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Requirement Analysis and Specification Document

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1 Introduction

1.1 Purpose

1.1.1 Description of the Proposed System

The project ČLup - Customer Line upïs a line spot reservation system that is planned to be used by managers, clerks and customers of many local vendors and chains. The system aims to come up with a handy solution for the ongoing issue of proper social distancing management particularly in the matter of grocery shopping, by providing assistance to cope with the customer load for managers and helping customers access to products in a safe and controlled manner.

In particular, users will be able to see the locations, get a line number and book in advance for the grocery stores they would like to visit. Once assigned a line number, the customer will be able to track the estimated time of arrival of the line as well as will wait for the notification that informs about his or her line's forthcoming arrival, hence waiting time in the line in the crowd is minimum. Also, ČLupprovides uniquely generated QR codes per the line number, which can be utilized by the store managers as a proper monitoring tool in the entrances and exits of the locations. All in all, the general purpose of the product is to keep the congestion levels in lines of the locations at minimum via providing useful features for all the users.

1.1.2 Goals

- G_1 Customers can issue a line number for a location.

- G_2 Customers can issue line numbers for their future visits.

- G_3 Customers can detail their visits by category and/or product.

- G_4 Customers can plan their visit to the store.

- G_5 Customers may prefer to use alternative time slots or partner stores for their visit.

- G_6 Managers can prevent customers from issuing line numbers.

- G_7 Managers can customize the system to allow optimizations for increased granularity, flow control and time slot forecasting.

- G_8 Clerks and Managers can monitor the customers through their entrance and exits.

- G_9 Customers can obtain printed line number tickets.

1.2 Scope

1.2.1 Targeted Users

CLup aims to resolve the problem of Customers queueing up in front of a location, without any control over the availability of place in the location and further contact tracing by the managers.

Customer:

Customers will be able to obtain specific line numbers for various locations using CLup, which they can track the estimated time available with and also view the location on a map application to plan their visit. Customers can further obtain line numbers for future visits, based on the info provided by the system about the availability of free spots on the specific time intervals. They may prefer to visit a different branch of the same chain. Furthermore, they can provide specific products they intend to purchase or set

an estimated time for their visit to allow finer granularity. Some customers may also prefer to obtain a line number upon visiting the store physically. To plan their visit in a time slot where the location will be less crowded, the users can see the occupancy of the location based on already taken line numbers and forecasts provided by the system.

Clerk:
The clerk (which can be a shopping assistant or a security detail) can monitor the flow of customers and manually intervene in case of missing line numbers via performing manual checkout for a specific customer, or by printing line numbers physically for some customers.

Manager:

The location manager (which could be an actual manager, or someone responsible for handling customer management) can provide details regarding the availability of products and the location in general, by setting the opening hours, maximum allowed customers in shop, in-shop location of different products and categories, maximum amount of reservations that can be made per customer, line number timeout and the location. Also, for chains and relevant stores, the manager can add chain members for the location.

1.2.2   Relevant Phenomena

Phenomenon	World / Machine	Shared
Line Number	Machine	Yes
Line Number Ticket	World	No
Product	World	No
Product Category	World	No
In-store Location	World	Yes
Occupancy Forecast	Machine	No
Store	World	Yes
Time Slot	Machine	Yes
Ticket Printer	World	Yes
Line Number Timer	Machine	No
Customer Scheduling Algorithm	Machine	No

Table 1: Relevant Phenomena of CLup

1.3   Definitions, Acronyms, Abbreviations

1.3.1   Definitions

- *Location*: the physical location of the business that operates the line reservation system

- *Manager*: the user in charge of executive action within the location

- *Customer*: the user with the goal of making a visit to the location

- *Clerk*: the user in charge of handling the entrance and exit of customers

- *Hard-coded Super User*: a single user that is used to create managers of locations administered by the software vendor

- *Visit Time*: the time interval in which a customer performs a visit to the location

- *Line Number*: A number that indicates the ordering of a specific customer in the line

- *Line Number Ticket*: A physical ticket printed that features the line number and the QR code.

- *Time Slot*: Specific intervals of time that are determined by the opening hours and average visit time per customer.

- *Partner Store*: A different location that is included in the same beneficiary chain of command (such as another member of the franchise or store chain) or in a mutual agreement with the specific location

- *Product*: Any item, items, service or services demanded by the customer, and provided by the location to the customer.

- *In-store Location*: A location of a specific product or a product category inside the location.

- *Working hours*: The time intervals that the store is open during each day.

- *Maps API*: A third-party mapping service implementation used for location tracking

1.3.2   Acronyms

- **RASD**: Requirement Analysis and Specification Document

- **QR Code**: Quick Response Code

- *API*: Application Programming Interface

1.3.3   Abbreviations

- G_n: n^{th} goal

- D_n: n^{th} domain assumption

- R_n: n^{th} functional requirement

1.4   Revision history

1.5   Reference Documents

- Specification Document: R&DD Assignment AY 2020-2021

- IEEE Std 830-1998: IEEE Recommended Practice for Software Requirements Specifications

- ISO/IEC 18004:2015 QR Code bar code symbology specification

1.6   Document Structure

This document is composed of six sections, each with the purpose described below:

- **Introduction**: This section provides an introduction of the problem, the scope of the project with details regarding the goals, target users and phenomena. The goals of the project are formulated in accordance with the description of actions and actors in the Specification Document. Within the project's scope, properties and duties of different users and user groups are described in Target Users section. Furthermore, under the scope of the project, the relevant phenomena of the project is presented through their relevance to the world and the machine.

- **Overall Description**: This section builds upon the introduction section by providing expansion of the scope and relevant functionalities of the system. The basic perspective is provided considering the shared phenomena between the world and the system and the integrations of the system with other parties and products. The overall actions that can be conducted over the system is described using a detailed class diagram, portraying all required components of the system, their inner state and provided functionalities for other components to facilitate their purpose. All core features of the system is listed and explained using user scenarios to provide a better understanding of the real-world condition on which the use case should apply to, a state chart for demonstrating the relationship between various states the system can be in during the execution of the provided core feature scenario. Next, the requirements for the system to archive the aforementioned goals and allow the execution of the provided scenarios. The user characteristics, based on their roles in the system is further evaluated in this section, through the means of the needs that they have, how the system archives those needs via its requirements and goals. No system can be designed without a broad idea on what domain it exists in and how much the environment limits its ability to perform its features. Ergo, we provide the expected assumptions of the domain, the dependencies of the system to external components and the limits imposed by the world on the system.

- **Specific Requirements**: This section is the main section of the document. The external interfaces that the system requires to function correctly is presented with details and additional mockups if needed. The interfaces section is mainly concentrated on different views of user interfaces as the user-facing part is the main way to integrate with the system. In this section, functional requirements of the system are presented in detail, a common use case diagram is provided, and each use-case of the system is analyzed with details on a use case description table and a sequence diagram. The performance requirements of the system, with a focus on The design constraints of the system, with a focus on different standard compliances, hardware limitations of the system to function and other constraints, like GDPR are also elaborated on this section. The vertical aspects that needs consideration are evaluated under the Software System Attributes subsection of this document, with an emphasis on Reliability, Availability, Security, Maintainability and Portability.

- **Formal Analysis Using Alloy**: This section features various models built and hypothesis verified using Alloy. This section demonstrates that some aspects of the requirements document can be formally proven to be correct and provides additional information about the proposed system to the engineers.

- **Effort Spent**: This section features the effort table, in which all team members provide a rough estimation on the time spent on creation of the various sections of the document.

- **References**: This section features different reference materials referred inside this document.

2 Overall Description

2.1 Product Perspective

2.2 Product functions

2.3 User characteristics

2.4 Assumptions,dependencies and constraints

2.4.1 Domain Assumptions

- D_1 %80 of the customers and all clerks and managers have basic ICT skills, has an email address that they are willing to use to authenticate to the system and has a smart phone or equivalent device that can connect to the Internet, have a browser that supports UTF-8, display QR codes and has a mapping application.

- D_2 Locations will not be visited by no more than 1000 people in any time slot.

- D_3 %98 of the customers will arrive at the given location either without a ticket or with a ticket that has not timed out.

- D_4 E-mail addresses are not shared by multiple users of the system.

- D_5 Clerks' mobile devices are equipped with at least one camera that the system can use.

- D_6 All users have a basic understanding of how the line numbering system works and respects the ordering provided by the system.

- D_7 Managers have an estimate for the amount of reservations that their location can at most have.

- D_8 Managers' device has location services that has a location acquisition error for no more than 20 meters.

- D_9 Clerks are constantly monitoring the locations entrances and exits.

- D_{10} Locations have printing equipments that are in 5 meters range of all the entrances that can print QR codes and line numbers.

- D_{12} At least one manager is available in the location during the working hours.

- D_{13} The customer's entry and exit to the store is determined by whether the clerks have checked them in and out.

- D_{14} The customer has their line number or line number ticket available with them through their visit, including their exit from the store

2.4.2 Dependencies

2.4.3 Constraints

3   Specific Requirements

3.1   External Interface Requirements

3.1.1   User Interfaces

3.1.2   Hardware Interfaces

3.1.3   Software Interfaces

3.1.4   Communication Interfaces

3.2   Functional Requirements

Name	Book future line number
Actors	Customer
Entry conditions	The customer is logged in the app and wants to book a visit to the store.
Event flows	• The customer clicks on the "Book a Visit" button in the app. • The app asks the time slot and the estimated time of the visit presenting as default value the average of the previous times of visit of the same user. • The customer sets the time slot and the estimated time of their visit. • The app asks what category of products the customer wants to buy. • The customer set the products categories. • The app requests the line number from the server. • The app generates the QR code on the response from the server.
Exit conditions	The customer has booked a visit for the store.
Exceptions	• The server cannot retrieve the line number since the time slot is full.

Table 2: Use Case: Book future line number

Name	**Grant access**
Actors	Clerk, Customer
Entry conditions	The customer has already obtained the QR code and they plan on entering the store.
Event flows	• The Clerk scans the QR code from the customer's smartphone or printed ticket using the app • The app analyzes the QR code and contacts to the Server • The server decides if the customer can enter based on the information received in the QR code • The server responds to the clerk app with the result • The clerk let the customer enter the store
Exit conditions	The customer enters the store
Exceptions	• The server communicates to the clerk that the customer cannot enter because their line number is not available.

Table 3: Use Case: Grant access

Name	**Initialize**
Actors	Manager
Entry conditions	The manager of the store needs to set the basic information of the store in order to start the service
Event flows	• The manager clicks on the initialize button • The app shows the location form to the manager • The manager fills the form and sends it to the server via the app • The server registers the information and acknowledges
Exit conditions	The system is initialized and can offer all its functions
Exceptions	• Some mandatory parts of the form are not filled.

Table 4: Use Case: Initialize

Name	**Monitor state**
Actors	Manager
Entry conditions	The manager wants to monitor the number of customers in the store in real time.
Event flows	• The manager clicks on the "Monitoring" button. • The app sends the number request to the server. • The server returns the number of customers in the store. • The app repeats the process periodically as long as the monitoring page is open.
Exit conditions	The manager is informed on the number of the customers in the store in real time.
Exceptions	•

Table 5: Use Case: Monitor state

Name	**Print guest ticket**
Actors	Clerk, Customer
Entry conditions	The customer has arrived to the location, doesn't have a ticket on their smartphone, and needs a physical ticket to enter.
Event flows	• The customer asks the clerk for a ticket. • The clerk generate a ticket using the app. • The app sends a request to the server to generate a ticket. • The server generates a line number and a ticket. • The server sends the ticket back to the app. • The clerk prints the ticket. • The clerk gives the ticket to the customer.
Exit conditions	The customer has a ticket.
Exceptions	• The server cannot generate a line number due to capacity constraints.

Table 6: Use Case: Print guest ticket

Name	Schedule a stop
Actors	Manager
Entry conditions	The manager wants to schedule a period of time in which the store will be closed so the users can not book a visit for that time.
Event flows	• The manager clicks on the "Schedule a Stop" button. • The app shows a form for the time of the stop. • The manager fills the form and submits it to the server through the app. • The server stores the information in the database and returns an acknowledgement.
Exit conditions	The system has a scheduled stop stored in its database and will use it to prevent customers from booking a visit in that time period.
Exceptions	• There is already a planned stop in that period.

Table 7: Use Case: Schedule a stop

Name	See amount of customers in the store
Actors	Customer
Entry conditions	The customer is logged in the app and wants to know how many customers are in the store in order to decide whether to book a visit or retrieve a line number
Event flows	• The customer clicks on the "Live Store Info" button. • The app sends a count request to the server. • The server returns the live data for the amount of customers in the store for each time slot.
Exit conditions	The customer knows the amount of customers in the store and can plan their visit.
Exceptions	

Table 8: Use Case: See amount of customers in the store

Name	**See store location**
Actors	Customer, Maps API
Entry conditions	The customer needs to know where the store is located and the travel time
Event flows	• The customer clicks on the "Store Location" button. • The app contacts the Maps API with the store location. • The Maps API returns a map from the customer position to the store with a time estimation.
Exit conditions	The customer knows how to go to the store and the travel time needed.
Exceptions	• The customer's smartphone doesn't provide or allow access to location services.

Table 9: Use Case: See store location

Name	**Sign up**
Actors	Customer
Entry conditions	The customer opened the app and they are not registered yet, and they want to register.
Event flows	• The customer clicks on the "Sign Up" button. • The customer inserts their credentials. • The app sends the information to the server. • The server stores the data related to the user. • The server returns an acknowledgement to the app.
Exit conditions	The customer is now registered and can use all the functionalities of the app.
Exceptions	• The e-mail provided in the registration form is already used by another user. • The credentials provided in the registration form are ill-formatted.

Table 10: Use Case: Sign up

Name	**Stop for emergency**
Actors	Manager
Entry conditions	An emergency occurred and the manager wants to immediately stop the system from distributing line numbers.
Event flows	• The manager click on the "Emergency Stop" button • The app asks for confirmation from the manager. • The manager confirms the stop of the system. • The app sends the system stop request to the server. • The server stops the service and return an acknowledgement.
Exit conditions	The system has interrupted the service.
Exceptions	• The manager aborts the operation.

Table 11: Use Case: Stop for emergency

Name	**Add Clerk**
Actors	Manager
Entry conditions	The manager wants to add a new clerk to the system
Event flows	• The manager click on the "add clerk" button • The system asks the data of the new clerk (e.g. the credentials) • The manager inserts the data and press "submit"
Exit conditions	The new clerk is added to the system
Exceptions	• The data of the clerk are incomplete or incorrect

Table 12: Use Case: Add Clerk

Name	**Add Manager**
Actors	Manager
Entry conditions	The manager wants to add a new manager to the system
Event flows	• The manager click on the "Add Manager" button • The system asks the data of the new manager (e.g. the credentials) • The manager inserts the data and press "Submit"
Exit conditions	The new Manager is added to the system
Exceptions	• The data of the Manager are incomplete or incorrect

Table 13: Use Case: Add Manager

Name	Login
Actors	User
Entry conditions	The user has already sign up and wants to login to use CLup functionalities
Event flows	• The customer clicks on the "Login" button • The user provides their login credentials. • The system authenticates the user
Exit conditions	The user is logged in and can now use all the CLup functionalities
Exceptions	• The credentials are wrong

Table 14: Use Case: Login

Name	Notify ticket delete
Actors	Customer
Entry conditions	A ticket of the Customer was deleted from the server.
Event flows	• The system sends an email to the customer to notify the deletion of their ticket
Exit conditions	The customer is informed about the deletion of their ticket.
Exceptions	•

Table 15: Use Case: Notify ticket delete

Name	Update user information
Actors	User
Entry conditions	The user wants to change an information of themselves.
Event flows	• The user clicks on the "Update User Information" button. • The app shows a form precompiled with user's previous information. • The user changes the information on the respective fields and presses the "Submit" button. • The system saves the changes.
Exit conditions	The user successfully updated their information.
Exceptions	• The new information provided is ill-formatted.

Table 16: Use Case: Update user information

3.2.1 Requirements

- R_1 The system must allow users to authenticate using their e-mail address and password.

- R_2 The system must allow customers to register using their e-mail address, their name, surname, phone number and a new password.

- R_3 The system must provide a hard-coded super user to allow addition of locations and managers of locations.

- R_4 Managers must be able to add additional managers and clerks as users.

- R_5 Managers must be able to set and update location specific information, that are maximum number of customers in the location at any given time, opening and closing hours of the store per each day, line number timeout, limit of reservation per customer on a predetermined time interval that is one of month, week or day, and location of the place

- R_6 Managers can add any other location as a partner store.

- R_7 Managers can stop the system from issuing any more tickets for a given day

- R_8 Managers can schedule the system stop for a future time.

- R_9 Managers can set the in-shop locations for different categories and product items.

- R_{10} In case of a system stop, no further line numbers can be issued for the given time slots.

- R_{11} In case of a system stop, all line numbers in the stop time slots has to be cancelled.

- R_{12} The system must cancel those line numbers that the customer didn't arrive to the location for more than the set timeout interval.

- R_{13} In case of a ticket cancel, customer must be notified with an e-mail notification.

- R_{14} Clerks must register the entrance and exit of customers via scanning the QR code for their line number.

- R_{15} Clerks must be able to generate line number tickets in a printer compatible format.

- R_{17} Customers must be able to obtain a line number, except when the system is stopped or the store is full.

- R_{18} Customers must be able to obtain line numbers for different time slots in the future.

- R_{19} Customers can not obtain line numbers that exceed the quantity per time interval limits.

- R_{20} Customers can not obtain line numbers for time intervals that the system is stopped by a manager.

- R_{21} Customers must be able to see the estimated time available for their line number.

- R_{22} Customers must be able to set or update their phone number, password, name and surname.

- R_{23} Customers can select specific product and/or product categories they plan to visit in the location while obtaining a line number.

- R_{24} Customers can set an estimated time for their visit while obtaining a line number.

- R_{25} Customers must be able to view the shop location

- R_{26} Customers can view the occupation forecasts for the location at different time slots.

- R_{27} Customers can see the alternative suggestions for time slots while obtaining a line number for the future.

- R_{28} Customers can view the occupancy for the partner stores, if preferred time slot is not available while obtaining a line number.

- R_{29} Customers can view their line numbers with the number and the QR code.

- R_{30} The system must be able to provide a forecast for the occupancy of each location for any given time based on past visits.

3.3   Performance Requirements

3.4   Design Constraints

3.4.1   Standards compliance

3.4.2   Hardware limitations

3.4.3   Any other constraint

3.5   Software System Attributes

3.5.1   Reliability

3.5.2   Availability

3.5.3   Security

3.5.4   Maintainability

3.5.5   Portability

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4   Formal Analysis Using Alloy

5 Effort Spent

Date:	Person:	Part:	Time (in hours):	Description:
18/10/2020	Ozan Incesulu	General Structure	0.75	Imported and built the general document structure, switched LF -> CRLF for Windows, replaced template parts with names, year and project title
18/10/2020	Ozan Incesulu	Introduction	1.5	Start writing introduction by adding comments for draft goals, adding further subsections, writing basic definition of the system, some abbreviations, definitions, acronyms and references
24/10/2020	Ozan Incesulu	Document Structure	1.5	Write the document structure of the introduction, provide some comments and assumptions regarding how other parts of the document shall be structured.
26/10/2020	Ozan Incesulu	Scope	1.25	Write the Scope section, by defining different users of the system and define different phenomena with the categories they belong. Also add additional definitions.
26/10/2020	Aydin Javadov	Scope	1	Extend the goal test to provide details about system function
29/10/2020	Ozan Incesulu	Introduction	0.25	Add the clerk role to the system instead of using door automation
31/10/2020	Ozan Incesulu	Domain Assumptions	1	Write domain assumptions for the system, considering different users and phenomena
31/10/2020	Ozan Incesulu	Requirements	1.5	Write system requirements for the system based on agreed goals of the system.
06/11/2020	Ozan Incesulu	Goals	1	Write system goals, merge changes from previous team member, some extra housekeeping tasks.