1. Introduction

Vandelay Industries has been looking at small-to-medium cargo transportation devices. Two proposed devices, the Battery Driven Cylinder (BDC) and the Pump Platform (PP), are compared below.

1.1 The Battery Driven Cylinder (BDC) [1]

The BDC is a cylindrical container attached to two sets of wheels and motors. It uses a battery at the bottom of the device, used with the handlebar which acts as a control for the user. A headlight is on the front of the device.

1.2 The Pump Platform (PP) [2]

The PP is a specially modified dolly with a pump. This allows the platform to go up and down. There is a set of large wheels at the rear with a set of small swivel wheels at the front. A set of four holes are located on the platform to allow changes to the device.

Refer to Appendix A for pictures of the devices. By comparing the two devices, we can recommend the better device for production.

2. Functional Comparison

The functions make up a critical portion of the design feasibility. Because both designs are designed with the main priority of moving cargo, the secondary functions are a basis for comparison, and these results used to determine functionality. The secondary functions of both devices are:

- Keep the cargo protected from weather
- Keep the cargo protected from theft
- Responds to user input
- Keep the user safe

The following table compares the means of the secondary functions.

Table 2.0.1: Secondary Functions and their Means

Secondary Function	Battery Driven Cylinder [1]	Pump Platform [2]
Cargo protection from weather	Hatch on the top prevents water from touching cargo	No protection from weather
Cargo protection from theft	Locks used to prevent theft	Does not stop theft
User input response	Converts user input into signals to run motors and brakes	Converts force into movement in the same direction
User safety	Device falls forward. Balanced on four wheels.	Device falls forward. Balanced on four wheels.

2.1 Conclusion

Both devices keep the user safe. They are balanced on four wheels, reducing the possibility of falling. The BDC converts user input into a signal to activate motors, different from the PP's push operation. The BDC protects from weather and theft through the use of locks and hatches, superior to the PP's incapability of preventing theft. The PP does not protect very well against weather such as rain or snow.

3. Stakeholders [2]

The stakeholders help determine the feasibility of any project. The concerns of the stakeholders should be addressed by the recommended design. The stakeholders and their involvement in the project are:

- Vandelay Industries – product manufacturer – cost, feasibility
- Users – Primary consumer
- Investors – Product success
- Government – Laws and standards
- Environmental Associations – Carbon footprints

The following chart plots the two devices with stakeholder requirements.

Table 3.0.1: Stakeholders

Stakeholder	Battery Driven Cylinder [1]	Pump Platform [2]
Vandelay Industries	D: Costly components [3] D: Costly research	A: Simpler construction D: Pump
Consumers	A: Safe, protected cargo D: Components eventually require replacement	A: Similar to hand trucks D: Not innovative D: Lack of cargo protection
Investors	A: Interesting design A: Innovative	D: Not innovative – reduced interest
Government	A: Follows government standards	A: Follows government standards
Environmental Associations	A: Recyclability D: Uses petroleum	A: Recyclability D: Uses metal
Total	A: 5 D: 4	A: 4 D: 5

Advantages are denoted by "A" and disadvantages by "D".

3.1 Conclusion

For environmental associations, the critical point is that both designs are recyclable and use non-renewable resources. Government standards are followed. The BDC requires Vandelay Industries to do research for components while the PP requires a pump. The user would not complain from using the BDC because their cargo would be safe, while the PP has potential for cargo damage.

4. Economics [4]

Money is used over construction, service life, and disposal. The design must minimise cost while maximising total benefits. The following tables show the initial, ongoing, and final costs of both designs.

4.1 The BDC

The following tables isolate the costs over a period of time. Some factors reoccur over longer periods of time. The relative effect column rates the factor's importance on a scale of one to five.

Table 4.1.1: Cost of multiple BDC units over time, view of Vandelay Industries

Cost factor	Recurrence of factor	Effect on total cost	Relative Effect
Acquiring raw materials	Repeated	Large increase	+3
Setting up manufacture process	Single	Slight increase	+0.5
Production	Repeated	Slight increase	+0.5
Shipping	Repeated	Slight increase	+0.5
Profit	Repeated	Large decrease	-5
Total cost			-0.5

For Vandelay Industries, there would be a profit.

The following table shows the effect on the user.

Table 4.1.2: Cost of one BDC unit over time, view of Users

Cost factor	Recurrence of factor	Effect on total cost	Relative Effect
Purchase	Single	Large increase	+3
Battery replacement	Repeated	Increase	+2
Maintenance	Repeated	Increase	+2
Disposal	Single	Increase	+1
Total cost			+8

The battery replacement cost is quite high; it is unlikely that a small battery has enough power. Disposal costs are higher because of the process of taking the BDC apart in order to recycle it.

4.2 The PP

The following tables isolate the costs over a period of time. The same scales are used.

Table 4.2.1: Cost of multiple PP units over time, view of Vandelay Industries

Cost factor	Recurrence of factor	Effect on total cost	Relative Effect
Acquiring raw materials	Repeated	Large increase	+2
Setting up manufacture process	Single	Slight increase	+0.5
Production	Repeated	Slight increase	+0.5
Shipping	Repeated	Slight increase	+0.5
Profit	Repeated	Large decrease	-5
Total cost			-1.5

For Vandelay Industries, the device would create a bigger profit.

The following table shows the effect on the user.

Table 4.1.2: Cost of one PP unit over time, view of Users

Cost factor	Recurrence of factor	Effect on total cost	Relative Effect
Purchase	One time	Large increase	+3
Maintenance	Repeated	Increase	+0.5
Disposal	Single	Increase	+0.2
Total cost			+3.7

4.3 Conclusion

The initial costs for the BDC are higher than that of the PP. The BDC is more expensive to manufacture due to petroleum and component costs. The PP has a simpler design that saves time in construction. Over time, the cost of maintenance of the PP is low due to the reliability of pumps. The cost of disposal is low because the design is not complex. The final costs for the PP are cheaper than that of the BDC because the BDC needs to be taken apart in order to recycle. The PP can be recycled as a unit.

5. Environment [5]

Each design has a different effect on the environment. This revolves around the carbon footprint of the device. The total effects on the environment are illustrated in the following table:

Table 5.0.1: Effects on the Environment

Factor	Battery Driven Cylinder [1]	Pump Platform [2]
Raw material use	Large negative effect. Use of petroleum resources. Production of batteries uses salt solutions.	Fair negative effect. Use of raw metals.
Waste	Battery replacement over time. Integrated circuits components may require replacement.	No effect – no by-products in manufacture and no replacement components required.
Recyclability	Fair positive effect. Electrical components can be recycled.	High positive effect. Pumps can be used elsewhere and metal can be

	HDPE is recyclable. Circuits can be recycled.	reformed.

5.1 Conclusion

The sustainability of both devices is very different. The resources consumed for the BDC are costly and repeat over time as batteries are replaced. The PP uses mostly raw metals. The BDC is more wasteful than the PP because of battery replacement. Both devices are recyclable and the PP has higher recyclability because of the design material.

6. Human Factors

Each design has a different effect on every person, and this is analysed on the physical, psychological, and political level [6].

6.1 Physical Effects

The following table isolates the effects on the human body.

Table 6.1.1: Physical Factors affecting the devices

Factor	Battery Driven Cylinder [1]	Pump Platform [2]
Ergonomic design	Easy to hold	Easy to hold
Forces	Force applied downwards to use device. May cause injury because excessive force will tip device.	Continuous force required to push device. Force required to operate pump

6.2 Psychological Effects

The following table isolates the effects on the human mind.

Table 6.2.1: Psychological Factors affecting the devices

Factor	Battery Driven Cylinder [1]	Pump Platform [2]
Ease of use	Easy to load Easy to use	Easy to load Easy to use
Intuition	People inclined to push device forward instead of down	Obvious that it should be pushed
Aesthetics	Device looks like a garbage receptacle	Looks like other hand trucks

6.3 Political Effects

The following table isolates the effects of law and government regulations.

Factor	Battery Driven Cylinder [1]	Pump Platform [2]
Transport Canada – Low-Speed vehicle standards [7]	Meets	

Occupational Health and Safety Act [8]	Meets	Meets
Disposal	Specific battery disposal	

6.4 Conclusion

The factors show that the BDC and PP have different effects. While government standards are met by both devices, the BDC requires less force to be applied, while the PP requires a continuous force to move. On a psychological level, the PP is intuitive because of its design. The unique handlebar of the BDC may cause confusion. The handlebar may cause injury because of its unique operation.

7. Social Impacts [9]

Social impacts revolve around how the design would affect different users. The designs are plotted on a table versus various people.

Table 7.0.1 Social Impact of Designs

Impact on:	Battery Driven Cylinder	Pump Platform
Society	None	None
Able Peoples	Little to none	Little to none
People with Disabilities	Positive	None
Vulnerable Peoples	Positive	None

7.1 Conclusion

The Battery Driven Cylinder has a positive effect on vulnerable and disabled peoples. The BDC increases mobility by providing the person with a force, lessening the amount of work. The PP is difficult for vulnerable peoples to use because of cargo loading. Both devices would not see a change amongst society and able people. The designs are not expected to be revolutionary.

8. Design Comparison [10]

The results of the previous sections are tabulated below. The functions, stakeholder concerns, and human factors are weighted more. The economics and environmental impact follow, and the social impacts worth less.

The following table plots the Battery Driven Cylinder and Pump Platform versus the sections. The relative importance is achieved by giving more points.

Table 8.0.1 Design Grades based on above Factors

Factor	Possible Points	Battery Driven Cylinder [1]	Pump Platform [2]
Functions	10	10	4
Stakeholders	10	7	5
Economics	5	4	5
Environment	5	3	5
Human Factors	10	6	7
Social Impacts	2	1	1
Total	42	31	27

The BDC is more functional than the PP. The capability for cargo protection and safety of the user is needed. The PP has potential to easily damage cargo. The BDC meets stakeholder concerns better than the PP. This design allows most stakeholders to be in favour of the design. The PP is too similar to the hand truck, so it is unlikely to succeed from the stakeholder's standpoint. The PP has better economic and environmental value; it costs less over its life cycle. It has higher recyclability than the BDC. The human factors on both devices are even but the Pump Platform is easier to use. The social impacts are even because they are to be used in existing markets.

8.1 Conclusion

Based on the above, the Battery Driven Cylinder is recommended over the Pump Platform. It excels in functional comparison and stakeholder concerns, primarily due to its innovative design. The BDC can be improved by incorporating a different control method, rather than forcing the user to push the handlebar down. Because of the lack of functionality the PP incorporates, it should not be considered.

9. Conclusion

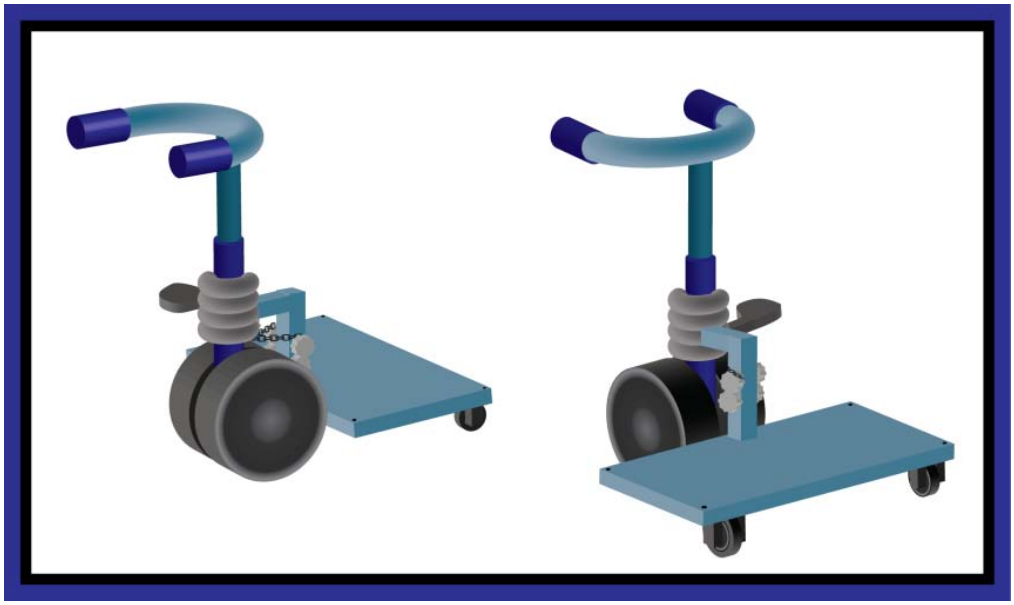
The Battery Driven Cylinder is the preferred design, based on its higher functionality and stakeholder interest. The functional means of the BDC are better than that of the PP, as well as the stakeholder interests. The PP is more environmentally and economically friendly than the BDC. The human factors and social impact of both devices are equal as they have a similar effect on the user and society. Because the functional means and stakeholders are more important than the environmental and economic factors, the BDC is preferred for production.

Appendix A

The following are images of the proposed designs.

1) Battery Driven Cylinder [1]

2) Pump Platform [2]



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