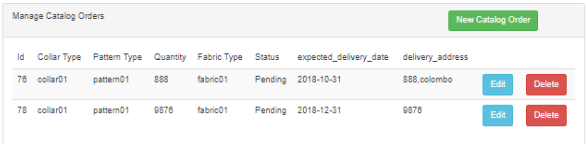
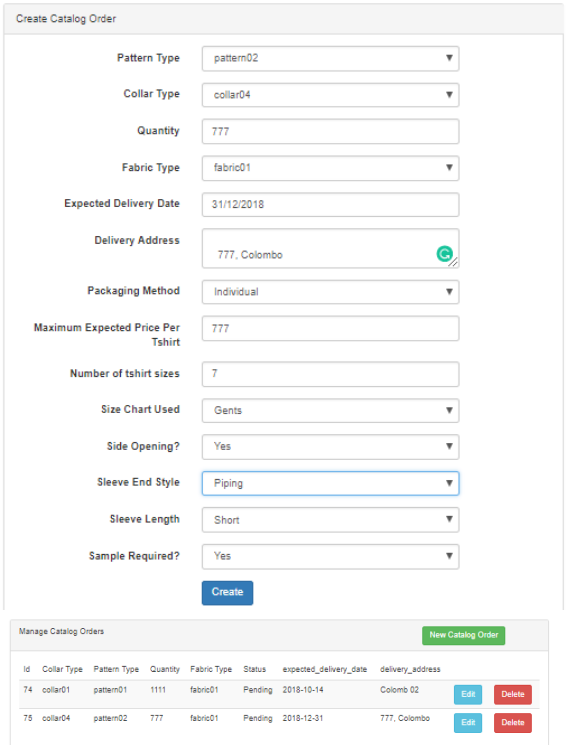
Test Id #	Description	Steps	Expected Result
5	Admin can add a new T-shirt pattern	1 Visit the admin's user interface 2 Click add new link 3 Give a name as Pattern Name 4 Add an image as Pattern Image 5 Click Add Pattern button	The new pattern must get saved in the database. 

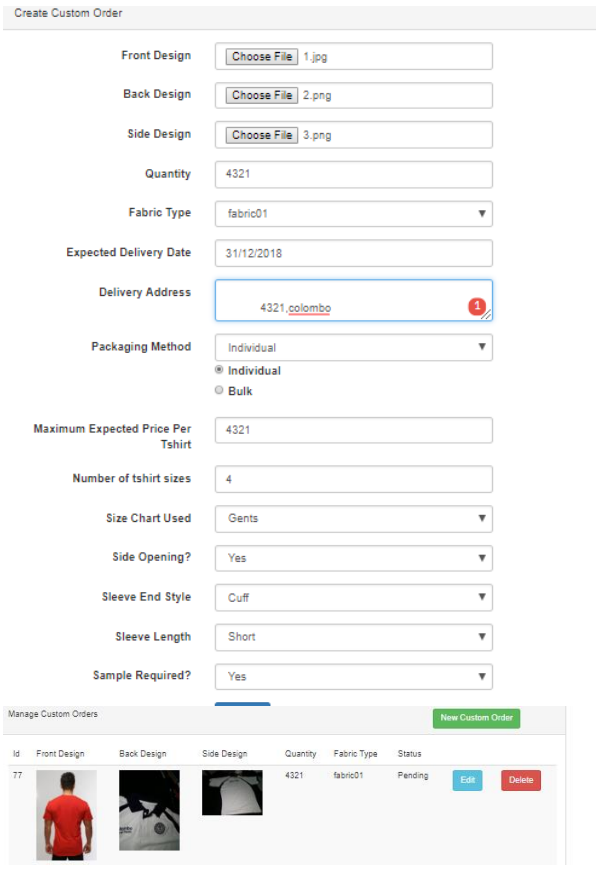
			 **STATUS:** **Attempt 1: √ SUCCESS**
6	Admin can see a list of patterns he has already added.	1 Visit the admin's user interface 2 Click View All link	A list of patterns will get displayed.  **STATUS:** **Attempt 1: √ SUCCESS**
7	Admin and edit an existing pattern	1 Visit patterns list 2 Click edit link for a particular pattern 3 Change pattern name 4 Add a different image as Pattern Image 5 Click Update Pattern button	Pattern changes must get saved in the database.  **STATUS:**

			Attempt 1: √ SUCCESS
9	Admin can delete a pattern he added earlier.	1 Visit patterns list 2 Click delete button for a particular pattern	The particular pattern must get deleted in the database. Before deleting:  After deleting:  **STATUS:** **Attempt 1:** √ SUCCESS

5.2.2 Client add catalog order

Test Id #	Description	Steps	Expected Result
9	The client can place a catalog order	1 Visit client's user interface 2 Click add new catalog order link 3 Select a pattern from the drop-down 4 Fill the form 5 Click Submit order button	New catalog order must get saved in the database. 

			 **STATUS:** **Attempt 1: √ SUCCESS**
10	New order should get the pending status	1 Add a new catalog order 2 Check order status	A new order must get the "Pending" status  **STATUS:** **Attempt 1: √ SUCCESS**
11	The client can add a custom order	1 Visit client's user interface 2 Click add new custom order link 3 Fill the form 4 Click Submit order button	New custom order must get saved in the database.

			 **STATUS:** **Attempt 1: √ SUCCESS**

APPENDIX 2: Sample user feedback form

(Mark X on correct selection)

1. How did you interact with the system? (Mark X on correct selection)

	As an Admin
	As a Client who wants place an order
	As a supplier who wants win orders

2. What do you think about the system?

	Bad	Average	Very Good	Excellent
Concept				
Design				
Usefulness				
Reliability				

3. What do you this about the usability of the system?

	Bad	Average	Very Good	Excellent
How easy was it use the system				
Is it productive				

4. How often you actually used the system?

	Few times a day
	Once a day
	Few times a week
	Once a week
	Once a month or less

5. What do you think about the overall experience?

APPENDIX 3: User feedback analysis

1. How did you interact with the system?

As an Admin	2
As a Client who wants place an order	5
As a supplier who wants win orders	3

2. What do you think about the system?

	Bad	Average	Very Good	Excellent
Concept	0	2	6	2
Design	0	7	3	0
Usefulness	0	3	6	1
Reliability	1	4	2	1

3. What do you this about the usability of the system?

	Bad	Average	Very Good	Excellent
How easy was it use the system	0	2	3	5
Is it productive	0	3	2	5

4. How often you actually used the system?

2	Few times a day
3	Once a day
3	Few times a week
1	Once a week
1	Once a month or less

APPENDIX 4: User feedback forms

User feedback form: T-shirt Bidding System

(Mark X on correct selection)

1. How did you interacted with the system? (Mark X on correct selection)

	As an Admin
	As a Client who wants place an order
X	As a supplier who wants win orders

2. What do you this about the system?

	Bad	Average	Very Good	Excellent
Concept				X
Design			X	
Usefulness			X	
Reliability		X		

3. What do you this about the usability of the system?

	Bad	Average	Very Good	Excellent
How easy was it use the system		X		
Is it productive			X	

4. How often you actually used the system?

	Few times a day
X	Once a day
	Few times a week
	Once a week
	Once a month or less

5. What do think about overall experience.

New Concept, need to improve further

User feedback form: T-shirt Bidding System

(Mark X on correct selection)

1. How did you interacted with the system? (Mark X on correct selection)

	As an Admin
X	As a Client who wants place an order
	As a supplier who wants win orders

2. What do you this about the system?

	Bad	Average	Very Good	Excellent
Concept				X
Design			X	
Usefulness				X
Reliability			X	

3. What do you this about the usability of the system?

	Bad	Average	Very Good	Excellent
How easy was it use the system			X	
Is it productive			X	

4. How often you actually used the system?

	Few times a day
	Once a day
	Few times a week
	Once a week
X	Once a month or less

5. What do think about overall experience.

The overall experience is good, specially the part bidding concept has been brought to tshirt manufacturing.

User feedback form: T-shirt Bidding System

(Mark X on correct selection)

1. How did you interacted with the system? (Mark X on correct selection)

(X)	As an Admin
	As a Client who wants place an order
	As a supplier who wants win orders

2. What do you this about the system?

	Bad	Average	Very Good	Excellent
Concept		(X)		
Design		(X)		
Usefulness		(X)		
Reliability	(X)			

3. What do you this about the usability of the system?

	Bad	Average	Very Good	Excellent
How easy was it use the system		(X)		
Is it productive		(X)		

4. How often you actually used the system?

(X)	Few times a day
	Once a day
	Few times a week
	Once a week
	Once a month or less

5. What do think about overall experience.

Improvements should be done to ~~me~~ the system by adding a Custom design tool. Setting up of payment gateways could also be looked on.

APPENDIX 5: User manual

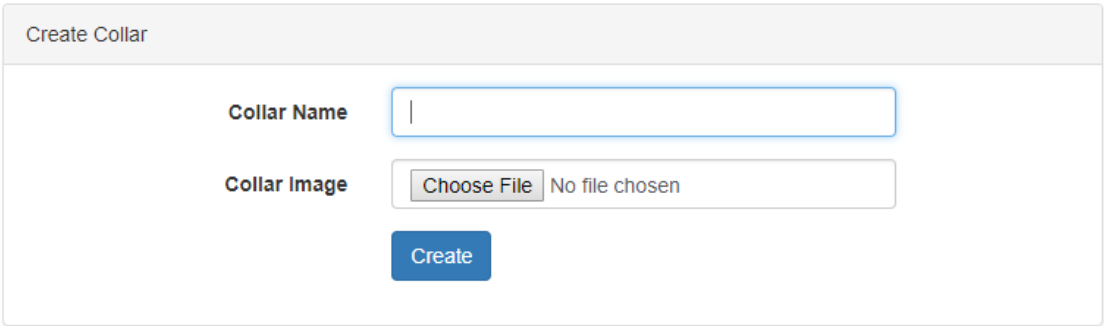
OVERALL SYSTEM INTERFACE

COLLAR TYPES

View all collar types

- Admin can add the name, the image for collar types. Further admin can edit and delete collar types.

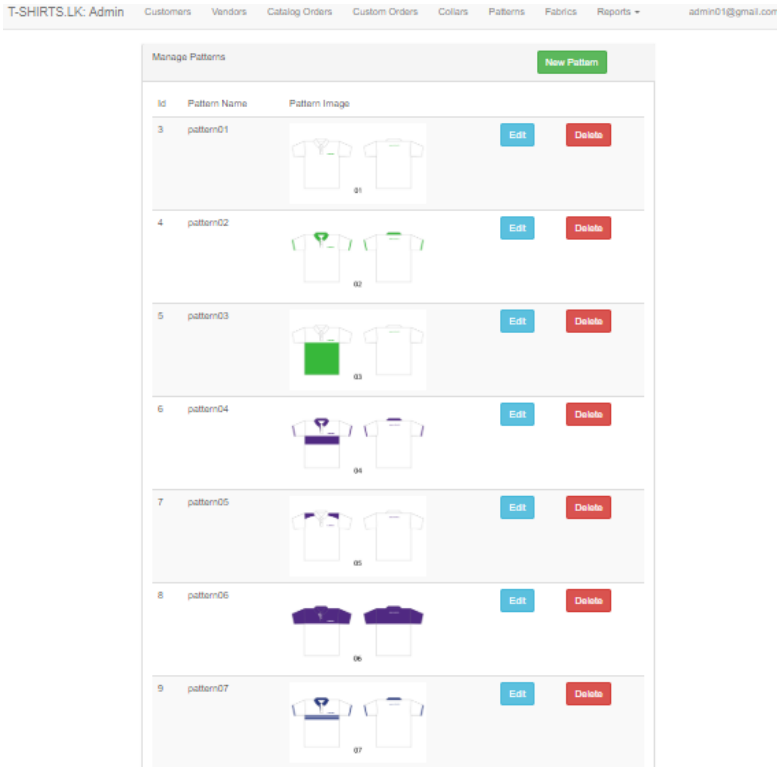
Add new collar type



- Admin can create a new collar type with the name and image of collar type.

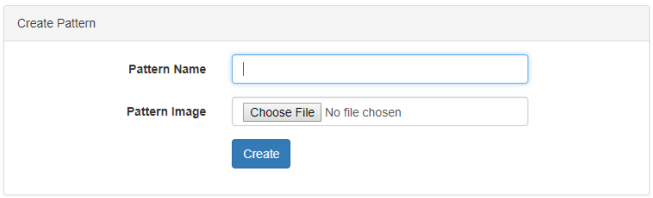
T-SHIRTS PATTERNS

View all t-shirt patterns



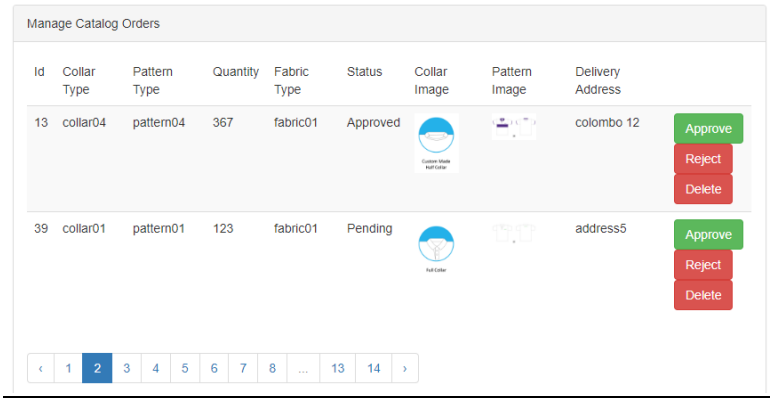
- Admin can view all t-shirts patterns. From this view, admin can view the name and image of all t-shirts patterns

Add a new t-shirt pattern



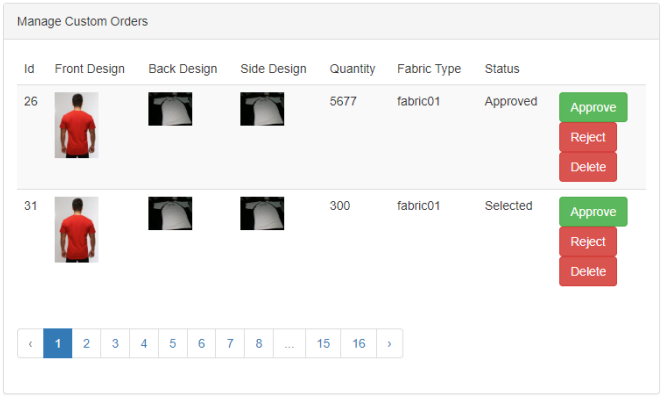
- Admin can add a new t-shirt pattern with name and image of t-shirt pattern.

CATALOG ORDERS



- Admin can view all catalog orders. From this view, admin can view the name, status, created date of all catalog orders.

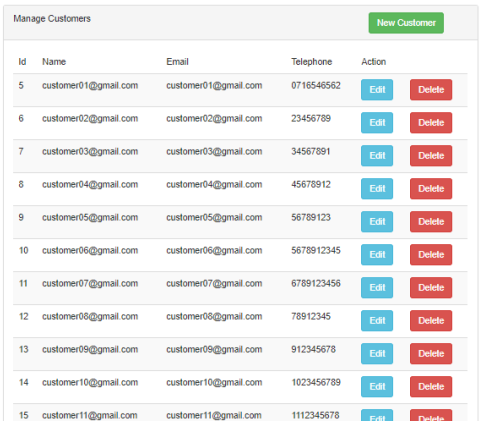
CUSTOM ORDERS



- Admin can view all custom orders. From this view, admin can view the name, status, created date of all custom orders.

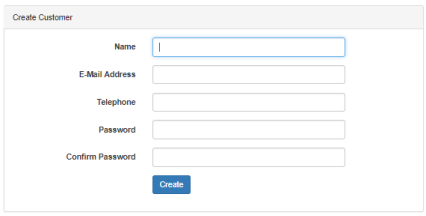
ALL CUSTOMERS

All customers



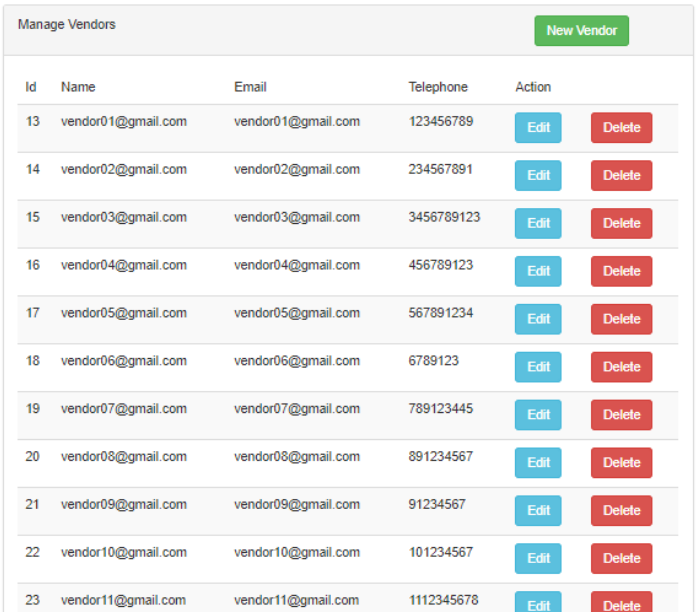
- Admin can view all customers in the system with name and email.

Add a New Customer



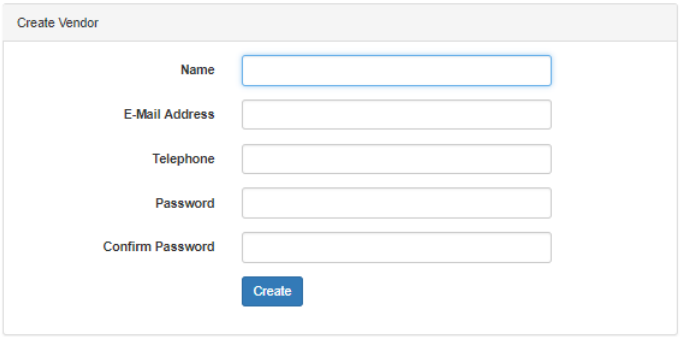
- Admin can add a new customer with name and email address

ALL SUPPLIERS



- Admin can view all vendors in the system with name and email.

Add a new supplier



- Admin can add a new supplier with name and email address