Project Proposal

Container Identification Application

Louise Pittman

18059081

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## Glossary

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| **Term** | **Definition** |
| Banding | Loading multiple containers onto the same pallet |
| Putaway | The dropping off of a container into a specified location |
| Empties | Empty container |
| Load Unit (LU) | A group of items, transported as one unit |

## 1. Introduction

1.1. Background

Through this project I aim to digitise the container identification system currently in use in Rolls Royce Motor Cars warehouses, through the development of an image-processing application. I was first introduced to colleagues at Rolls Royce during my industrial placement year at BMW Group UK, working as a Supply Chain Planner in Logistics. I wanted to amalgamate my experience in logistics with the technical knowledge from my degree to solve a problem in the area.

1.2. Problem Statement

The current system in place for container identification at the Rolls Royce Goodwood Manufacturing Facility is paper-based, meaning container locations via printed spreadsheets called Banding Lists. This is not only time-consuming, but increases the chance for human error (Torres, *et al.* 2021). The container identification application should aim to optimise this process through digitisation, to save time for users and reduce risk of error.

1.3. Objectives

The key objectives of the project are as follows:

* Analyse existing literature on areas in and around topic of project as well as competitors to form a literature review
* Conduct stakeholder interviews to understand the needs of each end-user at Rolls Royce
* Produce requirement specification and a set of User Stories for client review
* Develop web application that can be accessed by end-users to carry out different tasks based on the warehouse process (see 1.4.1)
* Conduct testing to discover weaknesses of the application and rectify
* Implement application (or prototype thereof) within Rolls Royce Logistics Department
* Write final report; justifying methods and exploring alternatives, evaluate project outcome

1.4. Product Overview

1.4.1. Scope

The identification application will be used to gather information about specific containers depending on user needs. Each user will have their own log in details. Upon the first registration they will have to identify “viewer preferences” via a checklist, but these can also be edited later as needed via a menu. Users will then be able to key in or use their device’s camera to scan and read the container number, which the system will identify in the database and pull the information selected from the user’s preferences and display it on the “viewer” screen.

The information that the application will pull from the database will differ depending on the end user. This is discussed in more detail in section 1.4.2.

1.4.2. Audience

Once implemented, the application will be contained within BMW Group. More specifically, Rolls Royce employees. The end-users will be as follows:

* Warehouse Operations employee (e.g. Empties Handler): Responsible for reading incoming orders from the manufacturing line and preparing the correct containers to be transported there. The Operations employee will be able to use the application to gather the following information:
* Drop-off location for the container
* LU band
* Drop-off Lane
* Relevant Logistics employee contact information should there be an issue with quality or delivery delay
* Logistics employee: Responsible for making sure the manufacturing components are delivered to the warehouse securely and in a timely manner. The Logistics employee will mainly utilise the app to find the following information:
* Access supplier information regarding the container (supplier name, supplier ID, country of origin, supplier contact)
* Delivery information (time, days, frequency)
* Warehouse location
* Alternative Logistics employee contact information (container planner, supply chain planner, etc.)

## 2. Background Review

2.1. Literature Review

Search criteria:

1. IEEE only (<https://ieeexplore.ieee.org/Xplore/home.jsp>)
2. Articles published 2015 onwards to ensure technology is up-to-date

Searches:

1. Automotive Warehouse Management System
2. Manufacturing Warehouse Management System
3. Number Recognition Image Processing

**\*Digitisation within warehouse management systems**

In a 2016 article exploring the uses of Warehouse Control Systems to automate operations, (Son, *et al.*), the introduction of automation for machinery, such as forklifts, can greatly improve efficiency and productivity. It is hoped that broader applications of IT in this area, such as digitisation of processes can have the same success.

This article focuses heavily on the positive impacts automation had on the warehouse staff, however to expand on this, it would be interesting to have insight into other stakeholders, and how it benefits the wider organisation.

**\*Existing warehouse management information system**

A 2015 article detailing the design and development of a warehouse management system for Hongxing Logistics by Ling, *et al.* explores the successes of the implementation. The project immediately optimised data transparency across business functions, as goods receipt was no longer reliant on inefficient, unreliable Excel spreadsheets. This improved efficiency and subsequently increased productivity – thus de-intensifying operational staff workload. Not only this but there was a considerable cost saving to come from the system, with less mistakes made. It is clear that management systems which optimise processes can greatly improve productivity and efficiency, which, in sectors like manufacturing can be invaluable.

**\*Number recognition through image processing**

An application with the purpose of reading number plates in India, 2021, proves that image processing for number recognition through Python and OpenCV is not only successful but “simple” to implement (Shariff, *et al.*). It would be interesting to see how versatile this image processing technique is when applied to other systems and functions.

**\*To be extended**

## 3. Technical Progress

3.2. Approach

**Software Development Model**

The software development model employed for this project will be Agile. There is extensive research to suggest that Agile is one of the most effective ways of working when it comes to software development, especially in terms of stakeholder satisfaction, (Serrador and Pinto, 2015) as it allows for thorough testing and incremental additions to be made as per the sprint format.

The software employed to provide Agile functionality support is ClickUp, (<https://clickup.com/>). After research, this software was chosen as it rates highest based on reviews and is currently the “#1 productivity app”, above Jira and Asana, (Gerdisch, 2021). Another reason ClickUp was chosen was because it provides all functionality needed all in one place, without payment. For instance, to create and update Gantt charts, based on tasks entered into the sprint plan.

**Prototype**

Applying Gilb’s Evolutionary Systems Delivery (Evo) framework (2015), it was decided to create a minimum viable product as a prototype. Evo is an Agile practice which prioritises value delivered to stakeholders, so for this reason, creating a prototype that stakeholders can test, concurrent to development. The Evo model is especially effective when considering high-risk deliverables, as these will be attempted first, immediately solidifying their true value within the project, (Gilb & Gilb, 2015). Within this project, an example of a high-risk task is to deliver functioning OCR, so to test this with a prototype allowed us to realise the value and understand how the technology functions.

The prototype software used was Google’s AppSheet (https://www.appsheet.com/) . This software was chosen for the following justifications:

* No-code environment allowing for quick assembly of web / mobile applications
* Google AppSheet connects directly to Excel workbooks, the format in which the current Rolls Royce Container Management data is stored.
* App user activity will sync to connected data source, allowing dynamic testing of the prototype

See below screenshots of working prototype (mobile application dimensions):

Graphical user interface, application

Description automatically generated

Figure 1: AppSheet Screenshots

**Data Normalisation (Excel)**

In order for AppSheet “views” to behave correctly per the requirements, it was necessary to normalise the data provided in the Container Management Excel. To reduce redundant data, such as duplicates, the data was normalised according to 2nd Normal Form (2NF). 2NF leaves no partial dependencies within the data.

In the example of Supplier: of 1016 entries for supplier, only 350 of these were unique values, meaning the de-duplication process was crucial. For examples such as this, where there are many duplicates, these were split out into separate tables, which then translate to Google AppSheet “views”.

**Requirement Elicitation**

In order to elicit further requirements, the two key Rolls-Royce stakeholders were given testing access to a prototype application on Google AppSheet. They were provided a questionnaire (seen completed below, *Figure 1*) with targeted questions pertaining to each section of the app, and each area of the requirements as had been agreed in prior meetings. A questionnaire was chosen as the main form of elicitation as it is less time-consuming due to the fact that it does not need to be completed face-to-face, allowing for an unbiased, honest review of the system, (Dar, et al. 2018).

Graphical user interface, text

Description automatically generated

Figure 2: Requirement Elicitation Questionnaire based on Prototype

Another key requirement elicitation technique will be to study of the current system-as-is from an Operational employee perspective. Identifying the key inefficiencies in the analogue system will aid in the design and functionality of the application

**Test and Evaluation Process**

To ensure a secure and functional application, test cases will be produced ranging from low-level integration testing to higher level functional testing. The tests will be completed by several users to increase the range of input. For quality assurance reasons, test results will be classed as a fail if the system does not perform in a responsive, efficient and user-friendly way, even if the functionality being tested works.

3.3. Version management plan

Version control will be completed using Git, via a GitHub repository. All versions will be visible so progress tracking and version history is clear to all stakeholders.

## 4. Project Management

Timeline

Description automatically generated4.1. Updated Gantt Chart

Figure 3: Gantt Chart to track progress (ClickUp)

4.2. Data management plan

All documentation will be managed within a Google drive folder, organised into sections for meeting minutes, specifications and reports. All development-related files will be managed within a GitHub repository to ensure accessible version history. Sprint plans will be located in Click-Up

4.3. Deliverables

The key deliverable will be the container identification web application. Supporting deliverables will include a requirement specification and literature review, encompassed in the Final Report.

## 5. Professional Risks

5.1. Professional Risks

The risks involved in the project mainly centre around the dependence on Rolls-Royce requirements. For instance, a risk could be that requirements change, thus meaning the course of develop changes. This would slow the project down, as the planned tasks would be moved back.

Another risk would be the use of sensitive company information within the app itself. This poses a risk as access to the app needs to be protected to ensure only those with admin privilege can view, edit or delete certain items.

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