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College of Engineering

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Senior Design Project Report

Manufacturing & Design of Go-Kart

In partial fulfillment of the requirements for the

Degree of Bachelor of Science in Mechanical Engineering

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Abstract

Go-karts are small-size and small-weight vehicles that were developed for racing. These are made with materials that are strong and durable. It consists of many parts which include a chassis, engine, steering and braking system, and electronic controls. The chassis is the main part that is responsible for the stability of the vehicle. Chassis is made with the material having greater endurance and rigidity. It was developed in the 1950s in the USA and now getting popular. These are now used in amusement parks as a recreational activities. Many researchers have done work on go-karts and improve their design.

This project was intended to design and fabricate a reliable and durable go-kart. Its primary objective to build a go-kart using local resources and applying different techniques to limit the cost of vehicles. These objectives were achieved by going through a detailed literature review and studying different techniques which can be implemented. A reliable design was chosen which can be implemented and can be completed in our period. Critically evaluate the design of the vehicle and then different parts were designed. Parts whose manufacturing easy and cost-effective were manufactured in a local workshop while other parts which cannot be manufactured locally and were costly, were purchased. The plan of the project was prepared, and software was used to build design sheets. To achieve the final product, around 5400SR was costed which is very economical.

Acknowledgments

We are thanking Dr. Mohamed Elmehdi Saleh, for his kind guidance at every step of our work. He is guiding us and from the start till this day. We are learning good research skills from him. Special thanks to our parents, friends, lab fellows, and all other well-wishers for their consistent support during

List of Acronyms

Abbreviation	Name	Unit
σ_b	Bending Strength	MPa
σ_y	Yield Strength	MPa
CAD	Computer added Design	
E	Elastic Modulus	GPA
I	Moment of Inertia	mm^4
ID	Inner Diameter	mm
k_b	Bending Stiffness	
ORV	Off-Road Vehicle	
OD	Outer Diameter	mm
y	Deflection in beam	mm
F	frictional force	lbf
N	front normal force,	lbf
μ	coefficient of friction	

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CHAPTER 1: INTRODUCTION

1.1 Project Scope

This project is based on the design and fabrication of the go-kart. Go-kart is known as racing vehicles that are similar in shape to formula 1 but their speed and strength are small. Go-karts are made in various shapes and sizes. They are developed by various companies and each company has its design criteria. Our project aims to develop the chassis in two parts. Then these two will be assembled with the help of nuts and bolts. A sample of the design of the chassis is shown in figure 1.

Figure 1 Model of Chassis of go-kart

1.2 Objectives of the Project

Objectives of the project are given as follows:

- Design and fabrication of go-kart.
- Design the chassis
- Design a safe and reliable vehicle for racing.
- Design the go-kart in such a way that the driver's center of gravity is aligned with the vehicle.

1.3 Project Specifications

This section is related to the overall functioning and components of the go-kart vehicle. Go-kart consists of the following types of systems:

1. Body
2. Controls
3. The engine of the go-kart
4. Transmission system
5. Auxiliaries

- Body of go-kart includes chassis or frame, axles, and tires. Most go-karts do not include a suspension system.
- Steering and braking systems are included in the design of controls.
- All the functions needed the power to execute. So, the engine gives power to all components to do specific functions.
- Clutch and gear systems are included in the transmission system.

- All the electrical circuits and batteries are included in the auxiliary systems.

1.4 Applications

Following are the cases of the go-karts vehicles:

- Go-karts are used for racing purposes. These are not comparable to formula 1 but they are designed to have great speed and stability.
- They can be used as a recreational activity. For this purpose, flat roads are built in parks.
- Mini go-karts are used by children in amusement parks.
- In some European countries with modification, these can be used for traveling purposes.

CHAPTER 2: LITERATURE REVIEW

2.1 Background

Go-kart is one of the famous vehicles consisting of small size tires, an engine, chassis, and single seat. All the materials used in manufacturing go-kart are lightweight, durable, and strong. No suspension system is involved in go-kart which makes it easy to operate. Other vehicles have a large clearance from the ground. But in the case of go-karts, a small clearance is left from the ground. Thus flat tracks are used to run go-karts on the roads. It was first time developed in the 1950s in the United States by Art Ingles. It was initially developed for racing purposes. In the 1960s and 1970s, it became popular in India, Europe, and United States. Now it is modified in various sizes and different technologies are used and used for many other purposes (Lal K., 2016). Following is the example of the go-kart model.

Figure 2

Now in the modern world engineers are building and modifying more reliable vehicles. The design and materials are improved to make the vehicles safe. Various analyses are performed to check the performance of the vehicle which includes load tests. These loading tests include front, rear, and impacts. Different stresses and vibrations are avoided. Nowadays testing and analysis of go-karts are getting more important than the theoretical results. Various simulations are carried out to check the reliability and safety of the go-kart.

These vehicles are used in racing. These vehicles require a lot of safety. Comparing to others racing and sports cars, these have become more popular as these are cheaper and smaller than conventional racing cars. It is becoming popular in children, adults and old age fellows. This industry is increasing day by day and has a bright future.

There are five major components in a go-kart. These include chassis, engine, steering system, braking system, and control systems. Chassis is the part in which all other components are fixed and mounted. So chassis must be designed in such a way that it has sufficient stability and structural rigidness (Pattenshett SV., 2016).

The engine is the most important part of the go-kart. It powers all the parts to make them able to perform their functions. In amusement parks, go-karts have four-stroke engines while in racing go-karts two-stroke engines are used (Chow H. Y., 2016).

The steering system consists of components, which form a mechanical arrangement. This arrangement ensures that the front wheels of the go-karts are moving in the right direction as they receive a command from the steering. The most common system used in go-karts is the rack and pinion system (Mitchell S. et al., 2017).

As the go-karts are moving, the braking system plays an important while adjusting the speed of the vehicle. The braking system provides the force to stop or lock the wheels. By doing this speed of the vehicle decreases or completely stopped.

2.2 Previous Work

Mitchell et al. studied go-karts. He showed that the base of the vehicle is the center distance between the front and rear wheels. He proved that if the base of the vehicle is large then it has more stability and reliability. He also showed that different types of designs for the go-karts have different criteria to check the stability of the vehicles. He concluded that research and study on go-karts should not be stopped as the designs must be updated with time (Mitchell et al., 2017).

Hajare K. et al. studied the design of the chassis with many design and analysis software. They used FUSION 360. They developed a design and made an analysis. Their results showed that the chassis had enough strength and stability and it can withstand stresses and impact loads (Hajare K. et al.).

Harshil et al. studied the aerodynamic behavior of the vehicle. They examined that body of the vehicle should be designed on the principles of aerodynamics and the engine must be chosen wisely. The speed of the vehicle can be sufficiently increased by following the above two points. As the speed is concerned, the braking system should be wisely chosen which is compatible with to speed of the vehicle (Harshil et al., 2015).

Kelkar K. et al. suggested that as the suspension is not used in go-karts, so series of tests should be conducted to verify that no harmful stresses would be generated which affect the performance of the vehicle (Kelkar K., 2017).

2.3 Comparative study

As there are various researches of different scientists are discussed above. Each has used a different design and used different tools to determine the performance of the go-kart. Some suggested that go-kart chassis should be made more reliable and safer by using better materials.

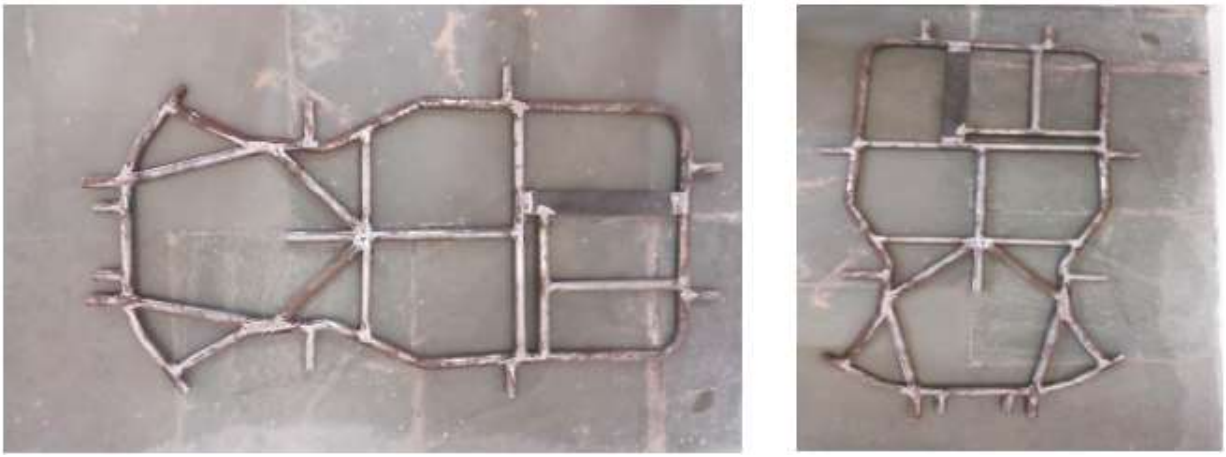

Figure 3 Mitchell et al. used this chassis for their go-kart

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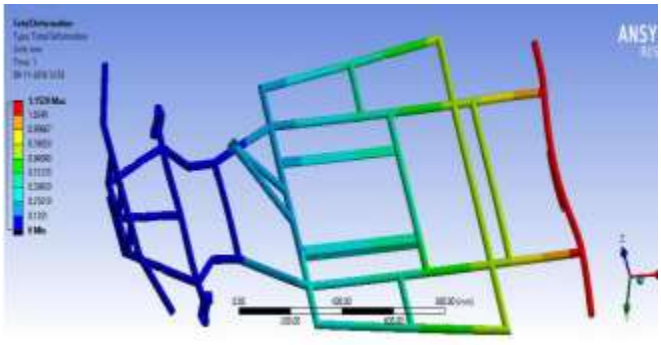

Figure 4 Go-kart analysis of impact deformation by Hajare K. et al.

In this project, the main aim includes building the chassis. Then these parts would be joined with the help of nuts and bolts. It will avoid the use of welding. As we know the welding is costly and it lowers the strength of the material. It is expected that our design would have better performance than other designs. All the other components would be used from the local markets. Materials and techniques would be followed which would be cost-effective and easily available.

CHAPTER 3: SYSTEM DESIGN

3.1 Design Constrains

Universally it is fact that whenever a system is designed either it is research-based, experimental, or practical application, it is designed by keeping in mind some specific parameters. Following are the design constraints for our project.

- **Safety:** In our project, the body or chassis is designed in two parts which is the main aim of our project. By using this instead of welding will give extra strength to go-kart vehicles. Thus it will be made safe and can withstand for a longer period. The chassis of the vehicle is designed following the body composition of the driver. Weight tests will be carried out later to check the stability.
- **Compactness:** Go Kart is designed in such a way that its size neither too big nor too small. Optimal size is taken in which all the components can be installed and the driver can be seated safely. The stability and performance of the vehicle are not compromised.

- **Weight:** Go-kart is designed by considering the weight and compactness parameters. Because these two constraints affect the performance of the vehicle. This vehicle is smaller in size than other vehicles in the market. Thus, it has a weightless than other go-kart vehicles. It was kept in mind to divide the weight equally to all four wheels as the performance and productivity of the vehicle are affected if weight is not balanced.
- **Cost:** As the manufacturing is done by using the local materials and components available in the local markets. As mentioned earlier that this vehicle would have less weight thus it decreases the materials and manufacturing costs of the vehicle. As the chassis is made in 2 parts and these parts will be joined by using the bolts. Thus it will also decrease the cost as welding is costly.
- **Serviceability:** As mentioned earlier that go-kart was manufactured by using locally made materials. Those parts whose manufacturing processes were easy were done in the lab. But those parts whose manufacturing was difficult or costly were purchased. It increased the quality and decreases the cost of the vehicle.

3.2 Risk Factors

There are many risk factors involved. Some of which are enlisted below:

- Safety
- Streamline motion
- Material and manufacturing cost

Go-kart is used for recreational purposes. So sometimes it is used in plain roads and sometimes in parks which have smooth road structure. In professional racing competitions, it has very high speeds. So, the risk of accidents increases. If an accident occurs, then how much safety of the

vehicle and driver is expected. These are determined by using different load and safety tests. This is not part of our study as it will increase the cost of our vehicle. It is stated earlier that vehicle is designed by using local materials and manufacturing methods.

We do not have efficient manufacturing machines which increase the productivity and finishing of the vehicle body. Due to which it might not have a streamlined body or great efficiency.

This project is completed by using local materials and techniques. We are making only one project so it might have high material and manufacturing costs. Manufacturing of this go-kart would cost a little higher than go-karts available in the markets. In plants, they manufacture more vehicles at a time, so they have low material cost as they buy material in bulk which costs low. Manufacturing costs also decrease as more parts are produced in one go.

3.3 Design Methodology

As we are building any product a specific set of steps are involved which are done one by one. In our project, chassis is the main concern in designing. It is designed to improve the performance of the go kart. Chassis or roll cage is the central component of the go-kart as the strength and performance of the go-kart depends on the design and specifications of the chassis. Following is the design methodology used to carry out the design of chassis and related components.

- Material Selection
- Cross-section selection
- Use of important formulae
- CAD Model
- Design specifications

As stated earlier the main objective of our project is to design the chassis in two parts. Then these parts will be made connected with the help of bolts. It gives strength and its maintenance will be easy. If one part got ruptured then it can be replaced while damaging other parts of the chassis.

3.4 Material Selection

Material selection is one of the important steps in the design process. As discussed earlier that material is selected based on weight, durability, and strength. The selected material must have low cost and low maintenance.

Different steps were followed to find the material best suited for the chassis. As we are using bolts to connect the two parts. The material must have high yield strength and high stiffness values. As stated earlier the chassis was made by using the local materials and manufacturing methods. Thus AISI 1020 was best suited to make the chassis of the go-kart.

Following are the composition and mechanical properties of the material.

Table 1 Material Composition

Serial No.	**Elements**	**%Composition**
1	Manganese	0.30-0.60
2	Carbon	0.18-0.23

3	Sulfur	≤0.05
4	Phosphorus	≤0.05
5	Iron	99.08-99.53

Table 2 Mechanical Properties of AISI 1020

Serial No.	**Properties**	**Values**
1	Density (x1000 kg/m3)	7.9
2	Poisson's Ratio	0.285
3	Elastic Modulus (GPa)	200
4	Tensile Strength (MPa)	395
5	Yield Strength (MPa)	295
6	Elongation (%)	36.5

Table 3: Standards Table

Standards Adopted	**Yes or No**

ANSI	YES
ASTM	YES
ASME	NO
ASHRAE	NO

Following are the specific standards applied on the buggy.

Table 3 standards followed

Standard name	Standard specification	Application
ASTM	The section A3 - 01(2019)	Specification for Steel Joint Bars
	A6/A6M	Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
	A449 - 14(2020)	Hex Cap Screws, Bolts and Studs, Steel
	A500/A500M – 21	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
	D5112 - 98(2015)	Test Method for Vibration
	A961/A961M	Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
	ASTM F833-13	Standard Consumer Safety Performance Specification for Carriages and Strollers,
	ASTM F833-19,	Standard Consumer Safety Performance Specification for Carriages and Strollers
ANSI	ASQ/ANSI/ISO 9001:2015	Quality management systems
	ASQ/ANSI/ISO 14001:2015	Environmental Management Systems

3.5 Cross-section selection

There are many cross-sections used for the go-karts chassis. But we found circular one more reliable and easier to manufacture. As circular pipes and beams were easily available and their manufacturing cost is low, thus we choose circular cross-section.

The diameter and thickness of the pipes used in the chassis are given in the following table.

Table 5 Cross-section dimensions

Parameters	Values
Outer diameter (mm)	25.4
Thickness (mm)	3

3.6 Formulae Used

$$(\text{Moment of Inertia} = \text{I} = \frac{\pi}{64}\ (O.D. - I.D.)^4 \quad (1)$$

Where

OD = Outer diameter

ID = Inner diameter

$$k_b = E * I \quad (2)$$

Where

E = 200 GPa

$$Bending\ Strength = \sigma_b = \frac{\sigma_y * I}{y} \quad (3)$$

Where

σ_y = 295 MPa

Impact test

- F x t = m x (Vi - Vf) (4)
- Factor of safety (FOS) = Yield stress / Working stress

Braking system

- N = (m*g * C) (5)
- f(rear) = μ*N(rear) (6)
- a = f(rear)/m , t = u/a, d = (V^2) / (2*a) (7)
- Outer Angle Tan A = L / (R - d/2) (8)
- Where, Wheelbase (L), Track width (T), Actual Turning Radius (R)
- Inner Angle: Tan B = L /(R + d/2) (9)
- Actual Turning Radius = T/2+L cosec (A/2+B/2) (10)

3.7 CAD Model

Figure 5 side view of the kart

3.8 Design Specifications

Some of the design specifications of the main systems are given in the following tables.

Table 4 Engine Specifications

Engine type	Air-Cooled 4-stroke OHV
Bore x Stroke	68x45 mm
Net power output	4.8 HP
Compression Ratio	9:1
Oil capacity	0.58 L

Figure 6 CAD model of go-kart

Carburetor	Butterfly

Table 6 Steering Mechanism

Sr. No.	Specification	Value
1	Wheel Base	1220 mm
2	Turning Radius	1800 mm
3	Outer turn angle	27º
4	Inner turn angle	44º
5	Ackermann angle	29º
6	Steering ratio	6:1
7	Camber angle	2º

3.9 Fabrication and Assemblage

All the parts were fabricated according to the design dimensions discussed earlier in this chapter. Materials were purchased from the local markets. Firstly, the body of the vehicle (Chassis) was fabricated. After this, some of the parts were purchased from the local markets according to the need of the project. These parts included bearings, seats, engine, brakes, and steering system. These parts were fitted in the chassis of in the desired place. The local workshop was used to assemble this go-kart. The final product is given in the following pictures.

Figure 6: Final Assembly of our Prototype

3.10 Economic Evaluation

Economic evaluation is done on go kart shows the investment done, and respective sales generated giving the profit and payback periods.

The initial phase of this project includes only prototype development with research as the main concern. In the first year, only research and development is done, and no sales are generated. In the next year, proper manufacturing and sales are taken into the consideration having sales in the next column for the respective year. From the sales, we analyzed the data and calculated the profit. Data is gathered for 10 years as shown in table 6.

Figure 6 shows the cash flow diagram for the data presented in table 6. From the figure, it is illustrated that no sales and profit is generated for year 1 while in the next year's sales and profits are given which are directly proportional to the investment done.

Table 5 Cashflow

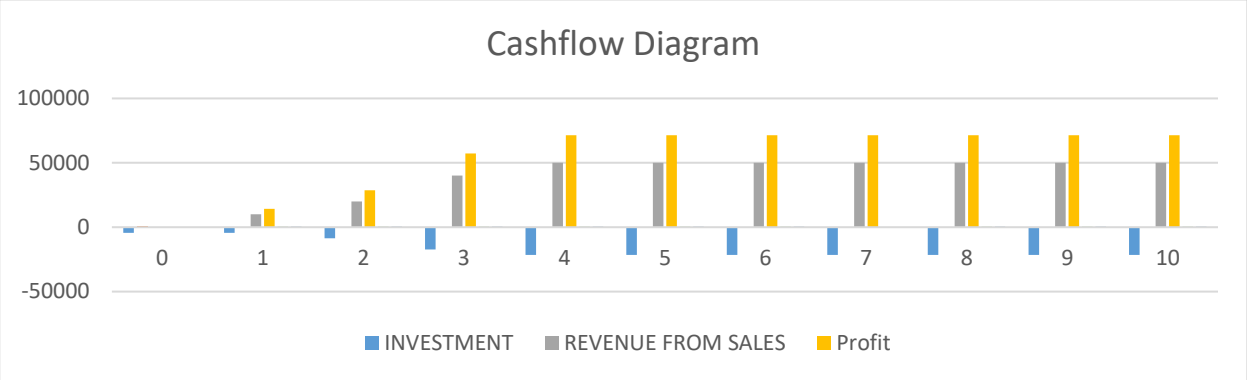

Figure 7 Cashflow Diagram

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capital Costs	500	500	500	500	500	500
Equipment	3000	3000	6000	9000	12000	15000
Construction	800	800	850	900	1000	1200
Total	4300	4300	7350	10400	13500	16700
Operating Cost						
Energy	100	100	100	150	150	200
Electricity	250	250	250	250	250	250
Insurance	0	0	0	0	0	0
Taxes						
Total	350	350	350	400	400	450
Revenues	0	10000	20000	30000	40000	50000
Total						
Profits	-4300	5350	12300	19200	26100	32850

By using the data of investment, sales, and the profits payback period was calculated. The first payback period was calculated in years and then in months.

The payback period chart is given in figure 7 and figure 8. The data shows a negative payback period as year 1 involves only investment and no sales and profits. While in the next year's cashback periods are given.

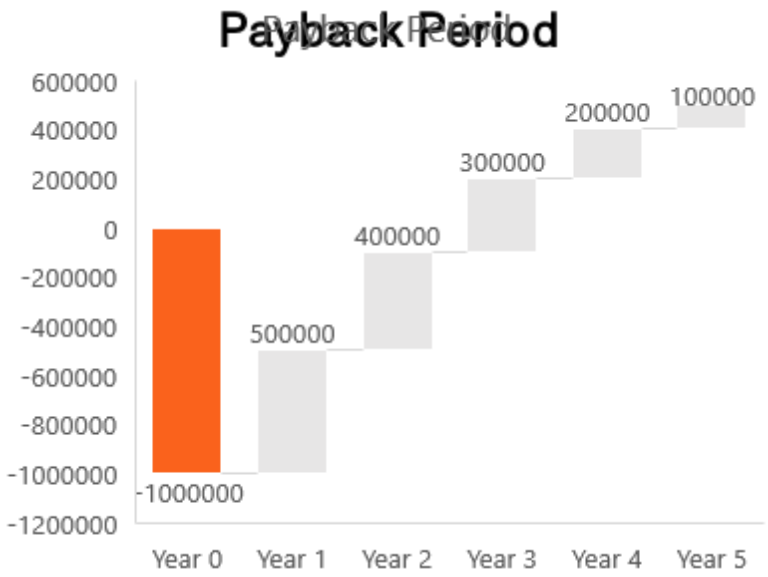

Figure 8 Payback Period

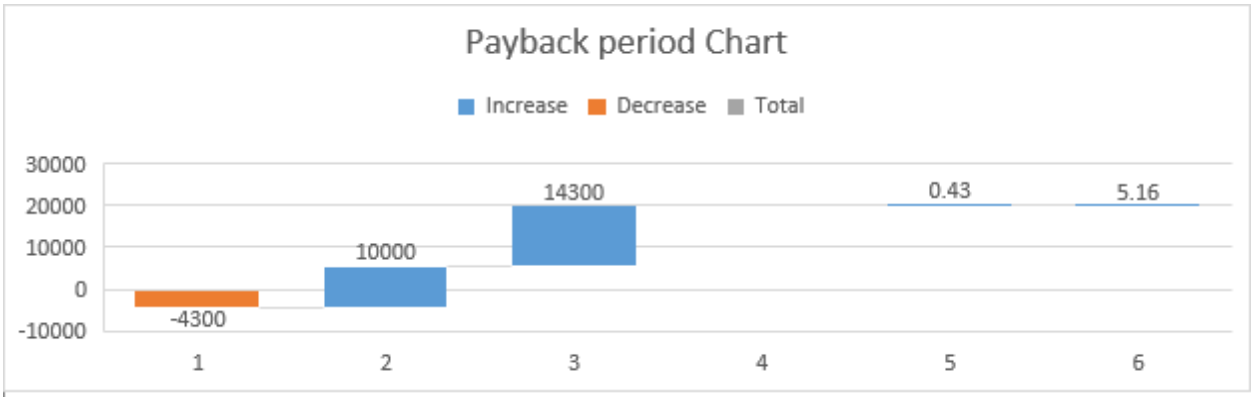

Figure 9 Payback Period Chart

CHAPTER 4: PROJECT MANAGEMENT

4.1 Project Plan and Student contribution

This section deals with the plan of the project. It includes the schedule of the project from the start to the end. The project was started from the project proposal to the final presentation. This schedule given in table 8 is followed throughout the project duration in sequence. Table 7 shows student names and IDS who were given a task to complete this project.

Table 6 Student Names and IDs

ID Number	Member Name
201500320	**Imtiyaz Uddin Ridoy**
201601830	**Abdulkarim Aljameel**
201403375	**Ahmed Alsenan**
201602624	**Osama Altherman**
201302234	**Mohammad Alquraya**
201502918	**Mohammed AlQahtani**

Table 8 shows the schedule of the project and the contributions of each member for each task.

Table 7 Project Schedule and contribution of each student

	ACTIVITY	Tasks	Responsible Person	Start Date End Date	Percent Complete
Introduction	Project allocation + introduction	Project Definition	Imtiyaz	(23/01/21) to (28/01/21)	100%
		Project Objectives			
		Project Specifications			
		Gantt Chart			
		SDP 01 SDP 02			
	Literature Review	Research & Application	All Members	(29/01/21) To (25/2/21)	100%
		Project Background			
		Comparative Study			
System Design	System Design	Sketching and Designing of the Prototype	Ahmed,Alqahtani & Osama	(26/02/21) To (6/03/21)	100%

	Equipment and material selection	Selecting Appropriate Materials	Abdulkarim& Alquraya	(07/03/21)To (14/03/21)	100%
	Calculations	Theoretical Calculations	Imtiaz & Ahmed	(15/03/21)To (21/03/21)	100%
	Prototype assemble	Buying and Assembling parts required for the project	All Members	(18/04/21)to (22/04/21	100%
Midterm	Powerpoint	Preparing Powerpoint presentation And working on SDP 03 SDP04	All members	08/04/21	100%
System Testing and Analysis	Experimental analyses	Experimental Setup, Sensors, and data acquisition system	All Members	(25/03/21) (14/04/21)	100%
		Results, Analysis and Discussion			
geme nt and Proje	Project	Project Plan	All Members	(22/04/21)to	100%

	Management	Contribution of Team Members		(28/04/21)	
		Project Execution Monitoring			
		Challenges and Decision Making			
		Project Expense Cost of Materials and Budget limitation			
	Project Analysis	Life-long Learning	All Members	(01/05/21)to (05/05/21)	100%
		Impact of Engineering Solutions			
		Contemporary Issues Addressed			
Final submission	Final Report	Completing the Report	All Members	10/05/21	90%
	Poster	Print the report	All Members	13/05/21	50%
	Brochure	Follow rubric	Abdulkarim& Ahmed	15/05/21	25%
	Final Presentation	Preparation of Slides and Presenting	All Team	(16/0521) to 17/05/21	50%
	Project Folder	Collecting all documents and videos	Osama, Alquraya	20/05/21	60%

Monthly progress report	Writing and submitting monthly reports (SDP 05)	Imtiyaz	Monthly	80%

4.2 Project Budgeting

This section is related to the cost of the project. The total cost consists of the individual components cost, their manufacturing cost, and assemblage or labor cost. These costs summed up and it was around 5400 SR. In table 9 bill of materials or budgeting is given:

Equipment and Labor	Cost (SR)
Bearings	200
Chassis	2000
Seats	300
Engine	850
Brakes	500
Steering	150
Assembly/ Labor	600
Axels	800
Total	5400

CHAPTER 5: PROJECT ANALYSIS

5.1 Lifelong Learning

- We enjoyed while working on this project. It was a fascinating as well as hectic experience. Sometimes you came across things which you are doing first time in your life and these things irritate you. We went through many things which were new to us and then we learned and implemented them in our project which we enjoyed. From design to fabrication, we came across the following experiences.
- First, we prepared the proposal for our project. After that, we started studying the background and related terminologies associated with our project. It was done in the first week. Then we study different techniques and designs which were used to build go-kart in the world. We went through some of the literature reviews. After that, we reached the most challenging phase of our project which was designing a go-kart vehicle. Each component was designed according to the requirements accordingly. In the literature review, we came to know about many designs and manufacturing techniques. But we only restricted ourselves to choose the method which approximately took 10-12 weeks. We used different constraints to develop and design each component. The biggest design constraint was to see the availability of materials in the market which should be manufacture in different parts of the vehicle.
- In the manufacturing phase, we took various market surveys. We manufactured components whose manufacturing was easy and can be prepared locally. While other components which cannot be manufactured easily or have high manufacturing costs were purchased. Cost-effectiveness was the key objective of our project to limit the prices of go-karts.

- We planned our project from start to end. All the schedules are presented in the previous chapter. We used MS Project to prepare our schedule. We used several different tasks in designing components of a go-kart. These include AutoCAD and Solid Works.

5.2 Impact of Project

It has been discussed earlier that go-kart vehicles developed in different designs which depends on the type of applications. There has been increased use of these vehicles for different purposed some of which were discussed in chapter 1. In the following paragraphs, some of the impacts which include economic, social, and environmental are discussed.

- **Economic:** As discussed earlier that go-karts have been used both for recreational and sports purposes. Go-karts is an ever-growing industry. The use of go-karts in the middle east, European countries, and the USA has exponentially increased. According to a recent survey, it is expected that the go-kart industry will gain growth of around a CAGR of 4.2 % in the forecast year 2021-2025. In 2019 go-kart industry generated about 235 million USD it is expected that in 2025 it will be 278 million USD. As the market grows and manufacturing grows positively, more employment opportunities are generated.
- **Social:** Go-kart vehicles are mainly used in sports racing. Most of the people drive them to the parks to spend their leisure time. Children used them in amusement parks. Thus, it provides recreational activities to the people. It is also used for transport in some European countries.
- **Environmental:** Go-karts have some advantages and disadvantages like other vehicles. It provides fun, entertainment and transport to the people which is the advantage of a go-kart. But like other vehicles, these produce dangerous gases and heat. For racing, separate racing

tracks are built which covers a large area of land. It also produces noise pollution which is bad for the environment.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The main objective of this project was to design and fabricate a go-kart vehicle. This go-kart should be safe, reliable, and cost-effective. These objectives are accomplished now. A reliable and low-weight go-kart has been fabricated. To accomplish this goal, a lot of research and manufacturing methods were applied. First, different designs were assessed, and a reliable design was selected which can be completed within 10-12 weeks. Each part was designed accordingly to their collective needs and it required a lot of studies and critical analysis. For manufacturing, various market surveys were conducted to limit the manufacturing cost. Only local-made materials were used to develop go-kart and assembling was done to achieve the final product.

It's already discussed that the main goal was to develop a go-kart by using local resources and manufacturing methods. These techniques were applied to limit the cost of the project. It was completed in time as materials were available in the markets.

It was a great privilege to work on a project like that. We have learned various research and design techniques. A critical part of the design process was to limit the materials and manufacturing costs. It was done by keeping in mind the reliability and strength of the go-kart. We utilized various software to layout plans, design sheets, and various other things.

6.2 Recommendations

Go-karts can be designed in various ways according to the type of use. Following are some of the ideas which can be implemented to extend this project further.

- The frame can be redesigned by using alloy materials and using the load test technique.

- Steering of go-kart can be made more stable by customizing differentials that are already used in ordinary vehicles.
- One can work to modify the shape of the go-kart to achieve streamline behavior which impacts the speed and acceleration of the vehicle.
- One can work on emissions and exhaust systems to limit the poisonous gases to limit the danger to the environment.
- More advanced materials can be developed to adapt the strength and reliability of the vehicle.

References

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2. Pattanshett SV, Design and analysis of GO-KART chassis, International Journal of Mechanical and Industrial Technology, 4 (1) 150-164, 2016.
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5. Hajare K, Shet Y, Khot A, Design and Analysis of a Go-Kart Chassis, International Journal of engineering technology, management and applied science, 4 (2).
6. Nath A, Vikram J C, Nongrum L, Marboh P, Design and fabrication of a Go Kart, International journal of innovative research in science, Engineering and technology, 4(9) 2015
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APPENDIX A: PROGRESS REPORTS

Student names and IDs

ID Number	Member Name
201500320	**Imtiyaz Uddin Ridoy**
201601830	**Abdulkarim Aljameel**
201403375	**Ahmed Alsenan**
201602624	**Osama Altherman**
201302234	**Mohammad Alquraya**
201502918	**Mohammed AlQahtani**

Schedule of Project:

	ACTIVITY	Tasks	Responsible Person	Start Date End Date	Percent Complete
Introduction	Project allocation + introduction	Project Definition	Imtiyaz	(23/01/21) to (28/01/21)	100%
		Project Objectives			
		Project Specifications			
		Gantt Chart			
		SDP 01 SDP 02			
	Literature Review	Research & Application	All Members	(29/01/21) To	100%

		Project Background Comparative Study		(25/2/21)	
System Design	System Design	Sketching and Designing of the Prototype	Ahmed,Alqahtani & Osama	(26/02/21) To (6/03/21)	100%
	Equipment and material selection	Selecting Appropriate Materials	Abdulkarim& Alquraya	(07/03/21)To (14/03/21)	100%
	Calculations	Theoretical Calculations	Imtiaz & Ahmed	(15/03/21)To (21/03/21)	100%
	Prototype assemble	Buying and Assembling parts required for the project	All Members	(18/04/21)to (22/04/21	-
Midterm	Power point	Preparing Power point presentation And working on SDP 03 SDP04	All members	08/04/21	100%

System Testing and Analysis	Experimental analyses	Experimental Setup, Sensors and data acquisition system	All Members	(25/03/21) (14/04/21)	100%
		Results, Analysis and Discussion			
Project Management and Project Analysis	Project Management	Project Plan	All Members	(22/04/21)to (28/04/21)	100%
		Contribution of Team Members			
		Project Execution Monitoring			
		Challenges and Decision Making			
		Project Expense Cost of Materials and Budget limitation			
	Project Analysis	Life-long Learning	All Members	(01/05/21)to (05/05/21)	100%
		Impact of Engineering Solutions			
		Contemporary Issues			

		Addressed			
Final submission	Final Report	Completing the Report	All Members	10/05/21	90%
	Poster	Print the report	All Members	13/05/21	50%
	Brochure	Follow rubric	Abdulkarim& Ahmed	15/05/21	25%
	Final Presentation	Preparation of Slides and Presenting	All Team	(16/0521) to 17/05/21	80%
	Project Folder	Collecting all documents and videos	Osama, Alquraya	20/05/21	60%
Monthly progress report		Writing and submitting monthly reports (SDP 05)	Imtiyaz	Monthly	90%

APPENDIX B: PROJECT BUDGETING

Bill of materials

Equipment and Labor	Cost (SR)
Bearings	200
Chassis	2000
Seats	300
Engine	850
Brakes	500
Steering	150
Assembly/ Labor	600
Axels	800
Total	5400

APPENDIX C: DESIGN SHEETS

Material Composition

Serial No.	Elements	%Composition
1	Manganese	0.30-0.60
2	Carbon	0.18-0.23
3	Sulfur	≤0.05
4	Phosphorus	≤0.05
5	Iron	99.08-99.53

Mechanical Properties of material

Serial No.	Properties	Values
1	Density (x1000 kg/m3)	7.9
2	Poisson's Ratio	0.285
3	Elastic Modulus (GPa)	200
4	Tensile Strength (MPa)	395
5	Yield Strength (MPa)	295

6	Elongation (%)	36.5

Followed Standards

Standard name	Standard specification	Application
ASTM	The section A3 - 01(2019)	Specification for Steel Joint Bars
	A6/A6M	Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
	A449 - 14(2020)	Hex Cap Screws, Bolts and Studs, Steel
	A500/A500M – 21	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
	D5112 - 98(2015)	Test Method for Vibration
	A961/A961M	Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
	ASTM F833-13	Standard Consumer Safety Performance Specification for Carriages and Strollers,
	ASTM F833-19,	Standard Consumer Safety Performance Specification for Carriages and Strollers
ANSI	ASQ/ANSI/ISO 9001:2015	Quality management systems
	ASQ/ANSI/ISO 14001:2015	Environmental Management Systems

Cross Section selection

Parameters	Values
Outer diameter (mm)	25.4
Thickness (mm)	3

Engine Specifications

Engine type	Air-Cooled 4-stroke OHV
Bore x Stroke	68x45 mm
Net power output	4.8 HP
Compression Ratio	9:1
Oil capacity	0.58 L
Carburetor	Butterfly

Steering Mechanism

Sr. No.	**Specification**	**Value**
1	Wheelbase	1220 mm
2	Turning Radius	1800 mm
3	Outer turn angle	27º
4	Inner turn angle	44º

5	Ackermann angle	29º
6	Steering ratio	6:1
7	Camber angle	2º