Shampoo/Conditioner Identification Device  
&  
Backpack Lever Arm System  

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**Shampoo/Conditioner Identification Device**

**EXECUTIVE SUMMARY**

Reduced visual perception and memory loss are conditions that hamper the progress of many individuals to become independent, especially in terms of carrying out daily activities. The client is an elderly woman with this disability, and wishes for an assistive device to help in identifying shampoo and conditioner bottles in the shower.

On the basis of client’s requirements and an analysis of engineering design (taking into account factors such as efficacy, practicality, safety, comfort, and cost), Team 4 has come up with a design to help the client achieve this capability. Fundamentally, the device is a touch-sensitive pad, wired through a logic circuit system and an output speaker to produce an auditory signal, helping the client identify the device that she is holding. The physical characteristics of the device have been determined on the basis of surroundings in which the device will be most frequently operated, the shower. Here, it will also be vital to account for size and weight. Other important factors include low maintenance and long-term product life.

The design is unique, as it is rare to find a device that uses client’s input to identify the object that he or she is holding. This is due to the combination of decreased eyesight and memory loss which made elementary solutions to this problem ineffective. Thus, a more sophisticated and technologically advanced design was requested to aid the client.

**1. INTRODUCTION**

**1.1 Background**

An innovative biomedical appliance is required to aid Mrs. Smith, an elderly woman with reduced visual acuity. In addition, Mrs. Smith faces mild-to-moderate progressive cognitive impairment. Despite these conditions, Mrs. Smith strives to remain independent and carry out her daily routine. One such task is the recognition of shampoo and conditioner bottles in the shower.

Her family has requested a lightweight waterproof shock-proof device that utilizes her auditory abilities. Several elementary alternatives have been attempted to resolve this issue, such as clearly segregating bottles with large letters and using containers of different dimensions, but have unfortunately failed. It is apparent that Mrs. Smith will require another means of discerning
between the bottles, thus eliminating the need to deal with shapes, colors, and sizes.

The product should be able to connect to each bottle. When squeezed gently, it should emanate an auditory voice signal - “shampoo” or “conditioner!” After an initial assessment of Mrs. Smith’s needs and environment in which the design is bound to operate, it is vital to account for safety (e.g. shock-resistant, corrosion-resistant). In addition, the device should be user-friendly and simple to operate.

1.2 Purpose of the Project

The purpose of this project is to design and develop an instrument that will allow Mrs. Smith to accurately differentiate between shampoo and conditioner bottles while in the shower. Due to conditions that result in reduced memory and vision, simple indicators to distinguish between these two objects have failed Mrs. Smith to reliably make a distinction between shampoo and conditioner bottles while in the shower. Other options have failed for Mrs. Smith because the effectiveness of those solutions relied on her memory and vision. Mrs. Smith requires a touch-sensitive device, which upon triggering will cause a sound signal to be produced.

1.3 Previous Work Done by Others

Several previous NSF projects are similar to the Shampoo and Conditioner Identification Device because they share the same goal of using voice outputs to aid people who are visually impaired.

Cynthia Henderson from the Department of Agricultural and Biological Engineering of Mississippi State University designed a voice output device for scientific calculators. The device sends user inputs from a calculator to a BASIC Stamp II microprocessor. The microprocessor then sorts and transfers the data to an ISD1000A voice chip that plays the information corresponding to the mathematical expression. This device is extremely helpful for people who need verbal reinforcement for visual stimuli.

Kurt Peterson and Neil Peterson of the Department of Electrical Engineering of North Dakota State University created a GPS voice output device for visually impaired cane users. This mechanism uses a GPS receiver and a PIC16F876 microcontroller to collect position, speed, and heading information every 1 to 5 seconds. These data are then processed by the V8600A Speech Synthesizer to generate voice outputs when users press on the keypad.
Verbal indication devices are also used in many children interactive learning toys. When user presses on the items, appropriate voice outputs help them to identify the objects, colors, shapes and learn phrases.

*Figure 1. Fisher Price - Laugh & Learn Learning Table 1*

Touch sensitive device with voice feedback are also used for training animals. When pets step on them, a sound signal emits out from the small speakers that are integrated in the device.

*Figure 2. Fisher Price - Jumbo Talking Elmo 1*

*Figure 3. High Tech Pet - Radio Mat, Electronic Scat 2*
1.3.1 Patent Search Results

U.S. Patent No. 6,449,887 – Water Globe with Touch Sensitive Activation
This device is a crystal ball system consisting of a support base and a display. The touch sensitive mechanism inside of the globe assembly drives the audio producing mechanism which produces voice outputs upon contact. 3

U.S. Patent No. 4,748,756 – Touch Activated Enhanced Picture Frame
The picture frame contains a sound generating device that emits voice when user touches the touch sensitive contact area. The concept behind this device is the touch sensed by control circuitry which responds by activating and controlling the functioning of the built-in speakers. 3

A microcontroller is built into the lamp, which is connected to the touch sensor. Upon contact the microcontroller initiates communication of audible messages. 3

U.S. Patent No. 7,269,484 - Vehicular touch switches with adaptive tactile and audible feedback
A manual control system for a vehicle includes a touch sensitive input element and an audible feedback generator. When user touches the device, a sound signal is generated and emitted. 3

2. PROJECT DESCRIPTION

2.1 Objectives

This innovation will make use of a mechanical stimulus (squeeze) by the client, and will result in an auditory signal indicating the appropriate item (shampoo or conditioner). However, various factors need to be accounted for, given the nature of the client’s particular needs and the surroundings in which the device is expected to be used. In addition, the device should be accommodative to different bottle sizes, so that the client has the freedom of using products of her choice.

Given the properties of water and proximity to electrical parts, all measures should be taken to ensure that any possibility of contact is eliminated. This will be carried out through a waterproof casing to maintain client’s safety. In addition to making the device shock-proof, corrosion resistance is absolutely necessary for daily use and long-term product life. However, it is essential to note that adding these features must not result in excess weight, to the point of causing any inconvenience to the client. A device that is light in weight would reduce risk of injury to the client, in-case the bottle/device falls.
Currently, we are thinking of customizing a touch-sensitive mat, used to train pets to refrain from entering certain areas of the house. Currently, ‘Scat Mats’ available in the market are used to cover large areas. The smallest one found is available through Sam’s Club, and is a thin, but long strip having dimensions of 12’’ x 60’’ . A positive feature of these mats is that upon contact, a sound signal is emitted to keep the pet at a distance from that area. As described by High Tech Pet, ‘When you select the Sound Blast feature, the pad emits a loud sonic blast at the touch of a paw.’ In this case, a small and light-weight speaker is attached to the mat itself, making the entire instrument light in weight. In addition, this device is made of a durable, nylon pack material that is water resistant and operates on a single 9-volt battery. These types of features are exactly suited to our purposes, since contact with water is undesirable and corrosion-resistance is necessary.

Using this idea, we must recreate and modify this device in a manner that it is scaled-down, but still retains its sensitivity. It must wrap around the bottle like a belt, with adjustable holes to account for the varying diameters of products. The belt itself will be made of this touch-sensitive material, so that the client does not have to be aware of pressing a particular button or area. Upon contact, a signal will be transmitted to the small speaker incorporated in the belt, to emanate a voice – ‘Shampoo’ or ‘Conditioner’!

The idea of a wireless transmitter-receiver to external speakers to emit the auditory signal was also analyzed; however, this would require extra space in the bathroom and greater maintenance of this device. Therefore, at this stage, the idea of a small speaker attached to the belt seems feasible.

2.2 Methods

The fundamental concept of this device involves translation of a mechanical stimulus into a sound wave output. The pressure sensitive pad will detect the squeezing movement. In general, pressure sensors involve piezoelectric concepts. One that we are investigating for our design is a micro-machines silicon diaphragm with a piezoresistive strain gauge diffused into it, fused to a glass plate. Upon application of pressure, induced strain increases the value of radial resistors and decreases the value of transverse resistors. This resistance change can be high as 30%. After this, an electronic signal will pass through a logic system, which will subsequently feed into a small speaker onto the belt, which will emit the appropriate voice signal.

Thus, two touch-sensitive belts that wrap around different sized bottles is a viable solution to the client’s problem. From preliminary research, there is no device similar to this one in the market. Although one may find various touch
sensors integrated with sound emitting devices, it has rarely, if ever, been used for healthcare in helping individuals with reduced visual acuity or memory become independent. In addition, toys require the user to press a button or particular region for the sound to emanate.

Our client’s product will be unique due to the ability to detach the device from a particular bottle and easily accommodate it to fit another’s size. Shampoo and conditioner bottles come in various sizes. With adjustable belt straps, it will be easy to use on a wide range of products. In addition, there is no need for the client to search for a button on the device. The entire belt will consist of the touch sensitive panel (similar to the Scat Mat sheet described above). Mrs. Smith will be informed of which bottle she is holding by merely placing her hand on it and applying slight pressure.

A small speaker will be incorporated into the belt. Soft insulation will be used to cover any wires to avoid any exposure of visibility from the outside. Furthermore, this will be covered in a nylon casing for its waterproof properties. By placing small speakers on the belt of the device, there is a need for an added auditory output system, which may be expensive, inconvenient, and more space–inefficient. However, we expect that placing the belt on a bottle will increase the total diameter by about 1” in the region of the touch sensor and 2” in the region of the speaker. Thus, one constraint is a little more space is required to store the bottles on a daily basis.
The potential of a client holding a particular bottle for an extended period of time poses a specific problem. Constant pressure on the switch will continually activate the circuit and trigger the voice prompt. In order to make the project more convenient and user-friendly, we plan to use a delay circuit. This will allow the switch to be closed for a prolonged period of time without constantly outputting the recorded message. Specifically, if the switch is activated, this system will give an initial prompt and then wait 30 seconds before prompting the user again.

In this logic system, the main component that will be utilized is an 8-bit digital logic counter. The counter will be enabled when the touch switch is closed. The counter will then be incremented using a 60Hz square wave oscillator as the clock signal. The rising edge of each pulse will correspond to one second in time. Using an array of 4 NOR gates, the circuit will output a prompt when the switch is initially closed. Then if the switch is held, the clock will increment until it reaches the 30th state (30th second). The binary output at this state will be 01111. Using an inverter on bit Q0 (output bit 0) and an array of 4 AND gates, the counter will be cleared and the voice prompt will be sounded again. If the switch is still closed, the counter will start the sequence over.

*Figure 4. Schematic for Shampoo/Conditioner identification device*
Figure 5. Circuit Diagram of the Microcontroller
3. BUDGET

The cost of similar products in the market ranges from $30 - $80. The budget allotted for this project is $750, and after a rough estimate, we are well within it. The majorities of components in this list is electronic parts required for a circuit and logic design, and are relatively inexpensive.

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*Table 1. Estimated Total Expense*

4. CONCLUSION

The utility of the shampoo/conditioner identification device can be seen in not only individuals such as our client, but those that may suffer from chronic conditions. Alzheimer’s diseases often results in memory loss, and affects a significant portion of the elderly population in America. In addition, this device may be useful for individuals that have recently been through surgical procedures involving the eyes, and need to temporarily adjust themselves while healing takes place. The reason I have not included completely blind individuals is that, for the most part, they have a highly developed sense of touch, and can easily identify objects by several hand motions along its surface. This particular device will be utilized in the shower, and will allow the client to be independent in area where individuals prefer privacy. Due to this device’s small size, it is naturally portable and can be used wherever the client goes, even is he or she needs to travel. Being independent is a fundamental desire of most individuals, and it is clear (at present, through other products) that helping them attain self-sufficiency is possible through the use of technology. Therefore, it is clear that a market exists for this type of device.
By designing and developing a device that is the first of its kind, we are creating an innovative and unique product. In general, features incorporated within the device such as touch-sensitive pads and small audio outputs are standard in other products. However, their integration and use to form a healthcare product is a novel concept. If this device is ever taken to the market, it will cater to a small group of customers. Production of such a device in this niche market will reduce the inconvenience caused to individuals suffering from a combination of health conditions. At present, raw materials for the design seem to be inexpensive; we have plenty of funds to work with, in case resources that we wish to work with change with adjustments in design.

REFERENCE

**Backpack Lever Arm System**

**EXECUTIVE SUMMARY**

Cerebral Palsy is a disorder that limits physical mobility, along with other symptoms such as irregular posture, reflexes, and muscle coordination. In many cases, this leads to increased dependence for the individual on others in terms of carrying out minor tasks. The client is an eight-year old with this disability, who wishes for an assistive device to help in removing and replacing items from his backpack.

Based on the client’s needs and an analysis of engineering design (accounting for various factors such as effectiveness, feasibility, safety, comfort and cost), Team 4 has come up with a design to help the client achieve this capability. Fundamentally, the device is a rotating arm (about a single hinge), which facilitates the movement of the client’s backpack along the arm via a motorized wheel mechanism. The exact position of the arm, and the materials by which it will be manufactured have been decided on the basis of the surroundings in which the device will be most frequently operated, as well as how to optimize space. Other important factors include long-term utility and low maintenance.

The design is unique due to its ability to bring the backpack to the precise position of the client’s mid-body line and fold once the cycle has been completed to form a compact structure, which is easy to carry and leave attached to the wheelchair when it is moving or stationary.

**1. INTRODUCTION**

**1.1 Background**

An innovative biomedical device is required to aid Mason, an eight-year old with cerebral palsy, a non-contagious disease that causes physical disability in human development. Typically, this disorder is characterized by abnormal muscle tone, posture, reflexes, or motor development and coordination. In addition, there can be joint and bone deformities and contractures. This condition generally leads to spasms and other involuntary movements.

Based on correspondence with the family, we have gained an insight on the nature of Mason’s specific needs. Particularly, this refers to the fact that Mason has a functional right shoulder/arm/ hand, capable of a wide range of motion and fine motor skills. However, his trunk is weak; but he can sit, if
properly positioned, upright in a regular chair for some time before tiring. He has trunk supports on this wheelchair to assist him with fatigue.

1.2 Purpose of the project

Mason’s health symptoms have caused increased dependency on others, even to carry out minor tasks. Our client has a strong desire to be independent and wishes for the capability to access his possessions without outside assistance. Specifically, this refers to being able to remove objects from his back pack, which is usually attached to the wheelchair.

1.3 Previous Work Done by Others

Thomas Cabell and Brian Deuter from the Department of Agricultural and Biological Engineering of Mississippi State University designed a device that transfers, supports and stores backpacks to facilitate independence for a student with cerebral palsy. This device is very similar to the one being developed in this project. An aluminum track with a 90º curve in the middle mounted on to the two parts of the wheelchair: the front main frame and the bar behind the seat. Attached to the track is a carriage consisting of six ball bearings and a rectangular piece of aluminum. One bearing supports the load while four others keep the rectangle tangent to the track.

![Figure 1. Backpack Transfer Device](image-url)
There are many wheelchair assistive products in the market. They are usually attached to different parts of the wheelchair to make certain items easily accessible. Some examples are camera holder and joystick holder.

![Image](image1.png)

**Figure 2. Camera Holder for Wheelchairs**

Although the products listed above share the common goal of aiding the wheelchair user gain easy access to their belongings, they are not as close to the device designed in this project as the Magic Arm made by Beneficial Designs Inc. Magic Arm has a 90 degree pivoting end, a 360 degree rotating end, and a 360 degree rotating elbow. Both ends have studs that are tapped and fit any standard 5/8 inch socket.

![Image](image2.png)

**Figure 3. Magic Arm**
1.3.2 Patent Search Results

**U.S. Patent No. 5,180,181 - Motorized Movable Storage Bag for Use on a Wheelchair**
A storage bag attachable to a wheelchair is moved from the back of a wheelchair to an accessible position. This is achieved by an electric motor which rotates an L-shaped bar supporting the storage bag. The motor works in both directions, and draws energy from a battery mounted on the wheelchair frame. 

**U.S. Patent No. 20050001405 - Pivoting Wheelchair Backpack Holder**
The device includes a lever rod, a swing-out handle, and a frame. The backpack that is being moved from the back of the wheelchair to the front is attached to the frame, which is moved by the lever rod. The backpack rests behind the wheelchair in its closed position. The operator grabs the swing-out handle and locks it to the lever rod which then brings the frame around to the best accessible position.

**U.S. Patent No. 4,919,443 – Swing-out backpack for wheelchairs**
The device is a box that has a top, bottom, left and right compartment. The box is pivoted at a rod which is mounted to the wheelchair. The box has the capability to swing from the back of the wheelchair to the side which gives the user more convenient access to their belongings.

2. PROJECT DESCRIPTION

2.1 Objectives

Our device is essentially an electrically operated roller, capable of moving Mason’s belongings to an accessible position. The backpack lever arm will be designed in a manner that takes advantage of our client’s functional right arm. The device will remain in close proximity to Mason’s wheelchair at all times; it will be located on the right-hand side to utilize his arm’s reaching capability. Designing this device on the opposite side of the wheelchair may cause Mason difficulty, as he may have to inconveniently stretch; therefore, this option has been ruled out. A switch mechanism will be used to conveniently position the device at Mason’s lower thoracic/upper abdominal level for optimum comfort. One of the clients’ requests is that the backpack be brought close to the body’s midline. This type of design will allow us to meet this requirement.

The foldable arm will involve a single-hinge joint at an appropriate position on the arm to allow for horizontal planar motion. The arm will have one joint, connecting two limbs. One limb will remain attached to the back of Mason’s wheelchair (at a height level that approximately 6 inches above that of
his arm rest) and the other will rotate to create a track on which the motorized roller will move. The end of the arm will serve as the final position for the motorized roller. The attached backpack will be fastened to the motorized roller wheel via an attachment accessory, such as a clipper.

To describe the functioning of the device in sequence, it starts with a user stimulus. When Mason wishes to obtain items from his backpack, he will turn Switch 1 located on a wireless remote controller (which is attached by a Velcro strap to his right arm chair). The free moving arm will rotate about the hinge 270 degrees in a counter-clockwise direction to form a path for the roller. The logic for this movement will be incorporated into the design. Once the arm has reached its final position and locked into place, Mason will turn Switch 2 to have the roller begin moving on the inner side of the track. It is presumed that the backpack will be facing inwards for convenience to client (minimize stretch). The wheel will initially roll on a straight path, and then be exposed to a curvature in the path; following this, it will resume on a straight path, perpendicular to the position in which it started rolling. Finally, the motorized roller wheel (with an attached backpack) will move around the second curvature and stop at a position that is directly in front of Mason.

Once he has removed/replaced the desired items from his backpack, Mason will turn Switch 2 on the wireless remote control. This will reverse the movement of the motorized roller wheel and bring it back across the curved track to the initial position. Once this has been achieved, Mason will turn Switch 1 to have the collapsible arm rotate about the hinge 270 degrees in the opposite (clockwise) direction to attain a folded position.

2.2 Methods

The following is a visual representation of how the device is supposed to function. The upper block diagram indicates the movement to bring the backpack from its initial position at the back of the wheelchair to the front – to our client’s mid-body level. The lower block diagram shows how, upon stimulus, the backpack returns to its initial position behind the wheelchair, followed by folding of the arm into a convenient and ‘collapsed’ position.
Figure 4. Flow Chart of Lever Arm Operation

The foldable arm itself will be made of low carbon steel, and will involve a single-hinge joint at the second curvature position on the arm to allow for the described movement in a horizontal planar motion. The end of the arm will serve as the final position for the motorized roller. The backpack will be attached to the motorized wheel, which will move the load; in order to fasten the backpack, an attachment accessory – the ‘H.B. Clipper Quickdraw’ will be used to hold the backpack. CFG Hinges from Monroe Engineering can be used for the joints. These are high impact strength technopolymers. They are also resistant to solvents, oil, greases and other chemical agents which may be needed for periodic lubrication and maintenance of the device. The motor will require a separate battery, capable of moving the roller wheel and the 30 lb backpack.

As the instrument is user-controlled, it requires an input from the user. We plan to incorporate a remote control with the two separate switches on any part of the wheelchair that the client finds comfortable. This will involve a
wireless component to our design, as separate signals will be sent from the switches (on the remote) to the rotational arm as well as the motor. In creating a wireless interface, we plan to use a BlackFin® Processor from Analog Devices, as well as LabView to enable this technology. The majority of the work will occur in creating a wireless transmitter. The following LabView VI shows some of the code that will be required for this creation. This will be modified to cater to the final design of the Backpack Lever Arm.

![Figure 5. LabView VI for wireless transmitter](image-url)
In terms of exact location and of the device, dimensions of the client’s wheelchair, the Quickie-500, must be taken into account. The seat has an adjustable width of between 12”-14”; the depth of the seat is adjustable between 10”-15”. Taking these figures into account, it becomes easier to specify lengths of the individual arm components. In this design, the first limb of the arm (L-shaped), which is attached to the back of the wheelchair, has the following dimensions – the part of the arm that is parallel to the back rest is 14 inches in length. At the point of the curvature, there will be a supporting fixture to the seat of the wheelchair to help hold up the arm. The limb that is parallel to the arm rest will be about 15 inches in length from the point of curvature to the hinge joint. The rotational (moving) limb of the arm that will allow the arm to be foldable/collapsible and permit movement of the backpack to a center position will be 6 inches in length. The height of these steel rods (used to form the limbs) will be 2 inches.

![Figure 6. Top view of the schematic of the Lever Arm System](image)

With reference to the environment, all measures will be taken to ensure that the device causes no harm to the surroundings. Specifically, this refers to the fact that the lever arm will be collapsible and will be located 6 inches above, and directly parallel to the arm rest. This way, there is no major protrusion away from the wheelchair when objects are being put into/removed from the wheelchair. However, care must be taken while the arm is folding/ unfolding.
Since there will be moving equipment, it is vital that there is sufficient space around the wheelchair. Since this device will be operational in a school surrounding, construction materials and design will account for our client’s health and safety as well as those around him; the curvatures on the arm will be rounded to ensure that there are no sharp edges that can cause injury to others.

With reference to the motor that will be utilized to move the wheel forwards/backwards, we are looking at a product from Golden Motor Inc., model number 93WS003. This motor dissipates 30 W of power and uses a 45 V DC source (battery), which can be recharged.

In terms of sustainability, our device will have to be capable of withstanding a variety of loads and weather, which it will be constantly exposed to. Storage temperature will be set between -40°F to 120°F. As the family lives in Canada, withstanding different weather conditions will be vital to long-term functionality. Selection of appropriate materials for this device will be essential for corrosion resistant properties. After analysis of strength requirements and sustainability, low-carbon steel with a corrosion resistant coating seems to be the best option.

In addition to using insulating material (to prevent shock in a wet surrounding), weight is also an important consideration in eliminating burden while operating and reducing the chance of an injury. Materials with rough edges or sharp protrusions will not be incorporated to abide by our underlying values, which is to guarantee the safety of our client.

There is one social constraint, which is that our device must be lubricated periodically to ensure smooth functioning of incorporated joints. This will require someone to visit Mason and carry out normal maintenance. Therefore, a minute element of dependency on another individual still exists.

3. BUDGET

Currently, the budget is based upon our preliminary design of the backpack level arm. Taking into account important factors in design and the client’s requirements, the following materials will be required for product development. This is an estimate, based on internet price quotes. Some product component requirements may change with modifications in the design of the lever arm.
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<td>Supports</td>
<td>20</td>
</tr>
<tr>
<td>Quickdraw Clamp</td>
<td>9.93</td>
</tr>
<tr>
<td>Misc. Electrical Components</td>
<td>30</td>
</tr>
<tr>
<td>Total Expense</td>
<td>230.42</td>
</tr>
</tbody>
</table>

*Table 1. Estimated Total Expense*

Most related products, which have been developed by Mississippi State University costs $1300. These have been described to a large extent in the ‘Previous Work’ section of the proposal. These products are the most similar to our design in terms of function. Products on the market like a three-dimensional moving robotic arm by Zap Dynamics to pick up objects and bring them closer to the individual are priced at $30,000. These obviously have a wider array of capabilities, and may be highly priced due to branding or reputation of the company. In comparison to this product, our lever arm will be less complex, since movement is in a single plane rather than three dimensions.

4. CONCLUSION

The utility of the backpack lever arm can be applied to not only individuals with cerebral palsy, but others that may have trouble with awkward postures. This can include individuals with progressed forms of muscular dystrophy or multiple sclerosis. This particular device will be applied in a school setting, and primarily involves the removal and replacement of educational accessories such as books or writing utensils. However, it is natural for a backpack lever arm to be used anywhere, whether in a professional scenario or casual social setting. Being independent is a fundamental desire of most individuals, and it is clear (at present, through other products) that helping them attain self-sufficiency is possible through the use of technology. Therefore, it is clear that a market exists for this type of device.

By adding a collapsible feature to the lever arm, we will be able to develop an innovative and unique product. The other features in this system are
standard, and can be found in related products. However, if this device is ever taken to the market, it is possible that we will have a competitive advantage over our competitors, as the foldable technology permits movement of the backpack to the exact position desired by the user. It also brings the object closer to the body, minimizing stretch and inconvenience caused. At present, raw materials for the design seem to be inexpensive; we have plenty of funds to work with, in case resources that we wish to work with change with adjustments in design.

**REFERENCE**