4TB6: SRS

Stonecap Solutions - Smart Serve

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Contents

List of Figures

List of Tables

Table 1: Revision History

Date	Developer(s)	Change
10/05/22	Max Turek Sam Nusselder Ryan Were Peter Minbasian David Bednar	Initial Draft
11/02/22	Sam Nusselder	Added new functional requirements ODR14 - ODR18 from Hazard Analysis Doc
11/02/22	Max Turek	Changed glass to cup for definitions, terms, acronyms and abbreviations table
01/04/23	Max Turek	Updated document to reflect issues from other teams. Removed ODR7, edited PR7 & PR8, rationale added for QR1 and citation added for HSR3. Added rationale to some requirements, added list of tables and figures and added value range for monitored variables
03/31/23	Ryan Were	Revised Functional Requirement numbers so they are sequential. Removed functional requirements that are no longer relevant
04/05/23	Ryan Were	Updated SRS to Rev 1. Updated according to instructor feedback (added more rationale to requirements, updated monitored variables, updated context diagram, stimulus effect table, and system response table)

1 Introduction

1.1 Purpose

Stonecap Solutions aims to solve existing issues in the billion dollar bartending industry relating to the process of fulfilling drink orders. Bars are often busy with many orders being processed through a mental queue by bartenders. This can result in long wait times. Furthermore, many restaurants and bars are susceptible to being understaffed, further exasperating this issue. Cocktails and other drinks are imprecisely made, varying in volume and consistency. When bartenders are rushing around to make these drinks, the risk of spilling them arises. If these issues are severe enough, it could result in unsatisfied customers, decreasing business profits.

Stonecap Solutions aims to solve this problem by developing a drink delivery system that streamlines the process of a customer ordering a drink up to them receiving it. The system would automate the tasks of taking customer orders, making the drinks, and alerting the end-user when the drinks are ready. This would result in a system that creates consistent, accurate and timely drinks while avoiding unnecessary spillage.

1.2 Definitions, Terms, Acronyms and Abbreviations

Term	**Definition**
Drink	Drink will refer to any mixed drink or cocktail made up of many or one ingredient.
Web App	Web application that is used by the customer to order drinks, and used by administrators to monitor the device.
Cup	Container that will hold the liquids/ingredients of a drink.
Operator	Usually a bartender or manager that is responsible for maintaining the system and has administrative privileges.
User	Individual that is interacting with the UI and requesting a drink from the system

Table 2: Table of Definitions, Terms, Acronyms and Abbreviations

1.3 Scope

The goals of the system are found in Table 3. These goals have determined the following primary behaviours that make up the scope of the project:

1. Ordering Drink: Users are able to interact with a user-interface to order a drink
2. Creating Drink: Drink is accurately and quickly created
3. Serving Drink: Customer is notified drink is ready

Goal	**Explanation**
Ease of Communication	End users are able to effectively communicate with Smart Serve. Users understand the status of Smart Serve. This would be measured by all customer orders being fulfilled correctly and all users being informed on their order status.
Ease of Use	System is simple and easy to use for all customers. This would be measured by at least 75 percent of users find the product intuitive to use.
Autonomy	Smart Serve is fully autonomous once starting up. This allows users to interact with Smart Serve without any human interaction.
Consistency	Smart Serve continues to pour a consistent drink after 100 pours.
Accuracy	Smart Serve pours drinks with accurate proportions. This would be measured by checking if the individual ingredients of a drink follow the appropriate proportion (i.e. 1.5 liquid ounces of rum and 4.5 liquid ounces of coke).
Fast Service	Drinks are served to users quickly. One drink is served within 60 seconds.
Operator	The operator had access to the operator controls in the web app. These controls allow the operator to manage ingredients in the web app.

Table 3: Project Goals

The stretch goals shown in Table 4 were not included in the scope because they are goals that will only be implemented once all the primary project goals are implemented.

Stretch Goal	**Explanation**
Self Cleaning	Smart Serve is able to clean all necessary components without human interaction.
Fool Proof	Any risks posed by realistic system malfunctions should be minimized through smart design.
Smart Recommendations	Smart Serve can provide drink recommendations. This can be measured by drink recommendations being purchased at least 20 percent of the time.

Table 4: Stretch Goals

1.4 Context Diagram

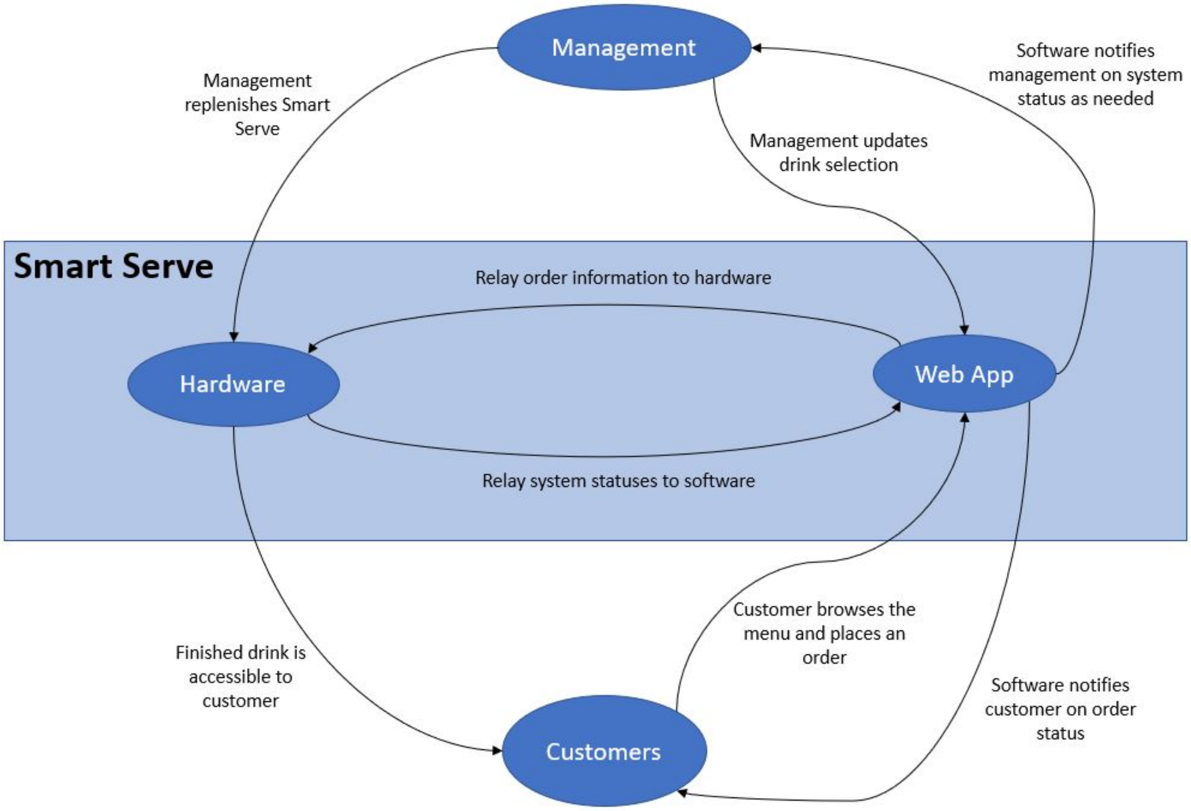

Management
Management replenishes Smart Serve
Management updates drink selection
Software notifies management on system status as needed
Smart Serve
Relay order information to hardware
Hardware
Web App
Relay system statuses to software
Finished drink is accessible to customer
Customer browses the menu and places an order
Software notifies customer on order status
Customers

Figure 1: Context Diagram

1.5 Monitored and Controlled Variables

1.5.1 Monitored Variables

- ingredientVolume
  - int: range 0-2000
- distance
  - float
- cup_status
  - True or False
- cup_status_turn
  - True or False
- fill_status
  - True or False

- shotType
  - int: range 0-4
- pumpconfiguration
  - an array with int values of 13, 15, 19, 37, and 40 to map where the ingredient is placed in the physical world to the correct pump pin on the Raspberry Pi
- username
  - True or False
- password
  - True or False
- order$_placed$
  - True or False

1.5.2 Controlled Variables

- output$_motor$
  - We are controlling the output signal of the turntable motor pin to be either on or off. Values of True or False. True is off and False is on.

output$_TRIG$

We are controlling the output signal of the trigger pin for the ultrasonic sensor to output a wave so we can sense the distance. Values of True or False. True is off and False is on.

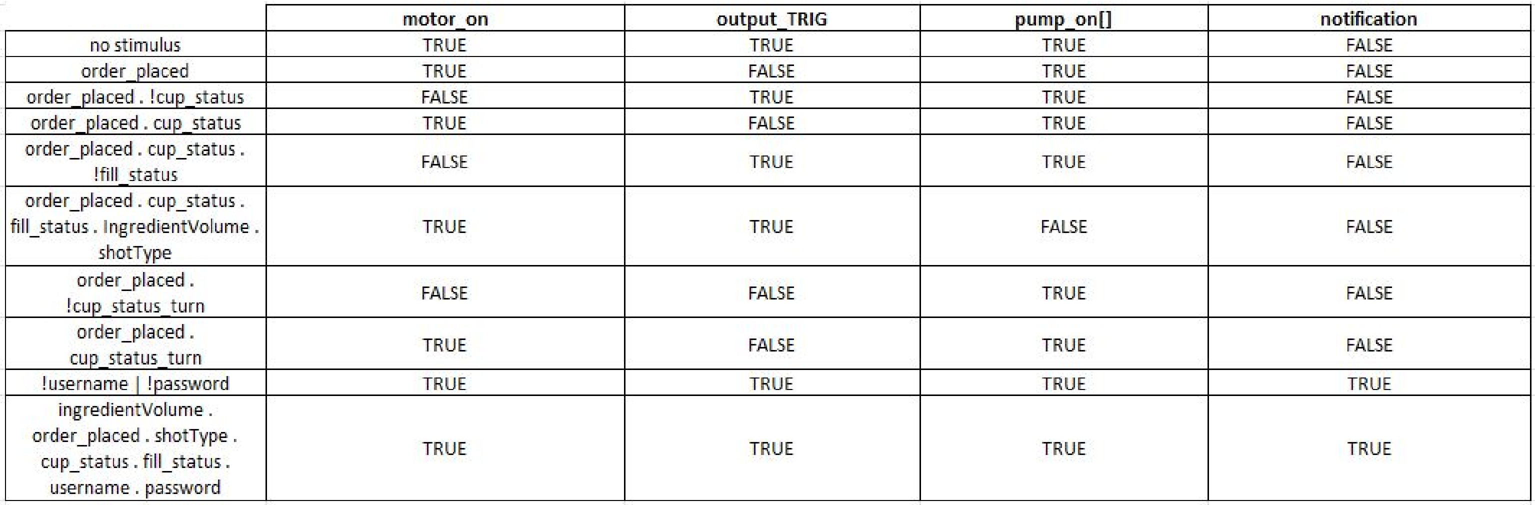
output$_pump$[]

We are controlling the output signal of the pump pin(s) to be either on or off. Values of True or False. True is off and False is on.

notification beginitemize

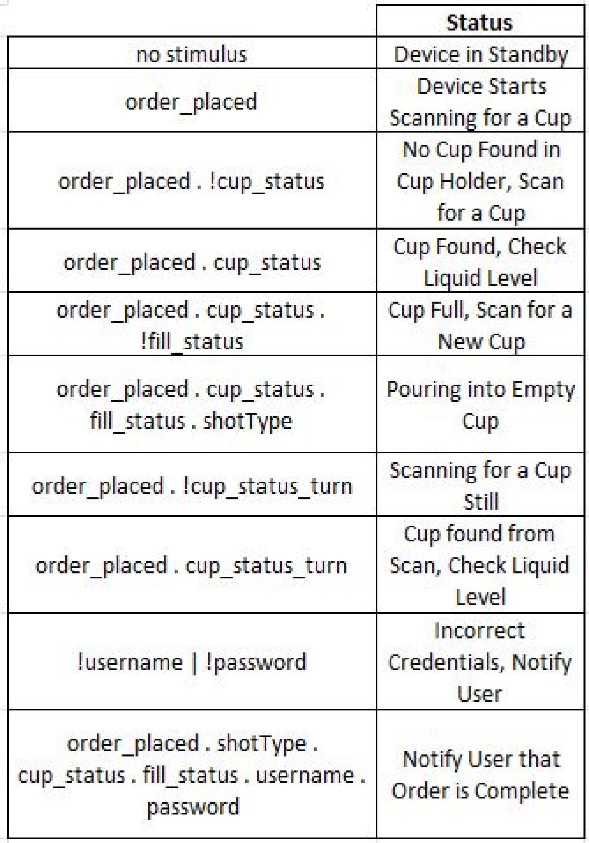
True or False for if a message is to be sent or not.

1.5.3 System Responses



	motor_on	output_TRIG	pump_on[]	notification
no stimulus	TRUE	TRUE	TRUE	FALSE
order_placed	TRUE	FALSE	TRUE	FALSE
order_placed . !cup_status	FALSE	TRUE	TRUE	FALSE
order_placed . cup_status	TRUE	FALSE	TRUE	FALSE
order_placed . cup_status . !fill_status	FALSE	TRUE	TRUE	FALSE
order_placed . cup_status . fill_status . IngredientVolume . shotType	TRUE	TRUE	FALSE	FALSE
order_placed . !cup_status_turn	FALSE	FALSE	TRUE	FALSE
order_placed . cup_status_turn	TRUE	FALSE	TRUE	FALSE
!username | !password	TRUE	TRUE	TRUE	TRUE
ingredientVolume . order_placed . shotType . cup_status . fill_status . username . password	TRUE	TRUE	TRUE	TRUE

Figure 2: System Response Chart



	Status
no stimulus	Device in Standby
order_placed	Device Starts Scanning for a Cup
order_placed . !cup_status	No Cup Found in Cup Holder, Scan for a Cup
order_placed . cup_status	Cup Found, Check Liquid Level
order_placed . cup_status . !fill_status	Cup Full, Scan for a New Cup
order_placed . cup_status . fill_status . shotType	Pouring into Empty Cup
order_placed . !cup_status_turn	Scanning for a Cup Still
order_placed . cup_status_turn	Cup found from Scan, Check Liquid Level
!username | !password	Incorrect Credentials, Notify User
order_placed . shotType . cup_status . fill_status . username . password	Notify User that Order is Complete

Figure 3: Stimulus Effect Chart

1.6 Constants

- Ingredient flow rate
- Cup size
- Turntable rotation speed
- Location of cup
- Ingredient vat volume

1.7 Behaviour Overview

Smart Serve is an autonomous system once the user orders a drink. The user can interact with the web app to place an order with Smart Serve. From here the system is entirely autonomous. Once the user is at the front of the queue, the drink will be created and then served where it can be picked up. Smart Serve will remain in standby mode when not in use, and wait for instructions.

1.8 Stakeholders

- Stonecap Solutions
- Restaurants and business owners that serve drinks
- Consumers seeking an autonomous drink creation system
- Bartenders
- Customers at bars

2 Project Overview

2.1 Normal Operation

Smart Serve is intended for users to order drinks and have their drinks robotically made for them. Users will be able to interact with Smart Serve using their phone allowing multiple users to simultaneously order drinks. This will also allow users to socialize with friends while ordering drinks as opposed to waiting in line. Once the order is processed, Smart Serve will begin creating the drink. This process will be completely autonomous. Once the drink is complete, the user will be notified. This will again save the user time waiting in lines for their drink to be made.

2.2 Undesired Event Handling

In the case that an undesired event occurs, Smart Serve should return to a safe state. During the transition into a safe state, Smart Serve should ensure that no harm is caused to the user or itself. This would be done by pausing the current action, notifying the operator to ensure no one is physically interacting with Smart Serve and allowing Smart Serve to return to the home state. The operator would then need to reset Smart Serve and send an alert to Smart Serve to notify that Smart Serve will restart the previous action. This would ensure that the user would still get their drink created at the appropriate spot in queue, while also ensuring the safety of the users and Smart Serve.

2.3 User Characteristics

There are two intended users for Smart Serve: Managers and Customers.

Managers are grouped as people who intended on using the system to replace bartenders. They own/operate an establishment that sells alcohol. The establishment is busy enough that automating these tasks is warranted to improve service time and reduce labor costs.

Customers would be classified as groups of people who frequently attend establishments that serve alcohol. These customers drink alcohol themselves, most likely drinking cocktails or mixed drinks. They own smartphones and have a basic understanding of modern technology and can navigate through a basic web app.

2.4 Constraints

Our product can only function within it's given constraints. Some limitations include but not limited to:

- Reliability of internet service via data or WiFi for UI and Cloud Operations
- Liquor laws and regulations involving the service of alcohol
- Sanitary regulations pertaining to the service of drinks

2.5 Assumptions and Dependencies

The following assumptions have been made while creating Smart Serve:

- All users are of legal drinking age
- All users are in a safe health condition to consume alcohol, including intoxication level
- All users have a tab created that is assumed to be paid in full once they have finished ordering all their drinks
- Smart Serve will be used in an indoor environment
- Ingredient flow rate is kept constant
- All cup sizes will be identical
- All cups will be plastic
- Smart Serve will be kept clean and not restricted due to usage
- Smart Serve will always have an internet connection
- Smart Serve will always have electrical power
- Ingredient viscosity is consistent

3 Function Requirements

3.1 Ordering Drink

ODR1. User can scan QR code launching smart-serve web app

Rationale: This makes it easy for users to access the Web App.

ODR2. User can access the menu and select drinks to order

ODR3. Users can view the placement of their order in the queue

Rationale: This allows users to get an estimate for when their order will begin so they can be by the machine when they need to be.

ODR4. User is unable to order a drink if the ingredients in the drink's recipe are out of inventory

Rationale: Users should not be able to order something that cannot be made as this will cause dissatisfaction.

ODR5. User is notified when their drink is done
Rationale: This is done so the drink does not stay idle while other customers are waiting

ODR6. Operator is notified if drink ingredients are out of inventory

Rationale: This allows ingredients to be refilled quickly so there is little downtime between drinks.

ODR7. Operator inputs all ingredients available for drinks into the web app

ODR8. Operator inputs dispenser location of each ingredient into web app
Rationale: This allows for more flexibility with drink mixing and makes the system more universal.

ODR9. User gets notified when the drink is ready via web app

ODR10. Web app keeps track of drinks made
Rationale: Data is used for analytics to track popular drinks/ingredients or for inventory check

ODR11. Server decrypts drink name and gathers ingredients

ODR12. User's drink is the same drink they ordered on the app

ODR13. User can log in successfully into the app

ODR14. User has user permissions

Rationale: This prevents users from being able to change the drink type and volumes inappropriately so operations can run smoothly.

ODR15. Electrical components of high exposure to liquids have waterproof covering

Rationale: This improves the robustness of the design as causes of failure for electrical components have been mitigated.

ODR16. Have a robust and durable architecture/components

Rationale: Bars and pubs can be high-traffic areas resulting in spills and collisions

3.2 Making Drink

MDR1. Hardware receives ingredients from server

MDR2. Hardware dispenses the appropriate amount of liquid from respective bottle

Rationale: This is essential so the volume of alcohol being served is consistent.

MDR3. Hardware can detect if a cup is present

MDR4. Hardware can detect if the cup is empty or full

Rationale: This is important to monitor so full cups are not poured into.

MDR5. Web app displays that an order is ready so the user can remove it

Rationale: This allows for a quick transition of the device to begin handling the next customer's order.

MDR6. Hardware will not start the next order until an empty cup is detected in the dispensing area

Rationale: This prevents spillage and customers' drinks needing to be remade.

MDR7. Hardware does not begin a new drink until at least one of two completed drinks are removed

4 Non-Functional Requirements

4.1 Quality requirements of the entire system

QR1. Smart Serve must be robust

Rationale: During steady state operation, Smart Serve will satisfy all its functional requirements.

4.2 Look and Feel Requirements

LFR1. The web app must be intuitive and visually appealing

Rationale: The least amount of clicks necessary will result in a more user-friendly UI.

LFR2. Smart Serve must have all electrical and mechanical components concealed

Rationale: This protects Smart Serve from being damaged.

4.3 Usability and Humanity Requirements

4.3.1 Ease of use

UHR1. Smart Serve must serve the drink at a height that is easy to grab for an average adult

Rationale: This makes Smart Serve more ergonomic and accessible to all people.

UHR2. Smart Serve must make grabbing the drink easy for the user, without blockages or inconveniences

UHR3. The web app must make it easy to navigate and select drinks

4.3.2 Ease of learning

UHR4. Finding and gaining access to the web app must be easy

4.4 Performance Requirements

4.4.1 Speed requirement

PR1. The drink must be ready and served within 60 seconds of when the drink began to be made

PR2. The web app must be highly responsive to user inputs

PR3. The web app must add a users order to the queue of orders within 5 seconds of ordering
Rationale: This requirement is set in order to be comparable to a human creating the same drink

4.4.2 Safety critical requirement

PR4. Smart Serve must not release more than 1.1x the amount of expected alcohol

Rationale: Consuming more alcohol than expected can be dangerous for a user

4.4.3 Precision requirement

PR5. Smart Serve must be able to measure drink ingredients within 10% of the expected value

4.4.4 Reliability and availability requirement

PR6. Smart Serve must be able to create the correct drink every time as long as it has the correct ingredients

4.4.5 Capacity requirement

PR7. Smart Serve must be able to store up to 5 ingredients

Rationale: This allows for a wide variety of drinks to be available at all times, this generally allows for 5-9 different drink combinations. **PR8.** Smart Serve must be able to store up to 2 litres of each ingredient
Rationale: This allows for Smart Serve to still be relatively small in size, but contain enough liquid for a minimum of 11 orders to be completed before having to refill an ingredient.

4.5 Operational and Environmental Requirements

4.5.1 Expected physical environment

OER1. Smart Serve must not be exposed to rain or poor weather

OER2. Smart Serve must be placed upright on a flat surface

4.5.2 Expected technological environment

OER3. Smart Serve must have access to wifi

OER4. Smart Serve must have access to electricity

OER5. The user must have internet access to the same wifi network as Smart Serve and a device to access the web app

4.5.3 Partner applications

OER6. Smart Serve must be equipped with a cup to serve a drink

4.6 Maintainability and Support Requirements

4.6.1 Maintainability

MSR1. Smart Serve should be cleaned at least once every day

Rationale: This is to follow health and safety standards.

MSR2. Smart Serve must be restocked with new ingredients to be able to serve drinks

4.6.2 Special Maintenance Conditions

MSR3. No electronic or water-sensitive components of Smart Serve can get wet during cleaning

MSR4. The operator must add the ingredients to the web app when Smart Serve is restocked

4.6.3 Portability

MSR5. Smart Serve must be modular and easy to transport

MSR6. Smart Serve must be under 100 pounds

Rationale: This is done so it can be carried with one to two people with ease

4.7 Security Requirements

SR1. Communication between the web app and Smart Serve must be secure

SR2. The operator must be responsible for correctly operating the machine and restocking ingredients

SR3. The user must provide identification and be of drinking age to order and receive a drink from Smart Serve

Rationale: This is to comply with liquor laws.

4.8 Cultural and Political Requirements

Not applicable

4.9 Legal Requirements

LR1. Smart Serve must only be used in countries where alcohol is legal

LR2. Smart Serve must not produce a drink that is consumed by persons under the drinking age

LR3. The owner of Smart Serve is liable for all drinks served

4.10 Health and Safety Requirements

HSR1. Smart Serve or the operator must not serve a drink to someone who is dangerously intoxicated

HSR2. Smart Serve should not be operational near unsupervised persons under the drinking age

HSR3. Smart Serve or the operator must not serve more than 2 drinks per hour to one user[1]

HSR4. No electrical components can come into contact with any fluid

5 Likely Changes to Requirements

5.1 Machine Improvements

Although the first design of the machine has a degree of durability and ease of maintenance, a goal within the group is to have the machine not only be able to last longer but allow for even less maintenance/care. This can be accomplished with the following new requirements.

RLC 1: Incorporate self-cleaning after every drink is made

RLC 2: Design system hardware to have a high water resistance

RLC 3: Have the system be more robust to lessen the risk of impact damage

RLC 4: Machine sends specific error codes to the operator to inform why the machine is breaking

5.2 Data Analytics

With the current design, the system will use basic Data Analytics to track information like popular drinks and stock of ingredients. A likely change will be to take advantage of the data to produce the following requirements.

RLC 5: Purchasing patterns are used to track optimal inventory

RLC 6: Analysis of user data is used to find correlations with drink orders to derive optimal drink mixes or drink recommendations

6 Unlikely Changes to Requirements

UCR 1: No new input of human interaction for base functionality.

Justification: One of the main purposes of this project is to incorporate more automation into the bartending profession. The requirements outlined reflect that. Any increase in human interference for base functionality will contradict this purpose.

UCR 2: Application will **always** comply with safety and the law.

Justification: Due to the device serving, it is important that all government regulations be followed. Misuse of the device could result in lawsuits, jail time, injury, or death. While handling alcohol, it is of the utmost importance that the device follows the substance's regulations.

UCR 3: Web Application must be user-friendly and very simple to use.

Justification: Theoretically, the system can be a substitute for the simplistic traditional human-to-human interaction of asking for a drink. The app must be at least as straightforward as the traditional method.

UCR 4: System must be able to create drinks with a high level of preciseness and consistency as an average bartender.

Justification: With the system replacing the need for a bartender, it must be able to (at the very least) create drinks with both the appropriate measurements and a strong degree of consistency.

UCR 5: Maintenance of Smart Serve must be simplistic.

Justification: It must be assumed that a large demographic of operators of Smart Serve do not have a background in technology. The maintenance of the device should be straightforward, with limited technological experience required.

7 References

1. Alcohol and your body. [Online]. Available: https://shop.ucsc.edu/alcohol-other-drugs/alcohol/your-body.html. [Accessed: 04-Jan-2023].

8 Appendixes

8.1 Reflection

Max Turek:
As a mechatronics engineer, we get experienced with software, electrical and mechanical aspects but never become experts in one. Therefore, one skill I will need to learn how to acquire is working on mechanical and electrical systems specifically pumps for transporting fluids. Furthermore, I will need to understand front-end and web development more in order to launch and troubleshoot our web app that supports the user interface. One way I find is best for acquiring new knowledge is youtube videos. It is possible to find a video explaining almost any skill now a days. The other channel of acquiring knowledge would to speak to alumni and friends that have completed a mechatronics capstone. I have many friends that are knowledgeable in software and hardware that are able to provide consultation and advice.

Sam Nusselder:
The team will need to have a strong understanding of mechanical, electrical and software components as well as the capabilities of integrating these systems. Mechanical and electrical systems related to delivering and controlling fluid flow will be required. Software knowledge with web-based applications will also be needed to develop an interface so users are able to interact with Smart Serve. Team management and group work skills will be needed in order to ensure a successful working team of 5 members. It will be important to make sure everyone always has a task to work on while also ensuring everyone understands the ”bigger” picture and is aware of the long-term goals.

Some approaches to acquiring a strong understanding of mechanical, electrical and software components is to review any applicable course work and to do more research online to learn about these topics. All team members will need knowledge in all of these areas, so they will need to pursue which ever approach works best for them as they feel they need a stronger understanding. To acquire better team work skills, team members can look past on their individual previous group work experiences and learn from things that went well and things that didn't. Another approach to improve team work skills is to speak with other current groups to learn and understand how they work effectively as a team. All team members can pursue the approach that works best for them. Not everyone has great team work experience to learn from, so this is where the second approach would be more effective.

Peter Minbashian:
As a computer engineering student at McMaster, a majority of my foundational knowledge, surrounding technology, revolves around embedded software. Although that is applicable to this project, I present not much value to the web development portion. Therefore, it would be best that for me to learn more about web development. Not only will this entail learning the basics (JavaScript, HTML, CSS) but also learning specific tools required for this project. This includes how to incorporate user log-in functionality on a website, connecting a website to a server, and connecting a website to an API. I believe I can learn this skill through two different avenues: Udemy and my friends/family. Although there are a plethora of free resources on the internet, I often learn new skills using Udemy. The website has a course for everything, at very affordable prices. The benefit of using the site is displayed in the quality of the instructors and mini-projects found throughout the course to apply the knowledge learned.

Another resource I intend to use is the help of others. I have many close friends who

work within the web development space along with my parents. I will not shy away from asking questions to gather a deeper understanding of the field.
The combination of both Udemy courses and my personal resources will allow me to gather a deeper understanding of web development and be a stronger asset to my team.

Ryan Were:
Important knowledge needed to successfully complete our capstone project will be the integration of software and hardware. Understanding how we will be communicating between the two will be crucial in getting the brains of our project to do the physical work. An important skill to have will be organizing specific knowledge champions in the group. This means that one person will be a subject matter expert on a certain topic and be able to mentor the rest of the group members in that area if needed.
To master software and hardware communication, one approach would be to review previous information provided to me in courses. Brushing up on what I have previously learnt will help reinforce this knowledge. Doing my own research online about this topic will also help greatly. It will allow me to develop a further understanding on specific areas that I may struggle in. Another approach that I could take is emailing a professor to see if they are willing to answer questions that I may have about this topic. Having an expert on the topic answer specific question I have would give me the exact knowledge I need quickly. The approach I'd take first is to do my own research. I think that in a workplace in the future, being able to find info you need on your own is a valuable asset to have. Regarding organizing knowledge champions, one approach to take is to have a group meeting where everyone discusses what they consider themselves knowledgeable in, and deciding what topics we are lacking in. That way we can organize the group efficiently to cover all the areas that we must be masters in to complete the capstone project. Another approach would be to just blindly assign people to certain topics. The first approach of communicating with the team sounds much more efficient and reduces redundancies, so I would take this approach. I believe this is important because communicating with people about their strengths and weaknesses and developing a strategy to get the most out of the group as a whole is a good skill to have for anyone who wishes to go into management.

David Bednar:
As a software engineering student working on a project with a large mechanical and electrical component, I will need to pick up some skills from both fields. I will be focusing mainly on the software side of the project, but I will learn mechanical and electronic skills relevant to the project before beginning so that I can help work on this. I also have most of my experience in backend software engineering and working on frontend is something that I have done but do not have the most experience in.
I plan on working together with my mechatronic group members to learn how to build different mechanical components, and connect electrical wiring. I will also get help from a colleague of mine who is currently working in a mechanical engineering role to learn how to use certain tools and machines. To learn frontend tools like HTML, CSS, and javascript, I will use online tools such as youtube and Udemy. I will also work together with my group mate Peter to learn about frontend principles and build up the frontend of the project together.