2022

Unit9 Assignment

ASSIGNMENT 2 & 3

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Contents

Gantt Charts of progress and planning

Start of the initial project: Initial Project Plan

Contingency Plan

Possible Risks

The potential risks that exist that could affect the project are as followed:

- Budget: The reason this is a possible risk that could affect the project, is if the budget is too low then the quality of the project would go down because we wouldn't have enough money to go for the best quality in each stage of the project and would have to prioritise certain areas like the development of the prototype over the analysis and design of the system; which could lead to even more problems. The other concern is going over budget and spending more money because once the project is complete and distributed around to attempt to sell the product, if units sold aren't met or the product becomes a failure for some reason. The company has then lost out on loads of money that was spent on this project.
- Delays within the team: A possible risk that could affect the project is delays within the team. If a team is not ready with their area of the project then that can cause lot of delays for the teams that are waiting on the resources they need from the delaying team. This is one of the reasons why, in the contingency Gantt chart, I have spared an extra two weeks to cover that possibility of having delays within the team.
- Market shifts: Another possible risk that could affect the project includes market shifts. The problem with market shifts are as time goes on and consumers or businesses use the product. Their needs change and mean that our product may need new features that we didn't possible originally plan for. This could mean doing the same project again for a second version that then fulfils the extra requirements needed for the consumers or businesses.
- Economic shifts: When it comes to economic shifts, these can have a massive impact on the project and end product because if the economic state decrease and gets low, the initial product sale price might be too expensive for consumers and businesses. This means a potential loss on profit from the product and also potentially a bigger lost to the company in terms of the costs of the overall project made and done for the product.

Identify resources to address risks

To potentially solve the possible risks that endanger the project, certain recourses may need to be created in the very early stages of the project. These resources can include:

- A content outline: A content outline would be covering the possible risk of market shifts. It involves creating an outline of the requirements by speaking thoroughly with the business or end-user. This is the best way try to optimise the gathering of requirements and getting the potential possibility of missing a market shift and making sure that the product meets everything that the business or end-user requires and makes them satisfied and happy with the end-product.
- An extended deadline: To combat the potential possibility of delays within the project and team. The idea of having an extended deadline would be one of the saftest bets to have because it can grant our team that may not have the ability to finish by their certain deadline and gives the overall project a bigger chance of finishing and not technically running over the deadline by extending it.

- Content Writers: Another way to deal with delays within the team and project, would to get content writers from other branches or businesses to come in and help with the process of writing up the content and documentation. This could be aspects such as the feasibility study or the analysis and gathering of details about what methodologies to use. By having these content writers, we can reduce the delay of the project and team by having them to fill in for people unable to attend or those that are just running behind.

Develop plans and procedures to utilise resources in specific events

As mentioned in (Identify resources to address risks), the plans and procedures of having:

- Extended deadlines
- Content Writers
- Content Outline

Can provide benefits to help utilise the resources in specific areas of the project and reduce the possibility of some of the risks mentioned in (Possible Risks), from even happening.

End Contingency Gantt Chart

After careful analysis of all the possible risks and solutions that are potential and possible, I have allocated an emergency two weeks to the project by moving other tasks and jobs further away from the initial deadline. You can find the new plan at this link: Contingency Project Plan

Feasibility Study

System: Temperature detecting alarm system

Purpose of the system:

The system that we have been issued to create, is an alarm system that the company wants to be able to detect temperature changes, provide them to the user in real-time and in data sets, and control environment control systems to ensure the environment is stable.

Factors to be taken in consideration:

Economic:

Some economic factors that would have to be taken into consideration for the project can include budget availability, import and export taxes. Interest rates and exchange rates.

Budget Availability

When it comes to the budget availability, depending on what solution I chose for the project, depends on the budget availability. However, due to being a college assignment and already having been given the hardware and software for the project. No money is being spent, however in a real-life project situation the budget availability would have to be considered everywhere, from equipment, tools and also paying project members. This can be a struggle for small companies but pay out big and is easy for larger companies to get the budget they need but could have a massive fall in income.

Import and Export taxes

Import and export taxes can have a massive impact on small and large companies because if this alarm system was to be produced on a massive scale, companies could be importing the parts in bulk

for super cheap cost. However, due to import and export taxes, the company would have extra cost but any goods imported to the UK under the price of £135 don't have import tax which would be great for a small start-up company. Larger businesses would have to pay 2.5% import tax on goods that range from £135-£630, anything higher than £630 could be slightly or massively higher based on the type of goods and the country that is exporting it. To large companies the tax could be nothing to them, whereas with small companies; It could matter a lot to them.

Exchange Rates

Exchange rates are another important factor to businesses, because it would give them the opportunity to bulk buy goods from other businesses at even cheaper prices. For example, a pound in the UK could be £1.50 for us in China and say that the product is worth £1 in the UK, a buyer could spend £2 on something in China and have no import tax and it would be worth £3 in China. Getting the buyer Three for the price of Two. In bulk buying, this would save the company a lot of money or cover the cost of the import tax making the company break even on cost of making the goods, to then profit selling the goods.

Overall, based off of some of the economic factors mentioned in the above paragraphs. I believe that the project is feasible and can make a return on investment after the cost of the project. Based off of the information found and the points spoken about. Some of the costs can be evaded or even provide lean way for the project depending on where resources are gathered and exchange rates and tax on import and exports.

Legal:

Some legal factors that would have to be taken into consideration for the project, include copyright/patent, GDPR, WEEE. These factors are just some of that could affect the project in a worldwide matter of distribution.

Copyright/Patent

Copyright/patent is the one of the first legal factors that would have to be taken into consideration for the project because it is the right to the product. The patent is the action of licensing or having the right to a product. For example, I would take out a patent for this improved alarm system. Meaning no one can make an exact copy of my product, otherwise I could sue them for copyright because I have a patent saying that I own the rights to this exact product. Patents are optional and have to be renewed after a set amount of time. For a small company, they could pay for the rights for a set amount of time to see if a similar product is released after their product is or for a large company, they would keep their product licensed based on the market of their product and then sue any companies that make an exact or a very close replica to the product that the large company has made and they would have the licenses for the product. I wouldn't license my product because this is within an educational matter and wouldn't be mass produced.

GDPR

GDPR would be a very important legal factor that would be required for the project if its to go out to other companies or used by just themselves because the system would contain important information that the company needs and requires to be able to do their jobs. If that is broken and they don't have GDPR, then the company could receive a massive fine and possibly jail time and the company name and reputation would be damaged. Making it harder to keep clients or receive new clients within the company.

WEEE

Waste Electrical and Electronic Equipment is another legal factor that would be required by the company because of the project they are working with involves electronic equipment. It would be important that at the end of its life cycle that it is disposed of in the correct matter of which certain parts are stripped down, separated, reused and organised in the right areas. If this doesn't happen and other people find out. The company can receive a massive fine and possibly even jail time. By going against WEEE it can also damage the name and reputation of the company and would be very bad for the planet as well. Whereas, if they do have it in place; not only is it good for the business but it also protects the environment of which the company is wanting to observe, track, and manage as a whole and make the company look really bad if they didn't follow WEEE in the area of which they work in.

Technological:

Internet connectivity is one of the big factors that would need to be taken into consideration with the project because the alarm system would connect to an API that would collect the data that the alarm system is collecting and if any major changes are detected, I will have the alarm system send an SMS or email to the client informing them that there has been a change.

M2M and Bluetooth

The alarm system would use M2M communication to send the data to the API and also send an SMS or email to the client. Alternative connections that can be used, include satellite, Broadband, cable and more. Each option has its benefits and constraints and is why they need to be analysed at and looked at and compared before making a decision.

Bluetooth would be another great option for distributing the sound of the alarm system because the company could purchase a series of Bluetooth speakers that would only need connecting to the raspberry pi Pico, making it super easy and they would run off of the same program and would only need a couple lines to configure and connect them along with the system.

Automation

Automation is a key technical factor for the project because automation would need to be used for sending data over to the API and also to keep it running if there was no-one there to run it manually. By using automation and the link to the API, the client would just have to go to the data set to look at the results that the system managed to pick up. It would also have a timer to turn on at the time of which the shop closes to shop opens. Otherwise the data could be incorrect due to the system thinking that every person walking in and out of the building is a possible breach and activating the alarm system. Whereas, if a timer is set for when the building closes till the building opens. Then any data gathered between that time period would be more accurate and wouldn't be collecting possibly false data and sending it to the data sets on the Adafruit API.

Wireless Charging

Wireless charging is another factor that could affect the project, however I wouldn't consider it because it may not always work and there for could die but I wouldn't recommend it at all because it needs sufficient and reliable constant power and using wireless charging would be too risky for the company. Whereas using mains would provide a constant charge of power and relays could be used to change and maintain the voltages that are moving across the raspberry pi Pico. However, if it had an independent power unit that didn't need to be connected to mains then the alarm system could stay operational if there was a power cut. Otherwise, the system would need to be able to reboot

itself and set itself up again in order for the alarm system to work because if it can't, then it will be a big problem for the company as they won't have an alarm system and a lot of important stuff could be at risk due the power knocking out the alarm system.

Current and Future Developments

Current deficiencies:

The current deficiencies involved with the current alarm system includes the fact that it doesn't provide remote management which then means the company can't control the system or use some simple features that the company may want to carry out, such as stopping and starting the alarm system or resetting it. Without having some form of remote management, the company cannot accomplish the goals or targets that were set out with this system. Therefore, this can cause a lot more problems for the company, especially if the system doesn't meet their requirements.

User Requirements:

The user requirements according to what the company want adding to the alarm system, include:

- Be able to take temperature reading of the surrounding area that the system is in.
- Provide real-time data and have them displayed in data sets for the company to analyse the data gathered.
- Have remote access and management to the system to ensure the environment is stable and make the changes required if it is not stable.

Potential Benefits:

Based on the given requirements the company wants within the system, I am able to give an idea of the potential benefits that the company and system would acquire through the new developments of the system. For example, with the implementation of remote access and management; the company would be able to control the environment that the system covers and would become more useful to the company because it would meet that requirement that the company wants. Another potential benefit that the company would also gain is the use of real-time data. Due, to the data being tracked within real-time and using an API to send the data and organise it into data sets. The company can analyse live and more accurate information and get a better understanding of what is happening in the environment that the system is covering and what the company may need to do to stabilise it or keep it at a fixed range. It would also inform the company if the environment is unstable and requires attention.

Constraints:

Based on the given requirements the company wants within the system, I am able to give an idea of the potential constraints that the company and system would acquire through the new developments of the system. If the system was to lose power due to a possible power cut. The alarm system might not reboot and start running again, if overnight when there are no workers. The company would also receive no input from the system meaning they aren't collecting the data they need to ensure if the environment is stable or not. Another possibility for time, is it cuts out for 5 or more minutes, the data the company is collecting wouldn't possibly be as accurate and could lead to possibly more problems.

Conclusion and recommendations:

Low Budget Solution/Recommendation

Equipment	Cost

Raspberry Maker Pi Pico	£10.99
DHT11 Temperature-Humidity Sensor	£4
1" Mini metal Speaker with Wires - 8 Ohm 0.5W	£2
Adafruit Software	Free
Thonny python IDE	Free
Total Cost:	£16.99

This is potential solution number 1 and it is the cheapest option for the company. Within the solution is the components that would be required to meet the user's requirements and can be seen in the table above. When it comes to the device/host of the system, I recommend using a Raspberry Maker Pi Pico because it is super cheap and has the capabilities of fulfilling the requirements set out by the company. Adafruit provides the requirement of having remote access and management, that the company requires. I will be using Thonny IDE to code the program for the raspberry Pi because it is one of the best and also comes at no cost and comes with easy integration and deployment of programs. A DHT11 temperature-humidity sensor would be used to collect the data that the company wants and to send to Adafruit for management and remote access if needed. I mini speaker would be used as the piece of hardware to produce the alarm if the environment changes drastically and requires stabilisation.

Medium Budget Solution

Equipment	Cost
Raspberry Pi 3 Model B	£34
Real Time Clock and Temperature Sensor Module for Raspberry Pi -	£12
Adafruit I2S 3W Stereo Speaker Bonnet for Raspberry Pi - Mini Kit	£12.30
Adafruit Software	Free
Thonny python IDE	Free
Total Cost:	£58.30

This is potential solution number 2 and is the second most expensive option for the company. The model of raspberry Pi I have chosen is the Raspberry Pi 3 Model B because it comes with a built in Wi-Fi and ethernet port to provide a connection and make the device more reliable by having the option for a more direct and secure connection. I decided to go for a temperature sensor with a built in real-time clock because this would help accurately provide the company with the real-time data that they require and want to be able to obtain and collect the appropriate data. For the speakers, I chose better quality ones with a Adafruit integration therefore the speakers could be controlled separately to the rest of the hardware and provide the company with more options for what to use the speakers for. I stuck with Thonny and Adafruit for the required software because they both can provide the best experience and ease of use for the company.

High Budget Solution

Equipment	Cost
Raspberry Pi 4 Model B	£54
DHT22 Temperature & Humidity Sensor	£8
Amplified Speaker Kit for Raspberry Pi -	£13.58
Adafruit Software	Free
Thonny python IDE	Free
Total Cost:	£75.58

This is my final and most expensive solution that the company can use to meet the requirements that the company demands. Firstly, I went for the raspberry Pi 4 model B because it has more RAM meaning it would be faster when it comes to processing and carrying out the actions of the remote

access and management that the company will have access to. Secondly, based on the environment that this system will be monitoring I suggest using a DHT22 temperature & humidity sensor because the range of the temperature that the sensor can detect and record, varies from -40 – 125 degrees Celsius and only has a temperature shift of point 5 of a degree give or take, which makes it more accurate than the DHT11 which has a give or take of 2 degrees and only ranges from 0 – 50 degrees. I also chose a amplified speaker kit for the raspberry pi because it would be louder and clearer and also designed to work with raspberry Pi's meaning that the setup of the speaker in terms of with the Pi would be easier and possibly more efficient in terms of setting it up to work with the Pi.

Final Conclusions

Overall, if the company has the budget, the high budget solution would be the best to use because of having better versions of the hardware required that can do more or is more efficient and sustainable which comes in very handy considering the type of environment the company could be tracking and covering. However, due to being in an educational matter I will have to use the lowest budget solution and the hardware provided by the college but in a real company matter. I would definitely go for the highest solution because of all the benefits it provides overall and over other solutions.

Methodology Solutions

Methodology Solution One: Waterfall

One of my methodology choices for a solution is waterfall. The processes that come into this methodology are as followed:

- Requirements
- Analysis
- Design
- Coding/Implementation
- Testing
- Operation/Deployment
- Maintenance

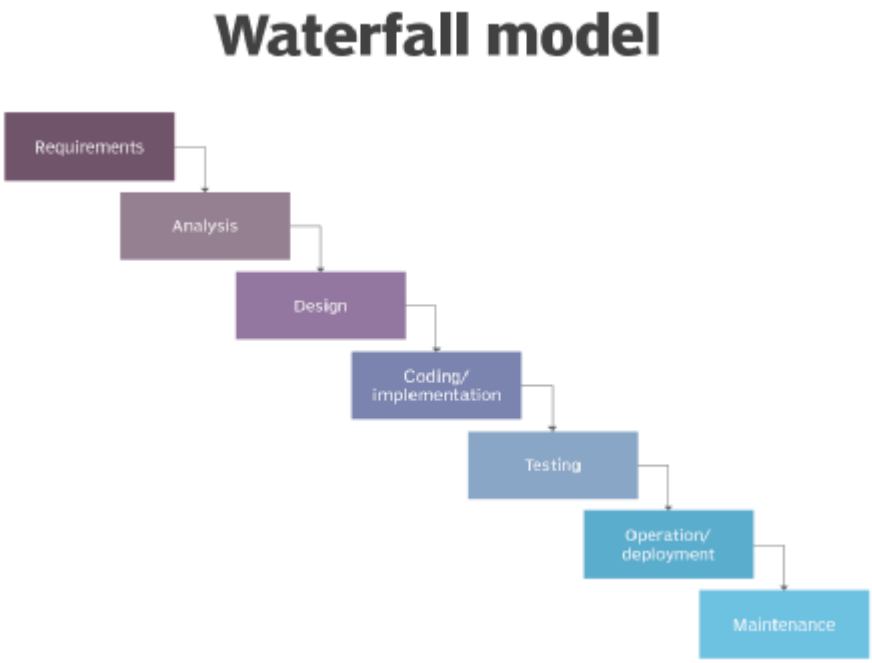


Figure1: Waterfall Model

Based off of the processes the waterfall model has, it could be used as the chosen methodology for the project prototype. However, a major constraint that the waterfall methodology would have is within the testing and deployment processes because every time that the company want to test the prototype because they want to change something after the testing stage; the company would have to go back to the first stage of the waterfall methodology. This would take up a lot of time and make the project take longer than it possibly should but then the process of having to back through all the stages of the methodology gets the company to double check everything and they might find something they missed or should add as an extra and gets it done without possibly having to go through it a third time. The process of going through it all again isn't ideal and therefore I shall not be using this methodology for the project.

Methodology Solution One: Agile

The second methodology option I have for the solution is the Agile methodology. The processes that are included with the methodology include:

- Plan
- Design
- Develop
- Test
- Deploy
- Review
- Launch

Figure2: Agile Model

The processes are similar to waterfall however the way you have to follow it is different. The waterfall flows like a waterfall, hence the name, it starts from the top and has to run to the bottom. Whereas, the Agile methodology could skip a step and rotate around to the desired process that the company needs to go through again. The Agile methodology also focuses on the development processes more than the rest of the areas. Which makes it especially good for the processes of developing, coding and testing the product and making the required adjustments and going through testing again, without having to do through the rest of the documentation all over again.

Methodology Solution One: RAD

The final choice for the solution is the RAD methodology. The processes involved in the RAD methodology include the following:

- Analysis and quick development
- Prototype cycles: build, demonstrate and refine
- Testing
- Implementation

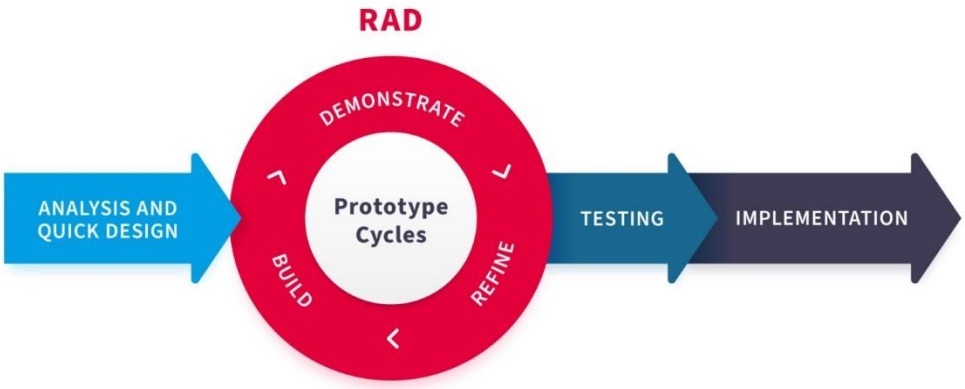


Figure 3: RAD Model

The RAD methodology is a really good fit on the bases of the type of project that we have been handed. The RAD methodology has a continuous prototype cycle that allows the developers to build, demonstrate and refine as many times as they need to but without having to touch the Analysis, testing or implementation processes. This is really good because it allows them to spend as much time as they need on the development of the prototype and refine it to the best that they can before implementing it to find the rest of the features of problems that they may have missed or forgotten about and then implement them into the prototype and resolve any bugs that the prototype has to make it into a sort of finished product that could essentially be released if the company and target audiences are happy with the end result. Also, by having not so many steps, more time could be allocated to certain areas within the process of creating the prototype project. Meaning the company can rub out any mishaps that could occur or that could be added to the documentation that could further help improve it or make it more efficient overall and tidy up the documentation side of the project.

Conclusion for the methodologies.

Benefits and Constraints of Waterfall being used for the project

Benefits

There are some key benefits that the waterfall methodology can provide for the project. Some of these benefits can include the following:

- Uses clear structure: Due to the processes found within waterfall, this methodology focuses more on a clear path of steps to get to the end goal. Also, due to needing to complete an entire step before moving onto the next step, this can allow the team to put that focus in and find the key parts that they need to add or take into consideration when it comes to the project.
- Transfers information well: As the methodology moves a step at a time and is highly methodical, it emphasizes an organised transfer of information which is vitally needed as the company progress further and further into the project. This allows the team to have as much information as they need and make it easier to find everything they need from the requirements needed to the design of the prototype. The team could also prioritise the information that they gather and receive and keep it all in the documentation to help further build up the project.

Constraints

Having key benefits can also come with big constraints. Here are some constraints that the waterfall methodology can have on a project.

- Low flexibility: Due to the waterfall methodology requiring a step to be completed before moving onto another, it greatly reduces the ability to make quick changes in other steps because you would have to finish all the steps and go from the start through all the steps again before you reach the area that you wanted to alter. This can take up a lot of time and could cause other problems for the team that are having to follow through the steps to complete the project that they are working through.
- Strict management: Using the waterfall methodology includes having strict management and regular monitoring because the methodology can only flow one way and would having to be

constantly monitored and managed to make sure that the team meet the deadline and don't go over it because they had to go through it again to make an adjustment.

Benefits and Constraints of Agile being used for the project

Benefits

There are some key benefits that the Agile methodology can provide for the project. Some of these benefits can include the following:

- Reduced risks: Due to the methodology having short sprint steps that focus on the continuous delivery of a prototype, there are less risks within the prototypes because it is undergoing loads of development, testing and refining. This is really good for making multiple versions of the prototype as well. Leaving the team with copies with or without some features if they find a different approach.
- Increased flexibility: There is more flexibility with the project because the methodology works in short sprints and not super long processes like the waterfall methodology does. This is really good in terms of making adjustments and not having to worry too much about not having the time to do it or meeting the deadline that the project has.
- Customer satisfaction: With this form of methodology, one of the biggest team members are the customers. The customers would be working with the project team in giving requirements and feedback on the prototypes of which the developers are then able to make those quick changes and hand out the new version to the customers to get their feedback to see if they are happy with it or if something else needs adding.

Constraints

Having key benefits can also come with big constraints. Here are some constraints that the Agile methodology can have on a project:

- Teams get easily side-tracked: A downfall to the processes being short-quick sprints, project members could get quickly side-tracked if other members are still processing their stage of the methodology. This could slow down productivity of the project and could cause problems if there are other jobs that need doing and the project members are unaware of the jobs needed completing.
- The level of collaboration can be difficult to maintain: Again based on the methodology using short sprint stages, collaboration can be harder to achieve and maintain because different areas would be finishing quicker or slower than others. Creating the problem of collaboration and especially if they are waiting on information from the other teams within the project.

Benefits and Constraints of RAD being used for the project

Benefits

There are some key benefits that the RAD methodology can provide for the project. Some of these benefits can include the following:

- Faster release of versions: Due to having a rapid prototype cycle, the project team would be able to make quick prototypes that they can get feedback on from the target audience or client that its being made for. Once feedback is gained, developers can make a better

version quickly with those changes and repeat the process of getting feedback and refining until they don't get any feedback that would be a drastic improvement to the project.
- Quicker adjustments: Similar to releasing versions faster, quick adjustments can be made by the developers because the methodology contains that rapid prototype cycle. This makes it efficient for the project team and means they save loads of time because other methodologies like the waterfall require all the steps being completed one-by-one before any refinements or adjustments within the project can be made.
- Better risk control: Again, rapid prototype cycle can also create better risk control because the prototype cycle contains constant development and refinement. This therefore creates better risk control.

Constraints

- May not be useful for large projects: The RAD methodology may not be suitable for large projects that require more steps or more time in the process of design, development and evaluation processes withing the methodology. This can cause important features needed in the project being missed. That can then lead to more problems for the project and create a higher chance of failure within the project.
- Need highly skilled developers: The company would need highly skilled developers that know loads about python, being the language the program is going to be coded in. This is vital because of the rapid prototype cycle and if the team don't have skilled developers. Then prototypes would be produced slower and take up the time of which some might be reviewed or refined.

Overall Decision

In conclusion, the methodology I am going to be using in the process of the project is RAD. My reasoning for picking RAD over Agile and Waterfall is because RAD had the rapid prototype cycle which is 100% suited to the project based on the given scenario. Also, flexibility is a big factor in the choice of methodology. Especially when the project requires constant refinement because if I had chosen Waterfall, then every time I'd want to refine or edit something in a previous step; I would have to complete the rest of the steps in the methodology and then go through all the steps again until I got to the point of which where I wanted to make an adjustment.#

It was a very close call between the Agile and RAD methodology but due to the RAD model fitting in better on the given scenario and having the RPC. I had to go for the RAD methodology.

Risk Assessment and Matrix

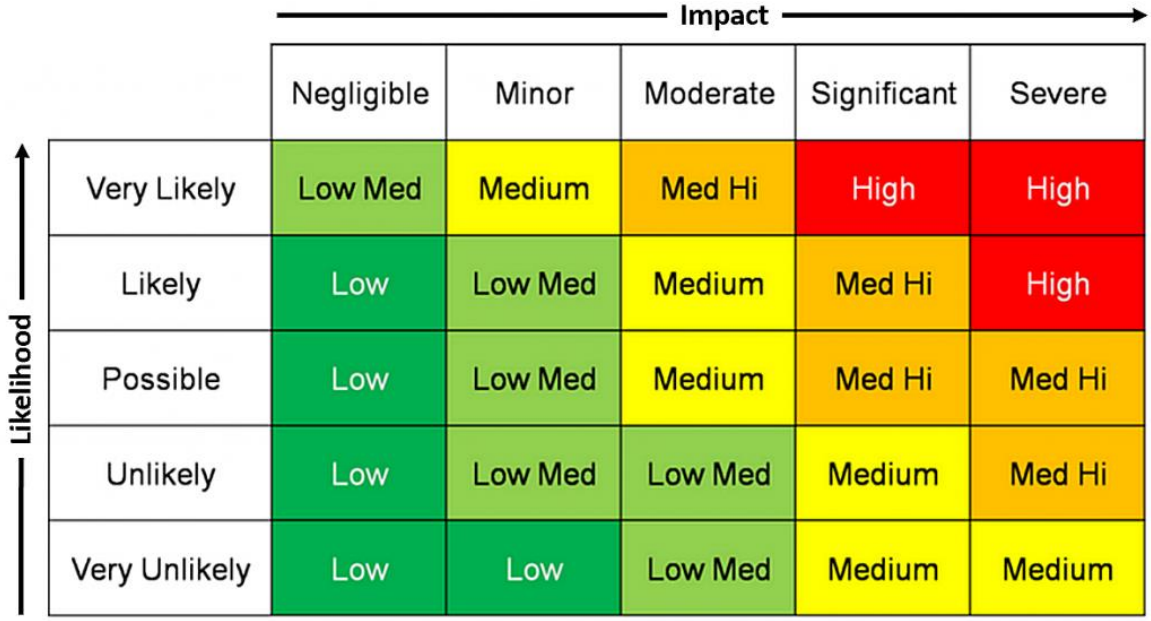


Figure 4: Risk Matrix

Threat 1

Threat Number	1
Threat Title	Adafruit goes down
Probability	Possible
Impact Level	Medium
Risk Severity	Moderate
Explanation of the threat in context	If Adafruit was to go down temporarily, the company would have a couple issues such as remote monitoring and control. As the company wouldn't be able to gain access to the data and read the temperature of the environment and wouldn't be able to remotely control environment controlling systems through Adafruit.

Threat 2

Threat Number	2
Threat Title	Relay blows
Probability	Possible
Impact Level	Medium/High
Risk Severity	Significant
Explanation of the threat in context	If the relay was to blow due to an energy surge or if it isn't operated properly, then it could possibly blow and within the project and system. It would mean that the company wouldn't be able to use/control the use of

	environment controlling systems such as an air conditioning unit because the relay is broken and cannot provide the needed power to the air conditioning unit remotely and could cause a problem for controlling the temperature of the environment.

Threat 3

Threat Number	3
Threat Title	Temperature Sensor breaks
Probability	Possible
Impact Level	Medium/High
Risk Severity	Severe
Explanation of the threat in context	If the temperature sensor was to break, then that would make a giant problem for the company because the system is then not monitoring the environment and not sending any data to the provided sets and would not warn the company of the temperature being too hot and therefore could not receive the actions needed to stabilise and control the environment.

Threat 4

Threat Number	4
Threat Title	Raspberry Pi Pico breaks
Probability	Likely
Impact Level	High
Risk Severity	Severe
Explanation of the threat in context	If the raspberry pi was to break for whatever reason, this would be a huge impact for the company because they wouldn't be able to do or receive anything about the environment that the system was implemented to monitor and control. Causing a very big problem for the company and possibly the work environment.

Threat 5

Threat Number	5
Threat Title	OLED Display Breaks or crashes
Probability	Unlikely
Impact Level	Low/Medium
Risk Severity	Moderate
Explanation of the threat in context	If the OLED display breaks or crashes for whatever reason, its not a massive problem because only the temperature is displayed on the screen for anyone that may be in the same room as the system.

How would I reduce the probability or impact of the threats?

Threat 1

What could be done to fix or reduce the occurrence of (Threat 1)?

To fix or reduce the problem of Adafruit going down, I can suggest the use of the OLED display to show the temperature of the environment because it is also connected to a buzzer which activates if the temperature is too high. The use of Adafruit is to monitor and control the environment remotely but if it is down then the company would have to resort to manual control. With the temperature being covered and monitored using an OLED display, to fix controlling of the system such as the air conditioning unit. I suggest that the company use the buttons on the board to control the air conditioning system through the use of the one button on the Pico that turns it on and off.

Threat 2

What could be done to fix or reduce the occurrence of (Threat 2)?

To fix or reduce the problem of the relay blowing up. I suggest that the company either have spare or bigger relays because a problem could be that the environment control system is asking for more power then the relay can offer, making it blow. When it comes to switching of the hardware, the company would just have to pause the system and shut it down for the safety of replacing hardware to make sure nothing is running, switch out the blown relay and then follow it up with just turning the system back on and starting it up again.

Threat 3

What could be done to fix or reduce the occurrence of (Threat 3)?

To fix or reduce the problem of the temperature sensor breaking. I suggest that the company has some spares of the same temperature reader because the system is coded to that specific one and uses modules that will only work for that model of temperature reader. When it comes to replacing the broken hardware with the new piece, the system would have to be shut down and completely powered off. Finally, it would be the case of just switching the two temperature readers and powering the system back online to proceed back to monitoring and controlling the environment.

Threat 4

What could be done to fix or reduce the occurrence of (Threat 4)?

To fix or reduce the problem of the raspberry pi Pico breaking. I suggest that either a spare is kept or that it is housed in a case for further protection. If the Pico was to break for whatever reason, then replacing it would be as easy as just getting another Pico and moving the files and hardware over to that device to get the system up and running again. It would be key to keeping spares and having the transfer of software and hardware easy because it means it would reduce the amount of set up time, which then reduces the amount of down time and can get the system monitoring and controlling the environment as soon as possible.

Threat 5

What could be done to fix or reduce the occurrence of (Threat 5)?

To fix or reduce the problem of the OLED display breaking or crashing. I suggest that the OLED, just like in **threat 4,** is housed in a case to protect it from getting physically damaged. To prevent crashes,

I suggest that the system doesn't get manually shutdown via a terminal and if it is to be shut down via terminal. That the company pause the system through Adafruit so that the display is closed and doesn't crashed when the program is killed. If the OLED was to get broken, like other cases it is just the idea of replacing the display with a new one and doesn't cause any major issues to the system or company if it takes longer than expected because it is just to allow staff to see the temperature if they were in the same room as the system. The temperature of the environment would still be accessible through Adafruit.

How will the system be maintained?

This system will be maintained through the use of the internet and basic power, the system would clearly require some form of power to get everything working and the internet would be used to carry out requests with Adafruit to control and monitor the system and environment. When it comes to updating the software on the Pico, the folder structure is labelled and made easy to understand and would only have to likely change the one file being the main system and adding any other libraries to the **lib** folder.

Meeting

Agenda
Date: 12/05/2022 Time: 13:30pm
Attendees: Connor Thompson and Supervisor Vanessa
Review of progress: - Feasibility Study is eligible and acceptable - Choice of methodology is suitable and acceptable
Future Progress/List of tasks: - Requires a risk assessment - Need a contingency plan

Evaluation of meeting

After meeting the supervisor, I was able to gather important information about what they were happy with within the project and also what could be introduced to make it better and to meet the user requirements.

As seen in the meeting journal, the tasks that need to be introduced to the plan include a risk assessment covering potential risks and provide solutions for them, a contingency plan in the case of which something may change within the weeks of the project and possibly causes delays.

Minutes

Minutes
Date: 26/05/2022 Time: 13:30
Attendees: Connor Thompson and Supervisor Vanessa
Topic: Review of last Meeting
Progress made after last Meeting: - There is a risk assessment within the project documentation that labels and provides potentially possible threats and also solutions on how to fix or potentially reduce the probability of them happening within the project and causing more issues. - There is a contingency plan within the project that provides a more processed plan based on possible risks that could occur and what plans and procedures that should be taken to reduce or eliminate the potential impact and possible risk.

Evaluation of meeting

After meeting with the supervisor again to re-establish the progress made and also the progress made on the recommended improvements made by the supervisor to meet the clients requirements.

As seen in the documentation of the review meeting, all recommended improvements have been made and implemented into the project.

The processes of using RAD for this software project –IoT Assignment

Phase 1. Analysis and Design

The first step of using the RAD methodology is analysing and designing the project prototype. In this section of the documentation. You can see that I made designs and also provided information about the design of the soon to be prototype. Features such as communications, actuators and inter-connections were analysed and discussed for the design of the prototype. Other aspects such as security were also taken into consideration and analysed with certain threats and the possible solutions that could be used to counter act them. You can find all the evidence for this stage below:

Design Stage

Diagram of the design

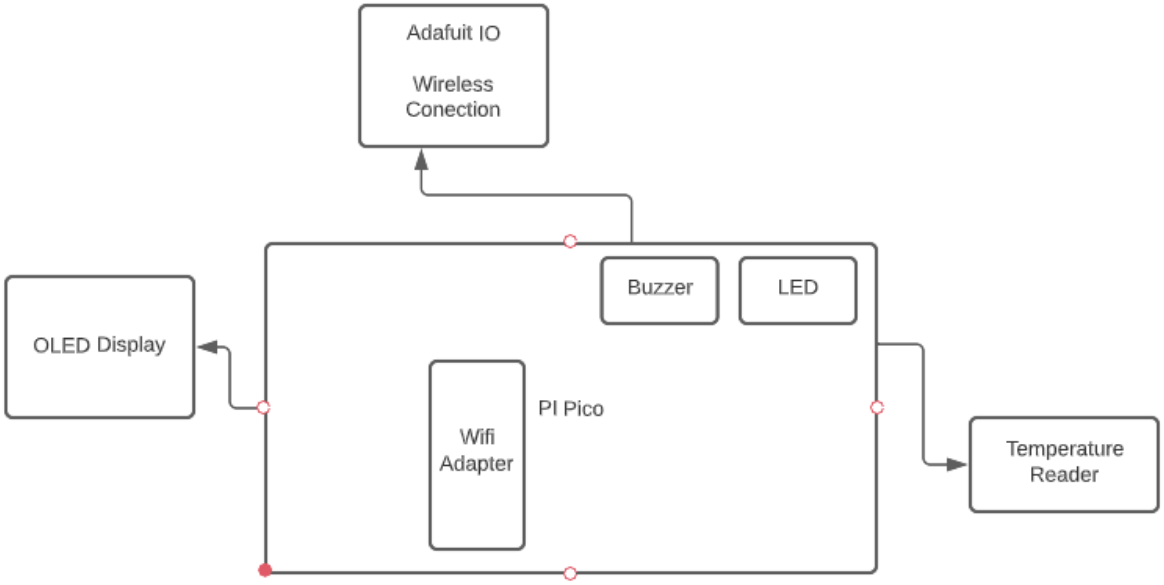


Figure5: Design of the prototype

This is my design for my prototype of the system. In the design the components involved include a temperature reader, WIFI adapter, buzzer, OLED display and an LED that can be found on the board. The components used are from the equipment we have been provided for this assignment due to being in an educational situation. In the design, I also show the use of Adafruit.IO for sending and receiving the data through a wireless connection.

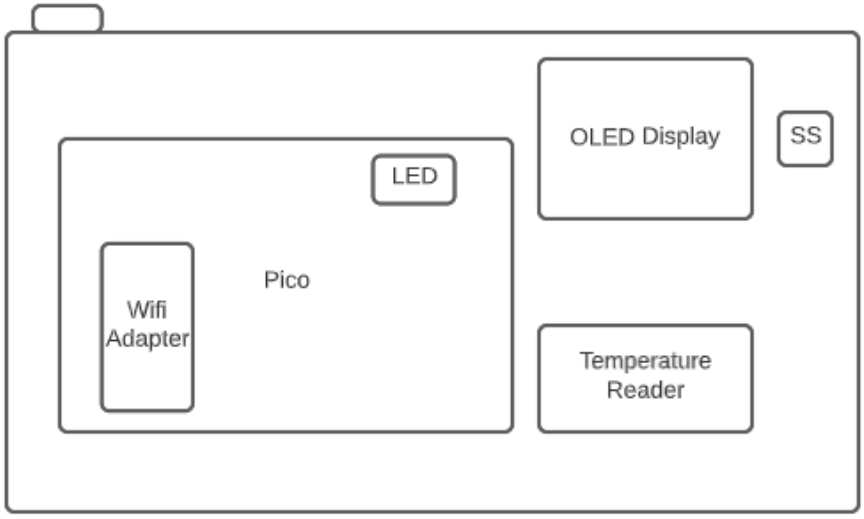


Figure6: Case holding prototype design

This diagram is an idea of a holding case if the prototype was to be made in production. The case would be a box with curved edges and would have transparent acrylic to show certain components and hardware such as the OLED and the Pico to ensure that the correct lights are lit up on the board to indicate the connection to the components and also to show the LED on the board. There would also be some small holes near the buzzer on the Pico to allow the sound to exit the case and get heard by the end-users.

Architecture

M2M system

Machine-to-Machine is the process of two devices communicating to each other using any type of communication wired or wireless that doesn't require any human interaction to start or finish the communication between the two devices. I have multiple options of communication that I can use with the prototype which have been assigned to design.

Smart Services

Sensor Networking

A sensor network is a network that uses sensors to monitor and track the physical condition of an environment and forward the gathered data to one location of which it can be monitored and used as needed by the person that is collecting the data. This would be really good for the project because we have to collect data of an environmental area of which we will be using temperature sensors to gather the data and send that data over a wireless connection to a feed using Adafruit to collect and organise the data into different sets according to the data being collected and then do as what is required with the following data. In this case, if the temperature hits a specific number, then an alarm goes off informing the company of a drastic or big change within the environment that they work in and that it requires attention. The company could also then use Adafruit and the data sets to view and monitor the temperature themselves at any time using a data feed of which all the data would be organised or put into a table to monitor the changes over the give time periods.

Sensors (Input)

DHT11

One of the sensors that would be used is the DHT11 temperature and humidity sensor. This sensor can measure and monitor the temperature of a room or environmental area within a building or outside of the building. The DHT11 is a good choice of sensor in the fact that it is being used within a building, meaning that it will be monitoring and gathering the temperature of a room most likely. The DHT11 is able to monitor temperatures ranging from 0-40 degrees with a +- of 2 degrees. This would be a good option for the company because there is a low chance that they would need to monitor a room that is over 40 degrees unless it was to be some sort of server room. However, the company could use a DHT22, not so much for the bigger temperature reading scale but the accuracy and durability of the component. The DHT22 ranges from -40 to +125 degrees with a +- of 0.5 degree making the reading more accurate than the DHT11 because it has a +- of 2 degrees. This would help the company monitor the environment better and get more accurate reading sent into the data sets which are viewed via Adafruit. With its durability to withstand more crucial temperatures, if something was to happen to the building which would inflict those kinds of temperatures. The DHT22 would stay functional and warn the company of the temperature within the environment that they have its setup in. However, given the fact that I am in an educational situation, I am going to have to use the given hardware which would be the DHT11 but in a real-world scenario, the DHT22 could be more beneficial and sustainable for the company and the project prototype.

Actuators (Output)

OLED

One of my outputs that may be used in my prototype is an OLED display. It would be helpful to have an OLED display because it can equally show the temperature of the environment and any of the company staff could then look at the system in the room to see the temperature as well, instead of always having the use the data feed online through Adafruit. It would be up to the company, whether or not they are after a decently sized OLED display or if they would be okay with a small one as long as they can see the temperature of the room/environment. This would be beneficial as a warning display because it could tell anyone in the room if the environment is too hot and requires action to control and stabilise the area.

Buzzer

The buzzer would be used in the design and prototype of the environment alarm system because it would give off a sound of which the company staff would be able to here. The buzzer could give off a constant tone or a patterned tone to get the companies attention and would be activated if the area that the system is covering and monitoring hits a certain temperature of which the company sets and if that temperature is hit, then the buzzer goes off giving off an alarm and informs the company to take whatever action is need to control or maintain the temperature within that area or environment. Due to being in an educational matter, I will have to use the buzzer on the raspberry Pi Pico; However, a speaker kit for raspberry pi's or a Bluetooth speaker could be used to provide the sound of the alarm.

Dashboard Outline

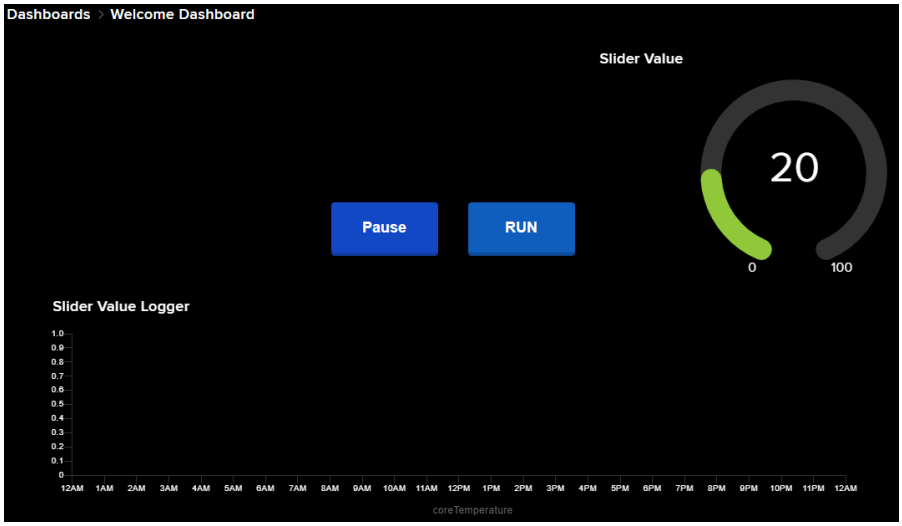


Figure 7: Dashboard layout for Adafruit

What Feeds am I going to use?

I am going to create and use a data feed that has features such as a pause and run feature or a timer feature of which they can control it and tell it not to operate during closed office times. This could be vital in sustaining the system or the possible extra cost of running it during closed times at the building.

What triggers will be set on Adafruit?

The trigger I will be using, is a temperature trigger. This trigger would work in conjunction with the buzzer because if the temperature set in the trigger is met and activated. Then the raspberry pi Pico would be told to turn on the buzzer to notify the company staff that the certain temperature has been hit and that the company need to take action to control and stabilise the environment they are monitoring.

Three temperature triggers would have to be set so that the feeds are different and aren't activating two functions at the time. Therefore, there would be a trigger for (below set temperature), (equal to set temperature) and (over set temperature). With each trigger having a different temperature differential target. Depending on which trigger is activated, depends on what action shall be taken; Will it activate the buzzer or just keep sending temperature data to the feed.

What buttons on Adafruit will be used?

I am planning on using two buttons on Adafruit to help the functioning and monitoring of the alarm system. The first button would be a run button if the system was to for whatever reason stop and would allow the company to get the system running again. The second button would be a pause button, this button would be used to put the system to a halt if the system needed some maintenance or if there were any hardware issues. It would be important to have a button the stops the alarm system and turns off the components because it could be a big risk and not very safe if the components were to remain on during the maintenance.

Quality of Service

With QoS, I have got three options of QoS 0, QoS 1 and QoS 2. QoS 0 focuses on delivering the best effort basis but without providing any form of confirmation of receipt. This means that there would be no confirmation of whether or not the message did arrive to the desired system. It also uses telemetry to gather information in the idea of that a message isn't received, a value can be still sent based off of the analysis of the other information that was collected. QoS 1 ensures that there is a receipt of confirmation because it makes sure that the message arrives to the system, but this can lead to a possibility of duplicated data because if the first message doesn't arrive in the given time, then it will send another and therefore can create duplicated data. Whereas with QoS 2, it guarantees the delivery of the message to the system in exactly one attempt without sending it again. This means that there wouldn't be any duplicated data that could affect the processing and actions of the system because it sends the message and delivers it in one shot to the system.

Standards

Frameworks

The framework that will be used in the prototype is the IEEE, also known as the P2413. This framework is a type of method for sharing data, consistency, and security of messages over a network of which components such as sensors and actuators and any other forms of devices can work together, regardless of the technology given for communication.

Communication Needed

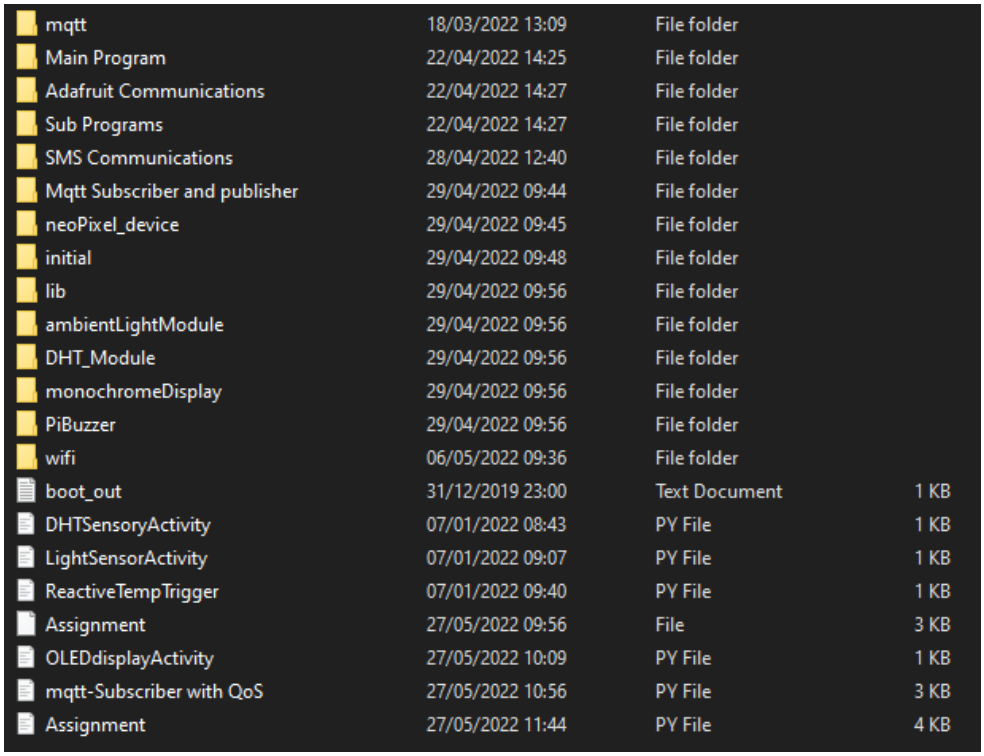
System inter-device types

I2C – Inter-Integrated Circuit Communication

I2C is the protocol that relies on sending data in a serial format using only data wires SDA and SCL. The data line cannot change when the clock line is high, but it can only change when the clock line is low, according to I2C protocols. Because the two lines are open drain, a pull-up resistor is necessary to make the lines high, as the I2C bus devices are active low. The information is sent in packets of 9 bits each. The two lines are used to send and receive data; a serial clock pin (SCL) that the Arduino Master board pulses at a regular interval, and a serial data pin (SDA) over which data is sent between the two devices.

File and folder layout

The file and folder layout are pretty important in the sense that it needs to be easy to follow so that the company can update any files that receive new versions and that they can track and replace the files with ease. The folder and file layout I am proceeding with can be found below:



mqtt	18/03/2022 13:09	File folder	
Main Program	22/04/2022 14:25	File folder	
Adafruit Communications	22/04/2022 14:27	File folder	
Sub Programs	22/04/2022 14:27	File folder	
SMS Communications	28/04/2022 12:40	File folder	
Mqtt Subscriber and publisher	29/04/2022 09:44	File folder	
neoPixel_device	29/04/2022 09:45	File folder	
initial	29/04/2022 09:48	File folder	
lib	29/04/2022 09:56	File folder	
ambientLightModule	29/04/2022 09:56	File folder	
DHT_Module	29/04/2022 09:56	File folder	
monochromeDisplay	29/04/2022 09:56	File folder	
PiBuzzer	29/04/2022 09:56	File folder	
wifi	06/05/2022 09:36	File folder	
boot_out	31/12/2019 23:00	Text Document	1 KB
DHTSensoryActivity	07/01/2022 08:43	PY File	1 KB
LightSensorActivity	07/01/2022 09:07	PY File	1 KB
ReactiveTempTrigger	07/01/2022 09:40	PY File	1 KB
Assignment	27/05/2022 09:56	File	3 KB
OLEDdisplayActivity	27/05/2022 10:09	PY File	1 KB
mqtt-Subscriber with QoS	27/05/2022 10:56	PY File	3 KB
Assignment	27/05/2022 11:44	PY File	4 KB

Figure8: File and folder Layout

Security

Potential Threats

Being a system with wireless connections to networks and having hardware that can connect to other services. There are a lot of potential threats that could affect the system, some of these include:

- **Hackers:** Hackers would be able to hack into the device and steal or encrypt all the files on the raspberry pi and that would then break the system and it wouldn't be able to fulfil its purpose that it was designed and made for. The hackers could also potentially get into Adafruit and mess with the remote-control features and create false data and cause problems for the company when they are analysing it and could possibly lock out the company and change the passwords, so that the company can't get in and collect the data readings from the system.
- **Viruses:** Viruses are another problem; these could delete and corrupt files and also steal any information that they find. The only way a virus could get onto the system is via manual installation or through a file they download and put onto the pi if the company is installing a system update and get a fake file without knowing and give the virus access to the system and all its contents.
- **Natural disasters:** A natural disaster like flooding or an earthquake could also be a problem for the system and corrupting the information on it unless they have a backup of the systems contents or have access to Adafruit to obtain the data that the system had been recording and collecting.

Physical Security

Physical security is a good thing to have when it comes to securing systems or important equipment. Some physical security that can be used to protect this system include:

- **CCTV:** CCTV would be a good option for security because if the system is in a hallway and there is CCTV, if the system got exposed to some deadly software through manual installation. Then the CCTV camera would be able to see who the culprit was and can then take further actions.
- **Locks:** If the system was to be in a specific room, having locks on the doors that gain access to that room would be another really good idea because it further prevents people from having 100% access to the system and doing something to it.
- **Access Control:** Access controls such as regularly changing the password to the Adafruit dashboard every week and making sure that only the correct personnel have access to the remote access option and also provides further protection to the data and information been collected and generated by the system and stored on Adafruit.

Remote into the system

When it comes to remote access, the company will be able to access the system and control it remotely through Adafruit. Features that Adafruit provide in supporting remote access include: Dashboards to create buttons for the raspberry pi of which they can code and use to remotely carry out functions of the raspberry pi Pico.

Phase 2. Prototype cycle – Build, Demonstrate, Refine

When it came to building, demonstrating and refining the prototype. I used different modules to connect components and other pieces of hardware to the raspberry pi Pico. Here are some images of the coding for the prototype.

```
#------------------------------------------------
#  load the required modules into the project
#------------------------------------------------
import os
import time
import board
import digitalio
from monochromeDisplay import grove_display

display = grove_display.BitmapDisplay(1)
#import microcontroller # to read core temperature
from piBuzzer import buzzerOut
piezoBuzzer = buzzerOut.Buzzer()

from adafruit_debouncer import Debouncer

relay = digitalio.DigitalInOut(board.GP7)
relay.direction = digitalio.Direction.OUTPUT
from wifi.secrets import secrets # to access AdaFruit account
from DHT_Module import DHT11_Module
from mqtt import mqtt # to access mqtt publish/subscribe processes
from neoPixel_device import board_neoPixel
neoPixel = board_neoPixel.neoPixel()
#------------------------------------------------
# Create connect to the wifi access point
#------------------------------------------------
from wifi import wifiConnectClass
myWiFi_Obj  = wifiConnectClass.WiFi()
wifiLinks = myWiFi_Obj.connectToWiFi()

tempUnit = DHT11_Module.TempHumid(5)
#------------------------------------------------
# Use WiFi links to open an MQTT link
#------------------------------------------------
subscriptions = ["/feeds/onoff","/feeds/quit", "/feeds/Relay"]
mqtt_Obj  = mqtt.Mqtt(wifiLinks[1], wifiLinks[0], secrets, subscriptions)
#------------------------------------------------
```

Figure9: Modules and connectors

In this figure, the code displays the actions of importing the required modules for hardware and other features such as time and the raspberry pi board itself. It also shows the code that enable the

grove connectors on the board to connect to the associated hardware; Such as the relay and temperature sensor. It finally involves the connections between the feeds on Adafruit which I used to send and receive data between the internet and the device.

Next is the portion of code that establishes the Adafruit account that the raspberry pi is to connect to and the functions of connecting with the buttons on the dashboard of Adafruit and the actions that are to take place if a specific button is pressed and the controls for the relay that acts as turning on an air conditioning unit to control the temperature of the environment that it is monitoring. You can find the code used and the dashboard layout below:

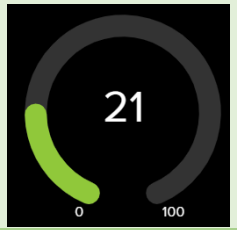
```
publisherLink = secrets["aio_username"] + "/feeds/coreTemperature"
#--------------------------------------------
run = True    # Controls the while loop -> False end the loop
pause = False
# Prevents publishing of the temperature
#--------------------------------------------
#  Loop to continually send MQTT messages
#--------------------------------------------
while run:
    result = mqtt_Obj.checkForUpdates() # Run the callback message if it receives data.
    # React to any new message received
    if(result != None):
        if(result[1] == "Pause"):
            pause = True
            display.closeDisplay()
            print("Paused")
        if(result[1] == "Run"):
            pause = False
            display = grove_display.BitmapDisplay(1)
        if(result[1] == "Stop"):
            run = False
            neoPixel.off()
        if(result[1] == "On"):
            neoPixel.setRed()
            relay.value = 1
        #show relay position (although you should see its led!)
            output = "relay on"
            print(output)
        if(result[1] == "Off"):
            neoPixel.off()
            output = "relay off"
            relay.value = 0
            print(output)
        # The publish script
    elif(not pause):
        temperature = tempUnit.getTemperature()
        print("Sending temperature: "  + str(temperature ))
```

Figure10: Connections and functions between Adafruit and the Pico

Figure11: Dashboard Layout with buttons to communicate with the raspberry pi Pico

Phase 3. Testing

Next are my test plans that were required as part of the RAD methodology after the Rapid Prototype Cycle. You can find my test plan down below:

Test No.	Testing	Expected Outcome	Actual Outcome	Works – Y/N	Solution if not working
1	That the pi connects to the internet	That it returns my request	It did as expected	Y	N/A
2	That the pi can connect to adafruit	That it displays a connection message	It displayed a message stating that it has connected to adafruit	Y	N/A
3	That the pi can grab and send the temperature to adafruit	That it prints "sending the temperature: temp" and shows a sent message	It did as expected and found the reading on adafruit	Y - 	N/A
4	That the pi activates the LED and buzzer if the temperature hits a certain mark	That the LED switches between blue and red and the buzzer gives off a simple sound to act as the alarm	It did as expected displaying red and blue lights and provides a sound as the alarm	Y	N/A
5	That the pi displays the temperature on the OLED	That it displays and updates the temperature on the OLED display	It did as expected	Y	N/A
6	Pause button on adafruit	The button when clicked should display a message on the terminal saying it is paused and should stop gathering temperature and close the display	It did as fully expected	Y	N/A
7	Run button on adafruit	Should go back to	It did as expected	Y	N/A

		reading and sending the temperature and turn the OLED back on to display the temperatures			
8	Relay button on adafruit	The switch should activate a red LED on the board and turn on the relay	It didn't turn on the really but could operate the LED just fine, I am not too sure what the problem is	N	A possible solution would be to make it manual but wouldn't fully meet the requirement of it being remotely controlled on adafruit.

Phase 4. Review and optimisation of the prototype

Next was the refinement of the prototype which involved getting reviews from possible end-users and optimising and re-testing the prototype. You can find all of it below:

Reviewer	Feedback Given
Dan	The design is simple and easy, and has nearly everything as required for the company, but I would add the relay to act like controlling other systems
Alex	The design is good and shows where everything is and what is being used and also shows that the pi will connect to Adafruit wirelessly.

Figure12: Reviews from the possible end-users

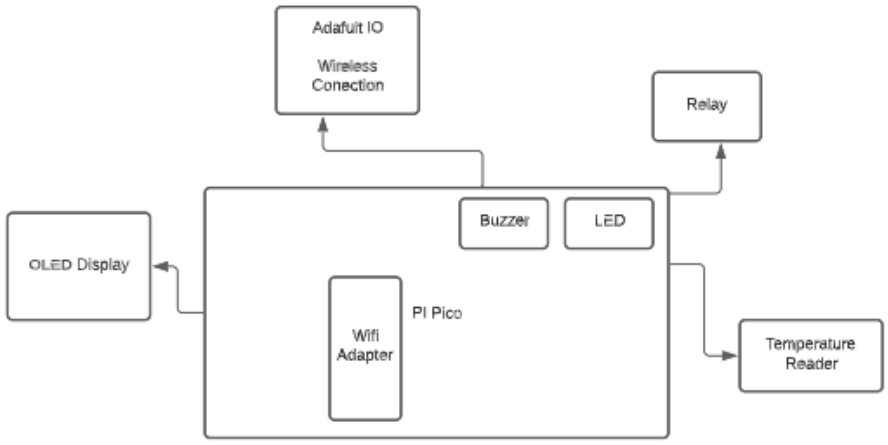
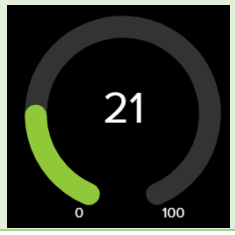


Figure13: Optimisation/refinement of the prototype based off of given feedback.

Regression test plan

Test No.	Testing	Expected Outcome	Actual Outcome	Works – Y/N	Solution if not working
1	That the pi connects to the internet	That it returns my request	It did as expected	Y	N/A
2	That the pi can connect to adafruit	That it displays a connection message	It displayed a message stating that it has connected to adafruit	Y	N/A
3	That the pi can grab and send the temperature to adafruit	That it prints "sending the temperature: temp" and shows a sent message	It did as expected and found the reading on adafruit	Y - 	N/A
4	That the pi activates the LED and buzzer if the temperature hits a certain mark	That the LED switches between blue and red and the buzzer gives off a simple sound to act as the alarm	It did as expected displaying red and blue lights and provides a sound as the alarm	Y	N/A
5	That the pi displays the temperature on the OLED	That it displays and updates the temperature on the OLED display	It did as expected	Y	N/A
6	Pause button on adafruit	The button when clicked should display a message on the terminal saying it is paused and should stop gathering temperature and close the display	It did as fully expected	Y	N/A
7	Run button on adafruit	Should go back to reading and	It did as expected	Y	N/A

		sending the temperature and turn the OLED back on to display the temperatures			
8	Relay button on adafruit	The switch should activate a red LED on the board and turn on the relay	The relay turned on, as well as the LED to act as if controlling an environment controlling system	Y	The solution made was to remove the toggle variabls and just state its on and off state using "relay.value = 1" and removing the "relay = True" statement because it made a value determination error.

Figure14: Regression testing after changes to the prototype were made

Phase 5: Implementation

This phase was implementing the system and making a final check to if it meets the clients requirements. The evidence can be found below:

The requirements are as followed:

- Detect temperature changes: MET
- Provide them to the user in real-time and in data sets: MET
- Offer remote monitoring and management: MET
- Control environment control systems to ensure the environment is stable: MET

As you can see from the check list, all the client requirements were met and the prototype was ready to be sent to the end-user.

Final production of actual progress on Gantt chart

Here is the final Gantt chart that covers and shows the actual progress made throughout this project. Click here the link to view: Final Gantt Chart of progress

Reflecting on the success of personal performance and the project outcome

Relevant Behaviours applied during the project and how effective they were

One behaviour that I applied during the project and that was effective was a contingency plan. By having a contingency plan, I was able to provide myself with an extra two weeks of free time by

planning the project to be completed with two weeks free but still keeping a normal production rate with the project. It came in super effective when I had missed out a week due to being ill and due to having those two extra weeks, I was able to complete the jobs required before the initial project deadline. However, due to this project being an individual project; in the events of someone being off in a group project; I would have used the procedure of using a content writer as explained in (Develop plans and procedures to utilise resources in specific events). This would then therefore reduce the risk of delaying the project due to staff being off ill. Meaning that the project would have still kept going and running on time.

Another behaviour that was applied to the project was problem-solving. This project management behaviour came to be effective when applied to the project because problem solving was used during the development and production of the prototype. Aspects such as solving errors that occurred came in even more effective through the use of my test plans because if the same type of error occurred after making a modification, I could go back to my test plan and find out how to solve it even faster.

How were project management skills used in the management of the project

What project management skills were applied and how effective were they? One of the behaviours that were applied to the project was time management and I can say that my planning for the project was most great because when it came to doing the allocated jobs within the project on the set week, targets were met on the corresponding week. This therefore meant that overall progress of the project was on time and set to meet the project deadline.

Another behaviour that was applied during the project was communication because meetings were made and documented to get the opinions and recommendations from the supervisor of the business. This was quite effective within the project because it gave me the insight of what the client was happy with and what they think needed adding to the project. Meeting were documented and applied to the project to meet the requirements of the client and provide customer satisfaction.

Another behaviour that was utilised in the project was risk management because areas of the project involved risk assessment and management along with the risk analysis and control of risks within the contingency plan. By applying this behaviour, I was able to go through the project with minimum risks and impacts that could have occurred on the process of the project.

Improvements I would have made to the behaviours and skills used in the project

What improvements would I have made to the behaviours and skills used in the project? Overall, I am happy with the way the whole project was ran and how the project was finished by the deadline and met all the client requirements. There are a couple of things I would have possibly altered in how they were done and one of those things would be my Gantt chart. I am happy that I planned it out weekly but I would have liked to of put the jobs into specific sections, so I can track specifically the areas of the project such as the design phase and the production phase because I did eventually struggle to follow the initial Gantt chart that I had created but was too far into the project to re-make and re-organise the Gantt chart because that could have led to taking up time and possibly causing delays but I managed to follow the plan and got the project in on time.