

QRU


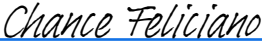



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Submitted to
the Faculty of the School of Information Technology
in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Science
in Information Technology/Cybersecurity

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April 2022

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Abstract

The medical field is becoming increasingly dependent on the sharing of patient information. Current systems are not easily compatible, resulting in delayed transfer between physician offices, hospitals, and treatment facilities. QRU aims to use innovative technology to simplify the process of gathering and inputting patient data across different platforms. Current required paperwork for patients seeking treatment is redundant for each visit at a new or different medical facility or office. QRU is an app that doctors and patients would use exclusively, and it would hold their patient's information and any medical information that may be critical in an emergency. The Microsoft PowerApps platform was selected to build the application because it is accessible to new programmers. Our team has 4 Cybersecurity majors, and we chose to use PowerApps because it was a website that gave you a template to create an app. We then used Microsoft Azure and Microsoft SQL Server Management Studio to add a database that holds all our data. The QRU application enables you to login or register as a patient or a doctor and access your patient profile. In this profile it has basic profile information such as name, age, insurance information. As a doctor you have access to the patient search feature which brings up a specific patient in our database and displays their information. This means that doctors have a quick and easy way to access any patient in their system and view their medical information to help assist in any treatment. This means that doctors will have access to all patient data with the scan of a QR code and be able to add updates and new documents to a patient's profile which will be a comprehensive profile for a patient when complete.

Introduction

Project Summary

Q.R.U. will store an individual's health care information into one place such as that will be accessible by medical personnel in an emergency. As reported in an article by the Harvard Business Review organization ([HBR](#)), the average wait time in a hospital emergency department is an hour and a half. Q.R.U will create a standardized platform that all patients can use to update and store their medical information as well as supply access to medical staff and emergencies. This hopes to speed up the process of identifying patients and providing the necessary care without the need for paperwork or multiple platforms.

Problem Statement

Access to medical care in the U.S. can be a very stressful time especially during this pandemic. A University of Iowa study showed that a similar program, Telemedicine, helps ER's treat their patients up to 6 times faster. In a report entitled, "Patient Intake Management 2018: Solutions for a More Efficient Practice," KLAS wrote, "Many outpatient facilities still require patients to fill out paperwork at each visit, and the paperwork is often the same from patient to patient, regardless of gender, age, or reason for visiting the doctor. Clinic employees must then manually enter patients' responses into clinical and practice management systems. The entire process takes up time that both patients and clinic employees could better spend elsewhere." (Gleave, 2018) IntakeQ elaborates, "Patients can spend up to 15 minutes filling out

intake forms before their appointment. By having the forms completed before the patient ever arrives, you can improve your patient flow and squeeze two or three more patients into each day. That's more money in your pocket." (Cassio, 2016)

Solution

Q.R.U. aims to provide a quick and secure way to access medical information. We want to provide a platform that is standardized and easy for everyone to take part in. Telemedicine is a similar product that has shown in rural hospitals it can lower patient wait times by up to 6 times. This service helps provide health care opinions virtually so patients can decide whether to come into the hospital. QRU would expand this so that if you are told you need to go to the hospital you would already have the forms filled out. "A 2016 study in the Journal of Medical Practice Management found that 96% of patients' negative online reviews of medical practices were related to service issues, such as poor staff communication or long wait times. Addressing the time-consuming processes that take staff time and attention away from patients can go a long way toward addressing that problem and ensuring that patients are engaged and satisfied" (McKinney, 2020). QRU will store a person's medical information in one place that can be easily and efficiently accessed in an emergency.

Project Source

Nicolaus Triplett, a member of the group, has family that has always been in medical care and that has inspired me to come up with a solution to a problem that I have seen and heard through stories and firsthand experiences. My father has worked in a hospital his whole life, my sister is a pharmacist, and my uncle owns a pharmacy, so I have seen and heard it all. I know there is a way our new technology can make their lives easier, and it is my mission in this project to try and make that a reality. One of our team members had an idea to implement a QR code to keep all your memberships but we did not feel that it solved a problem and that is where we decided to implement the QR code into the medical field. To complete our project, we require: A database to store medical information, Layers of security to ensure no harmful entities can access the data, an interface to view the data. Our team was formed through the Senior Designs team chat after posts that we were looking for a team.

Discussion

Project Objectives/Goals

Our solution aims to provide a simple way to provide patient intake by storing all a patient's info in one place that is accessible by a certain technology. QRU wants to help provide more accurate care by having quicker access to a patient's medical information in the emergency room when access to medical records may be more difficult. QRU will connect an application where a patient can enter their information and it will be stored in a secure database. QRU will abide by all HIPPA laws by safeguarding patient information in a database hosted on Microsoft azure. The information will be protected by strong passwords and multifactor authentication. QRU will be a user-friendly platform that will be simple to navigate and easy to understand. It will incorporate our smartphones and wearable devices to aid user/medical identification in emergencies.

Project Scope

QRU will implement a system in any medical practice that will allow medical personnel to access patients' medical information easily and efficiently. Patients will enter their information into an application and that will be stored in a database. Our database stores all patient and doctor information through Microsoft azure will be accessible by medical personnel after completing their security measures. When logging in all users must go through multi-factor authentication to ensure they are who they say they are. All users must have a username and password and password requirements will include a capital letter, number, and special character to make the passwords more secure.

Project Timeline

The project timeline outlines what will be done to the app through each week of working. It identifies the task and its name, a brief description, and how long it is estimated to get done.

Task #	Task Name	Duration	Start Date	End Date
1	Contract and Preliminary research: Team members sign appropriate documents and conduct research that is relevant to what the team is attempting to accomplish and showcase at the upcoming IT Expo. Research should be accurate and originate from reputable & credible sources.	2 Weeks	9/6/21	9/20/21
2	In Depth Research: SQL Studio Manager documentation, Azure web	2 Weeks	9/20/21	10/4/21

	services and PowerApps mock database setup and tests to ensure connections are stable and active			
3	Database Development: Development of SQL Database and implementation of tables along with setting values and creating Azure resource group + server to host database on Azure cloud services.	2 Weeks	10/4/21	10/18/21
4	Implementation of security measures into database and application: Incorporate security measures into the project to prevent unauthorized access. Some tools to research for implementation involve 2fa and user permission groups.	2 Weeks	10/18/21	11/1/21
5	Presentation: Team members will present what they've been able to accomplish during the fall semester.	2 Weeks	11/1/21	11/15/21
6	Research paper rough draft: A preliminary version of the research paper containing sources, sites, etc. that were used for the project.	1 Month	1/10/22	2/7/22
7	Write Research Paper Final Draft: Paper Final Draft: A final version of the research paper containing sources, sites, etc. that were used for the project.	2 Months	2/7/22	4/4/22
8	Polish Project: Implement all necessary functions and services including QR/Barcode scanner. Confirm database tables and values are correct and confirm	1 Month	3/7/22	4/4/22

	all inputs and application screens are accessible and check for errors within code. Replace or scrap any unused assets within application.			
9	Practice IT Expo Presentation: Practice IT Expo Presentation with group. Go over technology used and test all equipment. Make sure Azure and PowerApps function well and have all data connections active.	1 Week	4/4/22	4/11/22
10	IT Expo: Virtual event where teams showcase projects to various attendees. Confirm that technology used is in working order.	1 Day	4/12/22	4/12/22

Figure 1

Technologies Used

Microsoft Power Apps will be the main technology because it has easy integration and ensures seamless interaction between our different programs. QRU will use SQL Server management Studio and Azure for its database because of its ability to store substantial amounts of data and retrieve them quickly and efficiently. Cloud Storage is an important tool included in Azure that is used to back-up our database tables and values along with any documents attached to our application such as patient forms and organization notes that are encrypted to follow common healthcare procedures. Database will also be backed up using local storage as a secondary option but only including database and non-crucial patient data. There are also many data connections that set up an email server within outlook that connects to PowerApps to provide a way for QRU to communicate with users via email.

Technical Architecture Diagram

This is the logical architecture diagram. It shows how the data behaves on QRU when a user is using it, it shows how the data travels between devices.

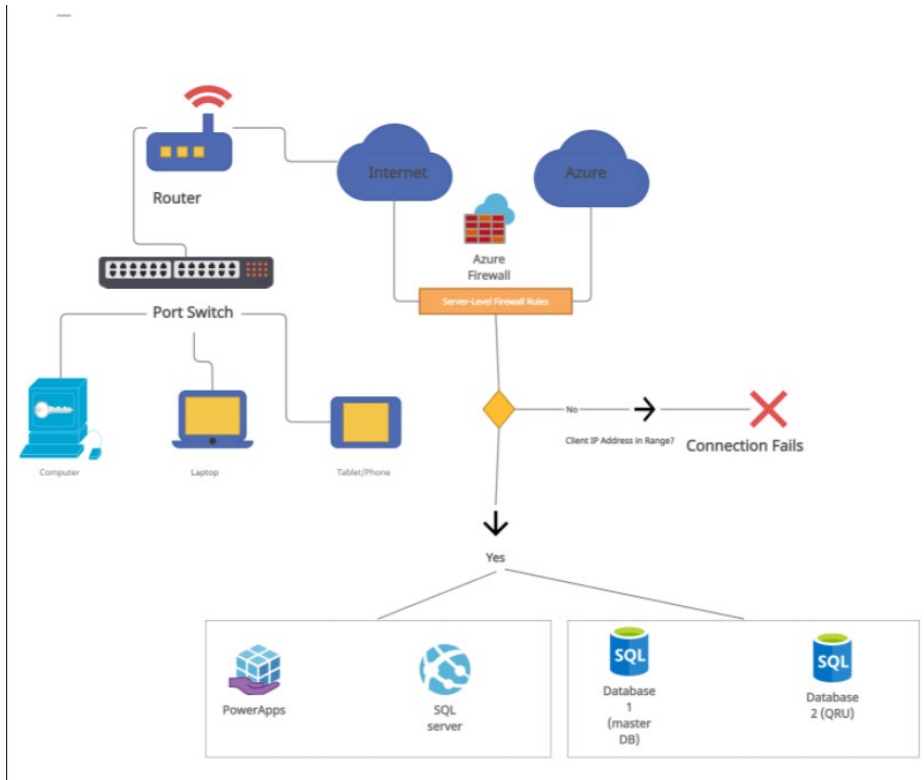



Figure 2

User Personas

The two user personas represent a larger group of users within the QRU App. Users will either be patients that use the app to upload their medical records and data or doctors who use the app to see a specific patient’s medical information for appointments or emergencies. The personas describe what each user group would be using the app for, their specific needs and goals and a representation of their age group.

Table 1 User Persona Table

User Persona: 1	
	Title Worried Patient
	Name Steve
	Age 28
	Gender M
	Behavior Frequent Doctor visits
Pain Prevalent health issues	

Needs & Goals	Wants a doctor who understands his health issues and can provide the best care. Goals: Knows that he is well cared for, receive accurate care, and wants to be stress free when going to the doctor.
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Figure 3

Table 2 User Persona Table


User Persona: 2	
	Title Caring Doctor
	Name Jane
	Age 35
	Gender F
Behavior	Meets with hundreds of patients. Utilizes medical documents to stay updated on the history of patients.
Pain	N/A
Needs & Goals	Needs to be as quick and accurate as possible to provide accurate care. Goals: Reduce pain and suffering, save lives, provide patient engagement and comfort.

Figure 4

Use Cases

Use Cases are a way to demonstrate the steps taken to perform all functions in an application. In QRU the use cases show all the different functionalities the app has for each specific user. It demonstrates everything from logging in successfully and unsuccessfully, using the QR Scanner, filling out forms, and logging out. It shows all possible clicks and the possible outcomes of those clicks within the app for each specific user that uses the app.

Use Cases:

Use Case ID	001
Use Case Name	Emergency room form fillout
Description	Patient logs into QRU to fill out their medical history forms

User/Actor	Worried patient
Trigger	Patients enters login information into screen and proceeds to account or registers a new account if needed.
Frequency of Use	1 in 5 U.S adults go to the emergency room per year. 77% of Emergency room visits were for a serious medical visit.
Preconditions	User wants to receive quick accurate care in an emergency.
Basic Flow	<ol style="list-style-type: none"> 1.) User Accesses QRU, Website. 2.) User logs in 3.) User updates medical records on file 4.) User clicks save and exit to save any changes. 5.) User Logs off
Alternate Flow	<p>AF1 -</p> <ol style="list-style-type: none"> 1.) User accesses QRU, Website 2.) User Registers a new account 3.) User uploads/Fills out any medical forms that will be needed. 4.) User clicks save and exit 5.) User Logs off <p>AF2 -</p> <ol style="list-style-type: none"> 1.) User Accesses QRU Website 2.) User forgot password 3.) User follows forgotten password procedure. 4.) User regains access to QRU 5.) User can access and edit information 6.) User saves and exits.
Postconditions	After exiting User is shown the home login screen of QRU.
Use Case ID	002
Use Case Name	Emergency room form access
Description	Doctor logs onto QRU to view patient information
User/Actor	Caring Doctor
Trigger	Patients enters login information into screen and proceeds to account or registers a new account if needed.
Frequency of Use	On average Doctors see around 20 patients per day and work close to 51 hours per week.

Preconditions	Doctor wants to provide quick and accurate care to all their patients.
Basic Flow	<ol style="list-style-type: none"> 1.) Doctor Accesses QRU Website. 2.) Doctor logs in using Organization sign in 3.) Doctor searches database for patient info 4.) Patient info is displayed, and accurate care is provided. 5.) Doctor Logs off
Alternate Flow	<p>BF1 -</p> <ol style="list-style-type: none"> 1.) Doctor accesses QRU Website 2.) Doctor Registers their organization 3.) Doctor must verify their organization is legally recognized. 4.) Doctor can search patient info once approval is granted. 5.) Doctor uses information appropriately and logs off. <p>BF2 -</p> <ol style="list-style-type: none"> 1.) Doctor accesses QRU website 2.) Doctor logins using organization sign in page 3.) Doctor searches patients' info 4.) Patients' info is not found. 5.) Doctor informs patient to update forms but continues appointment and gives the best care <p>BF3 -</p> <ol style="list-style-type: none"> 1.) Doctor accesses QRU Website 2.) Doctor cannot login because of forgotten password. 3.) Doctor must follow forgotten password protocols 4.) Password is reset 5.) Doctor regains access
Postconditions	After exiting Doctor is shown the home login screen of QRU.

Figure 5

Use Case Diagram

The Use Case diagram represents a user's possible interactions with the QRU app. It lays out the exact clicks a user could make and describes what those actions do. The Use Case diagram shows multiple use cases by multiple users within the QRU app.

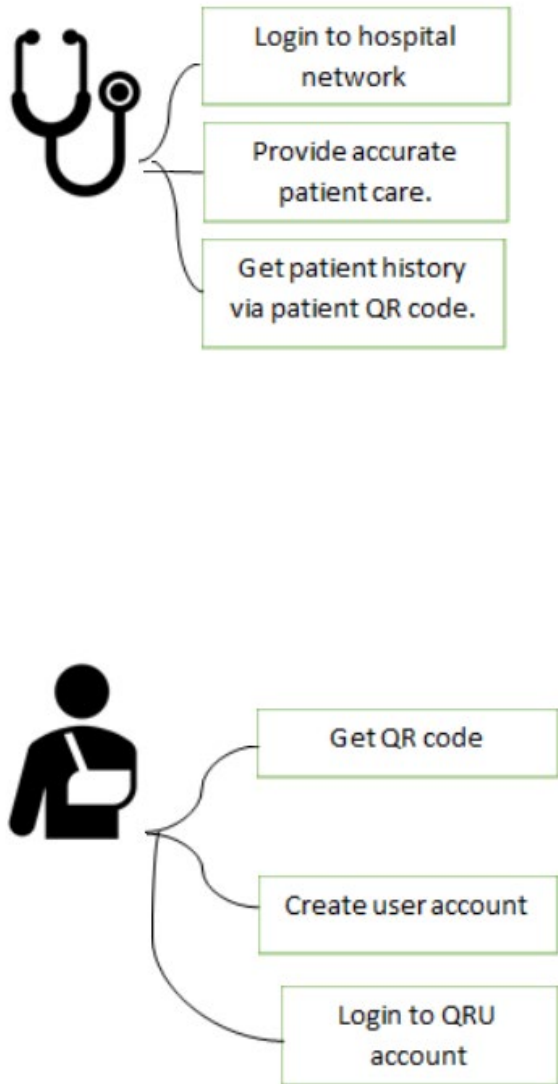


Figure 6

Testing Plan

Overview:

All the functions and possible uses of QRU are tested individually and together. Following the use cases, tests are run as each user to ensure that the app flows and works as intended. Features tested includes the login system, patients entering information, doctors entering/editing information and patient files, and the patient finder search. You will find the description of each testing case, what was tested, whether the test was successful or not, and the date the feature was tested.

Methodology:

Throughout the development of the QRU application, the most used testing approach is Integration Testing. Considering that the product is an application with multiple interactions with its databases, it is important to verify that all inputs and outputs are functioning correctly. Unit testing is also utilized to test various individual features such as buttons and inputs. Unit testing was used since the app has multiple different working parts. The unit testing was able to give the opportunity to see if each individual part works while the Integration testing would show how all parts of the app worked together. When testing the use cases, it was integral to use integration testing since the users were using multiple aspects of QRU. They would sign in, use the search feature, register a new account, upload documents, and use other functions. To provide the best app experience all aspects of the app had to work together and the integration testing is what helped to show that all these aspects worked as intended.

Scope:

The use cases tested include:

- Login
 1. Testing will ensure that users can register a new account
 2. Users will be able to login to that new account and have full access.
 3. Tests will be run to ensure users will be able to use the forgot password function in a situation where a password may be forgotten.
- Authorized Access to Records
 1. Tests will be conducted to show that doctors and patients are the only ones that can access records. These will need to be protected under HIPPA laws since it is confidential medical records.
- Patient Search
 1. Testing that the patient search feature for doctors works as intended. The search will bring up any patient based off search criteria and provide quick and accurate results.

These use cases were chosen for testing primarily due to them including security measures that should be guaranteed to function properly. They are also the most used features of the app and what will be used by almost every patient or doctor that uses the QRU app.

Objectives:

The tests will cover multiple objectives of the app to cover any possible cases QRU will experience:

- 1.) Tests will be conducted from a point of view of each user and their use case. (Worried Patient and Caring Doctor)
- 2.) The tests involving the user personas will follow each use case and provide any details on where the app experienced hiccups or features that didn't work properly.

Test Logs and Procedures

Item#	Test Case#	User	Expected Output	Actual Output	Pass/Fail	Reasoning	Date
1	AF1	Worried Patient (Sydney)	1.) User registers a new account 2.) adds documents, saves, and exits, and logs off successfully.	When registering a new account, I was able to input email and password and was prompted with the new user document. Document was filled out and saved successfully. Was able to logout and then log back in and see my profile and my information.	Pass	All intended user actions were successful and had no unexpected outcomes.	11/29/2021
2	AF2	Worried Patient (Steve)	1.) User Accesses QRU Website 2.) User forgot password 3.) User follows forgotten password procedure. 4.) User regains access to QRU 5.) User can access and edit information 6.) User saves and exits.	I can enter my email to send code, but it does not send code, also says credential does not match.	Fail	Does not send code to email, takes me straight to new password creation, even though credentials match it says they don't.	11/29/2021

3	AF3	Worried patient (Brandyn)	<p>1.) User Accesses QRU Website</p> <p>2.) Logins with username and password</p> <p>3.) Completes the one-time password sequence to get logged in.</p> <p>4.) User accesses QR Code</p> <p>5.) Doctor Scans QR Code which pulls up their medical information Profile.</p> <p>6.) Patient logs out</p>	<p>QR Codes are not active yet, but the barcode scanner is enabled and able to scan QR codes and launch the attached URL with the QR code</p>	Fail	<p>Have not been able to create a QR code that is attached to the user profile.</p>	2/3/2022
4	BF1	Caring Doctor (Jane)	<p>1.) Doctor accesses QRU Website</p> <p>2.) Doctor Registers their organization</p> <p>3.) Doctor must verify their organization is legally recognized.</p> <p>4.) Doctor can search patient info once approval is granted.</p> <p>5.) Doctor uses information appropriately and logs off.</p>	<p>Our app is not set up for the approval at this moment but is able to set up a new account and login.</p>	Fail	<p>Will need to add in the approval process and what that would be like.</p>	11/29/2021

5	BF2	Caring Doctor (Jane)	<p>1.) Doctor accesses QRU website</p> <p>2.) Doctor logs in using organization sign in page</p> <p>3.) Doctor searches patients' info</p> <p>4.) Patients' info is not found.</p> <p>5.) Doctor informs patient to update forms but continues appointment and gives the best care</p>	Patient search works as intended without any search hiccups.	Pass	I was able to use each search function. Each search pulled the exact results as to what was entered. I didn't get any wrong results	11/29/2021
6	BF3	Caring Doctor (Jane)	<p>1.) Doctor accesses QRU Website</p> <p>2.) Doctor cannot login because of forgotten password.</p> <p>3.) Doctor must follow forgotten password protocols</p> <p>4.) Password is reset</p> <p>5.) Doctor completes OTP</p> <p>6.) Doctor regains access</p>	Password reset did the same thing for the doctor as it did for the patient.	Fail	Let's you enter the email but doesn't give you the chance to enter a reset code, lets you enter in the passwords but said credentials don't match	11/29/2021
7	BF4	Caring Doctor (Jane)	1.) Doctor accesses QRU application	Doctor is able to login and access the	Fail	QR codes are not fully	2/3/2022

		2.) Doctor logins using username and password	barcode scanner but QR codes are not implemented	implemented yet.
		3.) Doctor accesses QRU Barcode Scanner	just yet so full tests of this use case have not been carried out	
		4.) Doctor uses scanner to access a user's medical information profile		
		5.) Doctor can pull up their medical information and documents		
		6.) Doctor makes revisions		
		7.) Changes are saved		
		8.) Doctor logs out.		

Figure 7

Testing Review

Testing revealed bugs that were still present in the QRU app. The main bug that was found while testing is the forgot password asset. It never sent the code and would always say the credentials didn't match. The best parts were registering a new account and adding in the profile information. It all worked flawlessly and was very easy and self-explanatory. There were some navigation concerns between screens that were noticed while testing that should be updated to make the flow of the app nicer. The testing was delayed because of the bugs that were encountered with integrating the database into the application but once the two began working together the testing took off. The use cases provided a guideline for testing and to see how the app would work from the eyes of the user.

Change Management Plan

The change management plan is a set of procedures that the QRU development team will follow. The change management plan has different levels that it goes through which are explained below.

- Changes must be approved by the change management team. The team will be comprised of the change management committee which is a group of people chosen

from all departments. The committee will represent each team that works with the app. All members must agree on changes for them to go into effect.

- Internally, the project manager may request a change, under circumstances that best fit. Based on role (Security Analyst, Software Developer, etc.) may request changes that are critical to their role.
- How are you going to triage it?
 - QRU's change management has 4 levels of criticality:
 - The first level will indicate a tolerability of implemented systems that may be inadequate or something that contributes to system failure.
 - Next level or criticality which may include heavy reliance on our servers, databases, or any other integrated system. May need backups and redundant power in case of failover
 - This level will support global business functions and should have an IT-Centric system along with a redundant power supply.
 - This is the highest level and should be used by larger corporations that need IT for all business and system functions. This is highly complex and has redundancy systems.
- Pros and Cons:
 - Pros:
 - The whole team is aware of changes that are being made
 - Helps the app to run better for the users
 - Prioritizes what changes will be implemented and in what order based off criticality.
 - Allows team members to keep track of changes as application develops
 - Cons
 - Does not detail how changes should be implemented.
 - More time must be invested into changes of app.
 - Can lead to disagreements between team members
 - Approval will be based off a team consensus. Anyone can bring a change up to the team and if most of the team agrees with the change, then it will be implemented. Anything that impacts access to the app for users will be most important.
- Information will be communicated with stakeholders any changes that are made through a document in a meeting that demonstrates what the change does and lists the benefits for the app.

Budget

While your project is currently being built at no cost, building a budget to assess the cost of the project will help consumers and stakeholders understand the value behind it. Using the

ROI worksheet, add the project budget table to this section along with an introduction on what was included in the budget and why.

Risk Avoidance									
Improved customer satisfaction									
Increased system availability									
Productivity or process improvement									
Reduced costs									
Estimated Cost Rough Order of Magnitude :									
	Rate Per/Hr	Work Effort (Hours)	1 X Costs	Ongoing Annual			Comments: Microsoft Azure credit our database. As more people use it will have to expand and more money doing so.		
				Rate Per/Hr	Work Effort (Hours)	1 X Support Cost			
Labor - IT	20	100	\$2,000.00	20	2080	\$41,600.00			
Labor - Ext	0	0	\$-	32	2080	\$66,560.00			
Software - External			\$600.00			\$-			
Hardware - External			\$850.00			\$-			
Misc.			\$-			\$-			
TOTAL			\$3,450.00			\$108,160.00			
5-Year ROI Analysis									
Description	5- Year Expected	Conservative (1.5)							
Total Costs	\$544,250.00	\$816,375.00							
Total Benefit	\$250,000.00	\$125,000							

Figure 8

Problems Encountered and Analysis of Problems Solved

There were problems encountered during the development of QRU. These problems can be categorized into two different groups which are group problems and application problems. Group:

- The group had some trouble at the beginning with finding open times for everyone to be involved in discussions and group meetings. Due to everyone’s different schedules, this is still a challenge, but the group is still able to find time throughout the week to discuss and go over anything project related.
- Lack of diversity between IT tracks has made it a challenge to figure out what everyone excels at as all members are on the same track.

This was mostly a problem in the beginning, but we all put in effort to learn new applications and programs to help make this project a reality.

- The PowerApps platform generally does not feature code for direct access to rows, however, with some manipulation utilizing the available code for accessing column information, it is possible to access any information in a row.
- At first, we couldn't connect the SQL server database to the application due to authentication issues.

Application:

- One of the starting challenges we had with creating QRU was not having the knowledge or experience to build an application from the ground up. We solved this problem by utilizing Microsoft PowerApps to help build our own application without needing previous knowledge. This let our group build a powerful application using tools provided by Microsoft to help us achieve our goals.
 - Our program requires a database to store valuable information in. Most Databases are expensive to host and maintain which was a main concern. At the start, we utilized Microsoft Excel to do a test run to make sure PowerApps will be compatible. After this was successful, the database is now hosted on Azure and is being funded through UC credits.
 - Azure Database is being managed by UC administration, there are some rules and restrictions that prevent us from using some functionality. Some firewall rules are blocking access to package plugins and data sources. The solution to this was to find other data sources within the approved list of services. SQL server connection to PowerApps was one of these alternative connections.

Conclusion

QRU has presented many challenges, but all were lessons that have brought us closer to completing our goal. Here are some highlighted lessons learned throughout the project:

- Confirming an application is compatible with your database and the application can connect to a data source like SQL server or have cloud services if you are not using local equipment.
- Not everyone will have the skillset needed to complete a task, there are many sources to help figure out something, especially related to Microsoft services. Utilizing Microsoft documentation and configuration files can help with managing your applications and services. QRU was a notable example of this as PowerApps is something new and has a lot of documentation, along with implementation of a database.
- This project helped develop technical skills including database management and application development.

- Hosting SQL server on Azure has been a challenge but has also been very educational on the costs, deployment, and other factors that have been learned over the past few months.
- The group learned many new skills throughout the development such as time management and communication.
- Group communication and involvement was essential in getting QRU up and running.

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Library Final Report

Final Audit Report

2022-04-27


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