## 4.0 Results and Discussions

In regards to the software, our project worked perfectly given that our code worked as it needed to. Both in terms of the backend connectivity with server and frontend interaction with the user. The user was able to interact with the database through the application and their play data was stored for future analysis. Our prototype regarding the hardware is incomplete as unforeseen circumstances prevented us from getting the required components from Humber College to fully build the machine. The group managed to learn quite a bit throughout the process of working on the group project. Firstly, the group was able to learn to combine all the pertinent hard skills, such as programming and circuit building, in a more concrete and visibly useful manner. The group learned how to collaborate and communicate effectively with one another, in terms of delegating and organizing tasks, in terms of when to get each done, and how long each task would take in accordance with what the professors outlined in the course schedule. The need to communicate effectively became even more useful after the campus closed as there was a necessity to keep one another informed on each other's progress verbally and visually through various programs, as we no longer had the privilege of working together in person. The group was able to organize and update all pertinent information through Trello, and Github, which served a similar purpose, but was useful in keeping the professor informed of our progress as well as keeping a centralized version control of all the documentation, PCB designs, mechanical designs and source code for both the app and the machine. We also had the privilege throughout the year of collaborating with an industry professional, Sebastien Dwornik. We managed to communicate with him regularly through a messaging program, Slack, in addition to regular video

conferences to discuss our progress with him. This allowed him to make recommendations or suggest new ideas to help our project develop in a more efficient manner, providing us a more nuanced perspective in working in a professional work environment and improving our communication skills even further. In terms of developing the actual project, we were able to use various programs such as Fritzing and Android Studio that managed to expand upon various concepts that we learned about from previous semesters. Fritzing gave us a more convenient way to develop and rework our circuits based on schematic criteria using one or more essential sensors or motors. It also helped immensely with developing Printed Circuit Boards (PCB's), as we went from just connecting wires according to circuit design to designing, building and testing one ourselves. During the project, we had to work concurrently between creating the code for our sensors and motors and creating the code for our application. In order to develop the code for the sensors and motors, it was required that we had to learn basic Python, enforcing the need to keep our minds adaptable and flexible to be willing to learn new skills as the project went along. We were also able to expand our knowledge in working with databases as we had to implement databases with different programs such as Cloud Firestore, in addition to implementing the necessary code in our Android Studio application code. In order to develop our application, we used Android Studio, and the Firebase tool supported by it that easily helped us connect to our Firebase Databases. I felt that the project was an overall success, barring a few setbacks that occurred from unforeseen circumstances.

## 5.0 Conclusions

The project was started with the idea of mass producing the prototype in mind. It was designed this way because of the problem specified for the project to be solved was, making a cheaper and competitive machine and bring it to market. The prototype was built using the basic components, but was run using advanced and refined methods in respect of the machines available in the market. The advanced methods like using a mobile application to control the machine, storing user data in Firebase database to keep track of progress, and running the machine on a Broadcom platform like the Raspberry Pi that has higher capabilities in term of memory and processing speed that are levels higher than simple built PLC chips. These methods were implemented so that it can accomplish the mark of competitive gameplay, instead of just randomly throwing balls at the user.

Hence, all the materials used are easily available and can be produced like in a production line, creating thousands of the different parts separately and assembling them and packaging them to make a marketable product.

For the goal of keeping the product cheap, the product needed to be based on limited number of components, but we believe that every product needs to be upgraded after some time. So, for further progress of the machine, we could still keep improving the application like, analyzing player history and display the growth in forms of charts and tables. We could also keep improving the firmware, which can be updated remotely on already sold machines. The improvements to the machine could entail more complexity in the process of setting up and launching the ball by adding more spin and lob shots.

Therefore, like all the innovations in history we need to keep improving on this idea and we may end up creating a device that leads to inspiration for some engineer in the future generation.

Prescreening Checklist

1. Has a Proposal for a Technology Report been submitted and accepted and a copy of the approved proposal included in the Technology Report?
   **Yes**
2. Has the Technology Report been submitted within one year since the proposal was approved?
   **Yes**
3. Is the Technology Report consistent with the Proposal (as approved and with the comments and suggestions made by the proposal reviewer)?
   **Yes**
4. Is the Technology Report typed, double-spaced and justified left?
   **Yes**
5. Has a 12 point Arial, Univers, or similar Sans Serif font been used?
   **Yes**
6. Is the body of the report a minimum of 3,000 words?
   **Yes**
7. Are the components included and in the following order: Title Page; Declaration of Authorship; Approved Proposal; Abstract/Executive Summary; Table of Contents; Lists of Illustrations/Diagrams; Body of the TR; Conclusion(s), and if applicable Recommendation(s); Bibliography/Technical References; and Appendices?
   **Yes**
8. Is there a signed Declaration of Authorship?
   **The declaration of authorship is not signed.**
9. Is the report dated?
   **Yes, it is dated to 14 January, 2020**
10. Is the Technology Report current? (The Technology Report should be less than 5 years old.)
    **Yes**
11. Is there a Title Page?
    **Yes**
12. Is there a Table of Contents?
    **Yes**
13. Does the Table of Contents correctly reflect the Components: Headings, Illustrations/Diagrams and Appendices?
    **Yes**
14. Are the pages numbered with appropriate page breaks?
    **Yes**
15. Is there an Abstract/Executive Summary and Introduction?
    **Yes**
16. Does the body of the report contain Section Headings?
    **Yes**
17. Are there Conclusion(s), and if applicable, Recommendation(s)?
    **Yes**
18. Is there a Bibliography with appropriately cited Technical References?

**Yes**

Report Mechanics and Structure Checklist

This section evaluates the structure, formatting and writing techniques used in the TR. Fulfillment of this criteria leads to a TR that looks professional, is easy to read and is representative of the formatting standards of the industry.

1. Does the Title, in ten words or less, inform readers of the precise subject matter contained in the TR? A title should be concise and include key words for indexing.
   **Yes, Smart Ping Pong Machine.**
2. Does the Abstract or Executive Summary provide a brief overview of the report in approximately 75 to 100 words?
   **The Executive Summary is 177 words**.
3. Does the Abstract or Executive Summary summarize the Conclusion(s), and if applicable, the Recommendation(s)?
   **The Executive Summary contains the recommendations for how to bring the finished product to market and concludes with some ideas to discover for the machine to after the prototype discussed in the report is completed.**
4. Does the Introduction state the reason the work was undertaken? What is the industry, organization or context? What is the problem?
   **Yes, it talks about the group members who contributed to this project, under the mentorship of Sebastian Dwornik. The introduction also mentions the idea behind the machine to solve a problem of high cost and lack of features in the products in the sports market currently.**
5. Does the Introduction cover the scope of the report? What is included and /or admitted, and what procedures are used?
   **The Introduction specifies the scope of the project in terms of features that are to presented for the machine and the mobile application associated with the machine. It talks about the methods we used to work on the project ranging from softwares we used for research and working on the app to tools used to create the hardware for the machine.**
6. Do the headings and subheadings in the Body adequately and accurately describe the section or subsection content?
   **Yes, each heading and sub-heading is there for all the small considerations to made for the various features and components of the project.**
7. Does the Body include information regarding the methodology? Does it indicate materials, equipment and procedures used and why they were selected over alternatives? Is there sufficient detail so that that the methodology can be duplicated by others?
   **The body of the TR contains information on the steps to re-create the project including the materials used for each step. For some cases, it**

**also has some key pointer to look after like some hints that are not obvious and could take up lot of time if missed, but also quicken the progress of reproduction if taken care of. The body also specifies details on how to sufficiently create and test the product when mass-producing it. The firmware code for the machine and the hardware are also present in the appendices.**

8. Does the Body include recent research findings?
   **Yes, the research is in regards to the motion of the throw to get ideas for what features to create for the machine and how to create them. The research was also in regards to previous products to highlight the shortcoming of the original products in the market.**
9. Does the Body include results/data from the study?
   **The idea and the mechanics for the launcher for the machine is based on a study that is referenced in the report. The study is about factors involving the ball across a distance and adding factors to it, like spins and lobs with respect to the number wheels used and the size and weight of the ball thrown.**
10. Are illustrations, tables, diagrams and charts clearly drawn, labelled and numbered?
    **Yes, illustrations of how the mobile application looks and the designs for the electric components for the machine are used in the report.**
11. Is each Conclusion, and if applicable, each Recommendation, stated in a separate paragraph and in a positive way? Conclusions should not be qualified with “it seems”, “probably”, “it may be”, or other words that dilute the strength of the conclusion.
    **Yes.**
12. Are the References/Bibliography complete? All materials referenced in the TR should be represented in the list of References/Bibliography.
    **Yes, the references are complete.**
13. Do the Appendices support the study? Do the Appendices include substantiating data and calculations? Extraneous material should not be included.
    **The appendices contain code that is used to run all the various components of the machine and also create and manage the database from the app.**
14. Is the spelling correct? Has either the Canadian or USA spelling system been used consistently through the TR. Is the language free of jargon? Are acronyms properly introduced? Are abbreviations appropriate and correct? Can someone without specific expertise in the field read and understand the TR?
    **Yes.**
15. Is the same voice (I, one, person, etc.) used consistently throughout the Technology Report? There should not be any switching from third person to first person or vice versa.

**As the project was a collective measure by three people the report, so the report is made from that viewpoint and that is signified from the use of the pronoun "We".**

16. Do the grammar and punctuation follow normally accepted rules of use? Use Ron Blicq's text Technically Write or a similar grammar reference as a guide.
    **Yes.**
17. Are thoughts and illustrations/diagrams/charts that do not belong to the writer properly identified and footnoted in the text? Are quotations indicated correctly? Are the authors referenced in footnotes and/or reference list? Do they include the author's name, the title of the article/book, the date of publication, and the publisher?
    **Yes.**

Report Content

This section evaluates the quality of the work completed when addressing the problem statement/hypothesis. Fulfillment of these criteria leads to a TR that makes a contribution to the field under study.

1. Are the Problem Statement and Hypothesis significant to the current state of the field/industry?
   **Yes.**
2. Is the Methodology scientifically sound?
   **Yes. The methodology was created following the scientific process of designing, testing and finalizing the prototype that was born from an initial idea.**
3. Are the engineering technology and applied science principles used in the Methodology and Analysis appropriate to the subject area?
   **Yes.**
4. Are the Data and/or Results complete?
   **No, the project was halted due to the COVID-19 outbreak and the progress was only made to the application and the database side of the project so the data for the methodology is incomplete in regards to the electric and mechanical aspects of the project. For the incomplete aspects, only the simulated designs are provided not their tested outcomes.**
5. Have the Mathematical formulae been applied appropriately?
   **The mathematic calculations for this project were the part of the firmware where calculations were to be performed on based of the data received by the machine from the database. And these calculations were applied according to need to output accurate signals to the machine components.**
6. Are the Mathematical calculations done correctly and accurately?
   **Yes, the calculations were done accurately as they were needed to be accurate for the machine to work. For example, in the case of the Servo**

**motor, if the calculations were wrong in calculating the PWM, instead of just going to the wrong angle the servo could also end up getting overdriven and break the gears in it.**

7. Are the Illustrations/Diagrams/Charts technically correct?
   **Yes.**
8. Is the Analysis of the results correct? Is the Analysis complete?
   **The results conclude that the machine that was proposed in the report, with all the mentioned features was created. From the actual results, one can believe that methodology given the report can theoretically be used to build the said machine. So, Yes, the Analysis of the results is correct. But it may still be lacking, as it could not actually test the machine with a live participant, which could have concluded the proposed product in its completion.**
9. Are the Conclusion(s), and if applicable the Recommendation(s), free of discussion, explanation and opinion?
   **The conclusions mention that the project has been completed and can be mass-produced using the methodology presented. But they also provide the group's opinion on further development of the product.**
10. Do the Conclusion(s), and if applicable the Recommendation(s), relate to and resolve the Problem Statement and/or Hypothesis?
    **Yes, the conclusions talk about ideas for further development of the product. And these ideas are for the software side not the hardware side, so no more rise in production cost, but still making the machine with abundant features at the same low cost. This was already the problem the project set out to resolve.**
11. Are the Conclusion(s), and if applicable the Recommendation(s), logical?
    **Yes, the given conclusions are made upon the logical reasoning that the machine accomplishes its task, while solving the problem mentioned the report. Also, it is of sound logic that one would want to upgrade their product further, which is the second part of the conclusions.**
12. Does the report make a contribution to the industry/field of study?
    **Yes.**