# PetWatch Project Closeout

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# Design Impact Statement

**1.0 Introduction**

The PetWatch product was created in order to address and mitigate the concerns of pet owners. When a pet is injured or has limited movement due to varying reasons such as surgery, the pet owner may be in emotional distress trying to watch over the pet constantly. This can impact their daily lives. With PetWatch, the device tracks the movement of the pet and transmits this information to a software application on a phone. The user will be notified of any movement above a certain threshold and they can then access a real-time graph of their pet's movement. This report will focus primarily on the assessment of PetWatch's design impact ranging from public health, cultural, environmental, economic and other miscellaneous impacts. The purpose of this report is to acknowledge inclusive design principles and ethical design techniques. The targeted audience for this report is the author's team, project partner, and instructors. Indirectly, this report can be referenced by other future project teams as well.

**2.0 Public Health, Safety, and Welfare Impacts**

There is a growing concern with humans becoming addicted to their smartphones due to social media or game apps. Some apps have been designed to deliberately attract your attention [1]. Apps have a common goal of reeling someone in and holding one's attention for as long as they can. For example, the Instagram app sends dozens of push notifications each week or user's stories to attract one's attention [1]. By simply sending out weekly push notifications, this can double user retention on iOS devices and have a 6-fold increase on Android devices [1]. Other apps such as Twitter and Facebook use a swipe function in order to load more content, which is also utilized in slot machines.

Overall, apps nowadays are designed to reel the user in and to keep them there for as long as possible. The app that the author created is very mellow and does not employ any of these tactics to get the user to stay. After several uses of the app, the user is able to familiarize themselves with the app and is user-friendly. By logging into the app and pressing "View Pet Movement," the user is brought to a graph which displays the pet's movement over time. The design is user friendly to first-time users and has no intrigue for them to continue to stay on that page more than for what they came for, which is to check on their pet's movement. A notification will only be sent out to notify the user that their pet is moving and will not send any other notifications. This would defeat the purpose of the app if there were any other notifications sent rather than those notifying that their pet is moving and that the owner needs to check on their pet. The highest priority of this app is to keep the pet safe and limited in movement.

**3.0 Cultural and Social Impacts**

The app could have been designed to replicate a social media app where users can see other users' pets movements. For example, User A can tap onto User B's profile in the app to see User B's pet's status (such as sad, hurt, happy, etc). Again, this defeats the purpose of the app and the app was not created in the manner to replicate a social media app. This can, in a sense, replace face-to-face communication when interacting with users on the app about their sick or injured pets [3]. While it is important to stay connected when possible, this app is only meant to be utilized during a recovery period of a pet or when their pet is limited to movement. This app was not created to deter users from face-to-face contact.

This device, much like an Owlet, was made to ensure that our loved ones are safe. If the device fails to succeed in notifying the user that their pet is moving and could possibly lead to more injuries that could be fatal, that would ultimately be the creators of PetWatch's fault. Social media is a very powerful tool to speak one's opinion and a bad review can cause outrage against a company. With this, PetWatch should not guarantee that the pet will be 100% safe but rather do its best to help the owner to keep an eye on their pet when they cannot.

**4.0 Environmental Impacts**

The smartphone seems to be the new social class indicator in today's world. To have the newest smartphone can indicate that someone comes from a higher-income background than those that have an older smartphone even if the older smartphone is a previous generation or two. Each smartphone has a life cycle, which includes production, usage and end-of-life disposal and recycling [3]. Throughout the life cycle of a smartphone, it has an environmental impact, including greenhouse gas emissions, waste, and natural resource depletion. The environmental impact of each smartphone is low compared to other electronics, their total impact could be very concerning due to the total number of smartphone users worldwide [3]. By creating a smartphone app, this is indirectly promoting smartphone usage since a way to access their pet's information is through an app. Some companies outright promote buying new phones rather than fixing current phones as their prices to fix the current phone can sometimes be as high as getting a new phone. While larger companies have recycling programs, this does not stop the social trend of "new is always better."

Not only does the app contribute indirectly to the waste of smartphones, the external device itself can contribute to the overall electronic device waste as well. Currently, since it is in a small state of production, the waste is more minimal than its counterparts such as phones, TVs, laptops, etc. The U.S. EPA estimates that 40 percent of lead and 70 percent of other toxics found there come from electronic waste even though it is a smaller fraction than other wastes [4]. To combat this, the PetWatch team can recommend places to recycle the device if the buyer no longer has a use for it, or promote buyers to mail back their external devices to recycle them.

**5.0 Economic Factors**

The creation of the app did not cost a cent, however, the concern that the author has is the ongoing support of the app. The user has no idea who will upkeep the app. Some ideas currently in play are that the author can generate minimal ads on the app to generate income to support the app, charge a fixed rate for the app, charge a monthly fee for the app or include the charge for the app in the overall product. With further research, the author found out that publishing an app for the public to download requires money, which would be $25 as a one-time fee for Google Play [5]. In addition, the pricing can be permanent such as setting the app to be free of cost. This cannot be changed once it has been published, but paid apps can be adjusted in price [5].

The author is hesitant to place an advertisement in the app as this can cause the app to be non-user friendly and defeats the purpose of the app. More research on what the product should be valued at altogether and the team's consensus will be needed in order to figure out which will be the most effective and ethical way to sustain the app overtime.

**7.0 Conclusion**

Mobile apps have a huge impact on users as can be seen by social media apps. By being mindful of how the software design impacts society as a whole allows the author to make any necessary adjustments to the app to be user-friendly and to not add onto the addictive algorithms that apps already use. The simplicity of the app allows the user to control their time on-screen and off-screen, which can allow them to actually spend time with their pet, control their daily lives and to be at ease emotionally while a device watches over their pet when they are away on errands.

# References


[1] A. Hartmans, “These are the sneaky ways apps like Instagram, Facebook, Tinder lure you in and get you 'addicted',” Business Insider, 17-Feb-2018. [Online]. Available: https://www.businessinsider.com/how-app-developers-keep-us-addicted-to-our-smartpho nes-2018-1. [Accessed: 16-Apr-2021].

[2] S. Allen, “Social media's growing impact on our lives,” American Psychological Association, 20-Sep-2019. [Online]. Available: https://www.apa.org/members/content/social-media-research. [Accessed: 16-Apr-2021].

[3] G. B. Choi, H. H. Lee, S. A. Oh, M. Kwak, S. Kim, and S. Lee, “(PDF) Effect of mobile apps on environmental impact of smartphones,” ResearchGate, Feb-2018. [Online]. Available: https://www.researchgate.net/publication/323111576_Effect_of_mobile_apps_on_enviro nmental_impact_of_smartphones. [Accessed: 16-Apr-2021].

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[5] “Publishing your first app in the Play Store: what you need to know,” Android Authority, 18-Dec-2020. [Online]. Available: https://www.androidauthority.com/publishing-first-app-play-store-need-know-383572/. [Accessed: 16-Apr-2021].

# Project Timeline

## ECE 441: PET MONITOR PROJECT

| | |
|---|---|
| TEAM MEMBERS | Zavi Kaul, Ricky Heidrick, Walter Agra Neto, Shayla Tran, Quinn Campfield |
| GROUP AVAILABILITIES | (Fall Term) Tuesdays 6-8pm, (Winter Term) Thursdays 5-6pm, (Spring Term) Wednesdays 5-6pm |
| PROJECT PARTNER | Ingrid Scheel |

| TASK TITLE | TASK OWNER | DUE DATE | TASK COMPLETE? | TURNED IN? | PHASE |
|---|---|---|---|---|---|
| **WEEK 1** | | | | | FALL TERM (Planning) |
| - | - | - | - | - | |
| **WEEK 2** | | | | | |
| Introductory Email & Initial Discovery Inquiry | Full Team | 10/8/2020 | ☑ | ☑ | |
| **WEEK 3** | | | | | |
| Team Protocols and Standards Document | Full Team | 10/15/2020 | ☑ | ☑ | |
| Biweekly Progress Videos | Software Team | 10/15/2020 | ☑ | ☑ | |
| Executive Project Summary | Full Team | 10/15/2020 | ☑ | ☑ | |
| Engineering Requirements Draft | Full Team | 10/15/2020 | ☑ | ☑ | |
| **WEEK 4** | | | | | |
| Biweekly Progress Videos | Software Team | 10/22/2020 | ☑ | ☑ | |
| Project Partner Update | Full Team | 10/22/2020 | ☑ | ☑ | |
| **WEEK 5** | | | | | |
| - | - | - | - | - | |
| **WEEK 6** | | | | | |
| Scope and Requirements Meeting | Full Team | 11/5/2020 | ☑ | ☑ | |
| Team Communication Evaluation | Individual | 11/5/2020 | ☑ | ☑ | |
| Biweekly Progress Videos | Sofware Team | 11/5/2020 | ☑ | ☑ | |
| Block Diagram Draft | Full Team | 11/5/2020 | ☑ | ☑ | |
| **WEEK 7** | | | | | |
| Project Charter Assignment | Full Team | 11/12/2020 | ☑ | ☑ | |
| Project Partner Update | Full Team | 11/12/2020 | ☑ | ☑ | |
| Instructor System Architecture Meeting | Full Team | 11/12/2020 | ☑ | ☑ | |
| **WEEK 8** | | | | | |
| Biweekly Progress Videos | Software Team | 11/19/2020 | ☑ | ☑ | |
| Teamwork Reflection Paper | Individual | 11/19/2020 | ☑ | ☑ | |
| **WEEK 9** | | | | | |
| Engineering Requirements | Full Team | 11/26/2020 | ☑ | ☑ | |
| Block Diagram | Full Team | 11/26/2020 | ☑ | ☑ | |
| **WEEK 10 (Dead Week, woohoo!)** | | | | | |
| Biweekly Progress Videos | Software Team | 12/3/2020 | ☑ | ☑ | |
| Block Validation | Individual | 12/3/2020 | ☑ | ☑ | |
| Project Partner Update | Full Team | 12/3/2020 | ☑ | ☑ | |

| | | | | | |
|---|---|---|---|---|---|
| **WEEK 11** | | | | | |
| - | - | - | ☐ | ☐ | |
| **WEEK 12** | | | | | |
| First Technical Cohort Collaboration | Individual | 1/15/2021 | ☑ | ☑ | |
| Project Database Update | Full Team | 1/15/2021 | ☑ | ☑ | |
| **WEEK 13** | | | | | |
| First Block Validation | Individual | 1/22/2021 | ☑ | ☑ | |
| Login features, User Interface completed | Software Team | 1/22/2021 | ☑ | ☑ | |
| Research Implication Report (complete draft due) | Individual | | ☑ | ☑ | |
| Initial PCB design sent to FAB | Hardware Team | 1/22/2021 | ☑ | ☑ | |
| **WEEK 14** | | | | | |
| First Block Check-Off | Individual | 1/29/2021 | ☑ | ☑ | |
| Research Implication Report (peer review due) | Individual | 1/29/2021 | ☑ | ☑ | |
| **WEEK 15** | | | | | |
| Calibration, Data Analysis, User settings all functic | Software Team | 2/5/2021 | ☑ | ☑ | **WINTER TERM (Implementing)** |
| Second Technical Cohort Collaboration | Individual | 2/5/2021 | ☑ | ☑ | |
| **WEEK 16** | | | | | |
| Second Block Validation | Individual | 2/12/2021 | ☑ | ☑ | |
| Testing initial PCB completed | Hardware Team | 2/12/2021 | ☑ | ☑ | |
| **WEEK 17** | | | | | |
| Final PCB design sent to FAB | Hardware Team | 2/19/2021 | ☑ | ☑ | |
| Second Block Check-Off | Individual | 2/19/2021 | ☑ | ☑ | |
| **WEEK 18** | | | | | |
| Third Block Validation | Individual | 2/26/2021 | ☑ | ☑ | |
| **WEEK 19** | | | | | |
| RIR Final Draft | Individual | 3/5/2021 | ☑ | ☑ | |
| PCB Assembly | Hardware Team | 3/5/2021 | ☑ | ☑ | |
| **WEEK 20** | | | | | |
| Third Block Check-Off | Individual | 3/12/2021 | ☑ | ☑ | |
| **WEEK 21** | | | | | |
| Send PCBs out to all team members | Hardware Team | 4/2/2021 | ☑ | ☑ | |
| **WEEK 22** | | | | | |
| Elevator Speech Assignment | Individual | 4/9/2021 | ☑ | ☑ | |
| **WEEK 23** | | | | | |
| Design Impact Assessment | Individual | 4/16/2021 | ☑ | ☑ | |
| **WEEK 24** | | | | | |
| Initial System Checkoff | Full Team | 4/23/2021 | ☑ | ☑ | |
| **WEEK 25** | | | | | |
| Complete draft of Project Closeout | Full Team | 4/30/2021 | ☑ | ☑ | |
| **WEEK 26** | | | | | **SPRING TERM (Documenting)** |
| - | - | - | ☑ | ☑ | |
| **WEEK 27** | | | | | |
| Final System Checkoff | Full Team | 5/14/2021 | ☑ | ☑ | |
| **WEEK 28** | | | | | |
| Project Closeout | Full Team | 5/21/2021 | ☐ | ☐ | |
| Project Showcase Assignment | Full Team | 5/21/2021 | ☐ | ☐ | |
| **WEEK 29** | | | | | |
| Project Voting (Extra Credit) | Individual | 5/28/2021 | ☐ | ☐ | |
| **WEEK 30** | | | | | |
| - | - | - | ☐ | ☐ | |

# Scope and Engineering Requirements Summary

The scope of this project will include a pet wearable, an android app, and a website, all of which will be implemented to fulfill the following eight engineering requirements:

1. **Motion tracking** - The system will sense the variation in motion of an object and transmit the data for processing.
2. **App for Wearable Device** - The system will display the past 24 hours of movement data in app on a mobile device.
3. **Website for Device** - The system will utilize a website for the user to access their pet's data. 9/10 users are able to navigate the website in order to display their pet's data for a specific date in under 1 minute once logged onto the website.
4. **Calibration** - System is reported to be easily recalibrated" by 9 out of 10 users."
5. **Rechargeability** - The wearable will be rechargeable without removing the battery and will have a battery life of at least 12 hours.
6. **Transfer of Data** - The system will report current pet wearable sub-system data within 30 seconds of real time.
7. **Animal Wearability** - The system will weigh less than 4 ounces and will be fastened onto an animal in under 1 minute through a strap.
8. **Real-time Data Graphing** - The system will display a graph of acceleration vs time which will update in real-time as data is collected.

# Risk Register

| ID: | Description: | Category: | Probability: | Impact: | Performance Indicator: | Responsibility of: | Plan: |
|---|---|---|---|---|---|---|---|
| R1 | Part shipments delayed | External, supply chain | 30% | H | Manufacturers have a disruption in manufacturing | Ricky | Retain, keep tabs on tracking informatio n for any orders placed |
| R2 | Team | Internal, | 20% | L | Differing | Zavi | Reduce, |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | members come unprepared to meetings | Interpers-onal | | | schedules, differing expectations | | keep open communic ation if falling behind |
| R3 | Hardware doesn't build together due to long distance team | Program managem-ent, planning, execution | 10% | H | Team cannot meet to ensure compatibility | Ricky, Walter | Reduce, all hardware will be gone over by multiple people to ensure compatibil ity |
| R4 | Use of tools, methods, and technologies where the developer has no previous experience (such as coding languages or hardware). | Technical | 25% | L | Invest a good amount of time researching, studying, and learning the equipment or language needed to code. | Shayla, Quinn | Reach out to other team members or TAs/mento rs for any help. |
| R5 | Team member has unexpected medical/pers onal Emergency | Personal Health & Wellness | 50% | H | Percent of COVID positive test rate for team members areas | Zavi | Keep good communica tion between the team and update each other when things come up. |
| R6 | Customer needs are not clearly specified due to lack of technical knowledge of the customer in | Technical | 10% | M | Compare website or application development to requirements listed from Project Partner. Present drafts or milestones of | Shayla | Communi cate often with project partner and review plans and engineerin g |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | regards to an Android application. | | | | website or application development to ensure that needs of the project are met. | | requirements for project often. |

Summary of most likely risks:

We anticipated that our most likely risks at the beginning of the project would include a team member falling ill, parts shipment delays, and hardware not working together due to distance of designers. Zavi was in charge of making sure all team members were alerted to possible health issues as they arose, Walter and Ricky were in charge of ensuring the final PCB designs were fully functional regardless of who designed the contributing parts, and Ricky was in charge of making sure all team members were aware of possible delays in part shipments as they arise.

Throughout the experience of developing this project our group did run into unforeseen risks and the risks we encountered taught us a few lessons. One risk we failed to take into account is the lack of resources available for utilizing some popular technologies, like with bluetooth. Originally our project was going to implement a human wearable that communicated with the system through bluetooth, but three team members all came to the conclusion individually that the difficulty needed to implement bluetooth would cause the rest of the project to suffer. While this risk is closely tied to R4 it is considered a unique risk in that it taught our group that a lack of experience cannot always be remedied through research. Additionally, our R5 risk made room for personal or medical emergencies, an obvious risk in the middle of a pandemic, but our definition of this risk may have not been broad enough. Through the course of this project our team also learned how taxing current circumstances can be on our collective mental health. While it is difficult to classify when mental fatigue is an emergency it certainly became an obstacle for the members of our team at various times throughout the year. This taught us that we should not only be concerned with the risk of an emergency to our health, but that we should make room for mitigating the effects of regular exhaustion and fatigue.

# Future Recommendations

If given more time with this project we would have liked to increase its scope and capabilities in the following ways:

1. M**ake the hardware user specific**:
   For the functional development of PetWatch there was no need to tie the pet wearable to a specific account; that is, to allow a user to register their specific hardware device with

their user account. If this product were to go to market users would need to be able to register their hardware with their account otherwise multiple pet wearables would not be able to work in parallel in the same database. While this issue should be simple to address in principle, the remote circumstances of project development made it so that our efforts needed to be focused on basic functionality of a singular device.

**Recommendation:**

A good starting point to remedy this issue would be to send a device ID in each data string along with the epoch time and the magnitude of the acceleration. The next step would be to develop a way for each pet wearable to generate a unique ID when paired with a user account.

2. **Firebase Interface is Laggy:**

   Currently the Firebase database crashes browsers occasionally and it is believed to be related to how big the Data object is in the main user. For the total amount firebase gives us to store we are not even close to being full but the amount of small items seems to have an impact.

   **Recommendation:**

   One possible way to solve this could be sorting the data inside Firebase and dividing the data based on date so one object isn't extremely large and instead spread through smaller objects. Oddly, the website and app both are able to handle getting and using this amount of data without issue, but the actual Firebase interface/website is struggling to show the data. Another solution would be storing data in a different database either another firebase database or a different database altogether.

3. **Create a human wearable to accompany the system:**

   Having a human wearable would allow the app to communicate with the user by sending a vibration or a sound to notify the user that their pet is moving. This could be connected via bluetooth or wifi to the app.

   **Recommendation:**

   Start by incorporating a bluetooth device into the system, get it to receive notifications from the app, and then make the additional wearable. This will be difficult given the fact that lots of bluetooth technology is heavily IP and not public information. There was not much documentation regarding Bluetooth and the way to work with it was overly complicated. However, if given enough time to work with bluetooth this would increase the overall usability of the system.

4. **Make the graphs more intuitive to the user and project partner:**

   The graph is currently of time versus the raw acceleration value put in the database by the accelerometer and microcontroller. It was difficult to determine how to intuitively read the acceleration values and what kind of graph the project partner desired. This caused it to be not straightforward to the user that the pet is moving or not. There is a notification for the user when the pet is moving above a set threshold which makes understanding the movement graph more clear.

**Recommendation:**

One could try to translate the current values we are calling acceleration (from the accelerometer) into more accurate accelerations for readability and clarity.

5. **Make calibration more accurate:**
   Currently it takes data from the past minute from the database and gets the highest value and sets a threshold value 300 units above that value. As of now if the pet's acceleration goes over this threshold is when the user gets notified.
   **Recommendation:**
   Calibration could be more complex and then more effective. A pet's size and weight could be something to consider in calibration to effectively get a better threshold value. Or threshold values for the type of movement if a machine learning aspect is also included. Additionally, the microcontroller is transmitting from the pets device every 30 seconds, possibly having higher frequency data sent during a calibration period would be useful.
6. **Implement machine learning algorithms:**
   This would allow classification of a pets movement (such as sitting, walking, laying down, etc.). This would allow the device to not send out “false positives” saying that the pet is in motion. Use this, along with calibration of the device, to determine the acceptable accelerations for each type of movement given the pet’s injury.
   **Recommendation:**
   An initial thing to consider and work into the program would be the location of the injury and the pets weight and size. Machine Learning would be much more complex to build into the system but the positive effects it would have could be very beneficial. As an example this would allow an acceptable range to be set for walking or light running for a pet but the user could be immediately notified if the pet jumps no matter the speed.
7. **Improvements to the wearable attachment:**
   One possible problem with this product as we have it is how the wearable attaches to the pet. Currently, the casing for the wearable has slits that a strap, such as an ace bandage, can go through and then wrap around the pet’s extremity. This is not the ideal solution though because if the bandage is too tight it could hurt the already injured pet, and if the bandage is too loose the data we collect becomes less meaningful.
   **Recommendation:**
   Ideally testing multiple different ways of attaching the wearable to a pet against each other. Comparing the current strap method to a clip or hook possibly through multiple clips/hooks or a velcro strap.
8. **Choosing the right battery:**
   The largest constraint we have on the size of the device is the battery within it. The best way for us to minimize the size of the battery is to reduce the power consumption of the device so that a smaller battery can be used.
   **Recommendation:**

Some ways to reduce the power consumption of the device would be to use bluetooth instead of wifi for the pet wearable device. This was decided against because the pet wearable would then need to be hooked up to a bluetooth device in order to transmit data to the database, but it would significantly reduce the overall power consumption of the device. The power consumption could also be reduced by using Arduino libraries for the ESP8266 that consume less power, or by transmitting the data less often. None of these solutions seem to be ideal given the current usage of the device but reducing the battery consumption would be the main way to make the device smaller.

9. **More research for choosing hardware:**
   One unnecessary aspect of our device is the use of both an accelerometer and gyroscope. Since our main data collection is worrying about the acceleration of movement, we are less concerned with the gyroscope data, however the device is always sending data concerning the three extra axes for the gyroscope that are not being used.
   **Recommendation:**
   In the future, we would most likely choose a module that is dedicated to the specific task of an accelerometer, rather than choosing an all-round device with multiple capabilities that won't all be used. For example, the MMA 8451 is an accelerometer with only three axes dedicated for the accelerometer only, rather than the MPU 6050 that we used which has a total of 9 axes. It didn't have any negative effects on the final product but it is good to keep in mind that there are hardware devices that have specific capabilities and choosing generic ones with multiple purposes could lead to having more hardware and power consumption than desired.