

**GNG2101**  
**Problem Definition, Concept Development, and Project Plan**

**Deliverable C**

**GROUP E1.3**

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# 1 Introduction

In this deliverable, we establish the preliminary problem definition, concept development, and project plan, which creates the foundation for the design for a lifting device designed to help people with disabilities when fallen. This deliverable outlines the direction we are looking to take and records the beginning stages of the project from problem definition to the first concept development. This document is organized into sections which will be described in the table of contents.

We have established the client's needs, defined the problem given by our client, and created a problem statement which will be of use during the concept development. In order to gather information on the current market for lifting devices, thorough benchmarking was conducted regarding metrics we have defined. Target specifications were also established concerning the need inspired metrics.

Based on our problem statement, each team member designed preliminary concepts that may solve the client's problem and through analysis of the concepts with reference to the target specifications, a global design concept was developed. At the moment, our group has assumed a smaller target audience scope for our first concepts in order to gather ideas and to present a greater variety of possible solutions to our client in the next meeting.

## 2 Problem Definition

### 2.1 Client Needs/Problems Definition

#### Problem Definition:

The client would like us to create a user-friendly and adaptable device to assist individuals lift themselves when fallen. The mechanism should be designed to accommodate individuals with varying mobility/disabilities, ensuring a safe lift process with as few transfers as possible. Consideration should be given to the ease of use for the person transferring and any caregivers involved (preferably the person should be able to use it on their own). The solution should consider different settings where individuals may have fallen and as a result be portable, of appropriate size, and should be adjustable to accommodate individuals with different physical abilities and needs. Additionally, the device should prioritize safety, stability, and minimal physical strain on both the user and the caregiver during the lift.

Our team will also need to define the main target audience and scope of the design the device is for. At the moment, the scope of the design is small and focused on our client specifically.

### List of unknown Information:

- Type(s) and style(s) of wheelchair(s) we are designing for
- Standard wheelchair dimensions
- The majority of conditions in the disabled community
- The duration of help needed to determine how long the device needs to operate

### Client Needs:

The client's needs are distributed across various components of the project. The primary focus is to develop a product that is not only efficient but also compact and portable. The product is required to be as simple as possible such that it contains user friendly components making it accessible and convenient for all users of all ages. Recognizing the need for ease of handling, the commitment to designing a solution that can be lifted and transported by individuals with varying levels of strength, is a required aspect as mentioned by the client. The design should strike the balance between functionality and affordability, ensuring that the user benefits from a seamless and an inexpensive experience.

Table 1: Client Needs

	<b>Client statement</b>	<b>Interpreted need</b>	<b>Subsystems</b>	<b>Importance and reason</b>
1	Lift someone who has a disability up alone (if possible with one arm/hand) or with limited help.	Device provides independent help or minimal help. Focuses on providing support without disrupting the user's flow or interrupting their activities unnecessarily.	<ul style="list-style-type: none"> <li>→ The lifting mechanism</li> <li>→ Control system</li> <li>→ Power supply</li> <li>-Includes a remote control or a button</li> <li>-180-degree foldable back support</li> </ul>	5: This component is critical since the main target of the device is to help the person in need to self-sustain.
2	Small in size	Minimal space occupied by the device and as compact as	<ul style="list-style-type: none"> <li>→ Frame and structure</li> <li>-Compact build</li> </ul>	3: space it occupies is important but not the most

		possible.		important since it could still be used if it's a bit bigger than expected.
3	Device should be able to go up and down the stairs and possibly outside.	Easily compatible and portable with the user lifestyle.	<p>→ Lifting mechanism</p> <p>→ Control system</p> <p>→ Power supply</p> <p>-Compactable and able to attach at the back of the wheelchair</p>	4: It has to be portable since it would make the life of the client easier.
4	Low cost and available for everyone.	Inexpensive, and affordable	N/A	2: Not a main point since the
5	Usable for support workers no matter the strength.	Device is usable by any support worker despite their physical limitations.	<p>→ Frame and structure</p> <p>-Light device by using light materials</p>	5: It's important to have this element in the device since the whole point of the device is to have the device easy to use.
6	Could be accessible and usable for different people with different disabilities.	Product is suitable for different types of disabilities and adapt to changes in disability	<p>→ Frame and structure</p> <p>→ Control system</p> <p>-Make it accommodate the different levels of barriers caused by disabilities.</p>	3: This criteria is not the main point since
7	Safe and reliable.	A robust quality	→ Lifting	5: Safety stands

		and safety control measures throughout the manufacturing process.	mechanism -Include an emergency safety button	as paramount consideration to ensure the well being of users.
8	The individual in care varies in size and the product needs to be able to securely withstand the user.	Lift someone of, at least 250 lbs.	→ Lifting mechanism → Frame and structure -Have the mechanism strong enough to endure maximum weight.	2: ranked at 2 since this comes into play later. There are other criterias that need to be accounted for.

## 2.2 Problem Statement

KPC Capability Inc. seeks a solution for individuals with limited mobility or one functional hand/arm, addressing the absence of a device for minimal work lifting. The challenge is to create a tool that ensures safety and portability which aligns with the client's mission.

## 2.3 Metrics

Table 2: Metrics

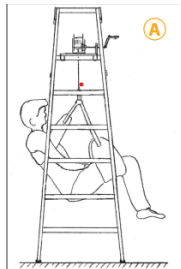




Need	Metric	Units	Explanation
2	Dimensions	inch	Dimensions are considered an important metric because the product is very specific to the wheelchair and not measuring the dimensions could cause serious issues, including safety issues.
8	Weight capacity	lbs	How much the product can hold is very crucial because the product is supposed to



			be used on humans so if the weight capacity isn't taken into consideration it could be a big safety hazard and the product could lose functionality.
1	Power	volts	The amount of power needed to power the product is crucial for the product to properly function.
3,5,6	Total Mass	lbs	The total mass of the product is important because the product is supposed to be portable.
4	Manufacturing cost	CAD \$	The cost of the product has to be measured and maintained under a certain budget to maintain low cost
7	Lifting Height	inch	The lifting height is important to the product for the safety of the person being transported.
7	Emergency Safety Feature	sec	In case of a mishap or malfunction in the product the emergency feature will have to work quickly to keep the person using and the person running the contraption safe.
7	Movement Control	m/s <sup>2</sup>	The speed of the product has to be taken into consideration because if it is too slow it's tiresome and if it's too fast it's unsafe.

## 2.4 Benchmarking

Table 3: Benchmarking of other products

	LaddaLift	The Assist Handle	LEVANTAR	IndeeLift HFL 400	Camel Lifting Cushion
<b>Company</b>	KPC	RESENA	Drive medical	IndeeLift	Mangar
<b>Description/ photos</b>	 <p>KPC uses a step ladder along with a winch and a sling to form a home lift.</p>	 <p>The assist handles can be used in a variety of ways to perform different kinds of transfer.</p>	 <p>The LEVANTAR is a heavy duty patient lift. A caregiver sets the sling under the patient and then controls the device to lift them and move across the room.</p>	 <p>The IndeeLift is designed to pick up people from floor to seat level. With its simple remote control it could be used by anyone</p>	 <p>The camel lift is a lift that is designed to lift people off the floor with the help of one person. The fallen person lies on the device while it is deflated and waits for it to fully inflate.</p>
<b>Cost</b>	Affordable since it uses a ladder which is common.	Manufacturing cost: \$9.79	\$2 894.05	\$2 295	\$2 850-\$4 019.99 Depend on the website that sells it
<b>Weight capacity</b>	250lbs	Not clearly stated. Made of plastic. Put 63.95% of the body weight on the handles	500 lbs	400 lbs	705.479 lbs
<b>Portability</b>	Hard to move around.	Outside, inside, up/down the stairs. Can be placed on the wheel to take anywhere.	Could be moved from room to room and outside	Easily portable anywhere by caregiver	Used inside or outside. Compactable into a bag to take anywhere.
<b>Size</b>	Big but compactable	Very small and compactable .	Hight: 76.3” Length: 52” Width: 27.7” Big	Medium size. Cannot be attached to the wheelchair	Lightweight and compactable. Rolled dimension 75cm x 20cm.
<b>Ease of use</b>	Require set up. Not very complicated.	Require quick set up	Long and complicated	Easy to use. Powered by a	Simple and suitable for none

	Not usable by everyone. Require someone to move it		assembly. Requires a caregiver to move the patient with the device	remote control. Need someone to move it but people can lift themselves.	professionals.
<b>Independence</b>	Not independent	Independent but require 2 hands	Needs a caregiver	Need some help	Need help of one person

Table 4. Benchmarking of other products evaluated with our ranking

	<b>LaddaLift</b>	<b>The Assist Handle</b>	<b>LEVANTAR</b>	<b>IndeeLift HFL 400</b>	<b>Camel Lifting Cushion</b>
<b>Company</b>	KPC	RESENA	Drive medical	IndeeLift	Mangar
<b>Cost</b>	3	3	1	1	1
<b>Weight</b>	3	2	3	3	3
<b>Portability</b>	1	3	2	3	3
<b>Size</b>	2	3	2	2	3
<b>Ease of use</b>	1	2	1	3	3
<b>Independence</b>	1	1	1	2	2
<b>Total</b>	32	49	32	51	<b>54</b>

After researching the market of lifting devices and consulting the client on devices they tried or heard of, we found that these 5 products are the most popular options out there. After comparing each product with our client needs and evaluating it with our ranking we concluded that the Camel Lifting cushion has the highest score due to its portability, compatibility and simplicity. Followed by the IndeeLift. During the making of our final global design we will refer to these two products.

## 2.5 Target Specifications

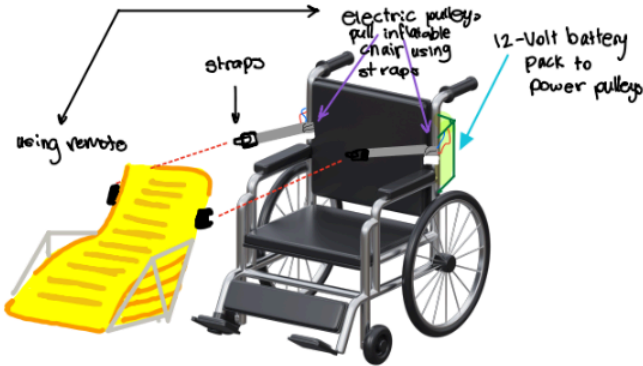
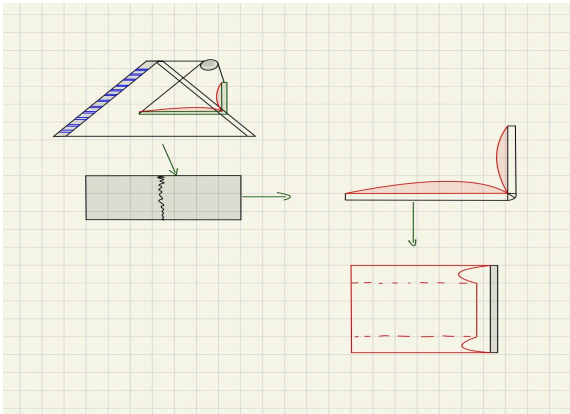
Table 5: Target Specifications

	<b>Metrics</b>	<b>Relation (&gt;, &lt;, =)</b>	<b>Value</b>	<b>Units</b>	<b>Explanation</b>
1.	Dimensions	<	24	inches	Appropriate size that can fit between doors
2.	Weight capacity	<=	250	lbs	Reasonable weight device that can support most users
3.	Power	=	12	volts	Reasonable energy requirement to use device (power source from wheelchair)
4.	Mass	<	22	lbs	Appropriate mass of device that can be handled by large audience
5.	Manufacturing cost	<=	200	\$ (CAD)	Device to be within budget
6.	Lifting Height	<=	19	inches	Maximum height that lifting device raises the user
7.	Emergency Safety Feature	<=	1	sec	Mechanism to immediately stop movement of device within a short time
8.	Movement Control	=	0.25	m/s	Speed and time required in order to safely lift the user.

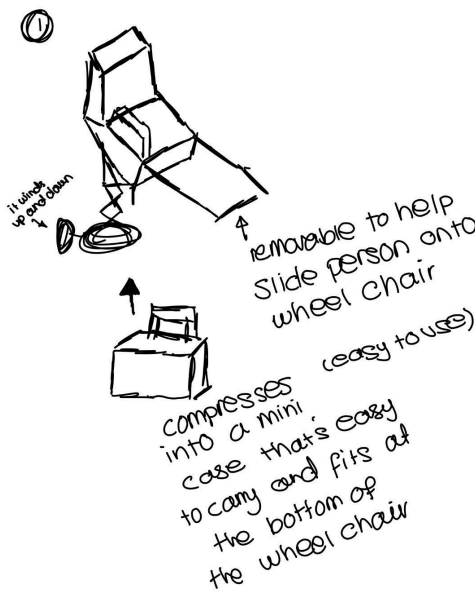
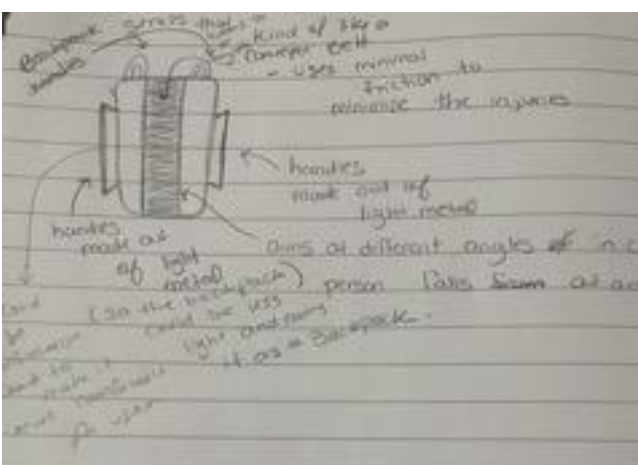
### 3 Concept Development

#### 3.1 Final Prototype Concepts

Table 6: Preliminary Concepts

	Concept	Explanation
<p>Ali's Concept</p>		<p>This design's purpose was to maintain the functionality aspect of the Laddal lift, yet improve on the portability of it. By utilizing a blow up chair and winches to raise the individual onto the chair, we could minimize costs and maximize efficiency.</p>
<p>Ibrahim's Concept</p>		<p>The design is supposed to improve on the pre-existing Ladalift and make it more efficient and portable. The original Ladalift was stationary and expensive. However, this design is intended to cut down on cost by using a basic ladder and welding an extra part that attaches to an inflatable foldable bed that lifts the person using an electric pulley and places them on the back of the wheelchair.</p>

<p>Liana's Concept</p>		<p>The main focus of the design is portability. The concept was inspired by lab jacks, due to their ability to be compact while holding a very strong weight. To make it easier to crank up a large weight, a handle bar could be used. There would also need to have safety measures, so handles or some type of strap would be added to the sides to allow the users to hold on.</p>
<p>Noor's Concept</p>		<p>The idea is to have an attachment that slides from underneath the chair. The fallen person can sit on it and can use a remote control to move it up or down to the desired height.</p>

<p>Sara's Concept</p>		<p>The way this design works is, that there is a chair that is attached to a jack that would then be able to raise the chair in wheelchair height. There is a removable slide attached in order to help slide the person onto the chair. The bag is then able to be compressed into a mini case that's easy to carry.</p>
<p>Fatma's Concept</p>		<p>This design is designed in such a way where it is a backpack with a conveyor belt attached to it. The conveyor belt is extendable so it could accommodate taller people. There are also handles at the sides that pop out on the sides for extra safety. The backpack is also an inflatable aspect that was put into place so that when the person falls it inflates and reduces any chances of injuries. The main focus of the design is portability. It's designed in such a way that it is small but it has been placed as 2</p>

		since it could get smaller than that. Independence is ranked at 2 since assistance is needed.
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## 3.2 Concept Analysis Against Client Needs

### 3.3 Table 7: Analysis of Concepts

	Ali	Ibrahim	Noor	Liana	Sara	Fatma
<b>Portability</b>	(3)Yes, the design of the inflatable chair allows for it to be stored away when not in use. Additionally, given that the material of inflatables is usually some kind of vinyl, the chair is very lightweight.	(3)Yes, the ladder and the bed are foldable and there are wheels at the bottom that have a locking mechanism	(3)Yes, attached to the chair and meant to fit under it to and slide like a drawer	(3)Yes, the device can be retracted after cranked up to lift the user. The small size would be able to be transported easily.	(3)Yes, The design is compact and as a result portable which matched two of the client's needs (portability and size).	(3)Yes The design is portable since it's a bag and holds all the components needed.
<b>Size</b>	(3)Can fit through average door frame. (<24in)	(3)Smaller than an average door frame	(3)Small to fit under the chair	(2)Small size and compact, but lift wouldn't be able to lift high enough.	(3)Small, compact.	(2)Small enough to be attached to be attached to the wheelchair
<b>Independence</b>	(2)May need help with positioning as there is no support to guide the inflatable into the wheel chair. Also, there is nothing between the	(1) The design is slightly complex and requires assistance from a second party to get on the device and run it.	(2)Might need a little help getting on it depending on the person's physical ability. If the user is strong enough to lift their own weight and sit then it is fully	(1)It would be difficult for the user to use alone once fallen, because it needs to be set up and cranked. The user would need help to get on the	(1)Need help to get on the device.Regarding independence, the design would not be able to be used alone and would require	(2)Might need help if the person falls on their side



	floor and the wheelchair acting as a “ramp” to assist it up.		independent. Otherwise users might need help getting on it.	device and the helper would need manual force to crank.	caregiver assistance hence the 1 ranking.	
<b>Weight capacity</b>	(3) The products weight capacity is completely at the discretion of the winch used, and usually winches even with a relatively small size can carry 400+ lbs at minimum.	(3) The product is generally no that heavy given that the ladder is a typical ladder and ladder’s dont typically that heavy	(1) Depend on the jack. After a quick search most affordable jack lifts don’t meet our weight requirements.	(3) several jacks can lift up to 300 lbs depending on the variant. The weight capacity is proportional to the cost.	(2) Depends on the jack, The weight capacity has been ranked a 2 seeing as this is dependent on the type of jack used and is relative.	(2) Varies, depending on the materials used.
<b>Safety</b>	(2) Sturdy, but is inflatable so there is risk of falls if not careful, there is no guided track/ramp to keep the chair in place which also raises the issue that the inflatable cannot actually get on the wheelchair without being wiggled up the profile of the wheelchair.	(2) Generally the device is safe however has some risks of falling off due to the pulley that has to balance the weight of the person and raise their backs which could cause some issues and risk of safety	(2) Somewhat Safe. there is no safety feature implemented. It also doesn’t have back support. However, it is used with remote control so a button can be added to stop immediately.	(2) There are handles and straps on the side to prevent the user from falling once on the lift. However the safety of the device getting onto the lift might be a little risky and need to be improved.	(2) Somewhat safe With safety, it was also ranked a 2 since the safety logistics needed more consideration	(2) Safe but haven’t implemented any safety features.
<b>Ease of use</b>	(3) Easy to use, the patient is simply placed on the inflatable, which will then be	(3) Easy to use, the person can just be placed on the inflatable and then they will be raised to	(3) Easy to use. The fallen person can pull the device from under the chair like a drawer and sit	(3) There are no complicated mechanisms. A scissor jack, handle, and lift with handles. The	(3) Easy to use, The ease of use was ranked 3 seeing as it had a very	(3) Easy to use since the person that’s on the floor could get picked up easily back into the

	pulled up by the winch, it require almost no effort from the patients themselves.	the level of the chair and placed upright using the controls on the pulleys.	on it then use the remote control to start the lift.	device should be easy for people with mobility to use.	simple mechanism.	chain]r.
<b>Cost</b>	(1)>200 generally, a quality winch will cost no less than 100\$, on top of this, the cost to manufacture a custom sized inflatable chair to fit the dimensions of a specific wheelchair is expensive.	(1)>200 Depending on the cost of the ladder, the pulley this product will be expensive however costs could be cut down if the ladder is made from scratch but the pulley and the inflatable would still be expensive.	(3)<200 Depending on the jack lift but from my research generally there are jacks that fit the budget.	(1)Depending on the weight capacity, the quality and the manufacturer, scissor jacks and the added safety features would cost a minimum of \$500, which does not align with client needs.	(2)<200 Regarding Cost, it was ranked a 2 due to the fact that the material was undecided and this had the potential of being cheap or expensive.	(1)>200 Depending on the material used, this design is found to be costly.
<b>Total</b>	64	59	64	56	59	59

### 3.4 Global Design Concept

The global design the team agreed on is a mix of all our ideas. We chose the best parts of each concept and integrated all the ideas into one global design.

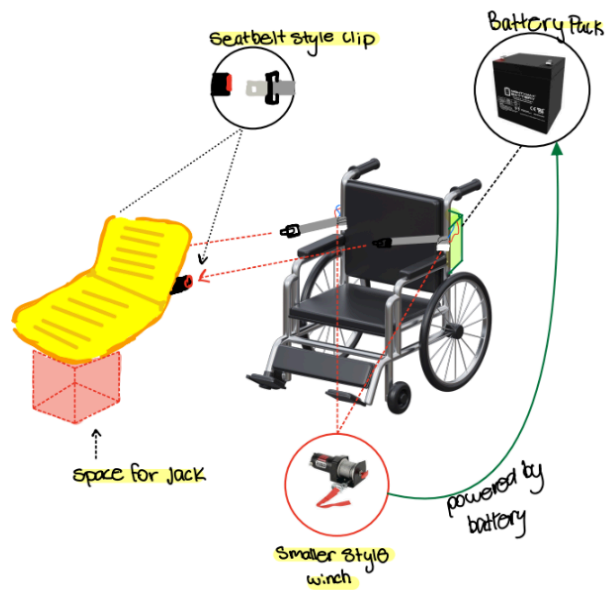
The device will be a compressible chair that is stored at the back of the wheelchair. The user can sit on the device and use a remote control to move up or down the level needed. The device will also have a wheelchair attachment to help the user slide back into the chair using pulleys that are permanently attached to the wheelchair which gives us a portability advantage the pulleys will be attached to the inflatable chair using straps.

The main advantages of the device are that it offers a good level of independence since everything is already on the chair and it is powered by a remote control. However, the user might still need help getting the inflatable chair off the back which could be handled by anyone due to its lightweight.

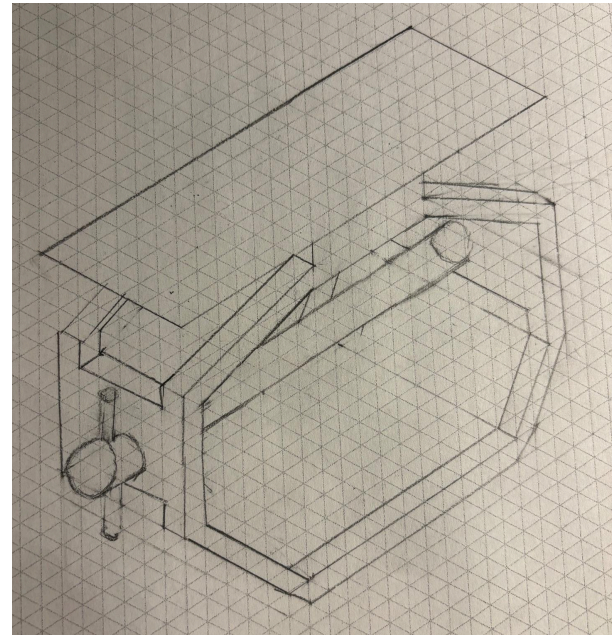
The design is also fairly universal as 95% of the chairs have handlebars or a place to attach the winches on it.

The disadvantages of the design are mainly the stability of the inflatable chair as the inflatable materials might be wobbly which affects the safety of the device. The other thing is cost since we intend to use powered winches which could be expensive and heavy.

### 3.5 Visual Representation



Lifting Device System

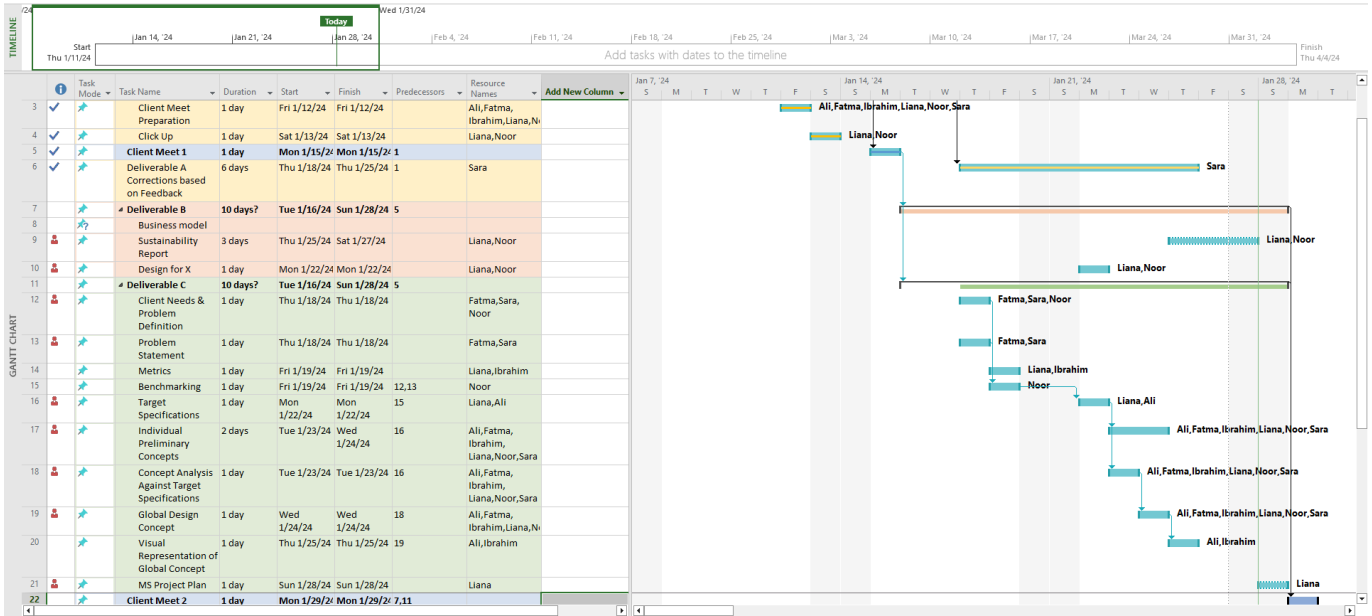


Lifting Jack

## 4 Conclusion

In conclusion, the client wants a solution that can help a person with disability back on their wheelchair in case of a fall accident. The device must be safe, reliable and easy to use by anyone to accommodate any care caregiver no matter their physical restrictions. After benchmarking the Camel Lifting Cushion and the IndeeLift HFL 400 got the best ranking when evaluated against the client so they were used as a reference and inspiration. All the group members agreed on the global concept after discussing and comparing their ideas and evaluating them against the target specification.

# 5 Gantt Chart



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