MIAE 380

Product Design and Development

15 April 2024

Portable Pedal Exerciser Project Report

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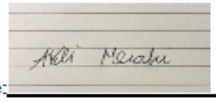
Name: Med Islam Anis Dahmani (please print clearly) ID No: 40228399 Signature:  Date: 15/04/2024

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Abstract / Problem Statement

The objective of our project was to develop a portable pedal exerciser suitable for individuals diagnosed with Ehlers-Danlos Syndrome (EDS). EDS is a rare connective tissue disorder characterized by joint hypermobility, skin fragility, and other musculoskeletal issues. Traditional exercise equipment may not be suitable for EDS patients due to their physical limitations. Therefore, our proposed pedal exerciser aims to address these challenges by providing a safe, effective, and convenient solution for maintaining joint health and overall fitness.[10]

Introduction

The goal of the project was to develop a portable pedal exerciser. Because EDS causes joint overexertion and instability, high-impact exercises may be difficult or painful. Using a portable pedal exerciser is an affordable, low-impact method of improving cardiovascular health, building muscle, and increasing mobility without putting undue strain on joints.
Planning, market analysis/research, customer needs analysis, product specifications, concept generation, concept selection, design, safety/validation, and risk analysis. steps of the product development process that we must follow to achieve this.
By implementing a product development process, we improved our project's coordination, planning, management, and quality assurance [9]. Regarding coordination, the steps provided a general plan for individual team members to follow. These steps improved our planning by creating natural milestones after each phase. The development process improved the management of the project by acting as a benchmark of sorts to gauge the progress of the project. At the end of each stage, we improved our quality assurance by ensuring that everything within the step was completed accurately. The end of each stage became a checkpoint.

Product Description

The product we have designed is shown in the images seen in Figures [1] & [2]. Figure one represents the final

product done using solid works, although it still needs more refining, and is very close to our vision for our market-ready product. Figure 2 shows the proposed prototypes that we had for the pedal exerciser. Our main goal was to ensure practicality without overcomplicating the design. And that's why we put most of our features inside the body frame, this has helped us consume less space on the floor. The main components are briefly discussed below:

Pedal Exerciser Frame:

A lot of thought was put behind designing and manufacturing the frame of our product. It has a sleek ergonomic design that demands less space without compromising any functionality. The frame is easily customizable with adjustable components such as pedal height, resistance, and a handlebar positioner.

Pedals:

The pedals were designed with the customer's comfort in mind, they boast an uneven surface that supports the grip for the feet, diminishing any risk of slippage or clash.

Interactive Screen:

With its lively colors and wide display, the screen offers a user-friendly interface that facilitates and enlivens the customer's experience with the product. The screen measures 6.3 inches diagonally with a thickness of around 0.5 inches. It is made of a grade A quality LED panel confined in an anti-scratch sturdy cover. The screen is easily detachable to simplify the process of moving the exerciser around.

Benefits and Use

Our product's design is to meet the unique needs of individuals with EDS, the portable pedal exerciser will offer a few benefits targeted at improving physical wellness and addressing the specific challenges of this community. Recognizing the importance of joint stability, the user features adjustable resistance levels that enable users to strengthen muscles around their joints in a safe manner. This focus on low-impact exercises is crucial for reducing the risk of dislocations, a common concern for those with EDS. Additionally, the device will play a significant role in improving cardiovascular health, an essential aspect for everyone but providing a safer alternative to high-impact exercises for EDS individuals. The design potentially allows for customizable

exercise regimens, helping accommodate the variability in symptoms that those with EDS experience in their daily life. Its portability will ensure users can maintain their routine in various settings, at home, in the office, or while traveling, addressing the challenge of consistent physical activity for people with mobility difficulties. Engaging in regular, gentle exercise with the pedal exerciser can also aid in managing chronic pain, a common symptom experienced within the EDS community, this method of physical activity will offer a different path to reducing the pain while avoiding the potential harm of more difficult exercises. Besides the physical benefits, the device contributes to psychological well-being. Engaging in regular exercise has been shown to alleviate symptoms of depression and anxiety, providing a valuable tool for stress relief and mental health improvement for those whose exercise options are limited. The device's ease of use, with ergonomic features, ensures it caters to various fitness goals, from strengthening the muscles and improving flexibility to simply increasing daily activity levels. [1]

Planning

Planning is critical to have a successful product and development process. After voting on over 10 possible ideas, our team selected the idea of a Portable Pedal Exerciser for EDS. Next, was the process of role assignment. After a couple of meetings, the following arrangement was made:

1. **Head of Design (Mouaz Samman)**
2. **Communications Liaison (Med Islam Anis Dahmani)**
3. **Administrator (Zein Deeb)**
4. **Coordinator and Cost Engineer (Junayed bin Zaman)**
5. **Team Leader (Merahi Mohand Akli)**

After the assignment of roles, our team promptly began building a long-term schedule in the form of a Gantt chart (see Figure [3]). To collaborate efficiently, we set up mandatory meetings 1-2 times per week depending on the workload of the tasks assigned. After exploring existing products that had similar functionalities, we understood that our product was going to be a derivative product. It will be an extension of an already existing platform but modified to serve a different customer base.

Market Analysis and Research

Data on Competitors

By doing research on similar products, we compared Marcy Cardio Mini Cycle NS-909, Under Desk Bike Pedal Exerciser by MERACH, Soozier Pedal Exerciser, and Under Desk Elliptical by MotionGrey to our product. We noticed many cons compared to our portable pedal exerciser. First, all four of them have high cost the Marcy Cardio Mini Cycle NS-909 is 122$, the Under Desk Bike Pedal Exerciser by MERACH is 210$, the Under Desk Elliptical by MotionGrey is 300$ and the Soozier Pedal Exerciser is 100$. Secondly, they are made of heavyweight material (allow steel) which is much harder to transport and to lift. All four of them are meant to stay at home mostly, they do not have a useful system of transportation (arm and wheels) for travelling. Thirdly, the competitors did not include a flexible mechanism to the pedals to change the angle, height, or distance of the pedals for comfort. We developed a cost-effective device with similar technological features for the general population, making it easy to use and transport.

Target Demographic

People with EDS illness make up the bulk of our core market. If the primary market does not provide a profit margin of +40%, we will target secondary markets such as healthcare (for the elderly and prevention), sports (knee exercise), and office/home exercise. Our device will allow the elderly to care for their knees without exerting too much effort or rushing outside, which can be challenging at their age. Our pedal exerciser can also be utilized by other users who work from home or in the office.

Analysis of Customer Needs

Customer Survey Results

The project group members distributed a sixteen-question customer survey to their personal connections to get information on product expectations and requirements. Of the 36 responses which are seen in Figure [] in the appendix, 63.9% are most likely to purchase a portable pedal exerciser in the next 6 months, and 82.9% would recommend a portable pedal exerciser to anyone with EDS. These findings demonstrate that there is a demand for our goods. To determine what price range people expected, we presented four distinct rates 16.7% of the surveyors responded to less than 100$, 63.9% chose in between 100-150$, and 16.7% picked the range 150-200$, and 2.8% picked more than 200$.When asked what your primary reason is for considering a portable pedal exerciser 33.3% chose for rehabilitation or physical therapy, 77.8% chose improving cardiovascular health, and 61% chose increasing physical activity while working or watching TV. These results show that even if our main customer target is not fully reached, we still consider our second market which is people that will use the pedal exerciser for physical activity at home or in the office.

Other significant questions produced the following results:

- 75% have you used a pedal exerciser before

- 58.3% are willing to allocate minimal space for storage of the portable pedal exerciser
- 83.3% find the noise level important during operation of the pedal exerciser
- 61% are between 18-24 years old and 38.9% are between 25-34 years old
- 100% want pedal exerciser with additional features such as a built-in timer, calorie counter, or Bluetooth connectivity
- 50% engage in cardio workouts 2-3 times a week
- 75% would stay on an indoor or outdoor bike for 15-45 mins

Concerning the features and the design of the portable pedal exerciser:

- 66.7% chose that strong support for stability of joints, size, and portability would be the most important in a portable pedal exerciser
- 63.9% would most likely use the pedal exerciser while traveling
- 77.7% find the appearance/design of the pedal exerciser important
- 38.9% would be motivated to purchase a pedal exerciser because of the convenience and 25% for lighter weight

All the data collected give us an idea of the customer's needs and help us modelling, designing and improving our product to satisfy the market needs.

Customer Survey Analysis

After examining the survey responses and considering the feedback from participants, we identified key customer preferences on a scale from one to five. The top priorities included maintaining a compact size for easy portability, ensuring durability and stability during use, providing adjustable resistance levels, and offering comfortable foot pedals. Additionally, respondents emphasized the importance of affordability, easy assembly, and the inclusion of features for tracking workout progress, the price ranging between $100 to $150.

Product Specification

Product specification translates customer's needs into measurable values. The product specification process consists of 3 main steps: set target specifications, refine specifications and reflect on the results [2].

Set Target Specifications & Refine Specifications

List of Metrics:

NEED #S	METRIC	IMP		UNITS
1,4,6	Area Size of the pedal exercise	4		Square feet
1,4,6	Weight of the pedal exercise	4		kilogram
1	Time to setup	1		minute
1	Time to deconstruct	1		minute
2,4,6	Resistance load	5		pounds
1,5,9	Screen size	5		Diagonal distance in
4,5	Screen weight	4		grams
5	Screen display	3		resolution
5	Software compatibility	3		Apple/Android/both
4,6	Rotations to failure (Standard Settings)	4		Number of rotations
4,6	Vibration test	3		amplitude
4,6	Stiffness of the base	2		newtons/millimeters
7,8	Pedal surface	4		CM^2
4,7	Strap tension	5		kilogram force
7,9	Strap material	5		list
1,8	Pedal sizes	5		Size list(US STD)
1,4,8	Pedal shape	5		list
4,8	Arch height	5		cm
4,8	Heel support Hight	3		cm
4,8	Heel support width	3		cm
9	Price	4		dollars
9	Warranty	3		years
9	Adjustability	3		Degree of
3	Sound pressure level	2		db

2	Resistance range	3		list
4,6	Number of speeds	3		list
1	Number of pieces			

To establish target specifications, the team must prepare a list of metrics by collecting competitive benchmarking information from similar products and setting ideal and acceptable target values. After analyzing the survey in Figure [4], we placed the customer's statements in Figure [5], ranking each statement by its importance. It helped us significantly focus on which features satisfied their needs. Moreover, figure [6] associates the metrics to customer's needs along with their rank of importance and measuring units. Each metric is established with the needs from Figure [6] to improve our customer's satisfaction. After collecting information on our competitors, the data provides more information to refine our product specifications because when comparing to others, it guides us to create a design superior to them. Subsequently, in Figure [7], we set the target values for the metric needs which is useful since the table expressed the ideal and marginally acceptable values. In conclusion, we were able to set the target values for the metric needs.

Reflect on the Results

After reflecting on the product specifications, we ensure that any significant specifications are not missing and are fulfilling customer's satisfaction. Overall, our team only wants the best for customers, having our product be a convenient solution to the customer's problem. With our winter shoe cleaner, users can easily utilize it daily and avoid any mess.

Concept Generation

The generation of ideas follows a process where a pool of ideas is brainstormed, and evaluated based on the criteria that it is feasible and that the users' requirements are met. They are further refined to the most viable solutions. This significant stage is the orientation of creativity and practical application, directed to the solution of the problem found, which, in turn, results in the innovative development of design relevant to the target audience. The method for generating concepts goes through five stages: clarifying the problem, searching externally, searching internally, searching systematically, and reflecting on the solution. [3]

Step 1: Clarify the Problem

Clarifying the problems will allow translating the key customer needs into metric and target specifications. Central to the approach and design requirements are the physical limitations and the joints' stability and needs of this population. This is through the problem decomposition diagram, as depicted in Figure [21], which forms a pillar tool at this stage. It will decompose the general challenge into specific and addressable sub-problems. From the conceptualization flowed the key sub-problems our design needs to solve. First, the energy input needs to be modulated, coming from the physical effort put in by a user pedaling, so as not to provide it in any kind of strain. And secondly, the subject of our design, that is, providing the adjustable resistance mechanism and the ergonomic pedal surface, requires innovation for handling a tender yet effective exercise session. Finally, in the signal element, it shows a need for an intuitive feedback loop between a user and the exerciser in real-time through changing resistance levels and ergonomic settings to an effective workout environment. [3]

Step 2: Search Externally

External searching involves looking for existing solutions that are faster and less expensive than developing new ones. Figure [8] provides a breakdown of the components that gather essential information about the portable pedal exerciser, including lead users, benchmarking, experts, patents, and literature. By using Figure [8], it becomes easier to compare competitors and customer preferences, thereby enabling the creation of a superior product.

Step 3: Search Internally

Searching internally utilizes innovative ideas from the use of personal or team knowledge. We brainstormed multiple ideas concerning the portable pedal exerciser making sure it was suitable for people with EDS. This was with major emphasis on key aspects of the resolution of issues on stability and safety concerns, ensuring sufficient range, ease of adjusting resistance, comfort, and ergonomics, clear user feedback, and as action points while trying to maintain the portability of the design. After carefully considering each idea, we put our potential solutions into a matrix format shown in Figure [9]. This helped us visualize and compare the alternatives for each of the sub-functions and laid the ground for an informed decision in the next phase of our development.

Step 4: Explore Systematically

Our design sub-functions were successfully spread onto the structured diagram for the final selection process from external and internal searches. These are displayed in figure [10] and figure [11]. With a group brainstorming session, we were able to extract the critical sub-functions and then select which combinations are particular and relevant to the design. In figure [11], the number of possible combinations is 144, derived from the available different options.

Step 5: Reflect on the Solution/Process

The systematic approach guided our decision-making process and ensured we tailored the design to meet its needs. Overall, it made the team feel confident in the concept selection.

Concept Selection

From the three prototypes shown in Figure [12], we derive the Concept Screening and Scoring matrices figures [13] and [14] respectively for setting strengths and weaknesses of our conceptual designs. The selected criteria are those considered, based on the highest metrics from collective research and the most beneficial sub-functions according to the survey. The Most relevant used were stability, adjustable resistance, ergonomics, portability, size, and weight.

Using the screening matrix, which is more of a preliminary assessment, all three prototypes demonstrated potential, meaning further analysis was needed. To help our process, we developed a concept scoring matrix, where we assigned specific weights to each criterion. The weighting shows the priority of Stability, Adjustable Resistance, and Ergonomic, each comprising 20% of the decision-making weight, recognizing their importance. Portability was weighted at 15%, while Size and Weight were deemed less crucial but still significant, at 10% and 15% respectively. The

results from the concept scoring matrix were instrumental in guiding our decision-making process. Prototype C emerged with the highest weighted score, suggesting that it offers the best combination of features according to our tailored criteria, however prototype C offers various design challenges that are out of scope to this project, so we decided to go with protype B as the next best option according to our concept scoring matrix.

Design Overview

Customizable smart Resistance:

Because EDS patients have different pedaling strengths, we made a smart resistance system that adjusts the resistance based on the amount of force applied by the user. This is possible by sensors built into the body of the pedal exerciser that sends signals to the control system to lower the resistance if it is taking longer to cycle after every cycle.

Stimulate heat:

With heat-resistant wire, we spread heat throughout the foot surface to help move blood around in the blood vessels. There are also heat sensors that ensure the safety of any fire hazard.

Interactive User Interface:

For a facilitated use of the control system, we made the screen bigger than our competitors and we installed special software that collects data from the machine and visualizes it in the shape of reports, warnings and reminders.

Portable Body:

To gain a market advantage and to offer a seamless smooth user experience, we made the body collapsable. Instead of adding bolts and screws we made the body with a mix of hinges and folding mechanisms. At the same time this reduces the number of parts thus making it easier to assemble and disassemble in a few minutes.

Cost Analysis/ Material Selection

After careful analysis of the material and quantity of each component, we determined the overall manufacturing cost to be $127.4. A breakdown of the approximation of these values and their respective calculations is in figure [16] and [17]. Our goal was to generate a profit of 40% by 2026. If we sold the product for 150$/unit to a retailer, our profit would be 15.07%.

Although low, we estimate that as production volume increases, our component cost will decrease. This will allow us to sell our product at the same price while generating more profit. Here is a summary of the material selection and component cost:

Pedal Mechanism:

- Plastic Pedals
- Cost: $6 set [2.1]
- Adjustable straps
- Cost: $2 set [2.2]
- Adjustable tension knob mechanism for flexibility
- Cost: $6 [2.3]
- Assembly and labor 3$

Base:

- 1/8-inch-thick plywood board (16" x 24")
- Cost: $20 [2.4]
- Anti-slip rubber mat (16" x 24")
- To make it non slippery
- Cost: $5 [2.5]
- Labor 3$

Support Structure:

- Custom made adjustable height metal frame (aluminum): $30 [2.6]
- Metal joints and connectors (set of 3): $2 each [2.7]
- Assembly 6.5$

Handlebars:

- Foam-covered metal pipes (0.5" x 12") (2 pieces): $4 [2.8]
- Adjustable metal connectors (set of 2): $8
- Assembly 1$

Display Panel (Optional, for tracking progress):

- 4.3-inch LCD screen with basic features
- For measuring time, calories etc.
- Cost: $16.14 [2.9]
- Batteries: $6 [2.10]
- Assembly 2$

Heat Resistance wires

- 5ft
- Cost $0.16 per ft. [2.11]

Heat Sensors

- Cost $2.96 [2.12]
- Assembly 1$

Safety

Following the Canada Consumer Product Act and the international series standard IEC 60335, the portable pedal exerciser prioritizes safety and good service as a household good. Following this international standard makes the respect of basic safety measures for domestic appliances compulsory [1]. Most of the edges of the pedal exerciser have been rounded to minimize any risk of injury or cut. Stability has also been considered as the product will be used on the ground, the design of the legs and the position of the wheel allow for a more stable usage and prevent any risk of being overturned or flipped upside down. The product has also been designed for easy maintenance, including the replacement of worn-out components, especially the pedals or even the resistance mechanism. This makes sure to minimize any accidents related to defective or worn-out pieces. Additionally, the product will be accompanied by an instruction manual with clear steps and instructions on how to replace any relevant part of the portable pedal exerciser safely. This instruction manual will also contain warnings and precautions to take every time the product is used to limit any injury to children and most importantly the elderly who might need medical approval before using this device.

Validation

Monitoring the progress of the product's development through design validation is a crucial process. The recommended method of testing that seemed relevant to this product is prototyping.

Objective of a prototype

The main objective of a prototype is to help the researchers evaluate the performance and impacts of their product relating to all its pertinent features. The goal is to reach an equilibrium between functionality and feasibility. This encompasses the selection of appropriate materials and the user testing with EDS patients supervised by physical therapists for example. The testing of alpha and beta prototypes is the way through which this will be done.

Level of the Approximation of the Prototype

As this Portable Pedal Exerciser is a basic product, just a physically focused prototype is necessary to verify the functionality of the components: the adjustable resistance, the comfort and ergonomics, the portability, and the user feedback. A detailed prototype will be created to assess the effectiveness of all aspects working together. A prototype is needed to confirm and correct the adjustable resistance of the manual dial with clear marking levels, and to ensure the functionality of the digital control and the resistance to the tension of the bands. Another reason prototyping is required is to assess the comfort and ergonomics of the user with the help of padded pedals with straps, gel padding, the strength of the pedal covers, and the efficiency of the adjustable height. We also want to test and adjust the portability of our

product by evaluating the brittleness of our collapsible frame and handle, and the feasibility of the detachable components of the product. Finally, the prototype will help measure the precision and the synchronization of the LCD, the smart app, and the auditory signals of the electronic system.

Experimental Plan

Two prototypes will be created to determine the most efficient material for the product frame by testing its strength while considering the product's weight and size. One prototype will be made of stainless steel, and the other out of aluminum. Four prototypes will be created to evaluate the varied intensities of each subsystem: changeable resistance, comfort and ergonomics, portability, and user input. Then, a prototype will be built to incorporate all the subsystems as a complete system model, and its overall efficacy will be evaluated through a demonstration for customer input.

Risk analysis

A risk is an event with uncertain outcomes that, if realized, could significantly impact the project's deliverables [7]. The risk analysis components include cost risk, market risk, and technical risk, which have been encountered or could be encountered throughout the development process of the portable pedal exerciser [Figure 18].

Cost Risk

The costs and risks related to the portable pedal exerciser are mostly related to manufacturing and distribution as the sourcing of lightweight durable materials and the partnership with experienced medical equipment manufacturers and distributors play an important role in reducing the expenses. Another cost risk, even if less likely, would be the research and development expenses directly linked to the EDS. To minimize the impact

of this risk, thorough user testing during the research and development phase, as well as a search for funding in medical device development.

Market Risks

While the market is not as large for medical sports items, competition can have an even bigger impact on the product. For that, prioritizing the development of unique features catering to EDS patients can make a difference. Another possible market risk is the change in customer preferences; the customer pool for this specific product is still progressing day by day, but that also means that any sway in public opinion or forums can heavily impact on the image of the product. To mitigate that, a constant implication with the EDS patient community and an open mind to features based on user preferences can go a long way in keeping our product relevant for our target audience.

Technical Risks

The main technical risk that can impact the development process is quality control. One of the biggest problems with pedal exercisers is mostly the quality of the parts and components. In the survey we conducted as well as the research we completed; the issue of quality kept coming back. To fix this problem, a strict implementation of quality procedures needs to be put in place. This includes meticulous testing for durability and safety. To make sure this does not dissuade potential customers, an extended warranty would bring peace of mind when purchasing.

Lessons Learnt

All good project management teams ask themselves how they could improve next time. They write down their team members' responses, so that next time, the project development process is more effective and efficient. The responses usually are categorized by what was done right, wrong, and what could be done better. As you can see from figure [19] in the appendix, we generally agreed on the fact that

Conclusions

Our mission was to develop an affordable portable pedal exerciser that could be used by individuals seeking low-impact exercise options. The idea stemmed from our own experiences and observations of the need for such a product. We noticed a lack of accessible and affordable exercise equipment, especially for those with limited mobility or space constraints.

After conducting thorough research, we found that there was a gap in the market for a portable pedal exerciser that met our criteria of affordability, effectiveness, and ease of use. To validate our idea, we conducted a customer survey, which confirmed the demand for a product like ours.

Throughout the development process, our team worked cohesively, delegating tasks efficiently and applying the principles of product development taught in our course. We established a clear schedule and approached each step of the process methodically, ensuring that we stayed focused on our goal.

Using peer reviews and checkpoints along the way, we aimed to maximize the accuracy and quality of our product. We constantly referred to the feedback from our survey participants, prioritizing key factors such as portability, resistance levels, ease of assembly, and affordability.

Ultimately, we succeeded in creating an affordable portable pedal exerciser that we believe will positively impact the daily lives of many individuals. Our product excels in the areas that our customers deemed most important, providing a convenient and effective exercise solution for people of all ages and abilities.

Recommendation

For the next steps in our project development process, we suggest patenting the trademarking the brand name, and design, and enhancing our project and process via reflection. If the pedal exerciser meets the conditions for a utility patent. This would assist our team, unfortunately, patent fees and expenses can exceed $100,000, necessitating a cost-benefit study [8]. On the other hand, trademarking the brand would allow our goods to be distinguished only

by its name or logo, but the expenses may be expensive.

Two crucial steps that must be taken in the next years are designing the product for the environment and industrial design. Industrial design is a process where a specialist analyzes the pedal exerciser looking for areas where customer needs could be improved [8] Designing for the environment is to reduce the environmental impact of the product throughout its life cycle. As a team, we will analyze the effects of each step of the product life cycle so that improvements can be made.

Finally, what we propose for the future is to enhance the project and process via reflection. This would be accomplished by using the lessons learned and the information we gained through the process. Any change, no matter how little, has the potential to save an enormous amount of time and money.

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(2.4) “Maple 1/4 single sided,” *Craft Closet*. https://craftcloset.com/products/maple-1-4-single-sided?_pos=8&_sid=4157d7361&_ss=r&variant=43634258182360

(2.5) “Anti Slip Runner Carpetfloor Runner Roll Rubber Mats Gym Plastic Pvc Coil Flooring 3mm Pvc Mat - Buy Rubber Mats Gym Flooring carpet Roll 3mm Pvc Mats floor Runner Mat Product on Alibaba.com.” https://www.alibaba.com/product-detail/Anti-Slip-Runner-Carpetfloor-Runner-Roll_1600228661867.html?spm=a2700.galleryofferlist.p_offer.d_image.2c0560ee8rTL02&s=p

(2.6) “Oem Customized Large Industrial Metal/stainless Steel Storage Rack Frame Welding Fabrication/sheet Metal Fabrication Services - Buy Custom Metal Works,Sheet Metal Manufacture,Laser Cutting Services Provider Product on Alibaba.com.” [Online]. Available: https://www.alibaba.com/product-detail/OEM-Customized-Large-Industrial-Metal-stainless_1601015588409.html?spm=a2700.galleryofferlist.p_offer.d_image.6610257baIN6Ud&s=p

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(2.8) “General PDP Template,” *Canadian Tire*. https://www.canadiantire.ca/en/pdp/armacell-foam-pipe-wrap-1-2-in-x-3-ft-0630060p.0630060.html

(2.9) “4.3" 4.3 inch 480x272 TFT LCD Display w/Optional Touch Screen Panel for MP4,Car,” *eBay*. https://www.ebay.com/itm/291812799328?itmmeta=01HVFG9VB2BAA61VG0WDCWMV6F&hash=item43f165f360:g:OHAAAOSwFSxaI1zD&itmprp=enc%3AAQAJAAAAwNUZ29IwIlEdRUctm0kF8KOQpaPSTMouiTxXl5PCW5cfuv2y8PsDHKSCfgzbpTSnZiKzCIv4jwRlcCrm80Tg5QBlwpT14M%2BuMB7YPKonbq8TIXJ1%2BJnMce31kRL45Z2gOgPArP02oYod6CQlaxajh%2Fg39LO34h%2BYoCUntJjUuw0Du3roXw%2BHfG39S35GXkhslaaSMV3PTjZ5iIIh1GYiWiFrJKXwoIT%2F3xMFjHqOY%2F%2BKYDgJNkIuCUGJIHTiXf%2BbKg%3D%3D%7Ctkp%3ABk9SR_q1p_DbYw

(2.10) “Uline Ultra Batteries in stock - ULINE.ca.” https://www.uline.ca/BL_2549/Uline-Ultra-Batteries

(2.11) “THHN Wire | Thermoplastic High Heat Nylon Wire | Allied Wire & Cable.” https://www.awcwire.com/hook-up-and-lead-wire/building-wire/thhn

(2.12) Texas Instruments. (n.d.). LM335Z/LFT7 Temperature Sensor. [Online]. Available: https://www.digikey.ca/en/products/detail/texas-instruments/LM335Z%2FLFT7/5864713?utm_adgroup=Texas%20Instruments&utm_source=google&utm_medium=cpc&utm_campaign=PMax%20Shopping_Supplier_Texas%20Instruments&utm_term=&productid=5864713&utm_content=Texas%20Instruments&utm_id=go_cmp-17862000620_adg-_ad-__dev-c_ext-_prd-5864713_sig-CjwKCAjw_e2wBhAEEiwAyFFFo4jZVaoKluG0OjhzHgJCOFy4JeFoIeIuRMAOFURquA1d4myKan8mHRoCDiAQAvD_BwE&gad_source=1&gclid=CjwKCAjw_e2wBhAEEiwAyFFFo4jZVaoKluG0OjhzHgJCOFy4JeFoIeIuRMAOFURquA1d4myKan8mHRoCDiAQAvD_BwE
Accessed on: April 12, 2024.

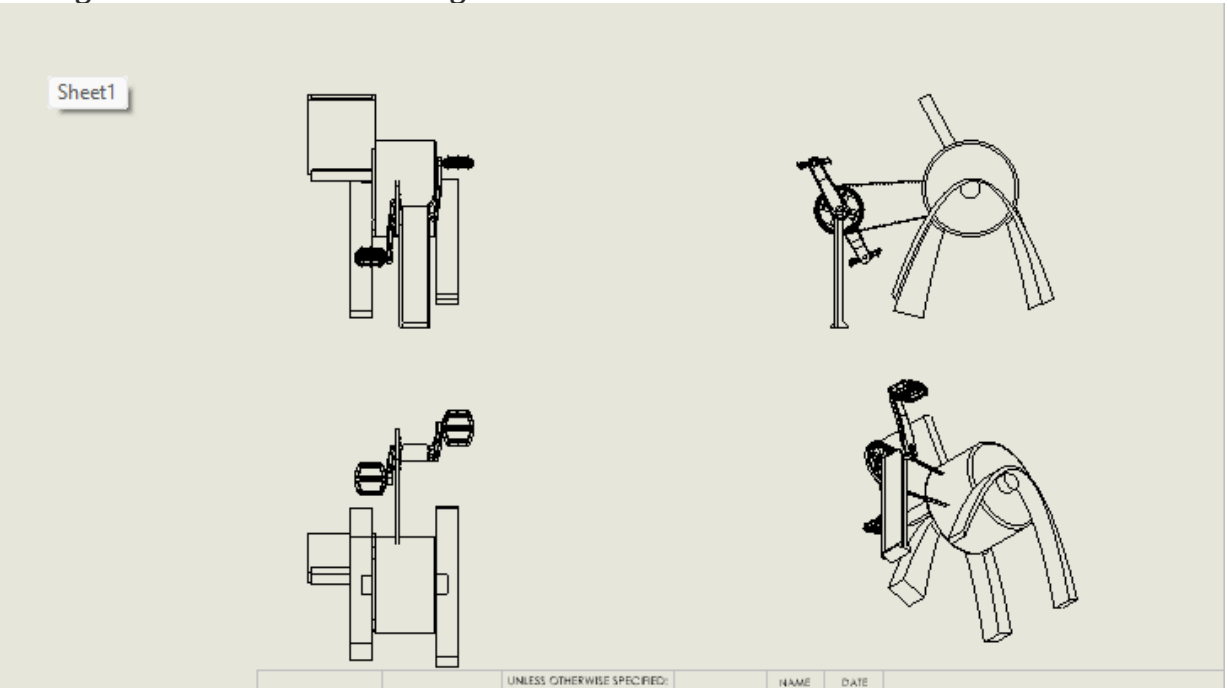
[3.1]: Soozier Pedal Exerciser, Hand Arm Knee and Leg Exercise Machine, Height-adjustable, with LCD Display and Foot Massage Roller | Aosom Canada

[3.2]: MotionGrey - Under Desk Elliptical, Sturdy Mini Leg Ellipse Leg Exerciser, Electric Elliptical Exercise Machine, Pedal Exerciser for Seniors, Remote Control 5 Speed Elliptical Machine for Home - Walmart.ca

[3.3]: Under Desk Bike Pedal Exerciser, Quiet Magnetic Mini Exercise Bike with MERACH App for Arm, Leg Recovery, Physical Therapy, Smooth Foot Desk Cycle with 2 Resistance Bands & Non-Slip Mat, Exercise Bikes - Amazon Canada

Appendices

Figure 1: SolidWorks Drawing



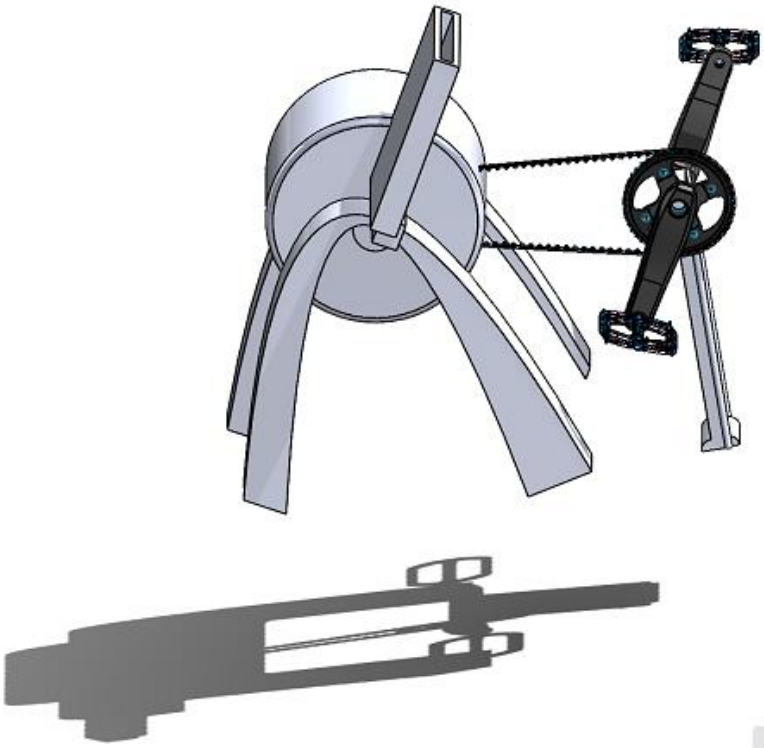
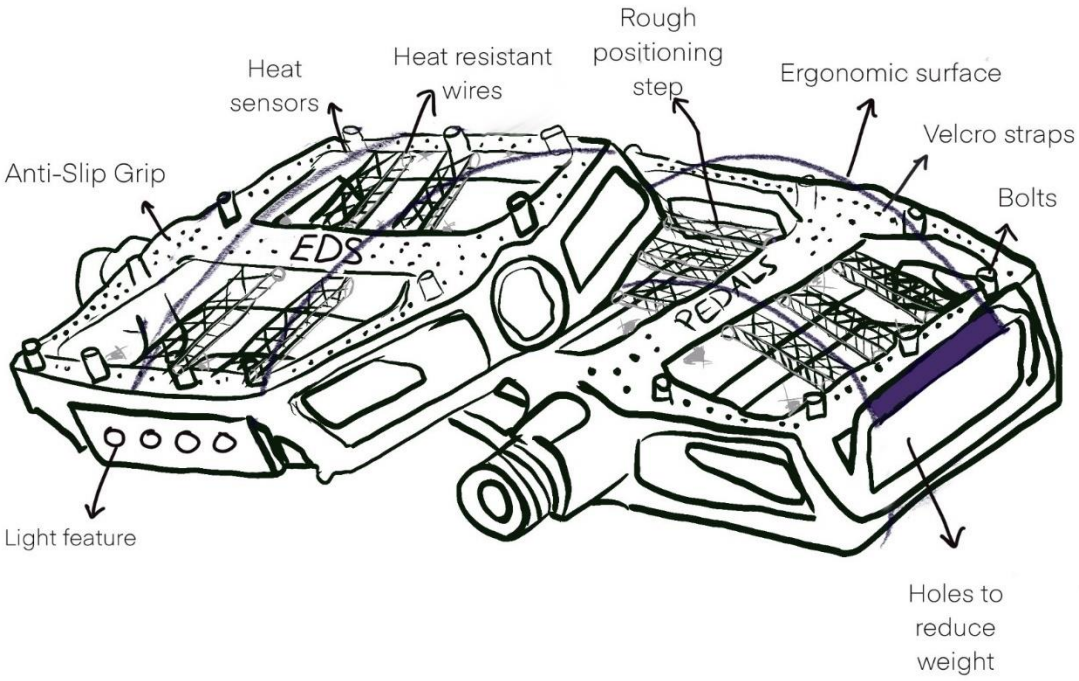
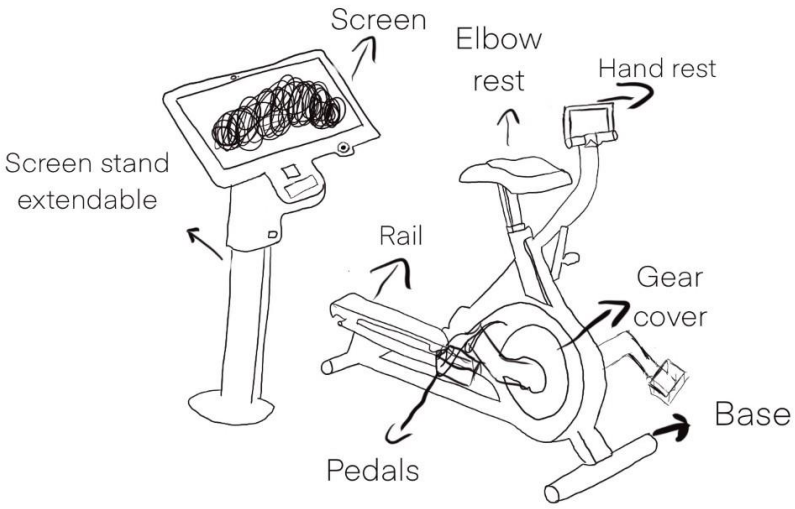
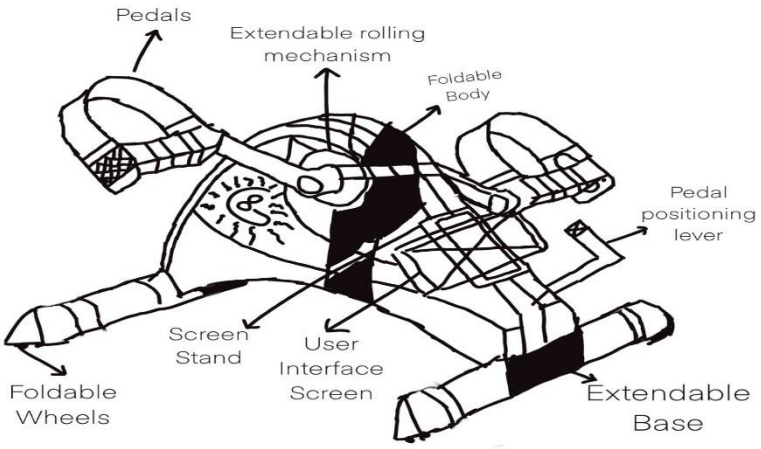


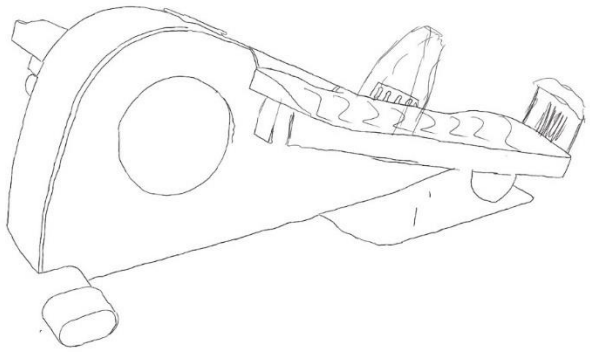
Figure 2: Prototype sketches




Screen
Elbow rest
Hand rest
Screen stand extendable
Rail
Gear cover
Base
Pedals

Open Form Prototype





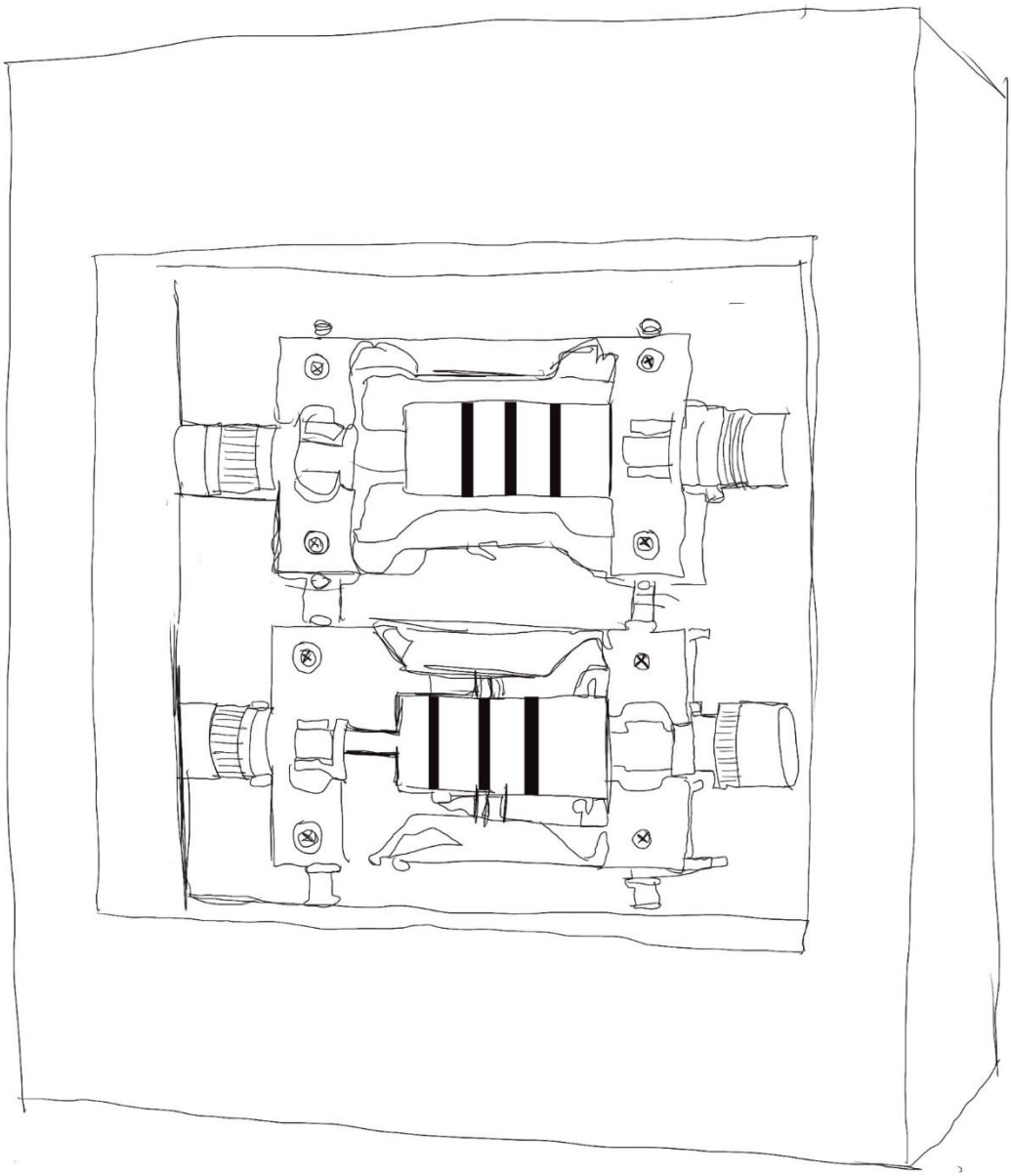


Figure 3: Gantt Chart

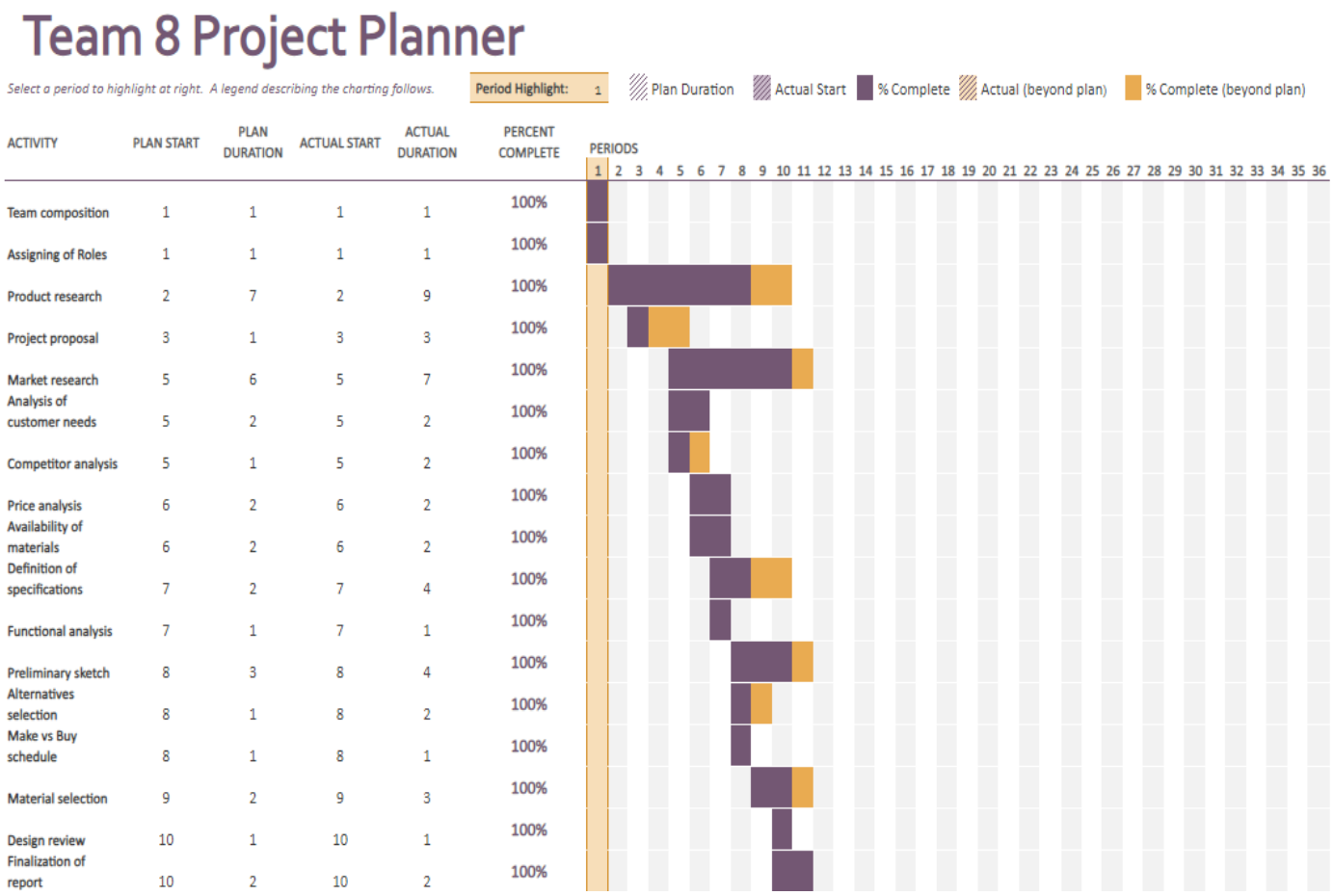
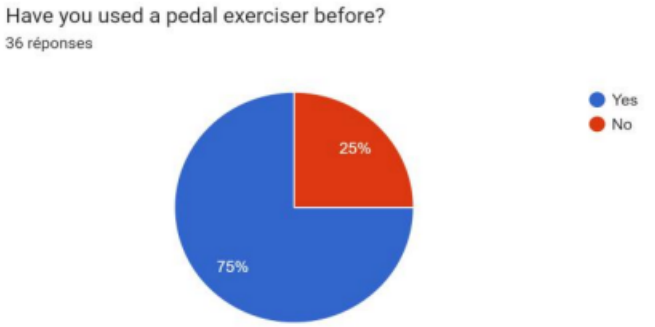
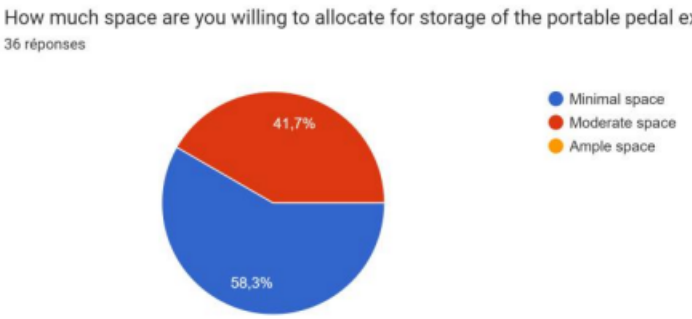
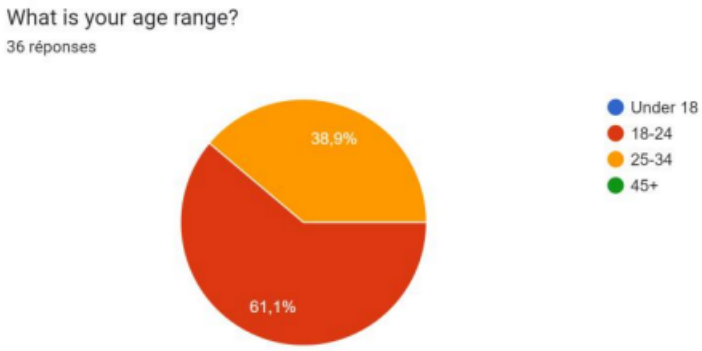
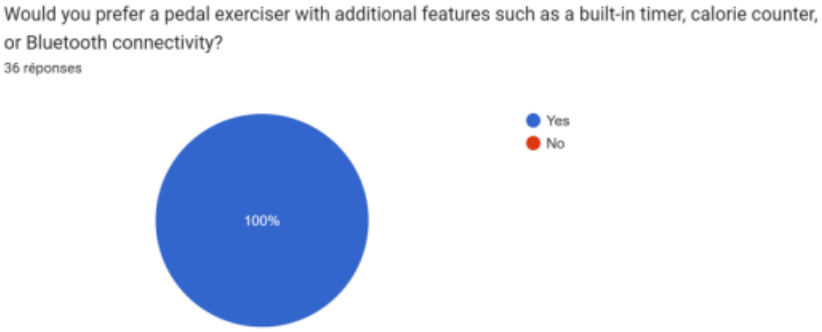


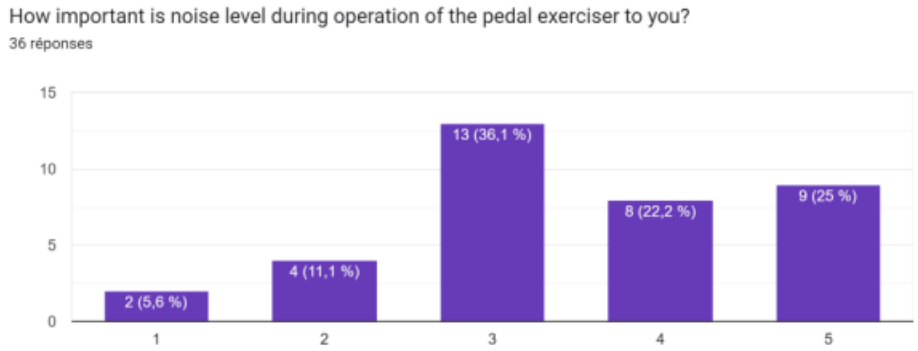
Figure 4: Survey Results

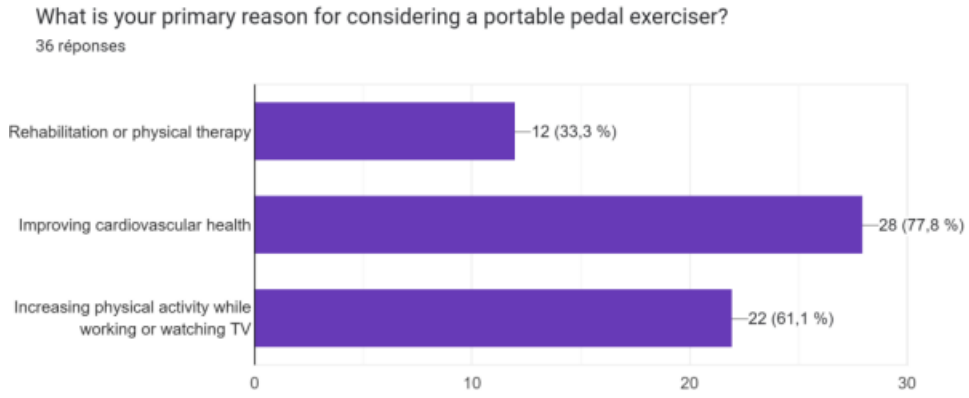






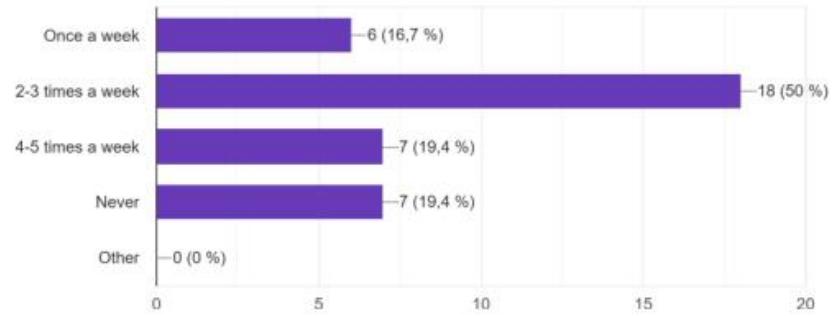






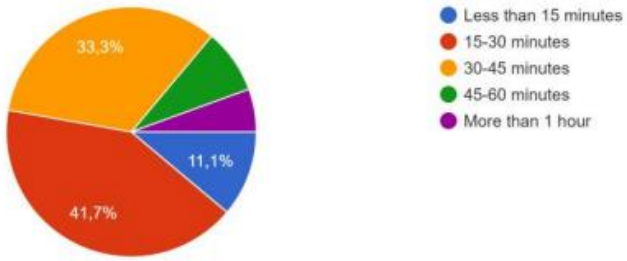
How often do you engage in cardio workouts?

36 réponses



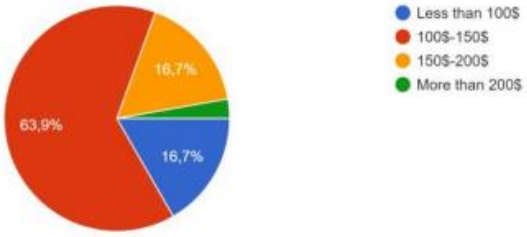
How long would you stay on an indoor or outdoor bike for?

36 réponses



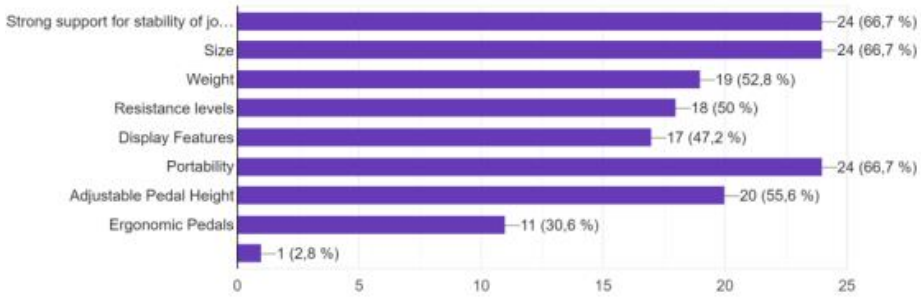
How much would be a suitable price to charge for a portable pedal exerciser

36 réponses



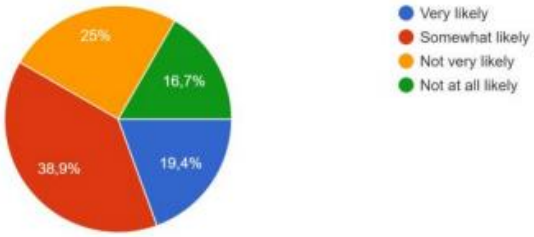
What features would be most important in a portable pedal exerciser? (select all that apply)

36 réponses



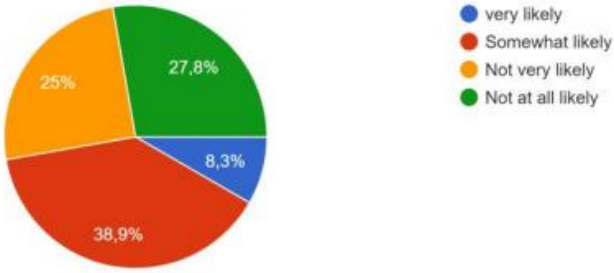
How likely are you to purchase a portable pedal exerciser in the next 6 months?

36 réponses



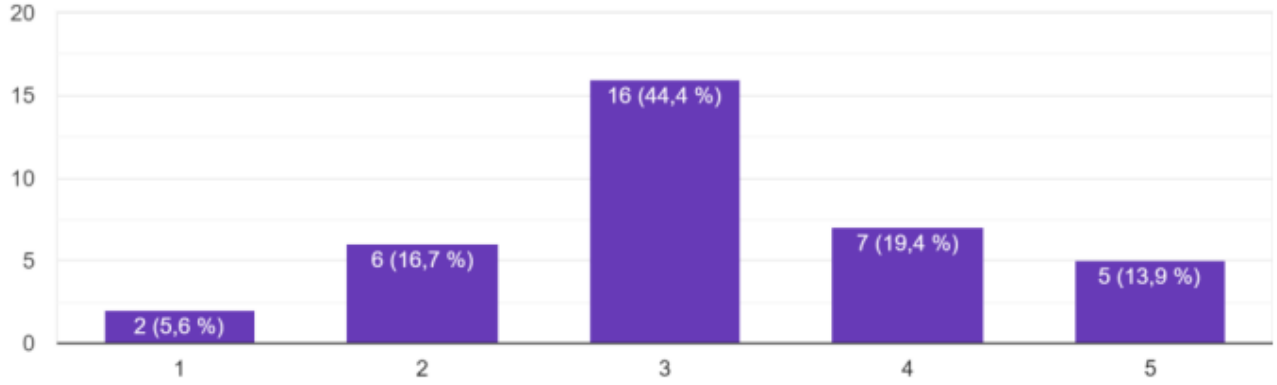
How likely are you to use the pedal exerciser while traveling?

36 réponses



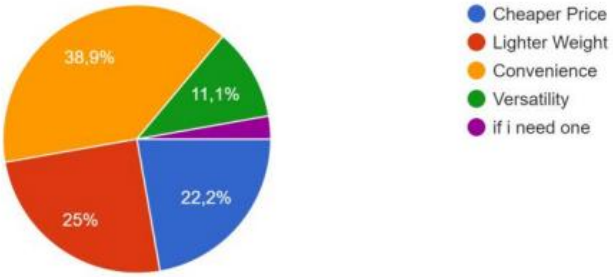
How important is the appearance/design of the pedal exerciser to you?

36 réponses



What would motivate you to purchase a portable pedal exerciser?

36 réponses



Would you recommend a portable pedal exerciser to anyone with EDS?

35 réponses

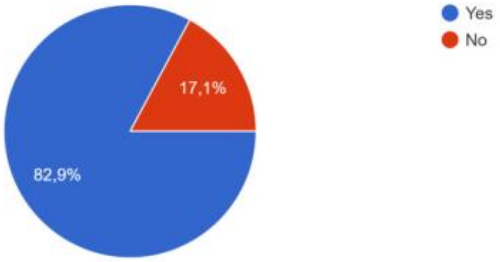


Figure 5: Ranking the Importance of Customer's Needs

#	SPECS	CUSTOMER NEEDS	Importance (Imp)
1	**Compact Design**	The exerciser should be small and easy to store.	4
2	**Adjustable Resistance**	Users need varying resistance levels for different fitness levels.	4
3	**Quiet Operation**	Minimal noise during use, especially for home or office settings.	3
4	**Stability**	A stable base to prevent wobbling or tipping.	5
5	**LCD Display**	Clear display showing time, distance, and calories burned.	2
6	**Lightweight**	Easy to move around or take on trips.	5
7	**Non-Slip Pedals**	Secure grip for safe pedaling.	5
8	**Comfortable Pedal Size**	Accommodate both feet and hands comfortably.	4
9	**Affordability**	Reasonably priced for wider accessibility.	4

Figure 6: Displaying Metrics with Customer's Needs, its Importance and Measurable Units

List of Metrics:

METRICS #	NEED #S	METRIC	IMP		UNITS
1	1,4,6	Area Size of the pedal exercise	4		Square feet
2	1,4,6	Weight of the pedal exercise	4		kilogram
3	1	Time to setup	1		minute
4	1	Time to deconstruct	1		minute
5	2,4,6	Resistance load	5		levels
6	1,5,9	Screen size	5		Diagonal distance in
7	4,5	Screen weight	4		grams
8	5	Screen display	3		resolution
9	5	Software compatibility	3		Apple/Android/both
10	4,6	Rotations to failure (Standard Settings)	4		Number of rotations
11	4,6	Vibration test	3		amplitude
12	4,6	Stiffness of the base	2		newtons/millimeters
13	7,8	Pedal surface	4		CM^2
14	4,7	Strap tension	5		kilogram force
15	7,9	Strap material	5		list
16	1,8	Pedal sizes	5		Size list (US STD)
17	1,4,8	Pedal shape	5		list
18	4,8	Arch height	5		cm
19	4,8	Heel support Hight	3		cm
20	4,8	Heel support width	3		cm
21	9	Price	4		dollars
22	9	Warranty	3		years
23	9	Adjustability	3		Degree of
24	3	Sound pressure level	2		db
25	2	Resistance range	3		list
26	4,6	Number of speeds	3		list
27	1	Number of pieces	4		number

Figure 7: Setting Ideal and Marginally Comparable Target Values

	Metric	Unit	Marginal value	Ideal value
1	Area size	Square feet	7	<8
2	Weight	kilogram	17-34	<20
3	Assembly/disassembly time	minutes	5-8 minutes	<5 minutes
4	Resistance load	levels	5 to 10	5 to 15
5	Screen size	inches	12-17 inches	>20
6	Screen weight	grams	450 g	<500 g
7	Screen display	resolution	360-720	>720
8	Rotation to failure	number	100000	>=100000
9	Pedal size	Max size	13 us	>12 us
10	Number of pieces	number	6	>4
11	Number of speeds	number	7-8	>7

Figure 21: Problem Decomposition Diagram of Step 1 in Concept Generation Process

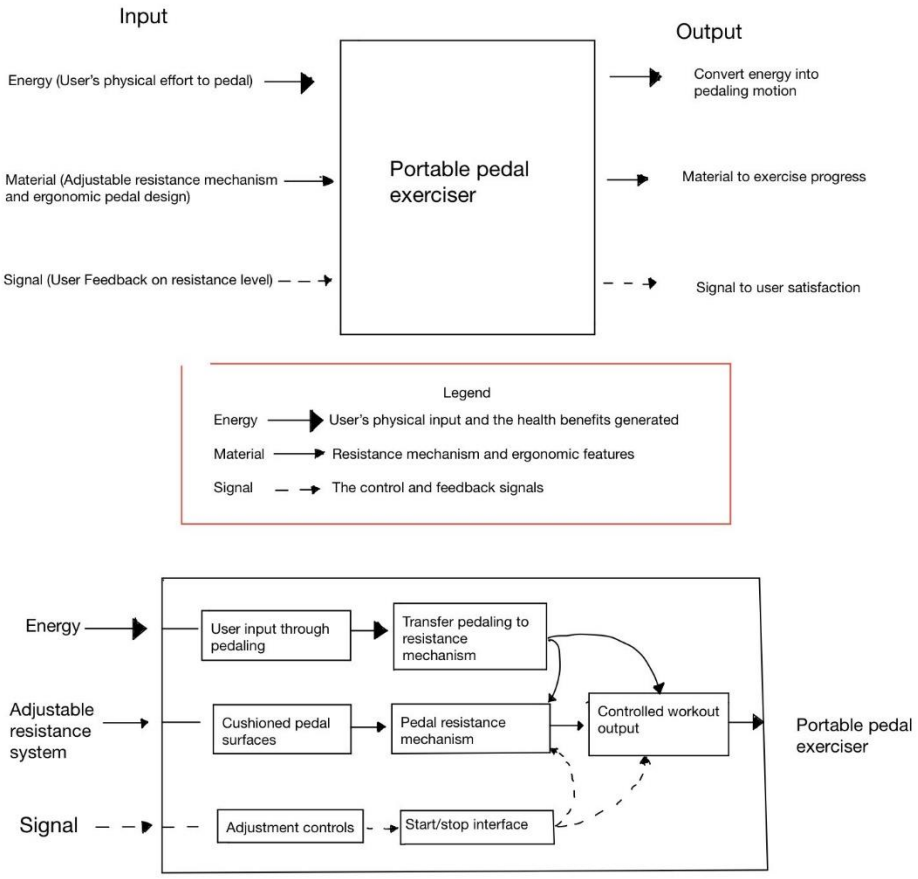


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Figure 8: External Searches in Step 2 of the Concept Generation Process

Lead users	1. Individuals with EDS who actively engage in low-impact exercise. 2. Physical therapists specializing in EDS or similar connective tissue disorders.
Benchmarking (Competitor products)	1. Soozier [3.1] 2. Motion Grey [3.2] 3. MERACH [3.3]
Experts	1. Exercise physiologists focused on hypermobility syndromes. 2. Occupational therapists with EDS expertise. 3. EDS support groups and community leaders.
Patents	1. Portable ergonomic workstation for use with exercise equipment. [10] 2. Portable pedal exerciser. [11] 3. Adaptive exercise equipment apparatus and method of use thereof. [12]
Literature	1. Research papers on exercise regimens for EDS patients. 2. Medical journals detailing the physiological impact of EDS on exercise. 3. Product design articles focusing on assistive exercise devices.

Figure 9: Search Internally: Brainstorming Sub-Functions and Concept Ideas for Prototypes

Sub-functions	Option 1	Option 2	Option 3	Option 4
Stability and Safety	Wide base with a non-slip surface	Weighted feet with retractable stabilizers	Suction cup feet for secure placement	Interlocking floor tiles for a customizable workout area
Adjustable Resistance	Manual dial with clear marking levels	Digital control with programmable settings	Resistance bands with different tension levels	Hydraulics-based resistance with smooth transitions
Comfort and Ergonomics	Padded pedals with adjustable straps	Gel padding on pedals and customizable handlebars	Ergonomic design compliant with EDS-specific recommendations	Memory foam pedal covers and adjustable height
User Feedback	User interface screen showing time, speed, and calories	Smart connectivity to apps for tracking and guidance	Auditory signals for start, stop, and milestones	Visual LED cues for resistance levels and completion
Portability	Lightweight design with possible foldable features for easy transport	Integrated carrying handle and collapsible frame	Compact design with detachable components	Wheels at the base and disassembling into a carrying case

Figure 10: Concept Classification of Each Sub-Functions

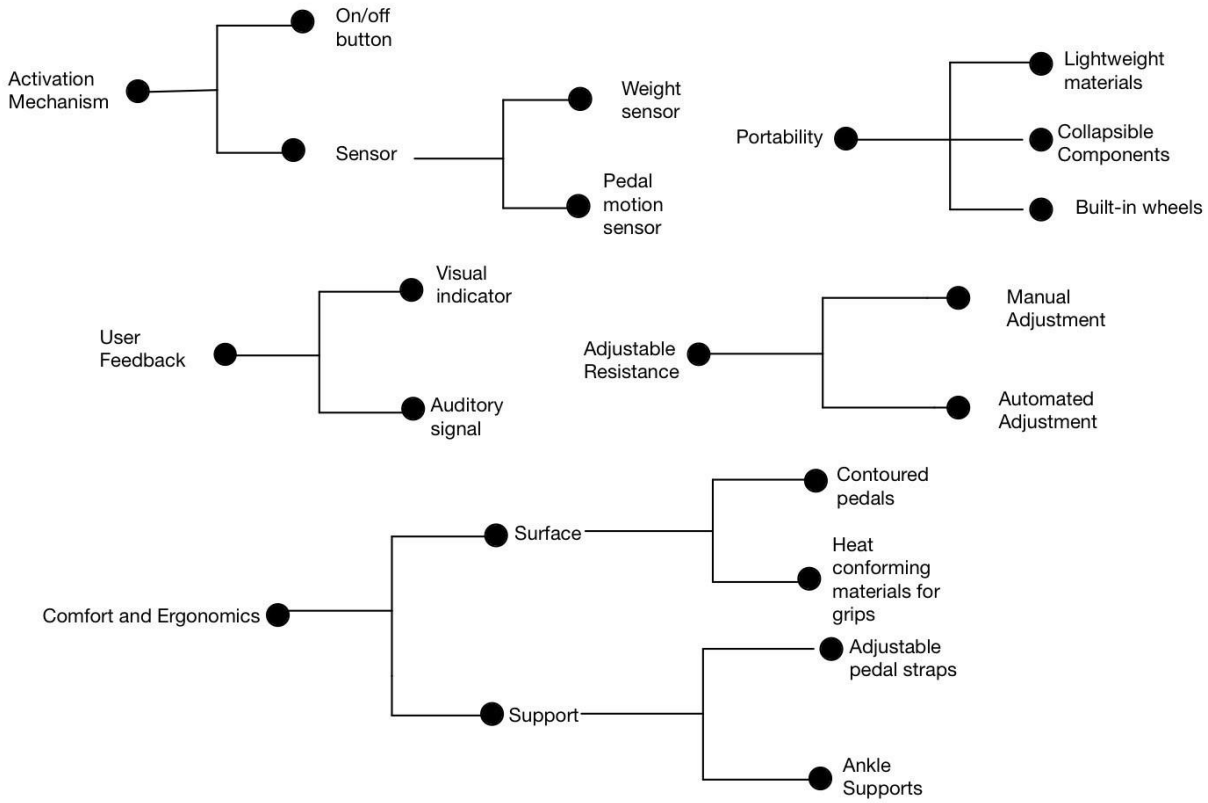


Figure 11: Combination Table of Each Sub-Functions

Adjustable resistance	**Comfort and Ergonomics**	**Portability**	**User Feedback**
Manual dial/knob	Padded pedals with straps	Lightweight Materials	User interface
Digital control	Gel Padding	Collapsible frame and Handle	Smart app
Resistance bands	Ergonomic design based on recommendations	Detachable components	Auditory Signals
	Pedal covers and adjustable height	Wheels at the base	

3x4x4x3 = 144 possible combinations

Figure 12: Three Different Prototypes Combinations Chosen

Prototype A	Extendable Screen, Elbow Rest, Rail, Gear Cover, Flat Base
Prototype B	Chain Pedal mechanism, Flywheel, Stable Base
Prototype C	Foldable Wheels, Adjustable Mechanism, User Interface, Extendable Base, Customizable Pedal positioning

Figure 13: Concept Screening Matrix

Selection Criteria	Prototype A	Prototype B	Prototype C
Stability	+	+	+
Adjustable Resistance	+	0	+
Ergonomic	+	+	+
Portability	-	+	+
Size	+	+	0
Weight	0	+	+
Pluses	4	4	5
Minuses	1	0	0
Net	3	4	5
Rank	3	2	1
Continue?	Yes	Yes	Yes

Figure 14: Concept Scoring Matrix

Decision Matrix

		Prototype A		Prototype B		Prototype C	
Selection Criteria	Weight	Rating	Weighted score	Rating	Weighted score	Rating	Weighted score
Stability	20%	4	0.8	3	0.6	4	0.8
Adjustable Resistance	20%	4	0.8	3	0.6	4	0.8
Ergonomic	20%	2	0.4	4	0.8	4	0.8
Portability	15%	2	0.3	4	0.6	3	0.45
Size	10%	3	0.3	3	0.3	3	0.3
Weight	15%	3	0.45	4	0.6	3	0.45
Total score		21	3.05	21	3.5	21	3.6
Rank		3		2		1	
Continue?		No		Yes		Yes	

Figure 16: Cost Analysis for Each Component in the Portable Pedal Exerciser

Component	Price	Material
Plastic Pedals	6$ pair	Plastic
adjustable straps	2$ pair	Fabric
plywood board	20$ (16 x 24 inch)	Maple wood
Anti-slip rubber mat	5$(16 x 24 inch)	Rubber
metal frame	30$	Aluminum
Metal joints and connectors	2$ each	Aluminum
Foam-covered metal pipes	2$ each	Aluminum
Adjustable metal connectors	4$ each	Stainless steel
LCD screen	16.14$	Ips panel
Batteries	6$	Li-ion
Heat Resistance wires	0.16$ per feet	copper
Heat Sensors	2.96$	Plastic and metal
Adjustable tension knob mechanism	6$	Plastic and Aluminum

Figure 17: Cost Estimation using the Bill of Material

Component	Purchased Materials	Assembly (Labor)	Total Unit Variable Cost	Total Cost
Plastic Pedals	6$ pair		6$	6$
adjustable straps	2$ pair		2$	2$
plywood board	20$ x 1=20$	2$	22$	22$
Anti-slip rubber mat	5$	1$	5$	5$
metal frame	30$	6.5$	36.50$	36.50$
Metal joints and connectors	2$ x 3=6$		6$	6$
Foam-covered metal pipes	2$ x 2=4$	1$	4$	4$
Adjustable metal connectors	4$ x 2 =8$		8$	8$
LCD screen	16.14$	2.00$	18.14$	18.14$
Batteries	6$		6$	6$
Heat Resistance wires	.16$ x 5=.8$		0.8$	0.8$
Heat Sensors	2.96$	1$	3.96$	3.96$
Adjustable tension knob mechanism	6$	3$	9$	9$

Total	112.9$	15.5$	127.4$	127.4$

Figure 18: Risk analysis

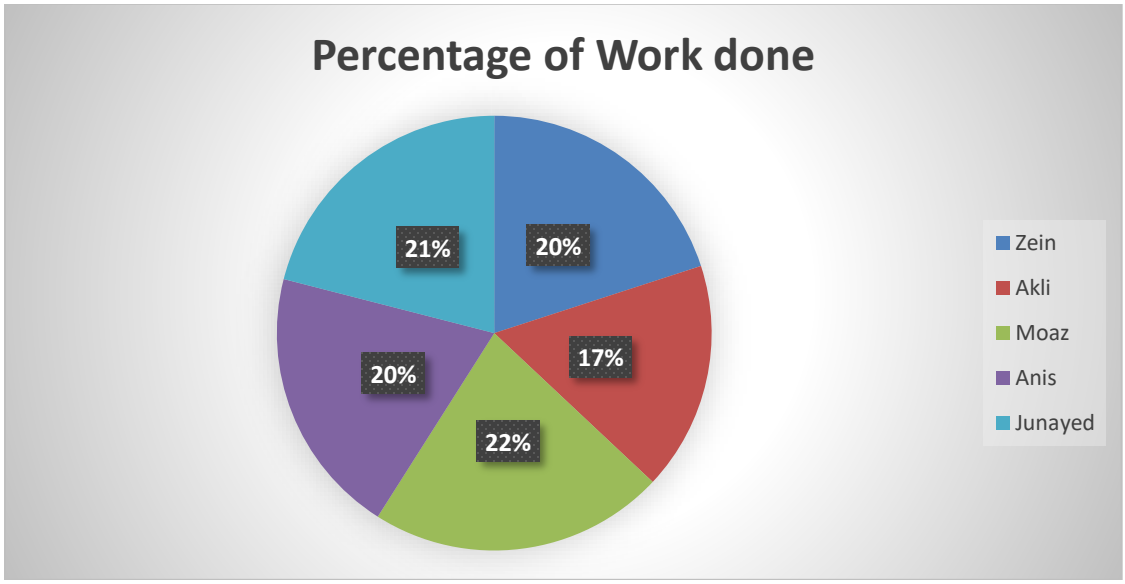
Risk type	Description	Likelihood	Impact	Action to Reduce Risk
Cost Risks	Manufacturing Costs	Medium	High	Source lightweight and durable materials; explore partnerships with manufacturers experienced in medical equipment.
	Distribution Costs	Medium	Medium	Partner with specialized medical equipment distributors; negotiate bulk shipping rates for medical devices.
	Research and Development Expenses	Low	High	Conduct thorough user testing during Research and development phase; explore grants or funding for medical device development
Market Risks	Competitive Landscape	High	Medium	Focus on features related to EDS patients: adjustable resistance levels,
	Changing Consumer Preferences	Medium	High	Regularly engage with EDS patient communities for feedback; adapt product features based on user preferences.
	Regulatory Compliance	Low	High	Consult with medical device regulatory experts from the outset; prioritize adherence to FDA or relevant regulatory standards.

Technical Risks	Design Challenges	Medium	High	Collaborate with physical therapists and EDS specialists in product design; conduct extensive usability testing with EDS patients.
	Quality Control	Medium	High	Implement strict quality control procedures, including rigorous testing for durability and safety; offer extended warranties for peace of mind.
	Component Reliability	Medium	Medium	long-term contracts with trusted suppliers; maintain inventory buffer to mitigate supply chain disruptions.

Figure 19: Lessons Learnt

Lessons Learnt		
What was done right?	**What was done wrong?**	**What could've been done better?**
Good communication and effective collaboration	Project scope was unclear	Clarify goals and task allocation
Great teamwork and great coordination to complete the report in time	Uncertainty about the product design and objectives at the beginning	Manage time more efficiently
Fair division of work in the final report	Specifications about the design was not communicated to everyone	Follow the Gantt chart

***Declaration of percentage of work done by each group member**



Member Name	Zein Deeb	Junayed Bin Zaman	Med Islam Anis Dahmani	Merahi Mohand Akli	Mouaz Samman
% Of Total Work Done for Project	20	21	20	17	22

Expectation of originality：

Form ENCS-SAS (03/04)

Faculty of Engineering and Computer Science
Expectations of Originality

This form has been created to ensure that all students in the Faculty of Engineering and Computer Science comply with principles of academic integrity prior to submitting coursework to their instructors for evaluation: namely reports, assignments, lab reports and/or software. All students should become familiar with the University's Code of Conduct (Academic) located at https://www.concordia.ca/conduct/academic-integrity.html

Please read the back of this document carefully before completing the section below. This form must be attached to the front of all coursework submitted to instructors in the Faculty of Engineering and Computer Science.

Course Number: MIAE 380 **Instructor:** Dr. Gabriel Taraboulsi

Type of Submission (Please check responses to both a & b)

a. _x_ Report ___ Assignment ___ Lab Report ___ Software

b. ___ Individual submission _X_ Group Submission (All members of the team must sign below)

Having read both sides of this form, I certify that I/we have conformed to the Faculty's expectations of originality and standards of academic integrity.

Name: Zein Deeb (please print clearly) ID No: 40200973 Signature: Zein Deeb Date: 15/04/2024

Name: Merahi Mohand Akli (please print clearly) ID No: 40216712

Name: Med Islam Anis Dahmani (please print clearly) ID No: 40228399 Signature: Date: 15/04/2024

Name: Junayed Bin Zaman (please print clearly) ID No: 40102660 Signature: Anis Dahmani Date: 15/04/2024

Name: Mouaz Samman (please print clearly) ID No: 40207939 Signature: Junayed Bin Zaman Date: 15/04/2024

Signature: Mouaz Date: 15/04/2024