

# Online Tea Auction System

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# **Online Tea Auction System**

**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

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under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: Dr. H. A. Caldera

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## **Abstract**

Tea production plays a momentous role in the Sri Lankan economy. Tea industry has been contributing a vital amount to the country's Gross Domestic Product (GDP) and government revenue earnings over the past years. It is the highest income generating product when compared to other agricultural products. Therefore, it is essential to strengthen the tea supply chain in the country to get the maximum output of the product.

In Sri Lanka, similar to other major tea producing countries, tea is mainly sold in an auction. In the entire tea supply-chain, the weekly tea auction plays a vital role. Tea auction involves different parties including tea plantations, tea brokers, buyers and tea board. Tea auction process has been carrying out manually for a long duration and have faced various challenges throughout. Therefore, there is a need in optimizing the tea auction process due to various uncertainties faced by all parties involved.

For a long period of time the online tea auction concept was on hold in Sri Lanka due to fear of losing the existing physical bidding. Then starting from 2013 several attempts were taken to automate the auction but none of the attempts continued to be a long-term success. However, due to curfew situation in the country following Covid-19 pandemic, the Colombo tea auction was held online in April 2020 for the first time in history. Though, the digital system moved on a slower phase than the manual out-cry system, it had ended successfully. Therefore, now the authorities are looking forward to continuing the electronic platform with further developments and value additions. While the situation within Sri Lanka is as above, India has been successfully using this concept for some time now. Moreover, this concept has been actively spoken in Kenya and many prototypes have been developed to achieve it.

This project is another attempt taken towards bringing the online tea auction concept alive in Sri Lanka. Here, an electronic system is introduced to automate the existing tea auction process that has been operating for prolonged period in the country. This system connects all parties involved in tea auction process namely, tea warehouse, broker, buyer, and tea board with a common database. All the processes currently carried out by each party manually, such as invoice adding in tea warehouse, tea valuation and catalogue preparation by broker, tea valuation by buyer, holding the tea auction and analysing results after a tea auction are automated with some value additions. A new way of holding tea auctions electronically incorporating a gaming concept is also introduced in the new system. Furthermore, the new system provides lively updating dashboards to each party, letting them evaluate their performance real time and take decisions accordingly.

Online tea auction system was designed researching and analysing a significant number of literature as well as a wider range of industrial survey. The prototype was built using various software development tools including modern BI tools. This solution was evaluated by all the related parties and highly rated in terms of novelty and coverage.

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## **List of Abbreviations**

CCC - Ceylon Chamber of Commerce

CTA - Colombo Tea Auction

CTTA - Colombo Tea Traders' Association

EATTA - East African Tea Trade Association

EDB - Export development Board

GDP - Gross Domestic Product

RUP - Rational Unified Process

SLTB - Sri Lanka tea board

## Chapter 1 Introduction

Tea production plays a momentous role in the Sri Lankan economy. It has been one of the important agricultural export items since 1883. Tea was first introduced to Sri Lanka by a British tea planter named James Taylor in 1867 and it was soon discovered by British carriers that this cultivated tea was very profitable [1]. Since then, Sri Lankan tea has been sold out globally for high prices for a long period of time and it has been the fourth largest producer of tea, in the world. The unique tastes and the unimpeachable aromas of Ceylon Tea is what, that has made it famous around the globe [2].

Tea industry has been contributing a vital amount to the country's Gross Domestic Product (GDP) and government revenue earnings over the past years [3]. According to reports from department of Census and Statistics Sri Lanka, for the year 2018, tea represented 12.2% of total export earnings (*Figure 1.1*). It is the highest income generating product when compared to other agricultural products. Therefore, it is essential to strengthen the tea supply chain in the country to get the maximum output of the product.

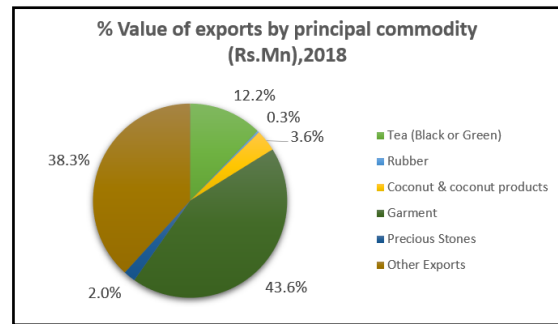


Figure 1.1 - % Value of exports by principal commodity, 2018 [8]

In Sri Lanka, similar to other major tea producing countries, tea is mainly sold in an auction. In the entire tea supply-chain, the weekly tea auction plays a vital role. Tea auction involves different parties including tea plantations, tea brokers, buyers and tea board. The auction process has been carrying out manually for a long period of time and have faced various challenges throughout. Therefore, there is a need in optimizing the tea auction process due to various uncertainties faced by all parties involved.

### 1.1 Motivation for the project

For a long period of time the online tea auction concept was on hold due to fear of losing the existing physical bidding. During early 2000s, although many people in the industry had begun to get used to the automated system, not all buyers were for it. Therefore, the automation concept was on hold for some time. Another factor was that it was unable to capture the subtle things like facial expressions that indicate what bidders are thinking, in an automated auction. Then in 2013 John Keells together with Mobitel innovated an electronic tea auction system named 'E-gavel' application which was a partial success [4]. Later in 2015, another application named 'mAuction' was developed by Mobitel business solutions taking inputs from the principles of the 'eGavel' solution [5]. This solution was not continued either. Finally, due to curfew situation in the country following Covid-19 pandemic, the Colombo tea auction was held online on 4<sup>th</sup> April 2020 for the first time in history. Though, the digital system moved on a slower phase than the manual out-cry system, it had ended successfully [6].

While the situation within Sri Lanka is as above, India has been successfully using this concept for some time now. The e-auction system for tea is being used by all the 6 auction centres (Kolkata, Siliguri, Guwahati, Cochin, Coimbatore and Coonor). The various users of the system like Manufacturers, warehouses, Brokers and Buyers have been provided with access to various functionalities of the system [7]. Moreover, this concept has been actively spoken in Kenya and many prototypes have been developed to achieve it.

Therefore, this project is another attempt to bring the online tea auction concept alive in Sri Lanka.

## 1.2 Problem Domain

Tea supply chain in Sri Lanka currently operates as follows:

Tea plantations will bring tea to the broker's premises and unload teas in the warehouses. In a warehouse, tea lines are allocated for each tea grade. As soon as the plantation completes unloading tea, an invoice will be sent to the broker. In some cases, the plantations will directly mail/fax the invoices to broker without sending it through warehouse. Broker will then enter the invoice details to a separate system. From each tea grade a separate small(1kg) sample is sent to the tea tasting room of the broker. There, the tea tasters will record the appearance of the tea, liquor and taste tea. Based on these characteristics a value is given for each tea grade from each plantation. These valuation details are recorded separately and will not be shared with the buyers prior to the auction. Apart from that, another document will be created including details of each tea such as, plantation, tea type, number of lots available, quantity in each lot, etc. This document is referred as the "Tea Catalogue", which is then distributed among the buyers two week before the auction. As soon as buyers receive the tea catalogue, they will come to the broker's premises with their tins and collect samples from each tea grade. Afterwards the tea is again tasted from the buyer side and they will give their own valuation for each tea grade which will not be shared to the broker.

Then at the auction, brokers will announce their pricings while the buyers will bid with their pricings. Auction will take place twice a week (Tuesday and Wednesday) full day at Colombo chamber of commerce. All eight brokers will take turns in the auction one after the other during the two days. Three separate auctions for each low grown, high grown, middle grown are being held simultaneously in three separate floors. At the auction, the brokers will cry out loud the price that they are willing to sell each tea. Subsequently, buyers will bid their price and tea will be sold for the highest bid. Once the deal is finalized the head broker will strike his gavel on the block. All the buyers will have the catalogue with them, and they will write down each price the tea was sold against the price that brokers are demanding. But if the bids are not up to the demanded price by the brokers the tea will not be sold in this auction. It will be taken out from the auction and will brought in back again in the next auction. This will happen repeatedly until the tea line is being sold.

Once the teas are sold over by the broker, the ordered tea lots will be delivered to buyers by the plantations. Sometimes brokers directly send the teas to the buyers. Buyers will then either sell the tea inside the country or export the tea to foreign countries. Furthermore, at the end of the auction all the information on the sales that have taken place will be sent to the tea board for in depth analysis, where most of the reporting is being currently done manually.



Figure 1.2 - Tea auctioning process within tea supply chain

The tea auctioning process (Figure 1.2) would begin from the point where tea was bought into broker's warehouse and end when tea was sold to buyers. When studying the entire tea auctioning process in Sri Lanka, there are many gaps which can be filled with the involvement of information technology. For example,

- When tea is bought into broker's warehouse, invoice details were recorded manually and sent to the broker. In some cases, only the tea samples along with tea invoice would

be directly sent to the broker by plantation. However, these details would then be entered into an electronic system by broker. This entire process takes significant amount of time and creates additional work to the broker.

- Tea auctioning process is mainly handled by the brokers. If the brokers part can be automated, it can reduce over-dependence on brokers, eliminate unfair practices like collusions and price manipulations. In order to automate the tea brokers part, first we need to come up with a mechanism to automate the tea valuation process.
- Next a mechanism is needed to automate the bidding process. This will also include a connection to online payment system.
- On the other hand, today with tea factories increasing the number of grades to meet buyer demand the number of lots are correspondingly increasing, placing a further strain on the system. Since it is an auction on two full days namely Tuesday and Wednesday, it results in a severe strain on buyers. They have to taste, grade and evaluate up to 12,000 different tea lots during the other days of the week, so that they could be prepared to bid for teas at the next week's auction.
- Moreover, when it comes to tea board the data collected from every tea auction will be further analysed which then again will consume significant amount of time due to unavailability of proper reporting system.

But if the tea auction process can be automated and all these stakeholders can be connected through a single software, the above-mentioned issues can be reduced up to a certain extent. It will not only increase efficiency, but also reduce the uncertainties face by the stakeholders. The Tea Auction will then be more transparent and less costly to operate thereby increase competition resulting in a win- win situation for all participants and stakeholders.

### **1.3 Project Objectives**

- Develop a web application, connecting main stakeholders of the tea auction process namely, warehouse, brokers, buyers and tea board.
- Build a prototype to automate the tea auction process (Selling and Bidding), which is currently done manually.
- Optimize invoice registration process at warehouse and reduce the burden from broker.
- Optimize the broker's and buyer's processes by adding more effective mechanisms.
- Provide a complete analysis to tea brokers, tea buyers and tea board, using dashboards.

### **1.4 Project Scope**

The project is focused on automating the auction process in the tea supply chain with a case of one tea broker (Forbes & Walker Tea Brokers PVT LTD), one tea buyer (Ranfer Teas PVT LTD) and the tea board (Sri Lanka Tea Board). Processes connected to tea warehouse, brokers, buyers and tea board will be considered. Processes of tea farming and tea processing will not be considered. Tea plantations will not be connected to the system. Similarly, delivery of purchased tea to respective buyers, tea exporting and importing processes will not be considered.

## **1.5 Outline of the remaining chapters**

### ***Chapter 2 - Background***

This chapter begins by looking into the history of tea auctions. The first Tea Auction in Colombo was held on 1883 in the office of Somerville & Co. From 1885 onwards, the tea auction was held in daily basis. With the time passing, Colombo Tea Auction (CTA) grew to be the largest tea auction in the world in terms of the number of lots sold. Today the Colombo Tea Auction is conducted in two days of the week. Likewise, the chapter continues with exploring the tea auctions in other countries, reviewing similar electronic systems, and investigating prior attempts taken in Sri Lanka to automate the tea auction.

The second half of the chapter contains an analysis carried out in the existing tea auctioning process in Sri Lanka. The main aim here is to identify the functionalities that can be automated and business processes that can be re-engineered. The functional requirements, non-functional requirements and a stakeholder analysis are also included in this chapter.

### ***Chapter 3 - Methodology***

Based on the behaviour of the requirements, different approaches and methodologies are selected to develop the project. The iterative and incremental development lifecycle is planned to be used as the development lifecycle. Object Oriented Approach (O-O) is selected as the most suitable approach. The selected development methodology is RUP (Rational Unified Process). Proposed system will be developed as a Web based system since there will be different users using the system from various locations. The proposed system will have a client-server architecture.

This chapter also includes details about design and implementation of the proposed system. WAMP is installed in the local server to carry out a successful implementation. Software tools such as php, html, javascript, css, powerbi are used to develop the Online Tea Auction system effectively.

### ***Chapter 4 - Evaluation and Testing***

Evaluation process is categorized into two main categories namely, user evaluation and author evaluation. In user evaluation a test run is carried out of the web-based system by tea brokers, buyers, tea board and warehouse. The self-evaluation is carried out to ensure that the project has met the planned objectives initially. Furthermore, a comparison of time spent on each task in current system and new system, is also included here.

The second half of the chapter includes an overview of various test methods carried out to check the functionality of the system.

### ***Chapter 5 – Conclusion and Future Work***

This chapter contains the conclusion of the project. It consists learning outcomes, limitations, review on objectives vs achieved and scope vs achieved. Moreover, it explains the future enhancements of the project that can be used to increase the project efficiency.



## **Chapter 2 Background**

### **2.1 Introduction**

Auctions are simple and well-defined economic environments. Immense volume of economic transactions is conducted through auctions [9]. There were four basic types of auctions that are widely being used all over the world. Firstly, the forward auction (English auction) where goods or services were presented for bidding at an ascending price where at the end of the auction, the bidder with the highest bid would be successful in purchasing the item. Secondly, the sealed-bid auction, where the auctioneer opened all the bids, and the item would be sold to the bidder offering the highest price. Thirdly, the reverse auction (Dutch auction) where the price was decreased descending order until the buyer accepts to pay for the price. Finally, the Vickrey auction where the winner would pay the price that the “runner-up” had bid, which was the next highest price [10]. However, most of the products were sold through auctions globally, at the moment.

When considering the tea industry, 77% of world’s traded tea was sold through auctions. The most common type of auction used for tea was forward auction [11]. Today, with the vast development of Information Technology online auction concept has become more popular. Online auction is an E-commerce technology for trading retail and services across e-marketplace using web-services [10]. Few countries have managed to sold tea through online auctions successfully while others have failed in the journey forward. This was mainly due to the fact that the coverage given by the automated system was not comparable with the manual auctioning process. When considering the Sri Lankan tea auction many attempts were taken to automate it but non- of them were successful attempts.

### **2.2 Tea Auctions**

#### **2.2.1 History**

When taking into account the history of tea auctions, it flies back to 19<sup>th</sup> century. By the middle of the 19th century, tea had become a very popular beverage so that auctions took place monthly, and later on weekly. Tea was transported from Sri Lanka, China, East Africa, and India for sale at the London auction. Different days of the week were devoted to each of the origin country. By 1950s, a third of the world’s traded tea was bought via the London auction [11]. London is the only Auction Centre in the world that is not a producing country but has been marketing teas from numerous producer countries. Once purchased, the tea was sent from the London warehouses either directly to the retailers who sold the tea as loose-leaf teas, or to companies that specialized in blending and packaging. These companies then sold the packed teas under a variety of brand names [12].

Soon after India, Sri Lanka and Kenya became independent states in 1947, 1948 and 1963, respectively, the auctioning activities dropped gradually. The London Tea Auction was closed in June 1997. Another important fact was that the British model relates to the main producing countries where British introduced commercial tea growing. All these countries established public Tea Auction Centres after independence. [11]

Today, there are public tea auction centres in India, Sri Lanka, Bangladesh, East Africa, Central Africa, and Indonesia, all based on the British model and all operating effectively. Some of them were operating for more than half a century. Not only these auctions were the best platform for ensuring satisfactory trade flows, but also the best possible mechanism for obtaining top prices, by ensuring fair competition through fully transparent methods [13].

### **2.2.2 Sri Lankan Tea Auction**

Moving forward to the history of Sri Lankan tea auction, the first Tea Auction in Colombo was held on 30th July 1883 in the office of Somerville & Co., down Queen Street. Prior to this, many tea plantations shipped Sri Lankan teas to the London Tea Auction or sometimes directly to overseas buyers [14].

Regardless of difficulties, Somerville & Co. and the other brokers were able to conduct auctions regularly from 1885. Then in 1894, the Ceylon Chamber of Commerce (CCC) set up the Colombo Tea Traders' Association (CTTA) to formulate rules to conduct the Tea Auction. They supported the common interest of buyers and sellers in the Colombo market [12]. Gradually with the time passing, Colombo Tea Auction (CTA) became the largest tea auction in the world in terms of number of lots sold. Sri Lanka competes mainly in the orthodox tea market where it is the leading producer [15].

In order to meet the changing circumstances, CTA had to undergo many changes over the years. Auctions were initially conducted in the CCC Building in Chatham Street on single day of the week on a regular basis in one auction room. As more and more teas were being sold through the Colombo Tea Auction and the number of lots increased, the auction split over to the second day. With further increase in the number of lots, the CCC Board Room was converted into a second auction room. Likewise, with emerging needs the CTA is now held on two consecutive full days, in three separate auction rooms, located in three different floors of the building, with thousands of transactions taking place each day [16].

### **2.2.3 Tea Auctions in other countries**

There are several tea auctions taking place around the world which are primarily located in major cities of tea growing countries.

#### **India**

India is the largest producer and the third largest Black tea exporter in the world. Tea production in India roots back to eighteenth century and since then the primary marketing channel for tea has been the public auction. Tea auctions in India were held under direct supervision of the auction organizers. The first tea auction in India was held in 1861 in Calcutta [18]. Currently, India has seven operating auction centres, three in North India, three in South India and a small centre in Amritsar. These centres conduct weekly auctions. The world's first electronic tea auction centre 'TEASERVE' was started in India in 2003. But it was unable to sell whole tea through e-auction due to various issues [17]. Therefore, different e-auction systems were introduced afterwards. Today, India is running all its tea auctions electronically and this is further discussed in section 2.3 under Pan India E-auction system.

#### **Kenya (Mombasa)**

The Mombasa Tea Auction was the third largest in the world after India and Sri Lanka. It had been held weekly, on Mondays for the past few years. The major cause for success of Mombasa tea auction was the well-executed pricing strategy. Everything here revolves around pricing and competitiveness. The Mombasa tea auction had created employment to a large workforce and had been the centre of tea business in the African region [19]. Their buyers were major tea

consuming countries in the world namely United Kingdom, Egypt, Pakistan, Afghanistan, Iran, Yemen, Sudan, United Arab Emirates, Ireland, Canada, Somalia, and Singapore. After the closure of the London Tea Auction in 1998 the volumes offered at Mombasa Tea Auction had considerably grown with a massive market expansion. All sales in the Mombasa tea auction were held under self-regulating rules and regulations of the East African Tea Trade Association (EATTA), whose main duty was to ensure fair play in the auction [19].

### **Bangladesh (Chittagong)**

Tea auction in Chittagong, Bangladesh could be introduced as a large, well-organized market for tea. Bangladesh government regulations had requested the tea producers to sell at least 80% of tea in the open market via auctions. Usually there are forty-five auctions held in Bangladesh every year on each Tuesday during months of April to January. These auctions were organized by the tea association of Bangladesh and were administered by the six auction houses in same venue in Chittagong city. On the auction day, all six auctioneers sell their lots one after the other. The sequence of the auctioneers in the initial auction of the year was decided by a lottery. Each auctioneer was allocated fifteen seconds on average to auction off a lot. The most interesting feature of Chittagong tea auction was that some of the large buyers, having their own brand of packaged tea for retail market, also own tea estates and even purchase their own tea from the auctions [20].

### **Indonesia (Jakarta)**

Tea auctions in Indonesia (Jakarta) were first traded in 1972. It was the only market where tea was auctioned in US dollars and only 15% of tea produced in Indonesia was marketed via auctions. Auctions were held on every Wednesday. The market structure applied here was oligopolistic where only few buyers dominate the entire auction. This market structure has caused the price transmission from consumer market to farmers to be asymmetric which means if price increases at the consumer level, the increase was not passed on to farmers quickly and perfectly. [27]

### **Japan (Kyoto)**

Tea auctions in Japan were a bit different to other countries. But most of the tea in Japan was sold via tea auctions. The first opening of the auction was always a great event. It gathers people from all stralls of the tea industry. Though tea buyers and tea wholesalers were the key participants here, tea farmers, agricultural cooperative staff (who are the organizers of the auction), as well as media representatives can also be found here. Majority of the tea in the auction was machine-harvested and processed. The auction starts in the morning when available tea is displayed in the evaluation plates. Potential buyers can walk around and check the samples of dry tea leaves and the brew of the teas available on that day. Once they have made their choices, they send their bid via electronic machines. Afterwards, everyone is invited to a celebratory lunch, prepared by the auction staff. In the Japanese traditions a toast is a must. Therefore, at this lunch everyone toasts with a cup of tea. While everyone is enjoying lunch, the auction staff will decide the winners of the bid and allocate the tea accordingly. At the end of the day, buyers can take back the tea [28].

## 2.3 Review of similar systems in other countries

- ***Pan India e-auction system***

This electronic auction system is being used by all six auction centres in India, namely Kolkata, Siliguri, Guwahati, Cochin, Coimbatore and Coonoor. Various users of this system including Manufacturers, warehouses, auctioneers, and buyers are provided with access to different functions of the system. This system integrates process starting from creation of invoices till the delivery of tea from the warehouse. Each auction centre is entitled to carry functions like registration, information maintenance etc. This system is supervised by the tea-board of India [21]. The main aim of launching this system was to link the gap between buyers and sellers and increase an extensive participation in the auctioning process, providing uniform auctioning rules across all auctioning centres in India. The e-auctioning system was initially started in 2009 but due to lack of uniform platform and rules, the growth was restricted [22]. Afterwards, in 2016 it was relaunched with adequate changes and is successfully operating until now.



Figure 2.1 - Pan India e-auction system

- ***FreeMarkets Inc.'s Bidware auction hosting software***

FreeMarkets Inc. started by conducting auctions online in 1995. Their main focus was in the industrial market. Though they had fast number of competitors they managed to gain leadership role in creating B2B online auctions for buyers of industrial parts, raw material, commodities and services around the globe. Its services have modelled around five main areas. Automotive, consumer, energy, high technology, manufacturing and public sector. The success of Bidware is mainly due to team collaboration as they successfully work closely with customers and suppliers. The aim they have on their customer is to establish their purchasing needs and expectations so as to connect with potential suppliers that will help them to meet those needs. Some advantages that FreeMarkets provide are cost savings, speed when completing negotiations, faster return on investment, supplier consolidation, global sourcing and better market information [24].

- ***Promena e-auction***

Promena offers Site recovery management services, e-Sourcing, e-Auction and e-Procurement with the aim of providing high efficiency, labour and cost savings and effective control of time to its customers in their purchasing activities. Promena supports 5 types of auctions which are commonly used by buyers: English Auction, Japanese Auction, Dutch Auction, Yankee Auction, Brazilian Auction. This was found in year 2001 by Koc Holding, Turkey and Carlyle Group, USA. Their main aim was to provide effective control of time, labour and cost savings

to its customers in their purchasing activities. To achieve its main objective, it combined both global and regional market know-how, and high technology system. This e-auction solution provides on demand electronic auction event management services and integrations with ERP. It handles wide variety of goods and services [29].

- ***Xpert auction software***

Xpert Auction is an auction company based on Dallas that provides superior performing auction solutions for all industries such as weddings, Golfing, clothing, Pets, Freelancers etc. It was a single seller auction system and handles various business lines such as: commercial auctioneers, collectibles dealers, charity events, advertising and promotional auctions and auctions for media outlets like radio, television or newspaper. Their goal was to ensure the success of Online Auction Companies. This software was created for Online Auctioneers by Online Auctioneers. It is tailor made for estate liquidation sales & auctions [29].

- ***eBay Auction***

eBay auction is the largest online auction site today. It was first started in April 1998. When a seller lists an item for sale in an eBay auction, he needs to choose a starting price, and interested buyers would then place bids. When the auction ends, the product would be sold to the highest bidder. Seller is given the chance to choose whether their auction should run for 1, 3, 5, 7, or 10 days. A 1-day auction is designed for time-sensitive items, such as event tickets. Unsold auctions would be relisted automatically. eBay's auction-style listing is called proxy bidding which is equivalent to a Vickrey auction (sealed-bid), with few exceptions [30].

## 2.4 Feature Comparison

System	Scope	Features	Drawbacks
Pan India e-auction system	Tea auctioning	<ul style="list-style-type: none"> <li>• Overcome challenges such as longer credit periods for sellers, handling buyer's payments by brokers and cancelling deals after knocking down of lots, etc.</li> <li>• Buyers can participate in all auction centres with a single registration.</li> <li>• Introducing online post settlement process through a settlement bank. [22]</li> </ul>	<ul style="list-style-type: none"> <li>• Broker centric.</li> <li>• No integration to the ERP system.</li> <li>• Issues in payment settlement. [23]</li> </ul>

FreeMarkets Inc.'s Bidware auction hosting software	Industrial parts, raw materials, commodities and other services around the globe.	<ul style="list-style-type: none"> <li>• While providing the auction software it also helps to ensure that the right bidders participate in the auctions. A market operations team works with customers to guarantee that the proper bidders are invited to auctions and that they are connected when the auction begins.</li> <li>• Superior design which provides immediate response. [24]</li> </ul>	<ul style="list-style-type: none"> <li>• No separation between Business-Consumer. [24]</li> </ul>
Promena e-auction	Management of Auctions, Bids, Catalogues, Contracts, Inventory, Invoice processing, punch-out, purchase-order, etc.	<ul style="list-style-type: none"> <li>• It is in Saas platform. [29]</li> </ul>	
Xpert auction software	Wide variety of commodities	<ul style="list-style-type: none"> <li>• This is a single seller auction. [29]</li> </ul>	<ul style="list-style-type: none"> <li>• Lacks specialized model. [29]</li> </ul>
eBay auction	Any item can be sold through e-bay auction	<ul style="list-style-type: none"> <li>• Allow buyers and sellers to provide feedback on their latest auction experience.</li> <li>• Offer buyer protection shield from \$200-\$500 with no additional cost.</li> <li>• Help users to prevent from online fraud, by conducting tutorials online. [33]</li> </ul>	<ul style="list-style-type: none"> <li>• Many fake items being sold in the auction.</li> <li>• Some delivery information is not shared with the buyer upfront. (e.g.: Carrier used to ship). [31]</li> </ul>

Table 2.1 - Feature comparison of similar systems in other countries

## 2.5 Prior attempts taken in Sri Lanka

- E-gavel Application

For number of years, the “online tea auction” concept was on hold. It was mainly due to fear of losing the existing physical bidding. During early 2000s, although many buyers in the industry had begun to get used to the automated system, not all buyers were for it. Therefore, the automation concept was on hold for some more time. Another factor was that it was unable to capture the subtle things like facial expressions that indicate what bidders are thinking, in an automated auction. Then in 2013 John Keells together with Mobitel innovates an electronic tea auction system named “E-gavel” application. It was a tablet-based application and the main purpose of it was to capture tea auction information real-time. This project initially started as a pilot project. John Keells PLC was one of the well-known and experienced tea brokering company in Sri Lanka. Therefore, the domain knowledge required to develop this application was provided by them. As soon as the buyer and the price information were captured, they were uploaded to back-end systems simultaneously. John Keells PLC CEO, Sudath Munasinghe pointed out that e-gavel was an error free system. However, E-gavel application was not continued for a long time due to some unavoidable issues [4].

- mAuction

Taking inputs from principals of E-gavel application, Mobitel once again in 2015 together with John Keells PLC, came up with an application named “mAuction”. The main aim this time was to bring the auctioneering services to the stakeholders’ fingertips in real-time. A high concern was given to time saving of application users. mAuction suite consisted of three parts. The buyer’s app, broker’s app and auction viewer software. The mAuction service was available to buyers, brokers and their back-office staff through the Buyer’s app, Broker’s app and Auction Viewer software, respectively. All three applications were compatible with Apple iPads. Also, users can get connected through web browsers in any device. Using the mAuction application, the buyers as well as brokers could analyse and track their demand and supply fulfilment, respectively in real-time during the auction. Afterwards, the data could be uploaded to their back-office systems for payment and logistical processing. This could be done through the web or via a CSV file transfer. This feature was mainly developed to eliminate the time spent on uploading auction details manually to internal systems by both brokers and buyers. Even though, there were many useful features, this application did not become a long-term success either [5].

- Online Tea Auction held due to Covid-19 pandemic lockdown

Due to Covid-19 pandemic, Colombo tea auction could not be hold for two whole weeks continually as Sri Lankan citizens were asked to maintain social distancing. Then, for the first time in history of Sri Lanka, the Colombo tea auction was held online on 4<sup>th</sup> April 2020. Here, four hundred million kilogrammes of tea were auctioned. The electronic auction was initiated

by Ceylon Tea Traders' Association (CTTA) with the help of Sri Lanka tea board (SLTB) and Export development Board (EDB). The platform was developed by CICRA Solutions. According to CTTA Chairman Jayantha Karunaratne, it was challenging at the beginning as they had to teach people how to take part in online auctions, while they had less time to prepare. Samples of the teas on offer were visually reviewed by the tea buyers and accordingly purchased by registering their bids from remote locations. The electronic auction was held straight for three days. The major problem in this system was that the selling moves in a slower phase when compared to the manual system. Therefore, it was held for four consecutive days [6]. However, the initial e-auction was a success and the respective authorities were hoping to continue the electronic platform with further developments even after Covid-19 [25]. Another noticeable factor was that, there was a very high demand for the Sri Lankan Black Tea during the e-auction as it was found by scientists that content of "Theaflavins" in black tea increase the human immunity against COVID-19 [26].



*Figure 2.2 - Sri Lanka's first ever tea auction via a digital platform*

## **2.6 Reasons for failure of online tea auctions**

In Sri Lanka, the role of tea auction is of great importance. It is mainly because the regulations have restricted producers from selling any considerable amount of their teas outside this channel. Therefore, the auction is conducted in a very transparent, organized, and disciplined manner. Prices paid for every tea on offer are publicly announced, which provides an equal level of playing field for all the participants [32]. Hence, the feeling of being equally treated is one of the crucial aspects that is difficult to provide immediately when using an electronic auction system.

During early stages, although many people in the industry had begun to get used to automated tea auctioning systems, not all buyers were for it. The major cause here was the fear of losing the existing physical bidding. It was unable to capture the subtle things like facial expressions that indicate what bidders are thinking, in an automated auction [4]. Each bidder tries to surpass his competitors every week. The auctioneer must maintain perfect eye contact with each buyer, who is seated on the semi-circular, tiered seating area for participants. This is of extreme importance because only occasionally a buyer would really voice his bids. He may make subtle gestures such as raise a hand, eyebrow, or finger, nod his head, or wink an eye. All these gestures are equally traditional [32]. But with an electronic auction system, these things are difficult to incorporate.

Therefore, it is important to take these factors which caused the online tea auctions to fail, into account when planning the new system. The rest of this chapter will include details of the existing tea auction process and requirements gathered through analysis of existing system and potential similar systems.



## 2.7 System Analysis - Introduction

In-depth analysis of the problem domain is crucial to find an appropriate solution for the problem. As mentioned in Chapter 1, presently the entire tea auction process in Sri Lanka is operating manually. Therefore, this analysis was carried out to identify the functionalities that can be automated and business processes that can be re-engineered.

## 2.8 The existing tea auction process

The starting point of the current auction process is when tea is being unloaded in broker's warehouse. The ending point is when the tea is sold to respective buyers.

- **Warehouse**

The tea is being grown either by estate owners or small holders. Tea collected from small holders will also be transported to estates. Then estate owners will bring tea to the broker's warehouse. The process taking place at the warehouse is displayed in the below context diagram.

Afterwards, the filled invoices along with tea samples will be sent to the broker's sample room.



Figure 2.3 - Existing warehouse process

- **Broker**

Prior to considering the processes carried out by brokers, there was another factor to notice. There were two types of estates where tea was grown. Main-estate and ex-estate namely. Tea from main estates would directly transport to broker's warehouse. But if the tea were from ex-estate, only the invoice and the samples would be sent to the broker. However, once the broker receives the invoices, he would feed the invoice data to an electronic system that is in use currently. Including that, given in the context diagram are the processes carried out by a broker.

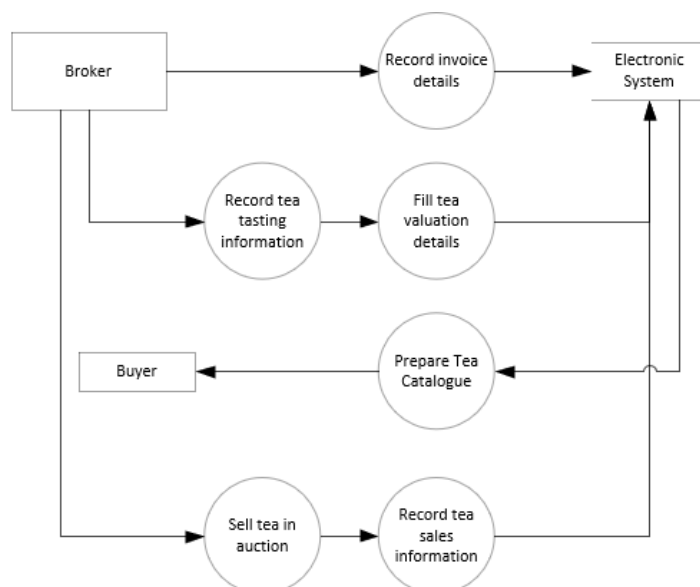


Figure 2.4 - Existing Broker processes

Once the tea valuation was done by the broker, he sends a report with planned pricings for each tea to the respective plantations/estates prior to the auction. Plantations were given the chance to negotiate the pricings with broker if they demand a high price for their products.

After the auction, brokers will deliver the purchased tea to respective buyers. Remaining tea from the auction would be re-catalogued to the next auction. If the tea remains unsold for a long period, the plantations will take them back.

- **Buyer**

Two weeks prior to the auction the catalogue would be distributed to buyers. Afterwards, buyers collect tea samples from broker and do the valuations separately, in which the results would not be shared with brokers. Buyers would reveal their expected prices for each tea only at the auction.

At the auction buyers were given the authority to bid for each tea and the tea purchasing will take place at the end of the auction. The context diagram of the processes carried out by ‘buyers’ is as displayed below.

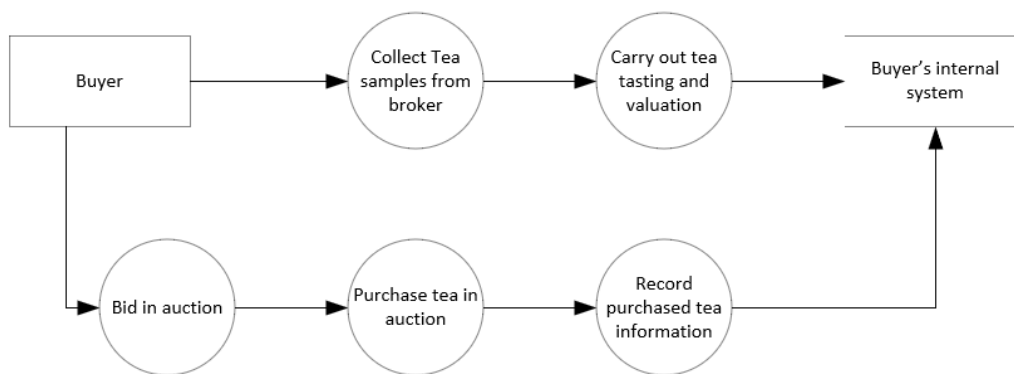


Figure 2.5 - Existing Buyer processes

- **Tea board**

After each auction, a report was sent to the tea board by broker, which would then be taken for further analysis. Apart from that, all catalogues, tea purchasing details and yearly reviews of brokers as well as buyers would be sent to the tea board. All these records were taken for decision making and to prepare government annual reports.

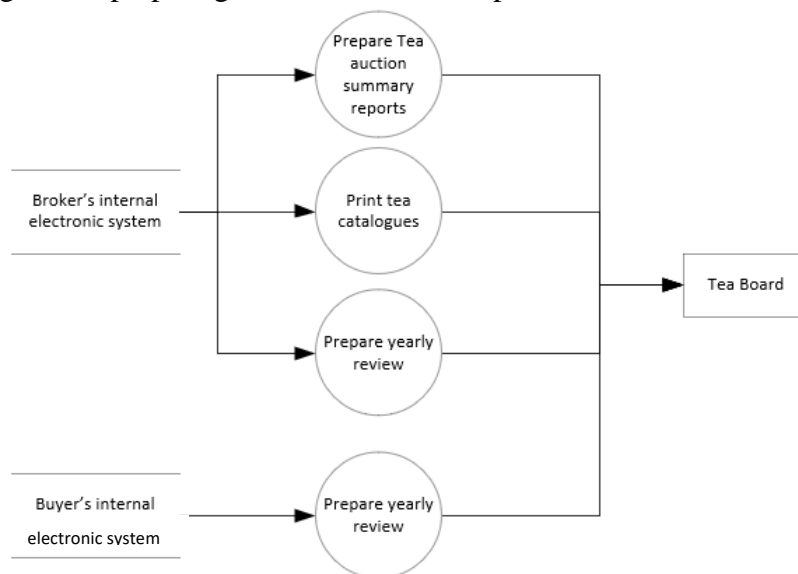


Figure 2.6 - Existing Tea Board processes

## 2.9 Functional Requirements

Functional Requirements of a system describes the behaviour of the system. In order to achieve the project objectives, these functionalities should be included in the system. They are unique to any given system. The high-level view of the functional requirements of Online tea auction system are as follows.

1. Tea Warehouse
  - Login to the system
  - Add new invoices
  - View plantation details
  - View past invoices
  
2. Tea Broker
  - Login to the system
  - Fill broker tea valuation details
  - Prepare tea catalogue
  - View tea auction interface
  - View tea broker dashboard (*Refer section 3.18*)
  
3. Tea Buyer
  - Login to the system
  - Fill buyer tea valuation details
  - View tea auction interface
  - Bid in auction
  - View catalogue
  - View tea buyer dashboard (*Refer section 3.18*)
  
4. Tea Board
  - Login to the system
  - View Tea board dashboard (*Refer section 3.18*)
  - View tea catalogue
  
5. Administrator
  - Login to the system
  - Add/update/remove users

A detailed elaboration of the functional requirements is given in table 2.2.

User	User Requirement ID	User Requirements	System Requirement ID	System Requirements	Use Case
Tea Warehouse	UR1	The user should be able to login to the system	1.1	The system shall allow the user to login to the system by providing the accurate username and password.	Log In
			1.2	The system shall generate an error message if the username or the password is incorrect.	
	UR2	The user should be able to fill the invoice data through the system	2.1	The system shall enable the user to add invoice details (Plantation, Tea grade, Quantity, Quantity in 1 bag).	Fill new invoices
			2.2	The system shall enable the user to submit the invoice details.	
	UR3	The user should be able to view the past invoices.	3.1	The system shall enable the user to retrieve the invoice data from the database.	View past invoices
Tea Broker	UR4	The user should be able to login to the system	4.1	The system shall allow the user to login to the system by providing the accurate username and password.	Log In
			4.2	The system shall generate an error message if the username or the password is incorrect.	
	UR5	The user should be able to fill the tea tasting / valuation details	5.1	The system shall enable the user to add tea characteristics.	Fill broker tea valuation details
			5.2	The system shall enable the user to add / update tea pricing.	

	UR6	The user should be able to fill catalogue details	6.1	The system shall enable the user to add catalogue details (Lot no, Bag type, No. of bags in a lot, Grade, invoice no. etc.)	Prepare tea catalogue
	UR7	The user should be able to view the auction interface.	7.1	The system shall enable the user to start auction.	View tea auction dashboard
			7.2	The system shall enable the user to bid in auction.	
			7.3	The system shall enable the user to end auction.	
	UR8	The user should be able to view the Tea Broker dashboard	8.1	The system should enable the user to view embedded Power BI dashboard	View Tea broker dashboard
Tea Buyer	UR9	The user should be able to login to the system	9.1	The system shall allow the user to login to the system by providing the accurate username and password.	Log In
			9.2	The system shall generate an error message if the username or the password is incorrect.	
	UR10	The user should be able to enter customize tea valuation details	10.1	The system shall enable the user to add tea characteristics.	Fill buyer tea valuation details
			10.2	The system shall enable the user to add/update tea pricing.	
	UR11	The user should be able to view the catalogue	11.1	The system shall enable the user to add comments to the catalogue including their pricing. (Only for personal reference)	View catalogue
	UR12	The user should be able to Bid in auction.	12.1	The system shall enable the user to enter their pricing in auction.	Bid in auction
UR13	The user should be able to pay online	13.1	The system shall direct the user to pay pal account.	Pay online	

	UR14	The user should be able to view the Tea Buyer Dashboard	14.1	The system should enable the user to view embedded Power BI dashboard	View Tea Buyer Dashboard
Tea Board	UR15	The user should be able to login to the system	15.1	The system shall allow the user to login to the system by providing the accurate username and password.	Log In
			15.2	The system shall generate an error message if the username or the password is incorrect.	
	UR16	The user should be able to view the tea board dashboard.	16.1	The system should enable the user to view embedded Power BI dashboard	View tea board dashboard
	UR17	The user should be able to view updated catalogues.	17.1	The system shall enable the user to view completed catalogues with final pricings	View updated catalogues
Administrator	UR18	The user should be able to login to the system using given credentials.	18.1	The system shall allow the user to login to the system by providing the accurate username and password.	Log In
			18.2	The system shall generate an error message if the username or the password is incorrect.	
	UR19	The user should be able to add / update / remove user profiles.	19.1	The system should allow the user to add / update / remove user profiles.	Add, remove and update users
	UR20	The user shall be able to allocate permission levels to users.	20.1	The system should allow the user to select permission levels for each created user role	Create user levels

Table 2.2 - Functional Requirements

## 2.10 Use case diagram



Figure 2.7 - Use case diagram

Refer Appendix A for modularized version of the use case diagram based on actors.

## 2.11 Use case Descriptions

### User Login

Use case name	User Login	
Description	This use case describes how a user will login to the system.	
Actors	Tea Warehouse	
Purpose	Enables the tea warehouse to login to the system to add new invoice or view past invoices.	
Pre-conditions	Tea Warehouse should be a registered member of the tea board and should have a valid account.	
Main flow	Actor's actions	System responses
	1. Tea warehouse click on login button in the homepage.  3. Tea warehouse enter the username and password.	2. The system will display the login interface.  4. Validate the user against the details entered.  5. Authorize the user to login to the system.  6. Redirect the user to pages where he has been granted permission.
Alternative courses	3a. In step 3, if the tea warehouse enters incorrect details or remain the text boxes blank an error message will be displayed requesting the user to re-enter the username and password.	
Post conditions	The tea warehouse will successfully login to the system.	

Table 2.3 - Use case description (User Login)



## View catalogue details

Use case name	View catalogue details.	
Description	This use case describes how the tea buyer will be able to view the catalogue after it is published by the tea brokers.	
Actors	Tea Buyer	
Purpose	Enables the tea buyer to view catalogue for the upcoming tea auctions and use it in their valuation process as well as bidding process at the auction.	
Pre-conditions	Tea Buyer should be logged into his account and be given the necessary permissions to access the catalogue.	
Main flow	Actor's actions	System responses
	1.Tea buyer access the catalogue tab.  3.Tea buyer add comments to the catalogue including their pricing for tea after their tea valuation.  5.Save final comments. 7. View the updated catalogue at the auction when bidding	2.The system will display tea catalogue for upcoming tea auction.  4.Enable tea buyer to add comments.  6. Save comments / pricing in a separate field. 8.Display updated catalogue.
Alternative courses	1a. In step 1, if the tea buyer doesn't have relevant permission to view the catalogue, he cannot add further comments to it or view it during the auction.	
Post conditions	The tea buyer will successfully view and add comments to the catalogue and use it as a record during the auction process.	

*Table 2.4 - Use case description (View catalogue details)*

Refer appendix B for other use case descriptions

## 2.12 Non-Functional Requirements

Non-functional requirements describe the quality attributes of the system. It validates the performance of any system. Given below are the non-functional requirements of Online tea auction system.

- User friendliness
- Reliability
- Availability
- Response time
- Security
- Compatibility

These non-functional requirements are further elaborated in table 2.5.

Requirement ID	Constraint	Description
NFR1	User Friendliness	<ul style="list-style-type: none"> <li>• The system should contain attractive features that will maximize user-experience.</li> </ul>
NFR2	Reliability	<ul style="list-style-type: none"> <li>• The website's maximum downtime should not exceed 30 minutes.</li> </ul>
NFR3	Availability	<ul style="list-style-type: none"> <li>• User should be able to access the website any given time.</li> </ul>
NFR4	Response time	<ul style="list-style-type: none"> <li>• The response time of the system should be less than 30 seconds.</li> <li>• The system should load all its functions in less than 2 seconds.</li> </ul>
NFR5	Security	<ul style="list-style-type: none"> <li>• The website should hold 5 different types of logins.</li> <li>• The website should be linked with backup software.</li> <li>• The website should be protected through firewalls.</li> <li>• The password should contain minimum 8 characters.</li> </ul>
NFR 6	Compatibility	<ul style="list-style-type: none"> <li>• The System should be compatible with mobile devices and different web browsers</li> </ul>

*Table 2.5 - Non-functional Requirements*

## 2.13 Stakeholder Analysis

Stakeholders are individuals or groups those who have an interest towards a system. Table 2.6 shows the stakeholders involved in the proposed system.

	<b>Stakeholder Name</b>	<b>Description</b>
Stakeholders within the system	PM	Manages the entire project while setting milestones.
	BA	Study the existing system, gather requirements, and prepare relevant diagrams and documentations.
	Developer	Builds a working prototype of the system after the functional and non-functional requirements are identified.
	Tester	Once the system is developed, does testing with the system functions to identify bugs.
Stakeholders in the containing system	System Admin	The system admin will have a major control over the system and will change user access levels and privileges according to user.
	Warehouse	The warehouse will be given the minimum permission level in the system as it has only permission to fill the invoice and view past invoices.
	Tea Broker	The tea broker will be the main decision maker in the system and will have a high influence over the system as he creates the catalogue and sell tea at the electronic auction
	Tea Buyer	The buyer will also have a high influence over the system as he can bid and purchase tea in the electronic auction.
	Tea Board	Will be able to view high level, summarized reports that will be used in government decision making.
Stakeholders in the wider environment	Competitor	Will have interest towards the methods of holding an online tea auction.
	Banks	The banks will have a significant influence over the system and there will be online transactions taking place during the bidding process.
	Government	Will have interest in productivity increase of tea trading sector by minimizing biasness towards tea brokers.

*Table 2.6 - Stakeholder Analysis*

## 2.14 Summary

In conclusion, the gathered requirements from literature review and analysing the existing system, will be used as features of the new system. This new system will not only increase the productivity of the tea auction but also add more value to the tea supply chain in Sri Lanka.

# Chapter 3 Methodology

## 3.1 Introduction

After analysing user’s requirements, available resources, and roles this chapter analyses the most suitable way to develop the designed solution for the system. High-level diagrams and structures are used to identify the best design for the system. The use case model provided in this chapter helped to understand the system requirements in this user-centred system. The use case descriptions help to understand the system functions in terms of business actions that cause the beginning of the events and how the system reacts to those events. The ER diagram produced in this chapter helped to design the database for the system. It graphically represents the relationship between people, object, places, concepts, and events within that system. Class diagram defines relationship between source code dependencies among classes. There are different approaches and methodologies used to develop the online tea auction system and each method is described briefly in this chapter. A summary is given below.

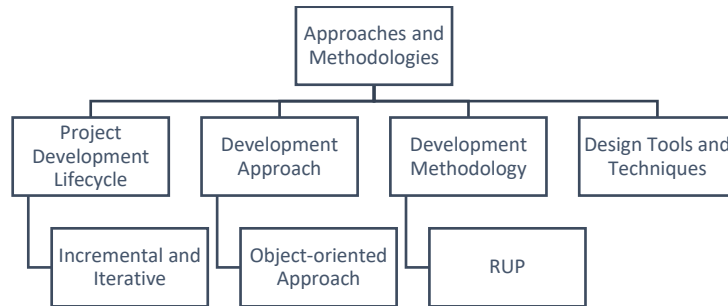


Figure 3.1 - Approaches and Methodologies used (Summary)

## 3.2 The proposed method

The proposed method is to implement a single electronic system connecting warehouse, broker, buyer, and tea board with a common database. All the processes currently carried out by each party manually, will be automated with some value additions. Paper based filing systems will no longer be required once this system is implemented. A new concept to hold tea auction electronically will be introduced in this method. Given below is an overview of how processes of each party mentioned in section 2.8, will be replaced by the proposed system.

- **Warehouse**

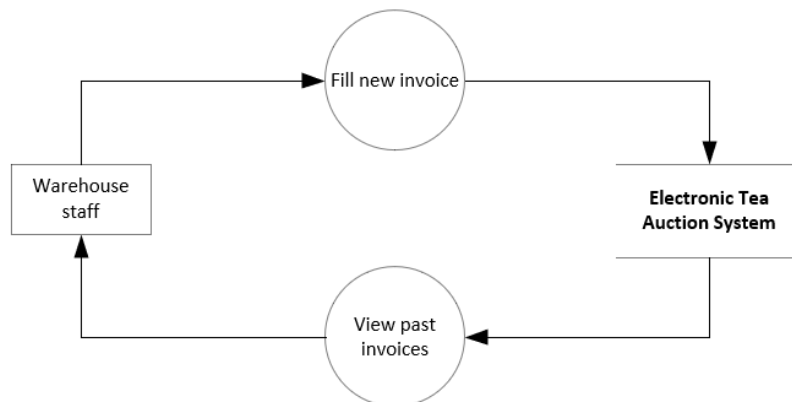


Figure 3.2 - Warehouse processes in proposed system

In the proposed system, the invoice entering part would be solely carried out by warehouse staff without involving the broker. Most importantly, invoices received via email/fax in different formats such as pdf, JPEG, .xls, .csv etc. can be uploaded to the system easily. Another major fact to note is that if warehouse staff gets any doubts regarding the invoice details while entering it to the system, they can easily clarify it with the sender as the system will prompt contact information of each plantation at a side of the same interface.

- **Broker**

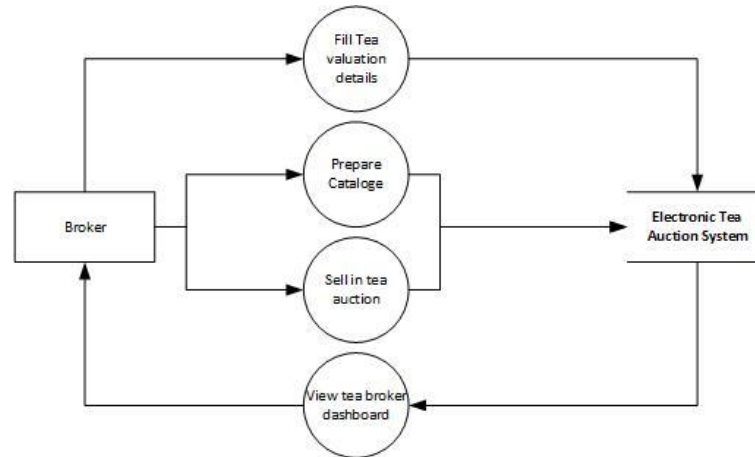


Figure 3.3 - Broker processes in proposed system

In the proposed system broker will have less details to enter to the system in both valuation and catalogue creation as most details will be auto prompt based on unique identifiers (Primary keys) to make their tasks easy-going.

When considering the method used for E-auction, it is more similar to a board game where the bidders were given a fixed time period to bid for a specific tea after the broker announces the expected tea pricing. At the end of the allocated time, the tea would be sold for the highest bid. Every time when a buyer bids for a tea, their demanding price will be displayed in the auction interface along with their identity / photo. A gaming concept was selected to retain the lively nature of the manual auction. Since there is a time allocation for each bid, the auction will not drag for long period unnecessarily.

- **Buyer**

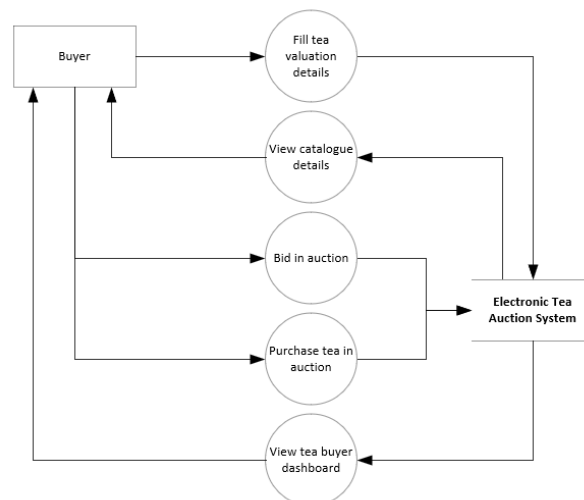


Figure 3.4 - Buyer processes in proposed system

Buyer will also have a similar process for tea valuation to broker. Apart from that during the E-auction buyer will get a chance to view the broker’s catalogue along with buyer’s demanding price while the auction is taking place. After the auction, buyer will have a separate interface to view the purchased teas and will be given the chance to pay online for their purchased orders there itself through a pay pal account.

- **Tea board**

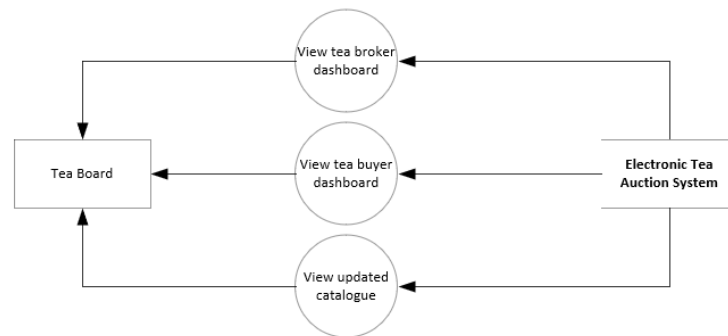


Figure 3.5 - Tea Board processes in proposed system

Dashboards play a vital role in the proposed system. Both brokers and buyers were provided with lively updating dashboards. The main aim here is to let them evaluate their performance real time and take decisions accordingly. In the existing system the dashboards were not readily available and most of the times reports were created feeding the data stored in excel files. Separate staff were also allocated to create these reports. But in the proposed system the relevant KPIs, metrics will be directly visible at any given time with a very short delay. Also, if a detailed report is required the dashboard data can be exported to pdf or csv easily.

In terms of tea board, the data that is required by the tea board will be easily accessed by simply granting permission to tea board, to the relevant web pages. Therefore, additional staff is not required to prepare reports to be sent to the tea board after every tea auction. Furthermore, the manual report creation carried out by tea board staff after every auction can also be eliminated.

### 3.3 Process / workflow diagram of the proposed system

Figure 13 depicts the process and the workflow diagram of the proposed system with the users, their tasks and the flow of the work.



Figure 3.6 - Process / Workflow diagram of the proposed system

### 3.4 Approaches and Methodologies used

#### Project Development Lifecycle

As the project development lifecycle, the waterfall lifecycle method and the iterative and incremental development lifecycle method were considered initially.

Based on the behaviour of requirements of the online tea auction system, *the iterative and incremental development lifecycle* has planned to be used for the project. There can be many changes taking place within the duration, in the different parts of the project, e.g.: problem domain, requirements etc. By using iterative and incremental life cycle it is possible to incorporate change without affecting the entire project. This is mainly due to repetition of phases of this life cycle. The risk and uncertainty of the project is low, as it breaks down the project into small, manageable parts such as designing mock-ups, developing high priority functions first etc.

But in the waterfall lifecycle method, all the requirements should be clearly defined at the beginning and each step (Requirements, design, development, Testing, deployment, maintenance) needs to be fully completed before going to the next step. Therefore, changes taking place during the project duration cannot be incorporated.

#### Development Approach

Structured approach and object-oriented approach were initially taken into account to select a suitable development approach to develop the prototype of the project.

*Object Oriented Approach* (O-O) is selected as the most suitable approach to develop this project. It is mainly due to various reasons, such as code reusability and real-world modelling. Similar code could be used for similar functions. For example, tea valuation function of the online tea auction system was used by both broker and buyer. Therefore, the similar code could be used. This save the additional time spent on development while reducing the cost. Real world modelling concept of O-O approach will help to minimize the complexity of the system functions as they could be analysed, designed, developed in different phases.

The structured approach was omitted due to the fact that it uses the traditional waterfall lifecycle which does not incorporate change in the project. Since the requirements of the project can be easily changed based on the needs of the main stakeholders, this approach will not be useful for the project.

#### Development Methodology

*RUP (Rational Unified Process)* is selected as the most suitable development methodology for this project out of all other methodologies under object-oriented approach. RUP splits the project life cycle into four phases where all six core development disciplines take place during each phase. RUP enables adding new requirements or changing the existing requirements of the project with less risk. The main goal of RUP is to create high quality software with a predictable time frame and budget. Each of the life cycle phases

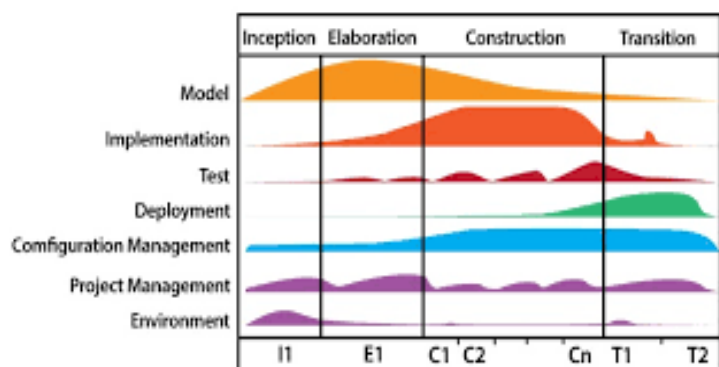


Figure 3.7 - Rational Unified Process model

can be repeated, if required, until the main objectives are met. Once the transition stage is completed successfully, the project is over.

These features were highly required in this project since it had many suggestions from the different stakeholders involved. Therefore, with the new knowledge gaining, the functions had to be changed completely. Use of RUP methodology aided in handling this issue with minimum impact to the rest of the tasks in the project.

### Application type

The proposed system will be developed as a **Web based system** as there will be different users using the system from various locations (e.g.: tea brokers, buyer, tea board etc.). Therefore, it is more convenient for the users to log into the system through internet from any electronic device rather than having the software installed on a on premise desktop. Moreover, the user-interface of web-based applications are easier to customize than desktop applications which leads to easy updating feature. Developing a web-based application is more cost effective when compared to desktop application as it can be developed for a single operating system.

### Architecture

The proposed system will have a **client-server architecture** as it gives anytime accessibility, improved collaboration, remote access, enhanced security when compared to other architectures. These are vital for this system as different user roles will be using the system from various locations. Client-server architecture also provides room for business growth which will also be an advantage for this system.

### 3.5 High-level Architecture of the system

The system will consist one database server with four separate user logins to the system.

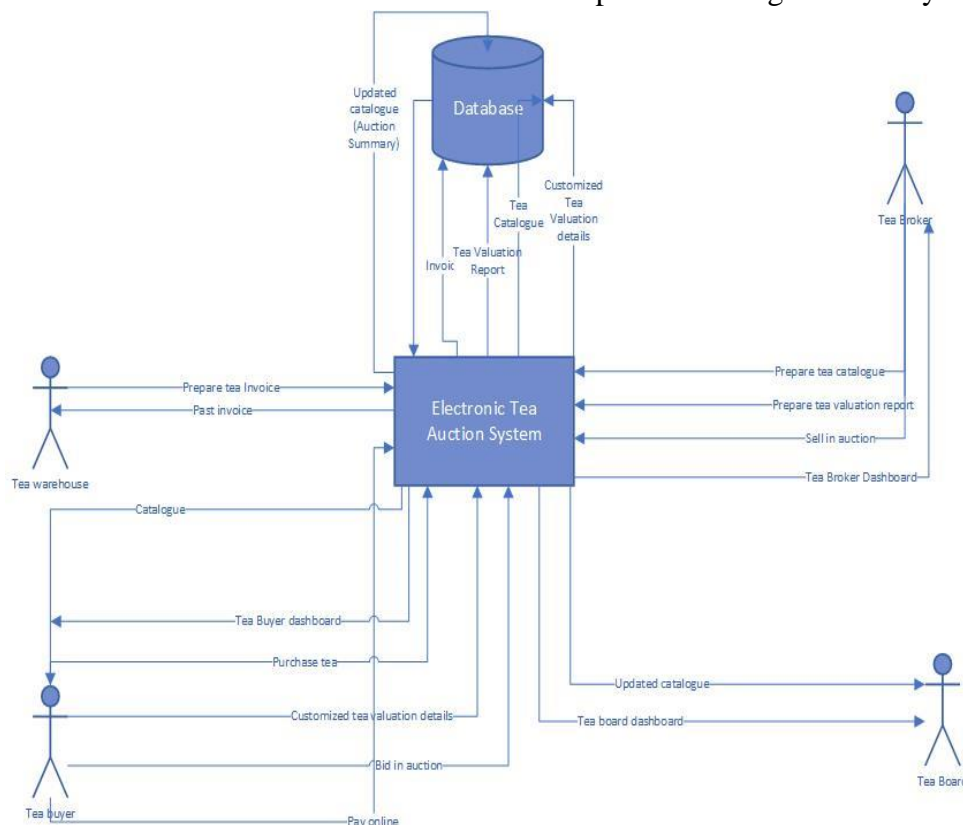


Figure 3.8 – High-level Architecture of the system



In addition to above-mentioned approaches and methodologies, a range of software tools and techniques are also used in this project for process improvement.

### 3.6 Tools

#### 3.6.1 Software Tools

The final system runs on a typical web environment which consists of relational database system, web server, web application and the user interface or client browser. The system was developed in a single machine or server with the following software installations.

Purpose	Selected tool	Remarks
Server Operating system	Windows	Windows provides access to many freeware and shareware. It also provides more options to hardware when compared with other operating systems.
Web server	Apache 2.4.41	Apache web server is selected due to its speed, security and reliability when compared with other web servers.
Web applications	PHP 7.3.12 Java Script CSS HTML	These were used as developing languages. HTML was used to create interfaces of the website.
Prototyping	Notepad++	Notepad++ software is used to develop interfaces of the web application.
Database	Maria DB 10.4.10	Used as Database server
Database Interface	phpMyAdmin	Used as Database Interface
Project documentation	MS Word 2016	MS Word was selected for the entire documentation of the project as it is commonly used and accepted by majority. MS Word 2016 provides various templates and formatting options to fulfil the requirements of the user. It is more user-friendly, when compared to open office. Moreover, MS Word provides users many new features that aids the documents to be prepared in a professional manner, where such features are lacking in open office.
Referencing	RefMe	RefMe was selected for the referencing of the entire project as it is less time consuming and provides accurate results while having a high usability.

Diagramming (General) Storyboarding/Mock-ups	MS Visio 2010	MS Visio provides large number of features compared to other diagramming tools available.
Survey	Google Forms	Google Forms was selected because it was easier to understand than Survey Monkey and provides a responses summary feature which is useful when analysing the results of questionnaire.
Survey analysis	MS Excel 2010	MS Excel 2010 was used to analyse the questionnaire results by creating graphs for each key findings of the survey. This was selected over google sheets due to its availability of range of features.
Dashboard creation	Power BI	Power BI was used to create the auction interface and other dashboards.

Table 3.1 - Software Tools used

### 3.6.2 Hardware Requirements

Along with the above software tools, the final system had below hardware requirements.

	Minimum Specification	Recommended Specification
Processor	Intel(R) Core I5 or equivalent	Intel(R) Core I5
Memory	16 GB	16 GB or more
Wired network card	10/100 baseT Ethernet	10/100 baseT Ethernet
Hard Drive	1 TB hard drive space	1 TB hard drive space or more

Table 3.2 - Hardware Tools used

Apart from the software and hardware requirements below communication requirements were also needed by the system.

- TCP/IP would be used for main communication interface
- Dedicated internet link would be used in the future

## 3.7 Techniques

### 3.7.1 Sampling techniques

Sampling techniques are widely used due to the speed at which the data can be collected and the low cost. There are two main types of sampling, and each one includes their own sampling methods.

1. Probability sampling – Each member of the population has a non-zero probability for being selected. The sampling error can be counted, in probability sampling.
2. Non-probability sampling – Members are selected from a population in a non-random manner, but the degree to which the sample differ from the population remains unknown.

Due to the limited time allocated for the project, it is impossible to gather data from all those who were involved in the tea auction process. Therefore, non-probability sampling technique was selected.

### **3.7.2 Fact finding techniques**

#### **Interview**

Interviews facilitated in-depth research on the existing tea auction process without misunderstandings. One-to-one structured interviews were carried out with tea broker company, Tea buyer company and Sri Lanka tea board. They were able to describe current systems and practices and highlight drawbacks of the process. Interviews also helped to validate findings of Literature Review.

#### **Background reading**

Background reading was done by reading many online sources, including journal articles on online tea auction systems, various paper articles on tea brokers, tea buyers, annual reviews of tea brokers, central bank reports, tea board reports etc. These sources were widely useful to obtain a basic understanding of the project at the beginning.

#### **Literature survey and review**

For the successful completion of the Literature review, many sources needed to be referred. This took significant amount of time when compared to other chapters. These sources were compared afterwards. Few of these related findings are covered in Chapter 2.

#### **Observations**

Observation is one of the most successful fact-finding technique carried out to understand a process clearly. Visiting and observing the live tea auction, visiting to a tea buyer company, and observing the tea tasting and valuation process were some of the observations done prior to the design of online tea auction system.

## **3.8 Design and Development Techniques**

#### **Use case diagram**

This is one of the major UML diagrams. It is used to identify the associations between the actors – warehouse, tea broker, tea buyer etc. and the functions (use cases) of the online tea auction system. This diagram was used in requirements analysis phase.

#### **ER Diagram**

ER Diagram shows the relationship of entity sets stored in a database. An entity here is an object or a component of data. An entity set is a collection of related entities. These entities have attributes that define their properties. Through defining the entities, their attributes, and showing the relationships between them, ER diagram explains the logical structure of databases. ER diagram was used in the database design stage of the online tea auction system.

#### **Class diagram**

Since the object – oriented approach is used, the class diagram was essential. The class diagram provided a visual illustration of the tables such as invoice, tea valuation, catalogue etc. along with the attributes, functions and relationships.

### **Activity Diagram**

Activity diagram is an important behavioural diagram used in UML. It is used to describe the dynamic aspects of a system. It can also be named as a flowchart that represent the flow from one activity to another activity. Activity diagrams can be used to describe steps in a use case diagram.

### **Sequence Diagram**

Sequence diagram depicts interaction between objects in a sequential order. The interaction here could be between the user of the system and the system, between system and other systems or between subsystems. The horizontal axis of a sequence diagram displays the elements that are involved in the interaction while the vertical axis represents time proceedings.

### **Database Diagram**

Database diagrams were designed prior to creation of database. it represents the structure of the entire database. It includes the tables, columns, keys and relationships in a database.

### **Storyboards/Mock-ups**

Storyboards/mock-ups were used to visualize the design of the web application and ensure that the design suited the requirements gathered, before development began. The mock-ups were created using the Visio tool. This is in line with the iterative and incremental project lifecycle. Each version of the prototype included a few of the requirements where each version could be evaluated, and any drawbacks can be addressed in the next version.

### 3.8.1 ER Diagram

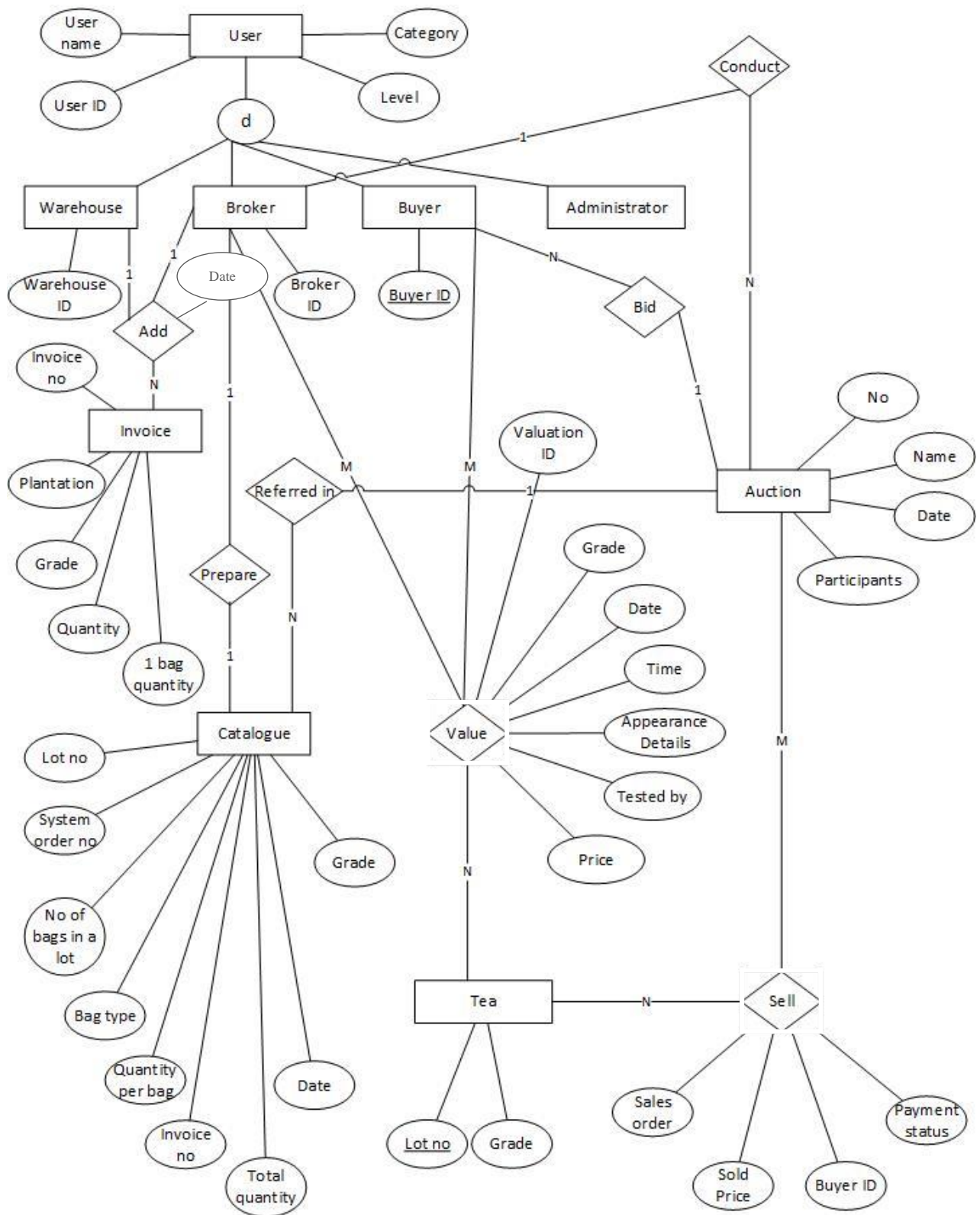


Figure 3.9 - ER Diagram

User (UserID, UserName, Category, Level)

Warehouse (UserID, WarehouseID)

Broker (UserID, Broker ID)

Buyer (UserID, BuyerID)

Invoice (InvoiceNo, Plantation, Grade, Quantity, 1BagQuantity)

Add (WarehouseID, BrokerID, InvoiceNo)

Catalogue (LotNo, SystemOrderNo, NoofBagsInalot, BagType, QuantityperBag, InvoiceNo, TotalQuantity, Date, Grade)

Tea (LotNo, Grade)

Auction (AuctionNo, Name, Date, Participants)

Value (BrokerID, BuyerID, ValuationID, Grade, Date, Time, AppearanceDetails, TestedBy, Price)

Sell (LotNo, AuctionNo, SalesOrder, SoldPrice, BuyerID, PaymentStatus)

### 3.8.2 Class diagram

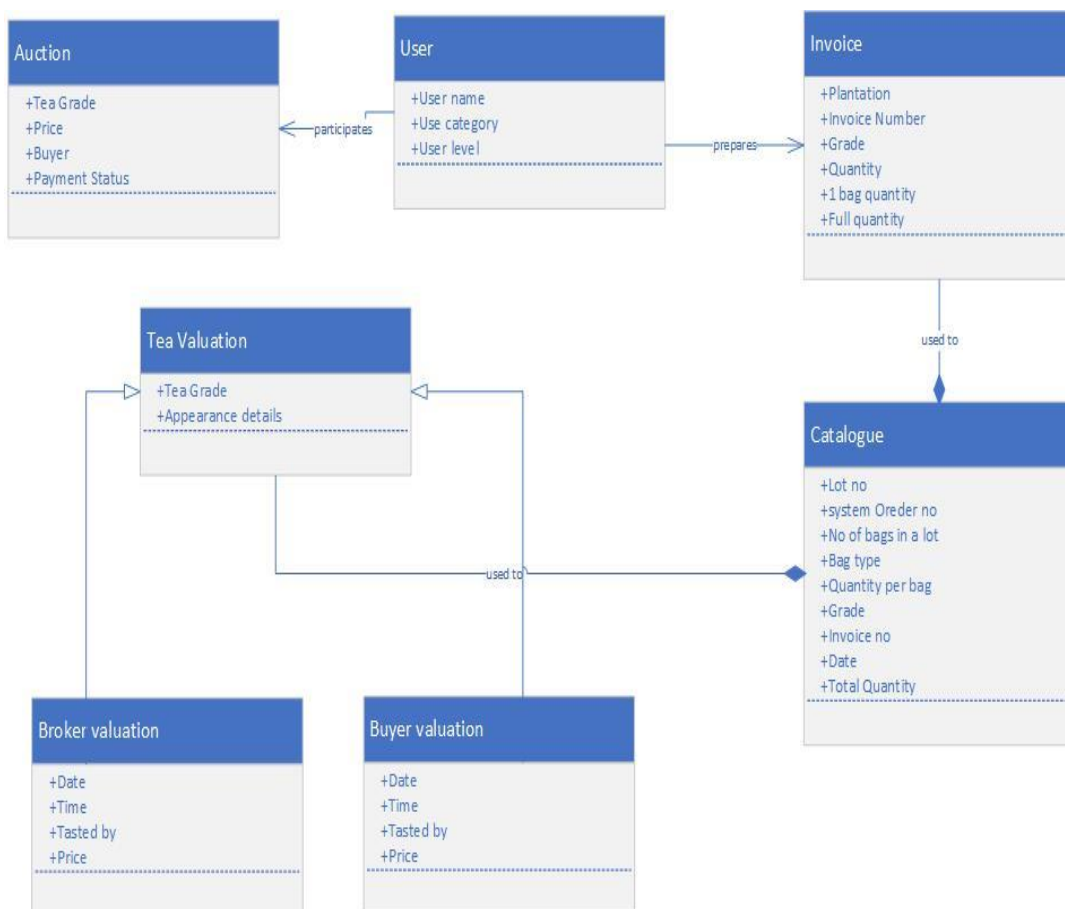


Figure 3.10 - Class Diagram

### 3.8.3 Activity Diagrams

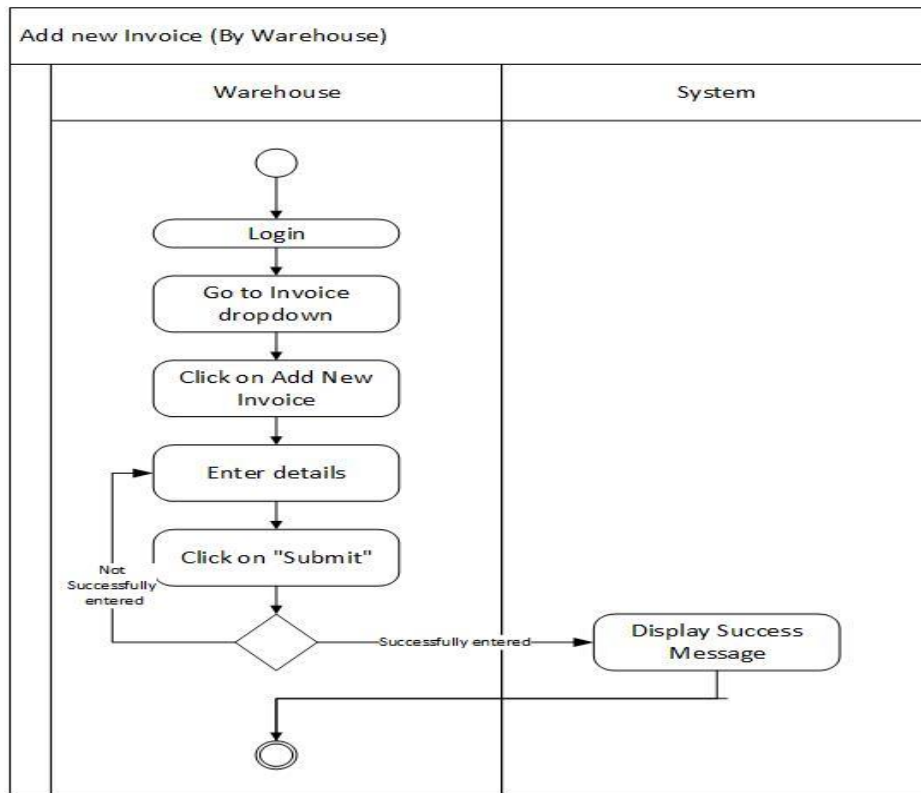


Figure 3.11 - Activity diagram (Add new invoice)

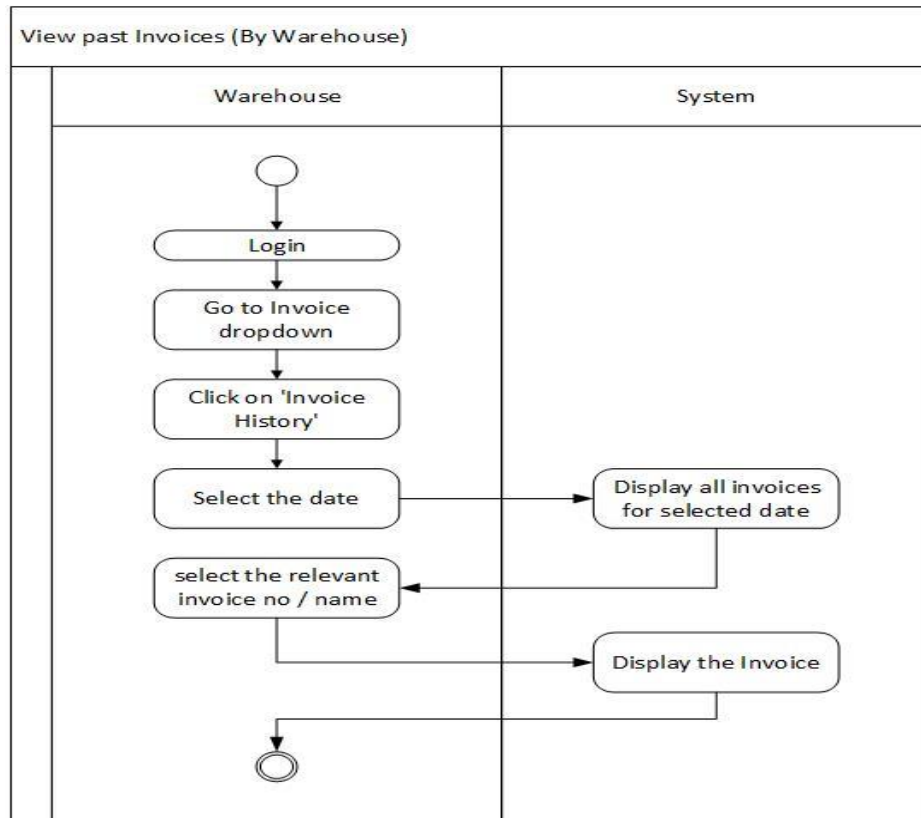


Figure 3.12 - Activity diagram (View past invoices)

Refer Appendix C for more Activity Diagrams.

### 3.8.4 Sequence Diagrams

#### User Login

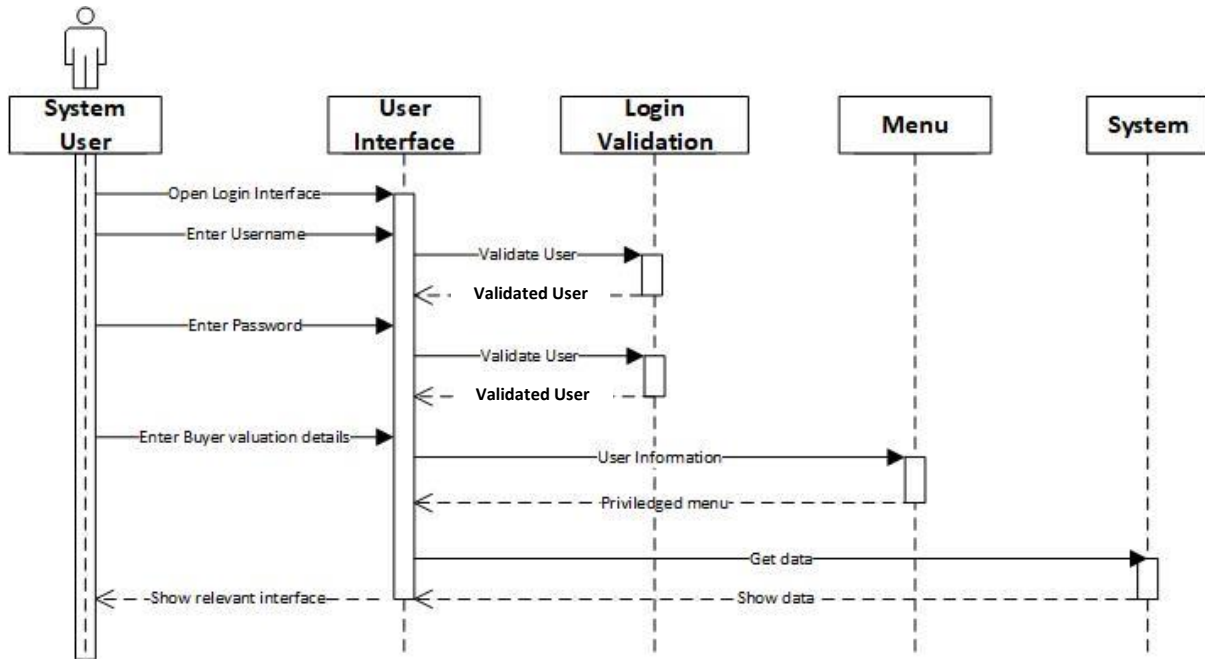


Figure 3.13 - Sequence diagram (User login)

#### Buyer Valuation

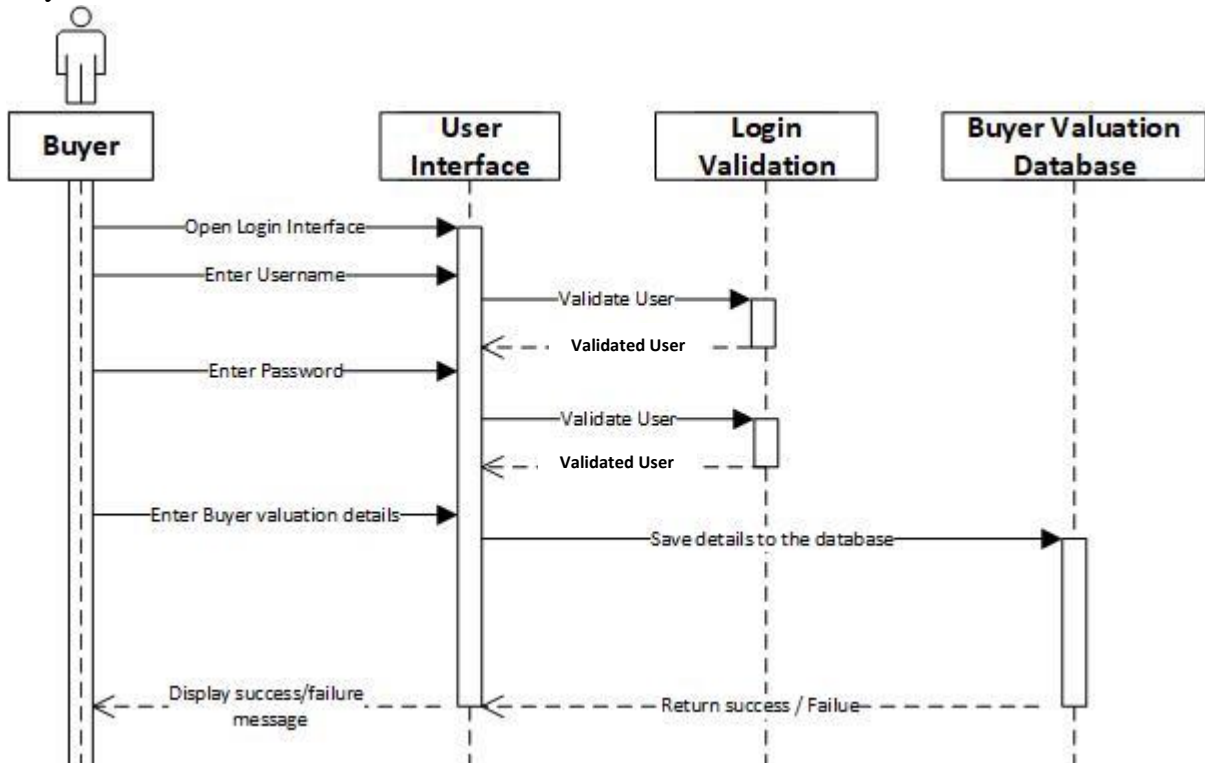


Figure 3.14 - Sequence diagram (Buyer valuation)

Refer Appendix D for more sequence diagrams.



### 3.8.5 Database Diagram

The database structure of the system is displayed here.

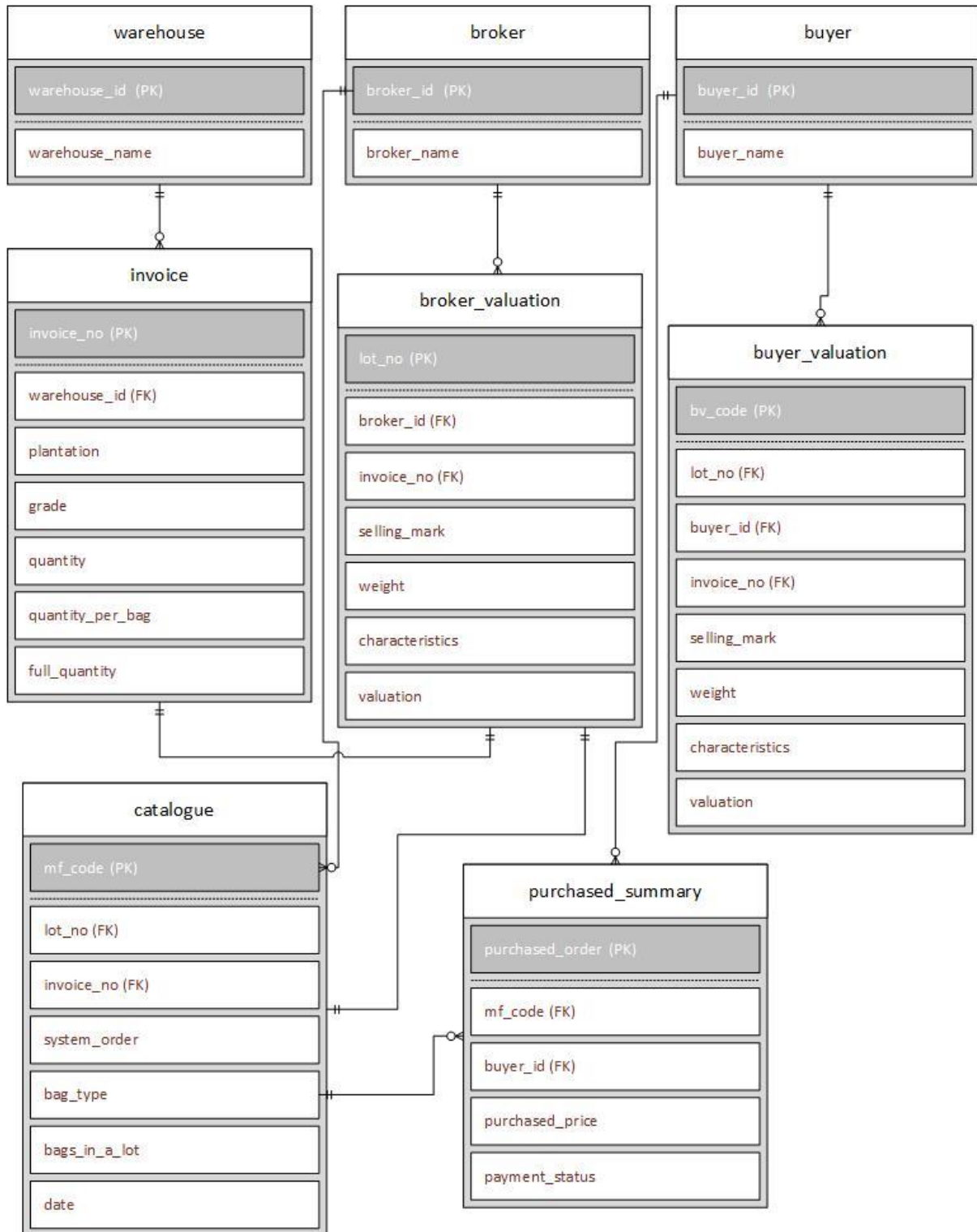


Figure 3.15 - Database diagram

### 3.8.6 Mock-ups

#### Warehouse Login

- Add new Invoice

The mock-up shows a web interface for the 'Electronic Tea Auction System'. On the left is a navigation menu with 'Home' selected, and options for 'Invoice', 'Add New Invoice', and 'Invoice History'. The main content area is titled 'Add New Invoice' and contains several text input fields: 'Invoice No:', 'Plantation:', 'Grade:', 'Quantity:', 'Quantity Per Bag:', and 'Full Quantity:'. Each of these fields has a placeholder text 'Enter Text'. There is also a 'Label:' field. At the bottom of the form are two buttons: 'SUBMIT' and 'CANCEL'.

Figure 3.16 - Add new invoice mock-up

- Invoice History

The mock-up shows a web interface for the 'Electronic Tea Auction System'. On the left is a navigation menu with 'Home' selected, and options for 'Invoice', 'Add New Invoice', and 'Invoice History'. The main content area is titled 'Invoice History' and features a table with the following data:

Invoice No
001
002
003

A mouse cursor is pointing at the '003' entry. To the right of the table is a 'Select Date' dropdown menu. Below the table is a 'CANCEL' button. To the right of the table is a form with the following labels: 'Invoice No:', 'Plantation:', 'Grade:', 'Quantity:', 'Quantity Per Bag:', and 'Full Quantity:'.

Figure 3.17 - Invoice history mock-up

Refer Appendix E for more mock-ups.

### 3.9 Implementation - Introduction

After analysing the functional and non-functional requirements, HTML, JavaScript and PHP were chosen as the most suitable languages to implement the project. Due to ease of use and scalability JavaScript was selected. PHP language was used, as it has the ability to embed HTML coding with it and it takes less time to load web pages. Moreover, the browser compatibility became an important factor to use PHP since this project was a web-based project. Developing was carried out using the WAMP server as the localhost and local machine as the main server. PHP 7.3.12 version was used for developments while Apache 2.4.41 version was used as the server application. MariaDB 10.4.10 was used for the database.

However, the deployment plan and configurations of the client machines and client server of the system will be different. Since this is a web-based system the client machines could use any operating system that supports web browsers. The server application will be installed in Apache web server machine. The database will also be hosted in this.

### 3.10 Development Environment and Tools

- PHP 7.3.12 as the development language
- MariaDB 10.4.10 as database management system
- Adobe dream-viewer CS 6 for website development
- Notepad++ for code development
- Adobe Photoshop 7.0 for image editing

### 3.11 Server-side implementation

The following steps need to be the carried out after actual deployment.

- Windows OS will be the operating system and MySQL 5.5.24 will be installed following phpMyAdmin for management interface.
- jQuery and JavaScript files will be imported into the server
- CSS files will be imported into the server

### 3.12 Client-side implementation

The following would be the implementation that would be carried out after actual deployment.

- Any operating system that supports a web browser.
- Any web browser preferably Google chrome.

### 3.13 Hardware Requirements

The final system that will be implemented in the client place will have the minimum hardware requirements as in table 3.5 along with the software requirements.

	Minimum Specification	Recommended Specification
Processor	Intel(R) Core I5 or equivalent	Intel(R) Core I5
Memory	16 GB	16 GB or more
Wired network card	10/100 baseT Ethernet	10/100 baseT Ethernet
Hard Drive	1 TB hard drive space	1 TB hard drive space or more

Table 3.3 - Hardware requirements for client-side implementation

### 3.14 Configurations

The basic configurations can be categorised in two sections, namely client-side configurations and server-side configurations.

#### 3.14.1 Server-side configuration

The following code was used to connect with the server and the database.

```
<?php
$user = 'root';
$password = "";
$database = 'tea_auction';
$port = NULL;
mysqli = new mysqli('127.0.0.1', $user, $password, $database, $port);
if($mysqli)
echo'connected successfully to tea_auction db';
else echo 'ERROR: Could not connect to database';
}?>
```

#### 3.14.2 Client-side configuration

The client should be in the same VLAN as the server. The client should be able to ping the server. The system use JavaScript and CSS 3.0 in client side. Any browser which supports JavaScript and CSS 3.0+ can be used for this system. Recommended web browser for this project is google chrome.

### 3.15 Database Implementation

MySQL with Apache was used to implement the database. Therefore, SQL queries were used to manage and to handle data in the database.

#### 3.15.1 Creating the database

The database was created manually in phpMyAdmin.

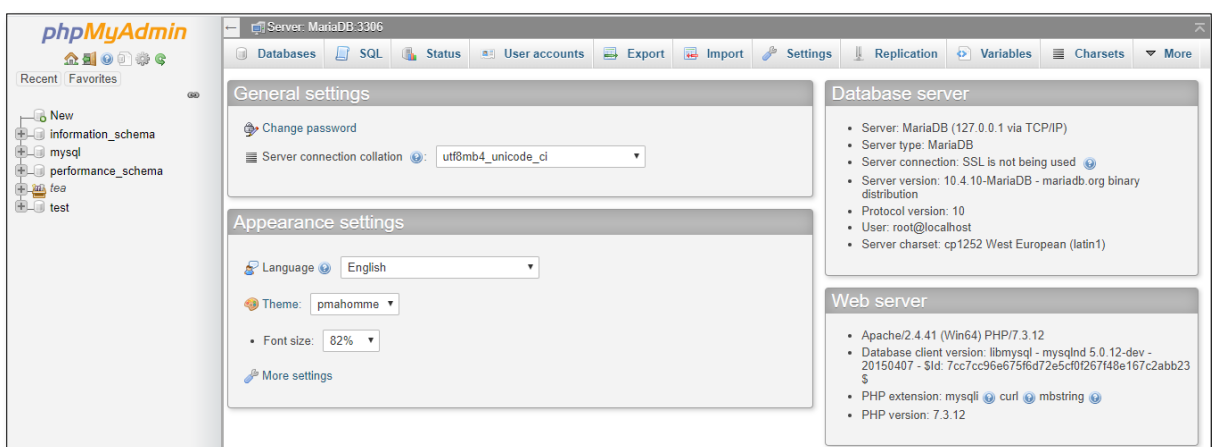


Figure 3.18 - Database created in phpMyAdmin

### 3.15.2 Creating a table in database.

Tables for the database were also created manually in phpMyAdmin.

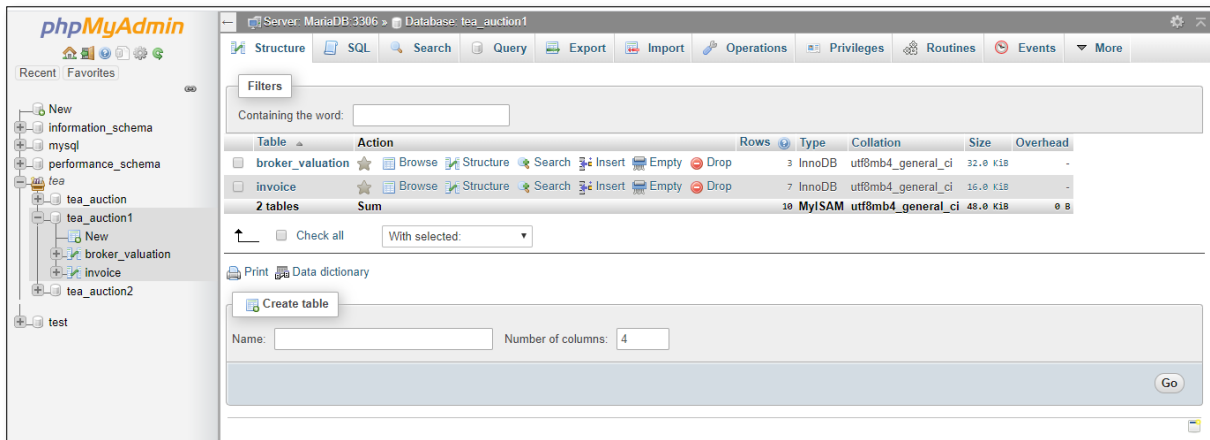


Figure 3.19 - Tables created in phpMyAdmin

### 3.15.3 Select from the database

Data was extracted from the database using SELECT command.

```
$sql="SELECT * FROM invoice";
```

### 3.15.4 Insert data to the database

Data was inserted into the tables in the database using the INSERT command.

```
$sql="INSERT INTO  
invoice(invoice_no,plantation,grade,bag_count,quantity_per_bag,full_quantity,Date)  
VALUES  
('$invoice_no','$plantation','$grade','$bag_count','$quantity_per_bag','$full_quantity'  
, '$Date')";
```

## 3.16 User Interfaces

Home page



Figure 3.20 - Home page

## Invoice

- Add new invoice

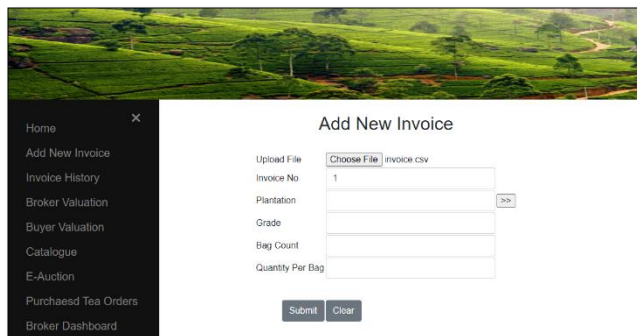
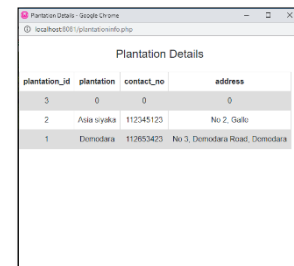


Figure 3.21 - Add new invoice user interface

Another important feature here is the “Plantation Details” window. This appears after clicking on the “>>” button next to plantation text box. This window enables the user to get contact details of each plantation, which maybe be useful to warehouse staff when filling a new invoice.

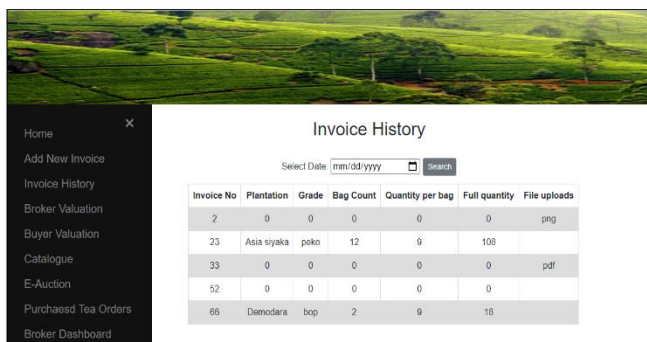
This interface can be accessed only through warehouse login. A user will be able to upload emailed / faxed invoices in "jpeg", "jpg", "png", "pdf", "csv", "docx", and "xlsx" formats and submit the invoice. If not, they can fill the displayed form and submit the invoice. However, the system will not allow the users to submit invoices without the invoice number.



plantation_id	plantation	contact_no	address
3	0	0	0
2	Asia siyaka	112345123	No 2, Galle
1	Demodara	112653421	No 3, Demodara Road, Demodara

Figure 3.22 - Plantation details user interface

- Invoice history



Invoice No	Plantation	Grade	Bag Count	Quantity per bag	Full quantity	File uploads
2	0	0	0	0	0	png
23	Asia siyaka	pekko	12	9	108	
33	0	0	0	0	0	pdf
52	0	0	0	0	0	
66	Demodara	bop	2	9	18	

Figure 3.23 - Invoice history user interface

This interface also can be accessed through warehouse login. All the invoices added through above form (Figure 3.22) will be displayed here. The user is given the chance to filter out invoices for a particular day by simply selecting the date at the top of the table. Apart from that, users are also given the chance to update/delete invoice details added previously.

## Valuation

- Broker Valuation

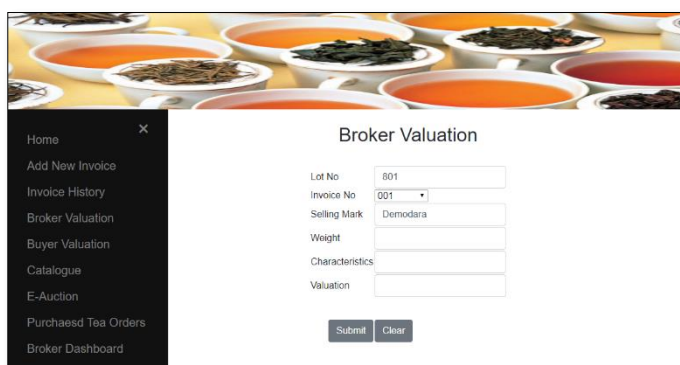


Figure 3.24 - Broker valuation user interface

This interface can be accessed via broker’s login. It is used to enter details when broker is carrying out the tea tasting and valuation process. Most of the existing details in the database are auto generated in the form allowing the user to fill minimum no of details, namely weight, characteristics, and value, while doing the valuation. Broker needs to submit one form for each new tea lot.



- Buyer Valuation

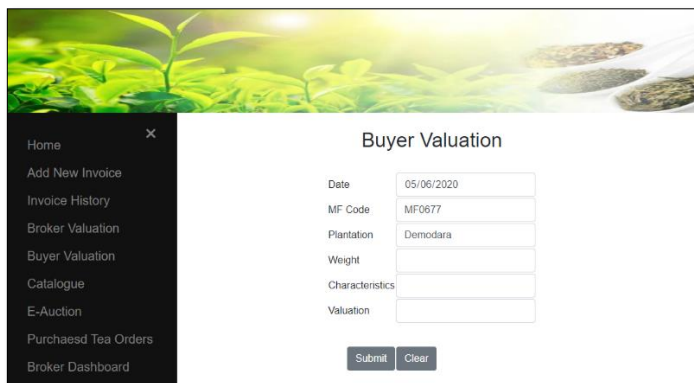


Figure 3.25 - Buyer valuation user interface

This form is used to fill details when carrying out the tea tasting and valuation process by buyer. It is similar to broker valuation form but can only be accessed via buyer’s login. The final value given by the buyer for each tea will be displayed along with the catalogue used by buyer in e-auction interface in order to make the bidding process easier for the buyer.

- Catalogue

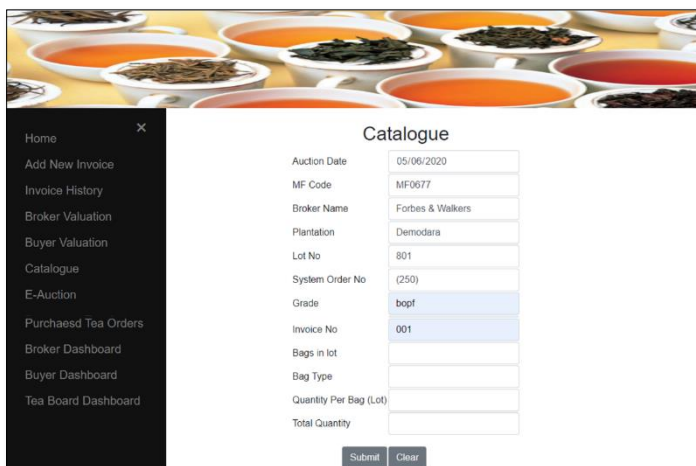


Figure 3.26 - Catalogue user interface

This is another interface which can only be accessed by broker’s login. The form given here is used to prepare the catalogue. Only few fields are required to be filled by the broker since most of the fields are filled with the data gathered via other forms. Once all the tea is entered to the catalogue, it can be printed as a pdf or csv. The final catalogue will also be available in the auction interface so that the buyers can easily refer it.

- E-auction

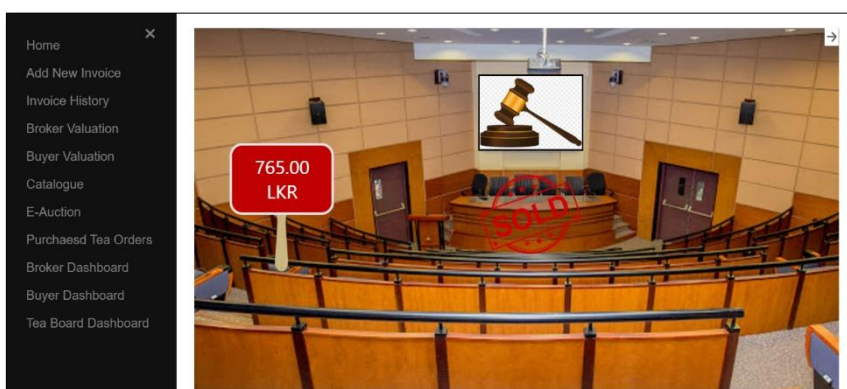


Figure 3.27 - E-Auction user interface

This interface can be accessed via both broker’s and buyer’s login. The buyer’s interface will have a countdown timer, brokers catalogue details including the buyer valuation field and bidding portal. The bidding application allow users to bid with their preferred price for

each tea. Once they submit their bids, the price will be displayed in the auction interface.

### 3.17 Code Segments

Add new invoice php code is as follows.

```
<?php

$user = 'root';
$password = ""; //To be completed if you have set a password to root
$database = 'tea_auction1'; //To be completed to connect to a database. The database
must exist.
$port = NULL; //Default must be NULL to use default port
$mysqli = new mysqli('127.0.0.1', $user, $password, $database, $port);

if($mysqli)
echo'connected successfully to tea_auction db';

$invoice_no=$_POST['invoice_no'];
$plantation=$_POST['plantation'];
$grade=$_POST['grade'];
$bag_count=$_POST['bag_count'];
$quantity_per_bag=$_POST['quantity_per_bag'];
$full_quantity=$bag_count*$quantity_per_bag;

$Date=date("Y-m-d");

$sql="INSERT INTO
invoice(invoice_no,plantation,grade,bag_count,quantity_per_bag,full_quantity,Date)
VALUES
('$invoice_no','$plantation','$grade','$bag_count','$quantity_per_bag','$full_quantity',
'$Date')";

if (mysqli_query($mysqli,$sql)){
    echo
        "<script type='text/javascript'>alert('submitted
successfully!');window.location.href =
'http://localhost:8081/addnewinvoice.html';</script>";
}else{
    echo "<script type='text/javascript'>alert('Failed. Please try
again. ');window.location.href =
'http://localhost:8081/addnewinvoice.html';</script>";

}

// Close connection
mysqli_close($mysqli);
?>
```

Refer Appendix H for related JavaScript code.



### 3.18 Report Modules in the system

#### Broker dashboard

Overall analysis of the tea auction, an analysis based on tea characteristics and valuation details, tea buyer wise analysis and tea plantation wise analysis is provided in tea broker dashboard.

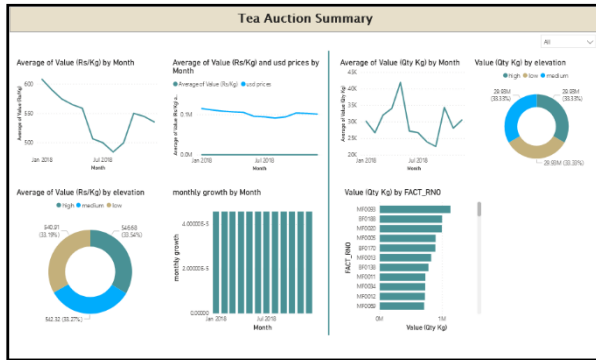


Figure 3.28 - Tea Auction Summary Dashboard

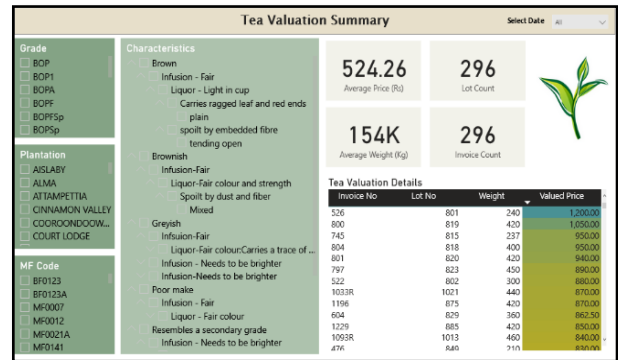


Figure 3.29 - Tea Valuation Summary Dashboard

#### Buyer dashboard

A complete analysis on their purchases and broker wise analysis is provided in the tea buyer dashboard.

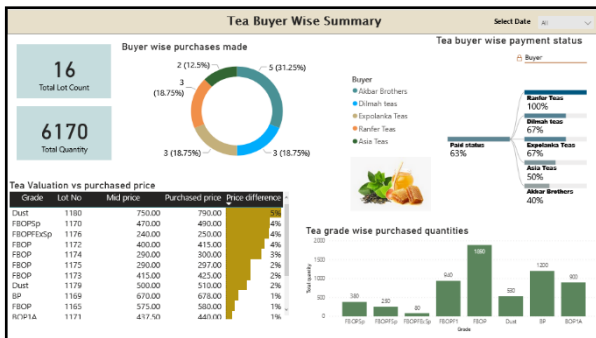


Figure 3.30 - Tea Buyer Wise Summary Dashboard

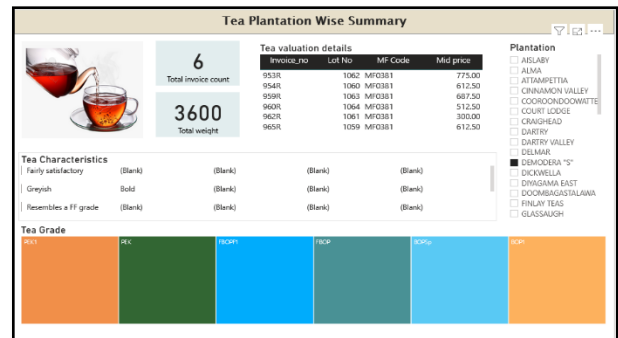


Figure 3.31 - Tea Plantation Wise Summary Dashboard

#### Tea board dashboard

Overall analysis on the tea market, tea buyer wise analysis and tea broker wise analysis is provided in the tea board dashboard.

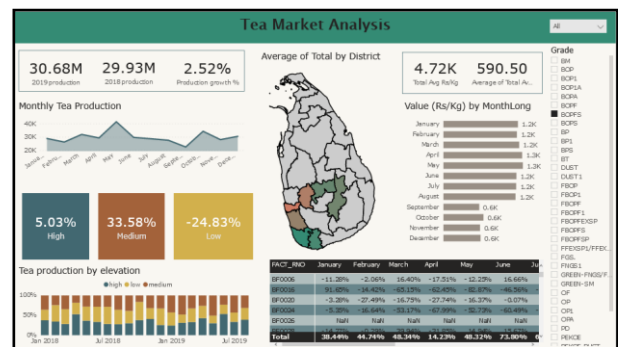


Figure 3.32 - Tea Market Analysis Dashboard

### 3.19 Summary

Design and implementation were two critical stages of the project development lifecycle. Successful implementation was carried out using the local server with WAMP installed. Software tools such as php, html, JavaScript, CSS, Power BI were used to develop the Online Tea Auction system effectively.

# Chapter 4 Evaluation and Testing

## 4.1 Introduction

Evaluation is an important phase in software development lifecycle since it critically examines the software. Its main purpose is to improve the effectiveness of the software. Testing is also another critical phase in software development. The quality of a system is determined by the number of successful tests carried out. The main purpose of testing is to detect whether and up to what extent the developed software meets its envisioned purpose and identify any defects if it does not. Testing aids the stakeholders to get informed decisions on whether to release a software or not.

## 4.2 Evaluation

Evaluation process could be categorized into two main categories namely, user evaluation and author evaluation. User evaluation is carried out by people who, the system is intended for. They seek the strengths and weaknesses of the existing system. Author evaluation is carried out by the author of the project who is also the designer of the proposed system.

### 4.2.1 User Evaluation

#### *Approaches*

Usability methods toolbox introduced by Mr. James Hom describes three user evaluation methods. They were Inquiry, Inspection and Testing respectively.

Inquiry method describes on obtaining information about users' preferences and understanding of the system by talking to them, directly observing them using the system, or allowing them answer questions verbally or in written form. The information could be gathered here using field observations, interviews, questionnaires etc.

In inspection method, usability specialists such as software developers or other professionals, inspect usability related aspects of a user-interface. Cognitive walkthrough, pluralistic walkthrough, heuristic evaluation, and feature inspections are some approaches used here.

Testing method lets users work on typical tasks using the system and the evaluators use the obtained results to understand how the user interface supports the users to do their tasks. Some of the testing approaches used here were performance measurement, thinking aloud protocol, question – asking protocol and shadowing method.

#### *User evaluation using questionnaire (Inquiry method)*

User evaluation was carried out using two questionnaires given separately to tea buyer company and tea broker company. Each of these questionnaires focus more on the functionalities developed for respective user. Overall system was evaluated by the tea board using a separate questionnaire. The questionnaires are given in Appendix G and the summary of evaluation results are displayed below.

According to figure 4.1 the users have highly rated the user-friendliness of the application. It was evaluated in three aspects namely look and feel, ease of use and ease of navigation. 65% of the users were extremely satisfied with these aspects of the system while 30% were very much satisfied. Therefore, more than 90% of the users were satisfied with the user-friendliness of the system.

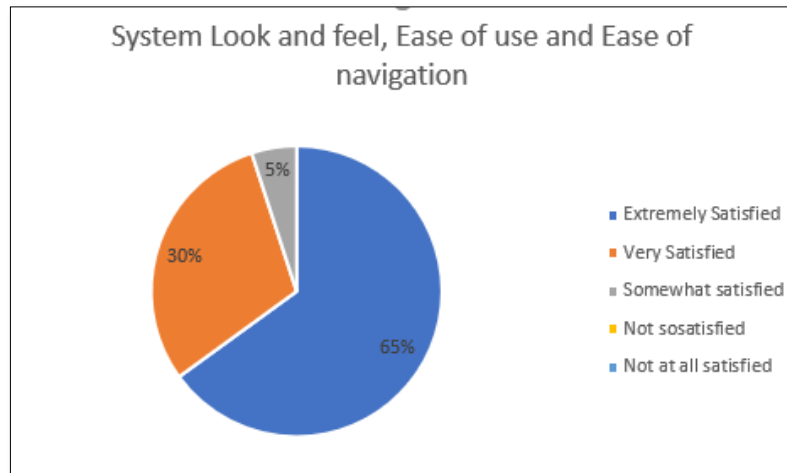


Figure 4.1-System look and feel, ease of use and ease of navigation

The system's features such as flexibility, adoptability, reliability, and speed were evaluated from the questionnaire provided to tea board. Users have rated each feature 40% of the users are satisfied with the speed while 35% of the users are satisfied with its flexibility and adoptability. Only 25% of the users were satisfied with the reliability of the system.

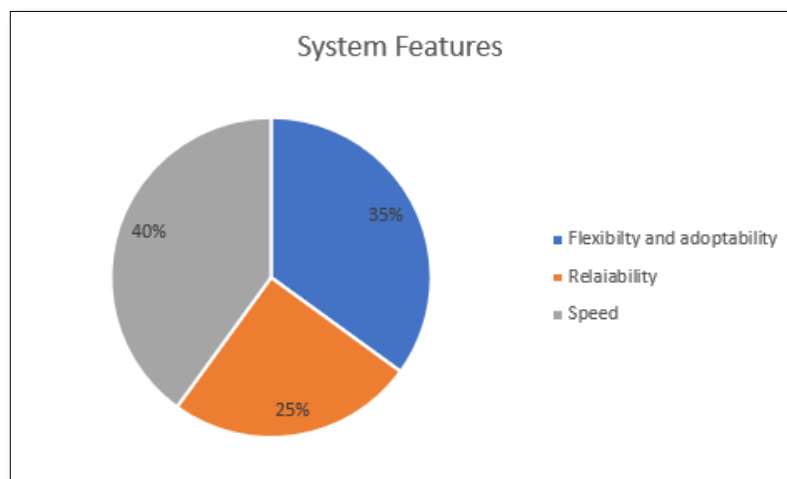


Figure 4.2-System flexibility and adoptability, reliability and speed

According to brokers and buyers, the features of the system were rated. Their most preferred features were online bidding and invoice uploading. Features such as plantation detail pop-up window, displaying user photo while bidding have a similar rating while the features such as informative dashboards and automated tea valuation features also have a similar rating which was slightly more than the initial two features.

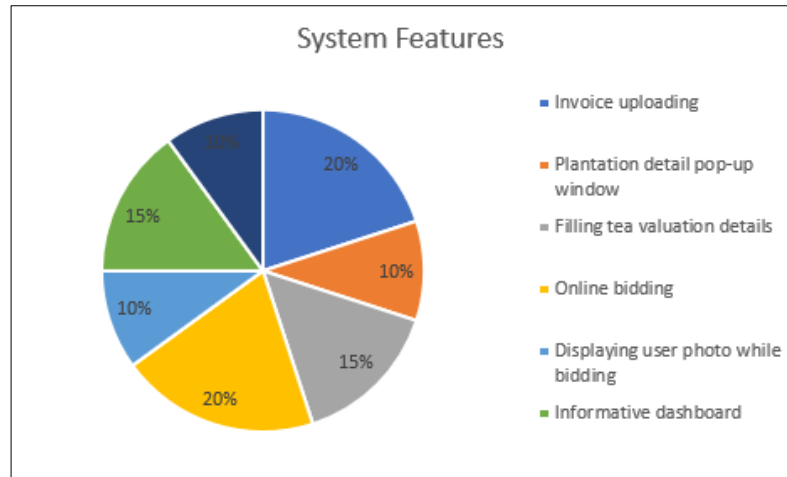


Figure 4.3-System features

The quality and usability of the dashboards were rated by the tea board. Half of the users agreed that the dashboards were informative enough.

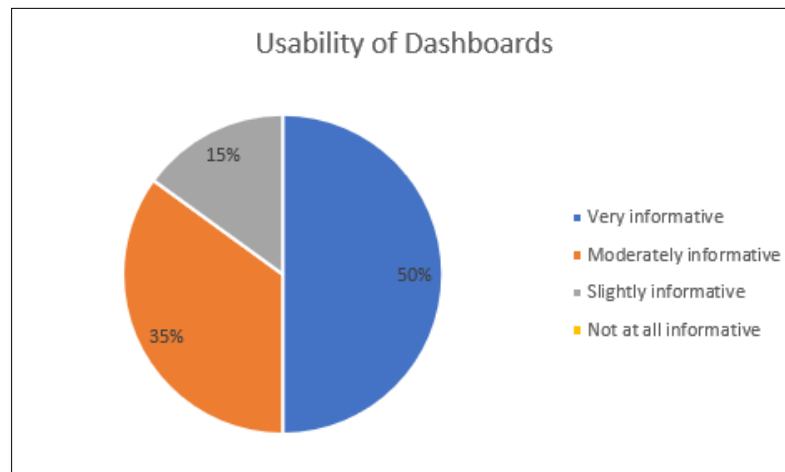


Figure 4.4-Usability of dashboards

Figure 4.5 displays overall rating of the system by brokers, buyers, and tea board. Nearly 90% of the users agreed that the system will be very much useful when compare to the manual system. Only few users were unsure of the usability of the system.

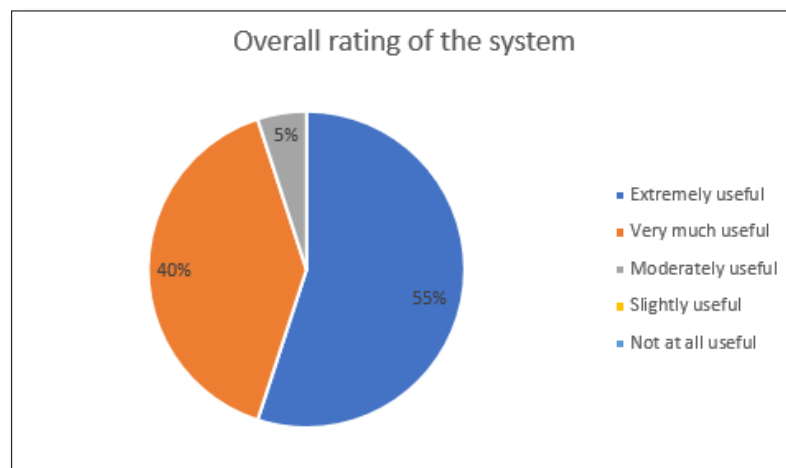


Figure 4.5-Overall rating of the system

### *User evaluation using SWOT Analysis*

SWOT analysis was carried out to evaluate the user experience. The evaluation factors were strengths and weaknesses of the system and opportunities and threats for the system. Strengths and weaknesses are factors within the system. Therefore, they can be changed. But opportunities and threats are external factors so that they could not be controlled by developing the system.

#### Strengths.

- After login to the system, the side menu of the system aids users to navigate through the system easily.
- Most people are using web applications at the moment. Therefore, a web-based system will have a vast market, and the user-friendliness of the site will let users easily handle the system.
- Having a single system with a centralized common database for different user roles will reduce extra work carried out by some users (e.g.: brokers)
- The timely and considerate error messages generated by the system help users to use the system without hassles.
- The real-time updating dashboard will help the stakeholders to get decisions quickly and easily using the provided insights.
- With the various authorizations in the system neither party could engage in any fraudulent activity with or without knowledge.

#### Weaknesses

- The system does not provide a solution to automate the valuation process. (i.e.: Predict the prices of tea based on its attributes such as appearance, taste etc.)
- The system does not provide any details about tea delivery after purchased by the buyer.

#### Opportunities

- Today there is a high need of an electronic system. Therefore, it is good opportunity to develop this system. For example, at the time of COVID-19 and curfews the auction could not be held for weeks because it was done manually, and large gathering were not allowed. But if this process was automated every week this could have been held without delays.

#### Threats

- Handling both buyers and brokers valuation details can lead to privacy issues between the two parties since if one party gets to know the pricing of the other party, holding the auction would be of less use.
- Automating a process which was done manually for a long period will get many resistances from the users. There can be a huge downfall in the demand at the initial stages and stakeholders will tend to seek out for alternative ways to keep the auction.

## 4.2.2 Author Evaluation

Given below is a comparison of time spent on each task in current system and new system.

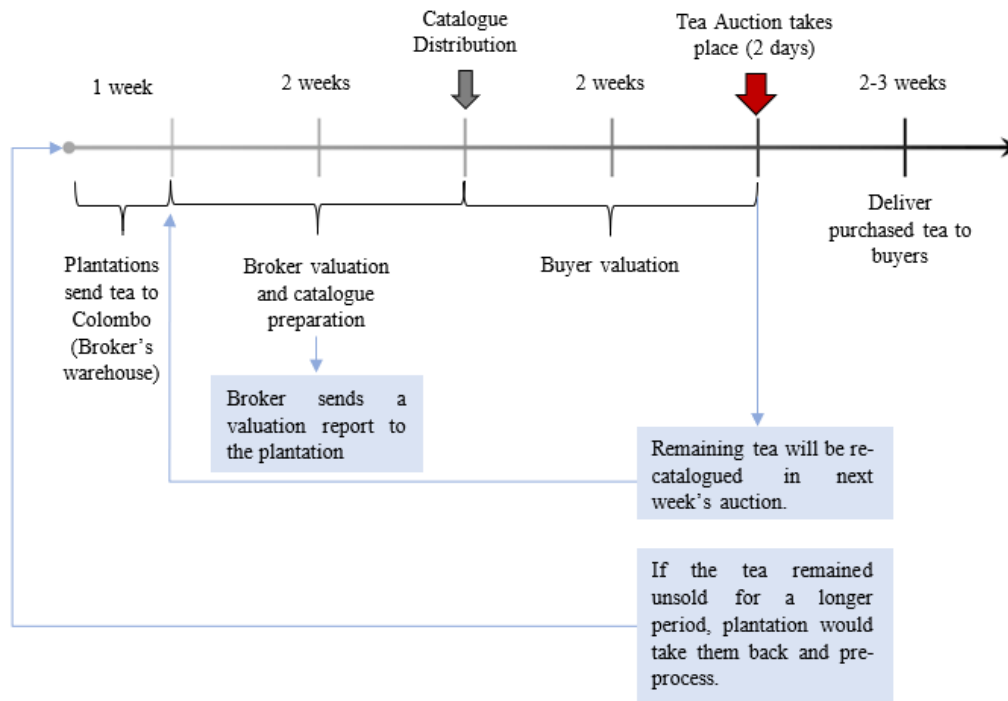


Figure 4.6 - Existing process timeline

When considering the time spent on each task in the existing tea auction process, it is clear that it takes nearly two months (8 weeks) to complete one auction cycle. But with the help of Online tea auction system, the time spent on each task can be reduced. For example, the broker valuation and catalogue preparation took two whole weeks initially. But with the new system it can be completed in less than two weeks, as the tea tasters only have minimum number of fields to fill out while carrying the tea tasting. Additionally, no time is spent on catalogue preparation or distribution, as the electronic version of the catalogue is readily available to all the buyers through the system. Similarly, Buyer valuation also takes less time to complete using the new system.

After broker valuation, brokers send a report with the prices to respective plantations before the auction. So that the plantations can negotiate prices with broker if they wish more value for their tea. Therefore, broker's need to prepare a separate report for this, which again consumes more time. But with the new system, the valuation details can be easily download as a pdf or csv. So, no additional time is required for this task.

Moreover, the tea auction conducted online will have a defined time frame, as there is a specified time allocated for each bid. Therefore, the time wastage during the auction is less. Furthermore, there were dashboards created for each party separately so that no additional time is spent on analysing results after an auction takes place. So that the brokers, buyers, and tea board can spend this spare time for something productive. As a conclusion when comparing time spent on each task in the existing system and new system, it is clear that the new system shortens the duration of one auction cycle.

Author's evaluation of project objectives and scope are discussed in conclusion chapter under section 5.4 and 5.5, respectively.

## 4.3 Testing Types

### 4.3.1 Functional Testing

In functional testing, the software is tested against functional requirements. Functional requirements of the online tea auction system can be found in section 2.9. The functions tested here are more system related rather than user related. Also, functional testing is not concerned with an application's internal details. Usually functional testing uses black box testing techniques, as the tester has no knowledge of the internal system logics. (Functional testing results are discussed in section 4.4)

### 4.3.2 Regression Testing

It is the testing of existing software application to make sure that a change or modification done to the software has not affected the existing functionality. Regression testing is usually carried out after a major code change. It can be performed to single component or a group of related units. Given below is the regression testing carried out on the Online Tea Auction System.

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Logging to the system using IE and Mozilla Firefox.	<ol style="list-style-type: none"><li>1. Open Microsoft Edge / Mozilla Firefox</li><li>2. Go to the login URL.</li><li>3. Login to the system.</li></ol>	<ol style="list-style-type: none"><li>1. Successfully login to the system.</li><li>2. Display all system components accurately.</li></ol>	Same as expected.	Pass

Table 4.1 - Regression Testing

### 4.3.3 Stress Testing

Stress testing is an extremely valuable testing used to test the stability and reliability of the system. In other words, the system's robustness and error handling abilities when there is a heavy load. It also checks whether the system displays appropriate error messages when the system is under pressure. Endurance testing is another name used for stress testing. This testing checks beyond the normal operating conditions.

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Inserting more than specified characters in a form.	<ol style="list-style-type: none"><li>1. Login to warehouse.</li><li>2. Click on add new invoice menu.</li><li>3. Fill the invoice details and insert a long number as the bag count.</li></ol>	Display error message.	Same as expected.	Pass

		4. Click on “Submit” button.			
2	Logging to the system using IE and Mozilla Firefox.	1. Open Microsoft Edge / Mozilla Firefox. 2. Go to the login URL. 3. Login to the system.	1. Successfully login to the system. 2. Display all system components accurately.	Same as expected.	Pass

Table 4.2 - Stress Testing

#### 4.3.4 Performance Testing

Performance testing checks the reliability, speed, response time and resource usage of a software. Mostly it tests the non-functional requirements. Given below is the performance testing carried out on the online tea auction system to test its behaviour on normal and peak conditions.

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Added 3 catalogue details using google chrome, IE and Firefox.	1. Open google chrome, IE and Firefox simultaneously. 2. Login to the system from the broker login. 3. Add 3 catalogues simultaneously.	Successfully added.	Same as expected.	Pass

Table 4.3 - Performance Testing

#### 4.3.5 Usability Testing

Usability testing is used to test the user-friendliness of a software. It mainly focuses on the ability of the system to meet its intended objectives. Usability testing is also named as user experience testing. Mock-ups were designed before developing the system in order to achieve usability. Usability testing carried out for Online tea auction system is given below.

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Upload invoices as csv, pdf, txt, etc. files to the system.	1. Log in as warehouse. 2. Select “Choose file” button. 3. Upload the required document. 4. Submit the invoice	Invoice submitted successfully.	Same as expected	Pass



2	Tea Broker being able to view summary of an auction transactions in the dashboard.	1. Log in as Broker. 2. Go to Broker Dashboard.	Display current auction results.	Same as expected	Pass
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Table 4.4 - Usability Testing

#### 4.3.6 Security Testing

Security testing is one of the most important testing for a software. It helps to detect all possible security risks in the system. Main purpose of this testing is to inform the developers about the potential vulnerabilities of the system so that they can fix it using coding. Given below are the security testing carried out for online tea auction system.

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	User authentication and authorization	Login to system using different logins (e.g.: warehouse, broker, buyer, tea-board)	1. Enable user to login successfully if the correct username and passwords have been used. 2. Display only the relevant interfaces to relevant users.	Same as expected	Pass
2	Going back using the back button in the browser after logging out from the system.	1. Log out from the system. 2. Press on back button on the browser.	Direct the user to login page	Same as expected	Pass

Table 4.5 - Security Testing

#### 4.4 Test cases

Test cases for Login

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Warehouse Login	1. Click on login button in the homepage. 2. Enter Username and Password. 3. Click on login	Successfully login to warehouse interface.	Same as expected.	Pass

2	Broker Login	<ol style="list-style-type: none"> <li>1. Click on login button in the homepage.</li> <li>2. Enter Username and Password.</li> <li>3. Click on login</li> </ol>	Successfully login to Broker interface.	Same as expected.	Pass
3	Buyer Login	<ol style="list-style-type: none"> <li>1. Click on login button in the homepage.</li> <li>2. Enter Username and Password.</li> <li>3. Click on login.</li> </ol>	Successfully login to Buyer interface.	Same as expected.	Pass
4	Tea Board Login	<ol style="list-style-type: none"> <li>1. Click on login button in the homepage.</li> <li>2. Enter Username and Password.</li> <li>3. Click on login</li> </ol>	Successfully login to Tea board interface.	Same as expected.	Pass

Table 4.6 - Test cases for login

Test cases for invoices

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Fill new invoice.	<ol style="list-style-type: none"> <li>5. Login to warehouse.</li> <li>6. Click on add new invoice menu.</li> <li>7. Fill the invoice details.</li> <li>8. Click on "Submit" button.</li> </ol>	Display the success message.	Same as expected.	Pass
2	Clear invoice details.	<ol style="list-style-type: none"> <li>1. Login to warehouse.</li> <li>2. Click on add new invoice menu.</li> <li>3. Fill the invoice details.</li> <li>4. Click on "Clear" button.</li> </ol>	Clear all the text boxes.	Same as expected	Pass
3	View past invoices.	<ol style="list-style-type: none"> <li>1. Login to warehouse.</li> <li>2. Click on view past invoices menu.</li> <li>3. Select the date.</li> <li>4. Click on ok.</li> </ol>	Display all invoice details saved on the selected date, in a table.	Same as expected	Pass

Table 4.7 - Test cases for invoices

### Test cases for Valuation

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Fill Broker tea valuation details.	<ol style="list-style-type: none"> <li>1. Login to broker interface.</li> <li>2. Select Broker Valuation from menu.</li> <li>3. Fill the required details.</li> <li>4. Click on the “Submit” button.</li> </ol>	<ol style="list-style-type: none"> <li>1. Auto generate the Lot No</li> <li>2. Auto display plantation and grade once you select the invoice no.</li> <li>3. Display the success message after selecting the submit button.</li> </ol>	Same as expected	Pass
2	Save broker tea valuation details with empty fields.	<ol style="list-style-type: none"> <li>1. Login to broker interface.</li> <li>2. Select Broker Valuation from menu.</li> <li>3. Fill the required details leaving some fields empty.</li> <li>4. Click on the “Submit” button.</li> </ol>	Display error message	Same as expected	Pass
3	Fill Buyer tea Valuation details.	<ol style="list-style-type: none"> <li>1. Login to buyer interface.</li> <li>2. Select Buyer Valuation from menu.</li> <li>3. Fill the required details.</li> <li>4. Click on the “Submit” button.</li> </ol>	<ol style="list-style-type: none"> <li>1. Auto display plantation once the “MF Code” is selected.</li> <li>2. Display the success message after selecting the submit button.</li> </ol>	Same as expected	Pass

*Table 4.8 - Test Cases for valuation*

Refer Appendix F for more test cases.

### 4.5 Summary

Evaluation and testing is another critical stage in the software development lifecycle. Success of a system highly depends on the results of tests carried out in the system prior to its release. Evaluation also gives the confirmation of how far that the system satisfies the user requirements which is again an important element of a successful software.

## **Chapter 5 Conclusion and Future Work**

### **5.1 Conclusion**

The main purpose of this project was to introduce an automated system with more effective features to replace the formal Sri Lankan tea auction and its related processes. The new features of the system will solve the issues currently being experienced by all parties involved. This system will not only keep all parties integrated but also save many resources. The extra work carried out by various stakeholders will be eliminated and additional pressure on some parties will be lifted to a certain extent. Moreover, the overall efficiency of the auction process will be increased while reducing the uncertainties faced by stakeholders.

If the proposed system is implemented, tea warehouse will get a more organized work structure and their tasks will be easier with the electronic system compared to existing methods. Tea brokers and buyers will find it easy to carry out tea valuation and preparing final reports. Most importantly the automated tea auction will give a great auctioning experience to both brokers and buyers. Lastly, the tea board will also find quick access to data that is required for their advance analysis.

The tea auction system has been developed in a manner which could incorporate even a slightest change request from the clients. For example, if the broker requests to add the tea delivering module to the system, this can be completed with a minimum effort.

For more than 125 years the Sri Lankan tea auction and its related processes have been conducted manually. But today due to various reasons the automation has turned to be one of the key requirements. Specially the situation arise with Covid-19 pandemic has made the manual system no longer be operated. Since there is no proper electronic system introduced in Sri Lanka to carry out all the tea auction related processes at the moment, this system can be of high demand.

### **5.2 Challenges**

Many challenges were faced throughout the project. Initially in the requirement gathering stage it was difficult to get permission to visit the client companies (e.g.: tea brokers, tea buyers and tea auction) as their operations were confidential and public were not allowed to access without special permission. Next, it was also difficult to collect relevant data to develop the web application as the data was coming from different parties involved. (e.g.: tea catalogue from brokers, tea valuation details from tea buyers and brokers, yearly reviews from tea board) Only few of these data were freely available in the web.

Coming up with a plan to automate a process which had been running manually for a long period of time was the next great difficulty faced. Since the buyers should be given the similar environment as the live auction in order for the auction to be successful, the system planning needs to be done carefully. Therefore, significant number of hours were spent on finding related literature and going through similar systems in detail within the country as well as outside the country.

Another major difficulty faced was sticking to the exact time frame planned initially as there were some delays in tasks in between due to various technical problems aroused while coding. Also, the evaluation chapter could not be completed within the planned time frame as it was unable to meet the relevant parties (tea board and tea buyers / brokers) to carry out evaluation due to curfew situation following the Covid-19 pandemic in the country.

### **5.3 Lessons learnt**

Many lessons were learnt during all phases of the project. The most important lesson was time management. Project work needed to be carried out with other academic processes including semester exams. Therefore, careful project planning in the initial stage was crucial. Trying out the best to adhere to the project plan afterwards was equally important to complete the project without last minute issues. While planning the project, each deliverable was broken down into sub tasks and prioritized. Then a specific period was allocated for each task. Here again, it was critical to identify the complete content of each task, which otherwise leads to poor quality deliverable.

Another lesson learnt was that the time spent on developing even a smaller function was not useless as all those small functionalities of the system add value to the final product. Moreover, the user friendliness of the system along with an attractive, eye-catching user interface was highly important as it will retain the user with the system for a longer period. Similarly, if the system was complex for users to use and understand, it will not be a valued product for the end user though it has many advance features.

Constant communication with the clients of the project is another worthwhile lesson learnt while doing the project that contributes to the success of the project. After gathering requirements from tea broker, buyer, and tea board, monthly follow-ups were carried out to be updated with the process changes in the industry, so that these can be incorporated in the developing system.

Less knowledge in different programming languages such as JavaScript and PHP, lead to greater difficulty at the beginning of the project. Learning a new programming language thoroughly was complex with the limited time available for the prototype. However, by the end of the project appreciable amount of knowledge was acquired on each language.

### **5.4 Objectives Vs. Achieved**

The developed system managed to achieve all the objectives of the project. The main objective was to develop a web application, connecting main stakeholders of the tea auction process namely, warehouse, brokers, buyers and tea board. The Online Tea Auction System was developed as a web application and have four separate logins for each user role. Moreover, each user is directed to different interfaces after login to the system based on the tasks they carry out.

The next objective was to build a prototype to automate the tea auction process (Selling and Bidding), which was currently done manually. This was achieved by using BI tools namely power bi and power-apps. A new concept of holding the electronic auction was also introduced here.

Some other important objectives were optimizing the invoice registration process at warehouse and reduce the burden from broker and optimizing the broker's and buyer's processes by adding more effective mechanisms. These were also achieved by incorporating more value adding features to the system such as uploading invoices in different formats like pdfs, csv, xls etc. and letting the user input minimum number of records to the system in all the processes.

One of the most critical objectives in the project was to provide a complete analysis to tea broker, tea buyer and tea board using a dashboard. This was achieved by creating three separate analytical dashboards for each user and giving them permission to access their respective dashboards. These dashboards were directly connected to the system database therefore, data collected through the proposed system will also get updated in these dashboards real time.

## **5.5 Scope Vs. Achieved**

The project scope of automating the auction process in the tea supply chain with a case of one tea broker (Forbes & Walker Tea Brokers PVT LTD), one tea buyer (Ranfer Teas PVT LTD) and the tea board (Sri Lanka Tea Board) was achieved through the Online tea auction system. As per the scope all the processes connected to tea warehouse, tea brokers, tea buyers and tea board were considered and included in the Online tea auction system.

Processes of tea farming and tea processing were not considered. Tea plantations were also not connected to the system. Similarly, delivery of purchased tea to respective buyers, tea exporting and importing processes were not considered either. The main focus was only given to the tea auctioning process throughout the project. But if requested by the clients the remaining parts which were mentioned above can also be incorporated in the system with minimum effort.

In conclusion, it can be clearly state, the system has achieved the scope that was laid out with various value additions.

## **5.6 Future work**

Currently the system was developed to automate the tea auction process in Sri Lanka with all its related processes. As mentioned in section 5.5, the plantations could also be connected to the system where the plantations could directly sell their teas to the buyers rather than selling them through brokers.

As a future development stock handling in warehouse can be included in the system. Or else the stock handling system can be connected with the Online tea auction system with the use of APIs. Another important fact is to build a prediction model to predict the prices of the teas rather than brokers and buyers going through tea tasting and valuation every week.

Moreover, a delivery system to deliver teas to respective buyers after purchasing is another significant part that can be added to the current system in the future. This will not only make the brokers processes more hassle free but also save them number of resources.

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# Appendices

## Appendix A – Use Case Diagram (Modularized Version)

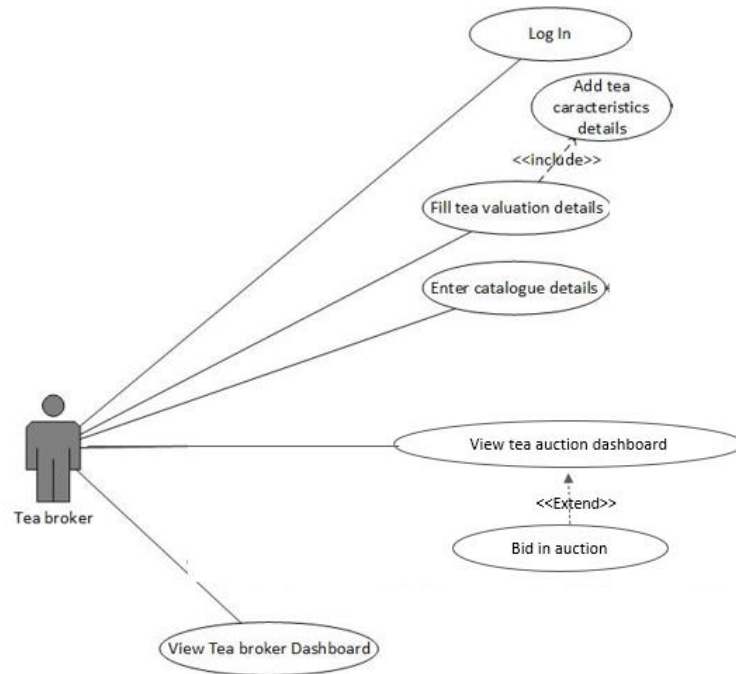


Figure 0.1-Use cases of Tea Broker

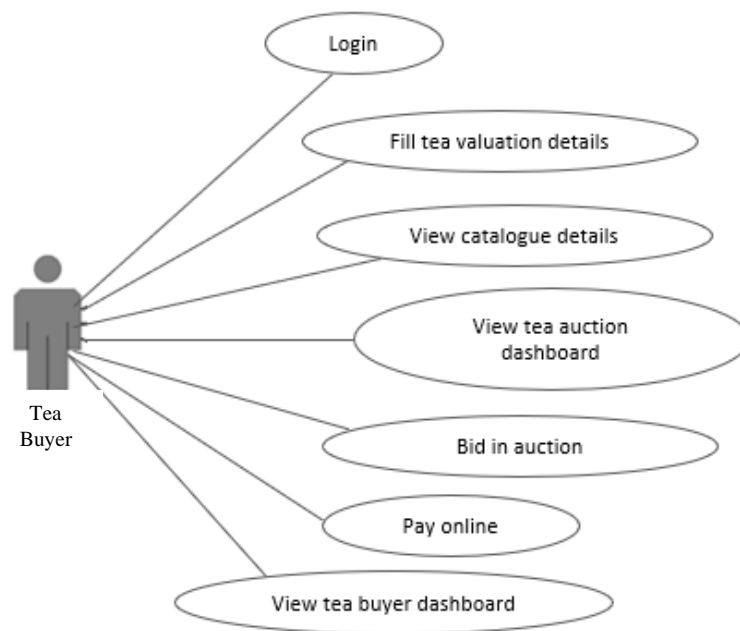


Figure 0.2-Use cases of Tea Buyer

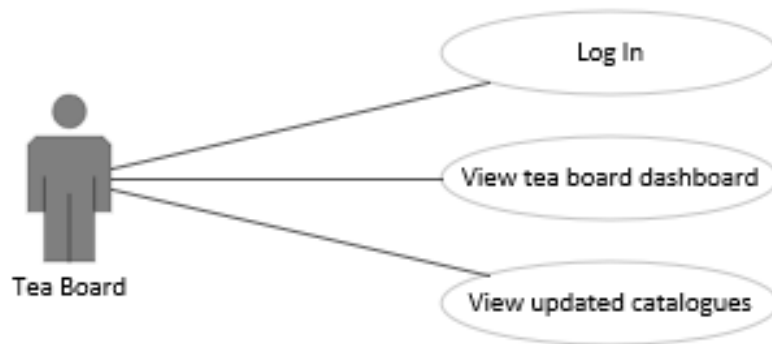


Figure 0.3-Use cases of Tea Board

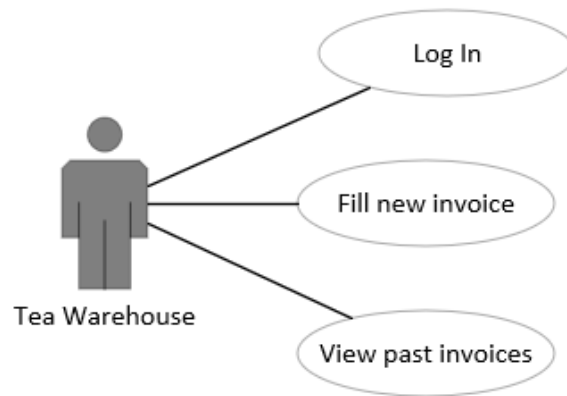


Figure 0.4-Use cases of Tea Warehouse

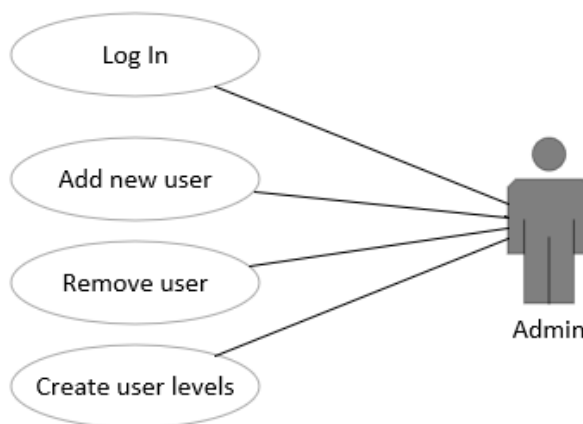


Figure 0.5-Use cases of System Admin

## Appendix B – Use case Descriptions

Use case name	Add new invoice	
Description	This use case describes how the tea warehouse will be able to add a new invoice to the system.	
Actors	Tea Warehouse	
Purpose	Enables the tea warehouse to add new invoice to the system.	
Pre-conditions	Tea warehouse should be logged into his account and be given the necessary permissions to access the relevant interface.	
Main flow	Actor's actions	System responses
	1. Tea warehouse click on add new invoice tab.  3. Tea warehouse fill in the relevant information in the form and click on submit. OR 5. Tea warehouse select upload image option. 7. Upload the image and click on save. 9. Click on the submit button.	2. The system will display a form to add new invoice, along with facilities to add an image, excel file or pdf.  4. Save data to the database and prompt success message. OR 6. Prompt the dialog box to browse for the image in the computer. 8. Display the name of the uploaded image. 10. Display success message
Alternative courses	3a. In step 3, if the tea board submits the invoice form with empty fields an error message will be displayed requesting to fill all the fields.	
Post conditions	The tea warehouse will successfully add a new invoice.	

Table 0.1 - Use case description (Add new invoice)

## Appendix C – Activity Diagrams

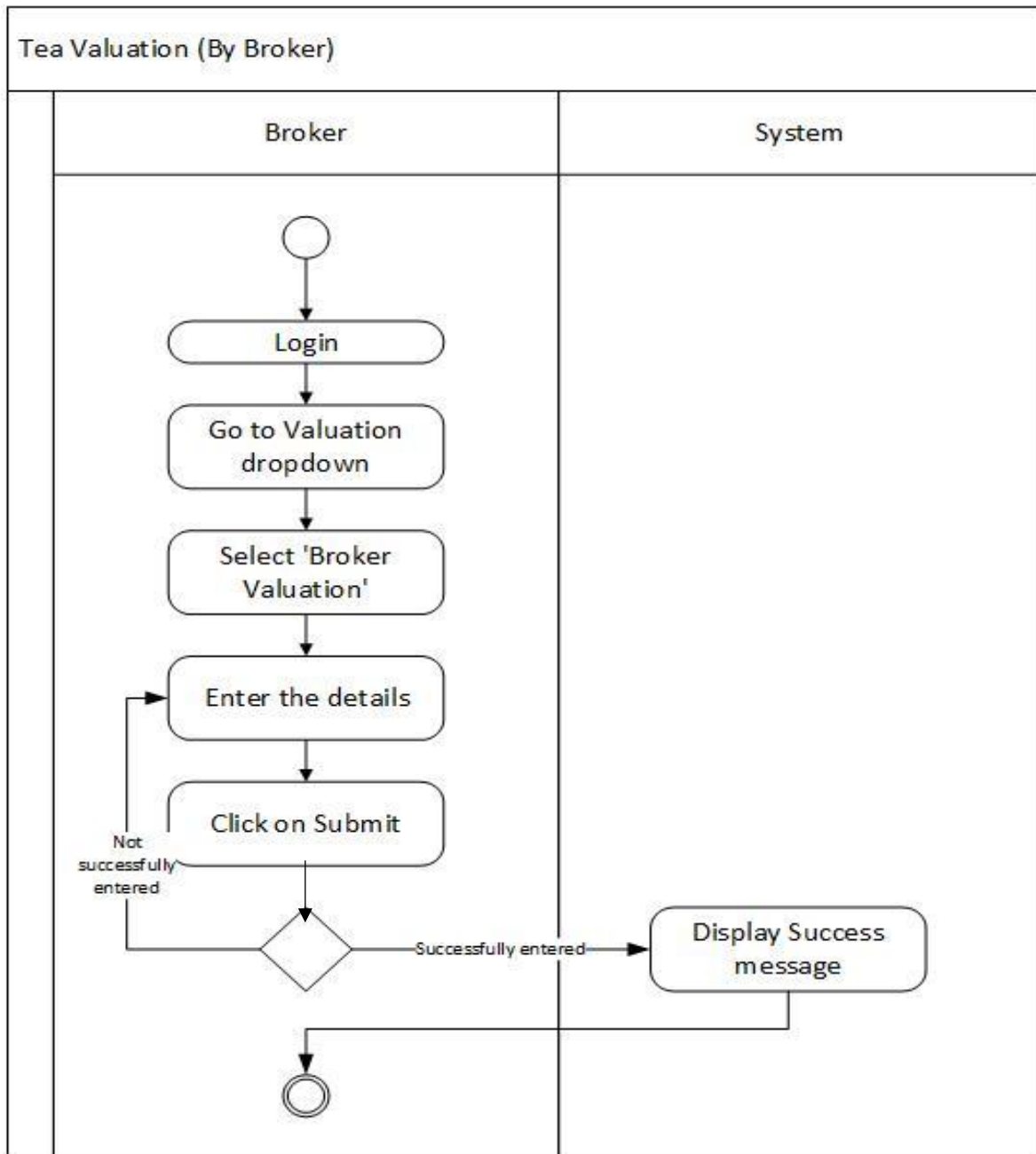


Figure 0.6 - Activity diagram (Tea Valuation)

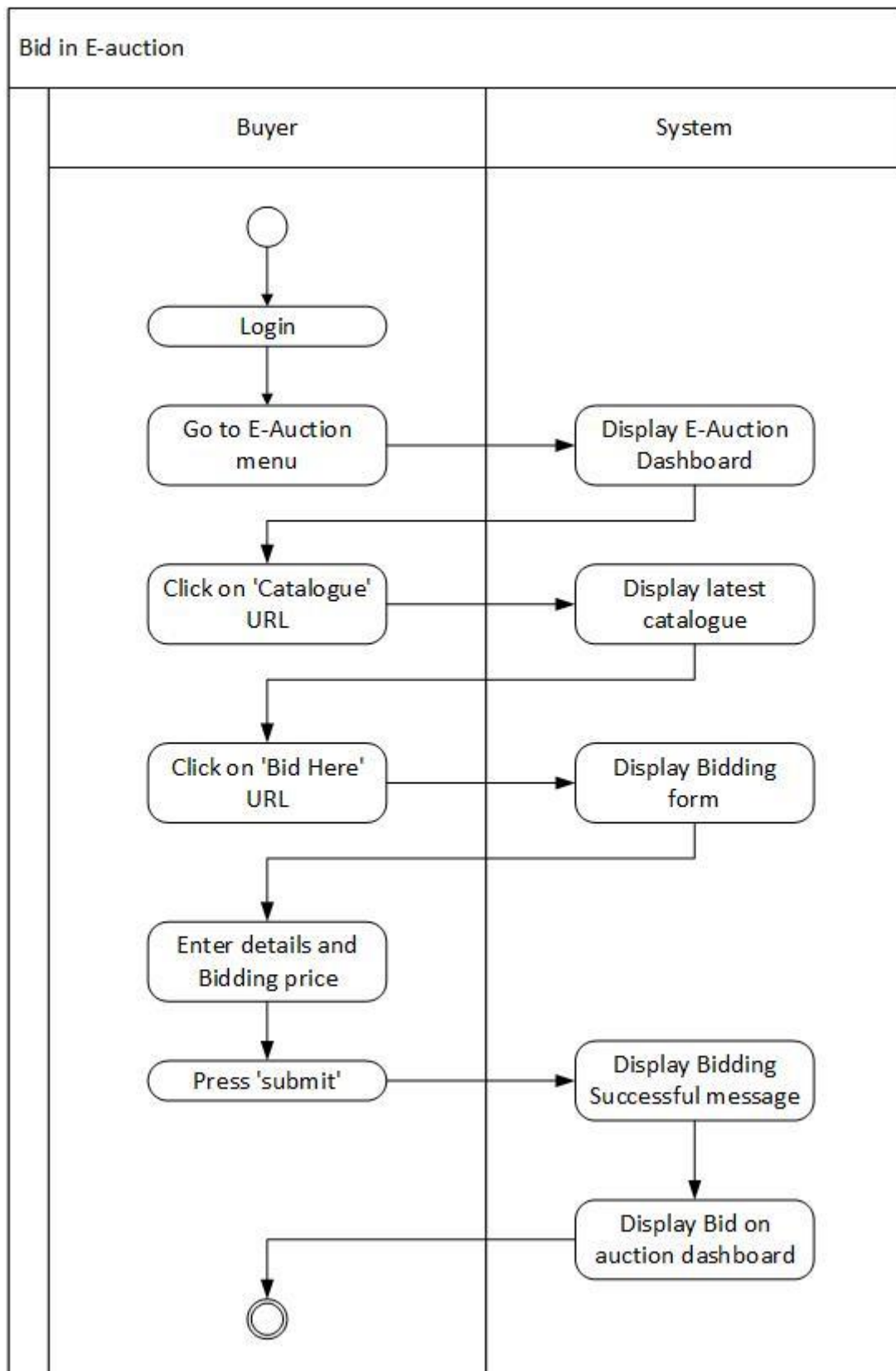


Figure 0.7 - Activity diagram (Bid in E-Auction)

## Appendix D – Sequence diagrams

### *View Broker Dashboard*

All the dashboards were created in Microsoft Power BI and published to power BI online. They were embedded to the Online tea auction system using an Iframe. Once a user logs into the system to view the dashboard, Power Bi will initially authenticate and then display the dashboard to the user.

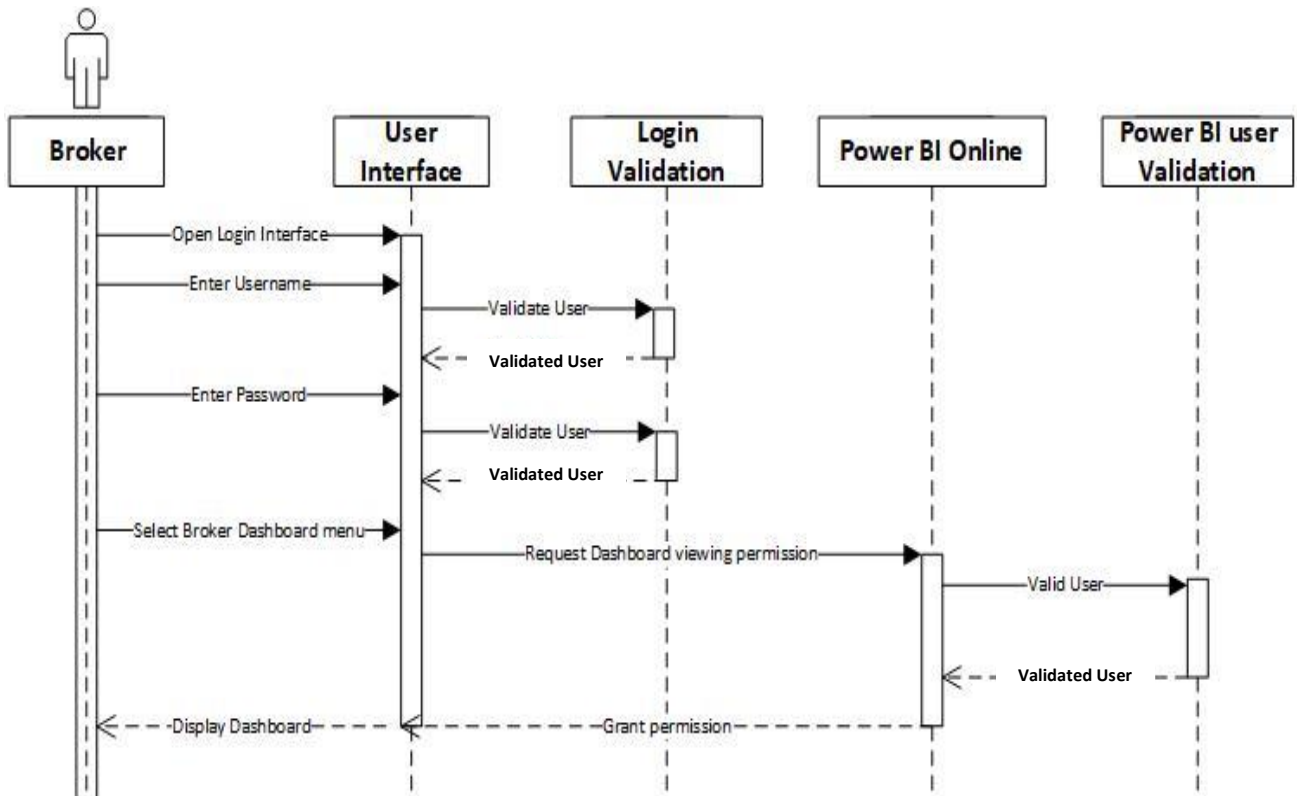


Figure 0.8 - Sequence diagram (View Broker Dashboard)

## Appendix E – Mock-ups

- E-Auction

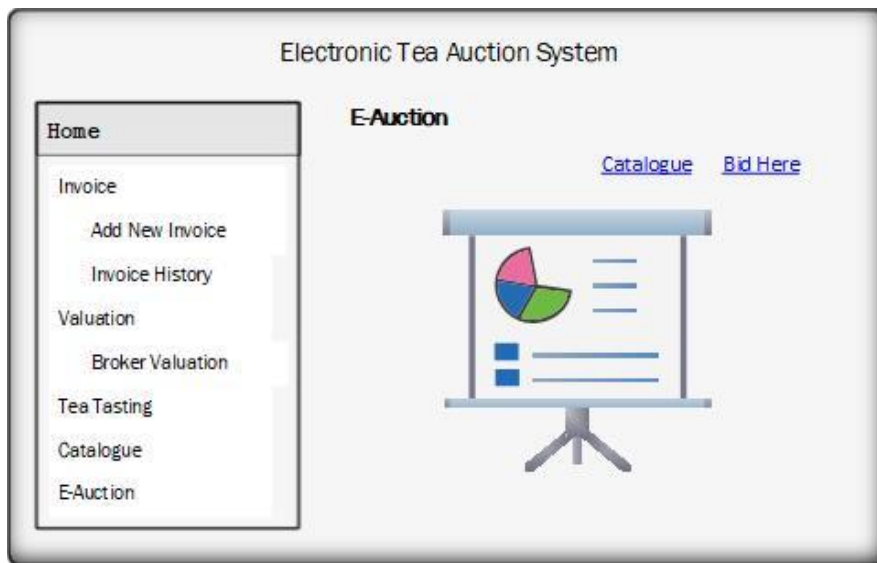


Figure 0.9 - E-auction mock-up

- Catalogue (As a reference for auction)

The mock-up shows a window titled "Catalogue" containing a table with the following structure:

Broker Name	Sales Year	Sales No	Category

Figure 0.10 - Catalogue mock-up

- Bidding Portal

The mock-up shows a window titled "Bidding Portal" with the following form elements:

Lot No :

Buyer ID :

Buyer Name :

Demanding Price :

Figure 0.11 - Bidding portal mock-up



## Appendix F – Test cases

### Test cases for catalogue

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Broker entering catalogue details.	<ol style="list-style-type: none"> <li>1. Login to broker interface.</li> <li>2. Select catalogue from menu</li> <li>3. Fill required details.</li> <li>4. Click on “Submit” button.</li> </ol>	<ol style="list-style-type: none"> <li>1. Auto generate ‘MF Code’</li> <li>2. Auto display ‘Plantation’ when ‘Lot no’ is selected.</li> <li>3. Display the success message after selecting the submit button.</li> </ol>	Same as expected	Pass
2	Buyer viewing catalogue during e-auction.	<ol style="list-style-type: none"> <li>1. Login to buyer interface.</li> <li>2. Select E-auction from menu.</li> <li>3. Click on “Catalogue” button displayed at the top.</li> </ol>	<ol style="list-style-type: none"> <li>1. Display catalogue at a side of the E-auction interface.</li> <li>2. Catalogue will display the expected price of the buyer as a new field.</li> </ol>	Same as expected	Pass

Table 0.2 - Test cases for catalogue

### Test cases for E-auction

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Bid in E-auction (Buyer)	<ol style="list-style-type: none"> <li>1. Login to buyer interface.</li> <li>2. Select E-auction from menu.</li> <li>3. Click on “Bid here” link given at the top.</li> <li>4. Enter require details and click ok.</li> </ol>	Display the bidding price in the auction dashboard.	Same as expected	Pass
2	View entire selling and bidding process in a dashboard	<ol style="list-style-type: none"> <li>1. Login to broker / buyer interface.</li> <li>2. Select E-auction from menu.</li> </ol>	Display e-auction dashboard with count down timer, catalogue component and bidding application placed aside.	Same as expected	Pass

Table 0.3 - Test cases for E-Auction

Test case for pay online for purchased tea

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	Pay online	<ol style="list-style-type: none"> <li>1. Login to buyer interface.</li> <li>2. Select 'Purchased tea orders' from menu.</li> <li>3. Click on "Pay" button.</li> </ol>	Redirect the user to pay-pal account.	Same as expected	Pass

Table 0.4 - Test cases for online payments

Test cases for Dashboards

Test case ID	Test Case	Steps	Expected Results	Actual Result	Pass / Fail
1	View Tea Broker dashboard	<ol style="list-style-type: none"> <li>1. Login to broker interface.</li> <li>2. Select Broker Dashboard from menu.</li> </ol>	Display Tea broker dashboard	Same as expected	Pass
2	View Tea Buyer Dashboard	<ol style="list-style-type: none"> <li>1. Login to buyer interface.</li> <li>2. Select Buyer Dashboard from menu.</li> </ol>	Display Tea buyer dashboard	Same as expected	Pass
3	View Tea Board Dashboard	<ol style="list-style-type: none"> <li>1. Login to tea board interface.</li> <li>2. Select tea board Dashboard from menu.</li> </ol>	Display Tea board dashboard	Same as expected	Pass

Table 0.5 - Test cases for dashboards

# Appendix G – Questionnaires

## Tea Buyer / Tea Broker questionnaire

The screenshot shows the first page of a Google Forms questionnaire titled "Electronic Tea Auction System System Evaluation Questionnaire". It contains questions 1 through 7. Questions 1, 2, and 3 use a 5-point Likert scale with radio button options: "Extremely satisfied", "Very satisfied", "Somewhat satisfied", "Not so satisfied", and "Not at all satisfied". Question 4 asks if the system will help complete tasks easily, with radio button options for "Yes, I think it will be really helpful...", "No, I feel that it will double my routine tasks...", and "There's no difference...". Question 5 asks if performing tasks is straightforward, with radio button options for "Yes", "Yes, but only few", and "No". Question 6 asks for the three most valuable features, with a "Check all that apply" instruction and a list of features: Invoice Uploading, Plantation detail pop-up window, Filling tea valuation details, Online bidding, Displaying user photo while bidding, Informative dashboard, and Online payment option. Question 7 asks for a rating of the gaming concept, with a 5-point scale and radio button options from "Not at all useful" to "Extremely useful".

Figure 0.12 - Tea Buyer/Tea Broker questionnaire (Page 1)

The screenshot shows the second page of the questionnaire, containing questions 8 through 11. Question 8 asks for a rating of the software's speed, with a 5-point scale and radio button options from "Very slow" to "Very fast". Question 9 asks for a rating of the overall system, with a 5-point scale and radio button options from "Not at all useful" to "Extremely useful". Question 10 asks if the system will replace the manual outcry system, with radio button options for "Yes", "No", and "Maybe". Question 11 asks for suggestions to improve the application, with four horizontal lines for text input. The page includes a footer with a disclaimer: "This content is neither created nor endorsed by Google." and a page number "44".

Figure 0.13 - Tea Buyer/Tea Broker questionnaire (Page 2)

# Tea Board Questionnaire

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## Electronic Tea Auction System

System evaluation questionnaire

1. Is performing tasks in the system straight forward?  
Mark only one oval.

Yes  
 Yes, most of the time  
 Yes but only few tasks  
 Not at all

2. Do you require any guidelines to operate the system?  
Mark only one oval.

Yes  
 No  
 Maybe

3. Is it easy to navigate through the system?  
Mark only one oval.

Yes  
 No  
 Maybe

4. Are dashboards informative enough?  
Mark only one oval.

Yes, Very Informative  
 Yes, moderately informative  
 Slightly informative  
 Not at all informative

5. How often does the software crash?  
Mark only one oval.

Very often  
 Moderately  
 Not at all

6. How do you rate the user-friendliness of the system?  
Mark only one oval.

1 2 3 4 5  
Not at all user-friendly      Very much user-friendly

7. How do you rate the flexibility and adaptability of the system?  
Mark only one oval.

1 2 3 4 5  
Not at all adaptable      Very much adaptable

<https://docs.google.com/forms/d/1G2N9yVhL02rrvQWwK0GcJwhuRj16-3DCu2C446BvA/edit> 10 <https://docs.google.com/forms/d/1G2N9yVhL02rrvQWwK0GcJwhuRj16-3DCu2C446BvA/edit> 25

Figure 0.14 - Tea Board questionnaire (Page 1)

©18/2020 Electronic Tea Auction System

8. How much reliable do you think the system is?  
Mark only one oval.

1 2 3 4 5  
Not at all reliable      Very much reliable

9. How satisfied are you with the overall performance of the system?  
Mark only one oval.

Very satisfied  
 Somewhat satisfied  
 Neutral  
 Somewhat unsatisfied  
 Very unsatisfied

10. Any suggestions to improve the software?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

This content is neither created nor endorsed by Google.

Google Forms

<https://docs.google.com/forms/d/1G2N9yVhL02rrvQWwK0GcJwhuRj16-3DCu2C446BvA/edit> 33

Figure 0.15 - Tea Board questionnaire (Page 2)

## Appendix H - Coding

- **Add new invoice Javascript**

```
<html>
<head>

<title>Add New Invoice</title>
<link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css"
integrity="sha384-ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T"
crossorigin="anonymous">
<style>
body {
  font-family: "Lato", sans-serif;
}
.sidenav {
  height: 85%;
  width: 0;
  position: absolute;
  z-index: 1;
  top: 165px;
  left: 0;
  background-color: #111;
  overflow-x: hidden;
  transition: 0.5s;
  padding-top: 30px;
}

.sidenav a {
  padding: 6px 6px 8px 32px;
  text-decoration: none;
  font-size: 20px;
  color: #818181;
  display: block;
  transition: 0.3s;
}
.sidenav a:hover {
  color: #f1f1f1;
}
.sidenav .closebtn {
  position: absolute;
  top: 0;
  right: 25px;
  font-size: 36px;
  margin-left: 50px;
}

@media screen and (max-height: 450px) {
  .sidenav {padding-top: 15px;}
  .sidenav a {font-size: 20px;}
}
#header {
  background-image:url("paper.gif");
}
img {
  width: 1400;
}
```

```

</style>
</head>
<body onload="openNav()">

<span style="position: absolute; top: 165px; left: 0; font-size:30px; cursor:pointer"
onclick="openNav()">&#9776;</span>

<div id="mySidenav" class="sidenav">
  <a href="javascript:void(0)" class="closebtn" onclick="closeNav()">&times;</a>
  <a href="http://localhost:8081/homepage.html">Home</a>
  <a href="http://localhost:8081/addnewinvoice.html">Add New Invoice</a>
  <a href="http://localhost:8081/invoicehistory.php">Invoice History</a>
    <a href="http://localhost:8081/brokervaluation.html">Broker Valuation</a>
      <a href="http://localhost:8081/buyervaluation.html">Buyer Valuation</a>
        <a href="http://localhost:8081/catalogue.html">Catalogue</a>
    <a href="http://localhost:8081/e-auction.html">E-Auction</a>
      <a href="http://localhost:8081/purchasedteaorders.html">Purchaesd Tea Orders</a>
        <a href="http://localhost:8081/brokerdashboard.html">Broker
Dashboard</a>
          <a
href="http://localhost:8081/buyerdashboard.html">Buyer Dashboard</a>
            <a
href="http://localhost:8081/teaboarddashboard.html">Tea Board Dashboard</a>
        </div>

<div class="row" id="header">
  <div class="col-md-3 col-md-offset-9">
    
  </div>
</div>

<script>
function openNav() {
  document.getElementById("mySidenav").style.width = "270px";
}

function closeNav() {
  document.getElementById("mySidenav").style.width = "0";
}

</script>

<br>
<h2 align="center">Add New Invoice</h2>
<form name="invoice" action=addnewinvoice.php method="post" enctype = "multipart/form-data">
<table align="center">

<tr>
<td> Upload File</td>
<td><input type = "file" name = "file" /></td>
</tr>

<tr>
<td> Invoice No</td>
<td> <input type="int" name="invoice_no" class="form-control" value=""></td>
</tr>
<tr>
<td>Plantation</td>

```

```

<td> <input type="text" name="plantation" class="form-control" value=""></td>
<td><input type="button" value=">>"
onclick="window.open('http://localhost:8081/plantationinfo.php','popUpWindow','height=500,width=600,left=1
0,top=10,,scrollbars=no,menubar=no'); return false;" /></td>

</tr>
<tr>
<td>Grade</td>
<td> <input type="text" name="grade" class="form-control" value=""></td>
</tr>
<tr>
<td>Bag Count</td>
<td> <input type="int" name="bag_count" class="form-control" value=""></td>
</tr>
<tr>
<td>Quantity Per Bag</td>
<td> <input type="int" name="quantity_per_bag" class="form-control" value=""></td>
</tr>

<!-- <script>

// Function to generate random number
function randomNumber(min, max) {
    return Math.floor(Math.random() * (max - min) + min);
}

document.write("Random Number between 1 and 100: ")

// Function call
document.write( randomNumber(1, 100) );
</script> -->

<!-- <form method = "POST" >
    <input type = "file" name = "file" />
    <input type = "submit"/>
</form> -->

<script>
function range(start, end) {
    var ans = [];
    for (let i = start; i <= end; i++) {
        ans.push(i);
    }
    return ans;
}
</script>

<br>
<td><br><br><input type="submit" class="btn btn-secondary float-right" value="Submit"></td>
<td><br><br><input type="reset" class="btn btn-secondary" value="Clear"></td>

</tr>

</table>
</form>

</body>
</html>

```