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Gujarat Technological University is a premier academic and research institution which has driven new ways of thinking and working, since its inception in 2007, by Government of Gujarat vide Gujarat Act No. 20 of 2007. Today, GTU is an intellectual destination that draws inspired scholars to its campus, keeping GTU at the nexus of ideas that challenge and change the world. GTU is a State University with 435 affiliated colleges operating across the state of Gujarat through its five zones at Ahmedabad, Gandhinagar, Vallabh Vidyanagar, Rajkot and Surat. The University caters to the fields of Engineering, Architecture, Management, Pharmacy and Computer Science. The University has about 4, 00,000 students enrolled in a large number of Diploma, Under Graduate, Post Graduate programs along with the robust Doctoral program.

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From the Desk of Editor-in-Chief

MESSAGE

I feel pride in publishing the eight issue of 'Multidisciplinary International Research Journal of Gujarat Technological University'.

This issue concentrates on Engineering and Pharmacy disciplines in which articles are written in different areas such as Vishwakarma Yojana, Hydrocarbon Gas Operated Air Gun, Impact of Social Media Addiction and Emerging Polymer used in Cancer Immunotherapy.

I hope all these articles will be useful for their range of applications and will also open up new directions for further research.

I take this opportunity to thank the GTU editorial board members & international editorial board members for their efforts in upgrading the articles in this issue.

Prof. (Dr.) Navin Sheth
Vice Chancellor
Gujarat Technological University, Ahmedabad

INDEX

VISHWAKARAMA YOJANA - AN APPROACH TOWARDS URBANIZATION OF KOLAT VILLAGE

Khushi Sheth
L.J Institute of Engineering & Technology

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ABSTRACT

The Poor economic conditions and lack of basic amenities in the village are the main push factor that drift the rural population to the urban areas. Vishwakarma Yojana is one of the initiatives by Government of Gujarat which is undertaken as a project scheme by Gujarat Technological University to urbanize rural areas of the country along with preserving rural soul. Kolat Village was selected for this purpose. After doing techno-economic survey and analysing present scenario of the village designs were proposed .These designs include library and design of Common Service Center. The aim of this study is to urbanize Indian villages, whatever is there in city must be in the village too so that villagers can't face difficulties and migration of villagers can be eliminated.

Keywords: - Urbanization, Infrastructure, Techno-economic survey, Social-economic

1. INTRODUCTION

"Rural areas" can be termed as the area having low population density and large amount of undeveloped land. According to Census of India 2011, the definition of rural area can be described as:

- A region of up to 400 per sq.km population density.
- Villages with simple borders, but no municipal board.
- A minimum of 75% of male workers which are involved in agricultural activities.
- In general, a geographical area that is located outside the cities is called as rural area.

The rural economy is an important aspect of India's total economy.[i] Because the majority of the poor live in rural areas, the primary goal of rural development is to improve the quality of life of rural residents by reducing poverty through self-employment and wage employment programs, providing community infrastructure such as drinking water, electricity, road connectivity, health facilities, rural housing, and education, and promoting rural tourism.[ii]

In rural areas, the quantity and quality of infrastructural facilities are significantly lower than in urban areas. The extension of basic infrastructure amenities in rural areas is hampered by a relatively low population density, low household incomes, and the lack of scale economies[iii]. The method of improving the quality of life and financial well-being of a person who specifically lives in populated and remote areas is typically linked to rural growth.[iv]

The ultimate goal of Vishwakarma Yojana is to remove difference between rural and urban area, by providing all the basic amenities to the villagers.[v] With all the smart amenities that a city has, our goal is to

grow our village too. This will help to grow the village in a sustainable way by reducing villagers' migration and avoiding urban pressure from the cities.[vi] The future scenery for urbanization can be sustainable by improving Rural India.

1.1 Objectives of Study

- This study aims to convert rural to urban means to satisfy all the basic facilities in village without disturbing the soul of village.
- The analysis will concentrate of development pattern, the village growth intensity and identify issues related to infrastructure.
- To provide all the basic facilities to the villagers, in order to minimize the migration of people from rural to urban areas.
- To study the existing infrastructures facilities and to proposed the proper solution for maintaining and developing the infrastructure.

2. METHODOLOGY

We began by studying numerous topics linked to village growth, objectives, and needs, and we chose Punsari as our ideal village.[vii] Following that, we did a techno-economic survey of Kolat village to learn more about the village's current situation. Interacting with villagers and panchayat members provided social, socioeconomic, and physical information of the entire village. From the Techno-economic survey.

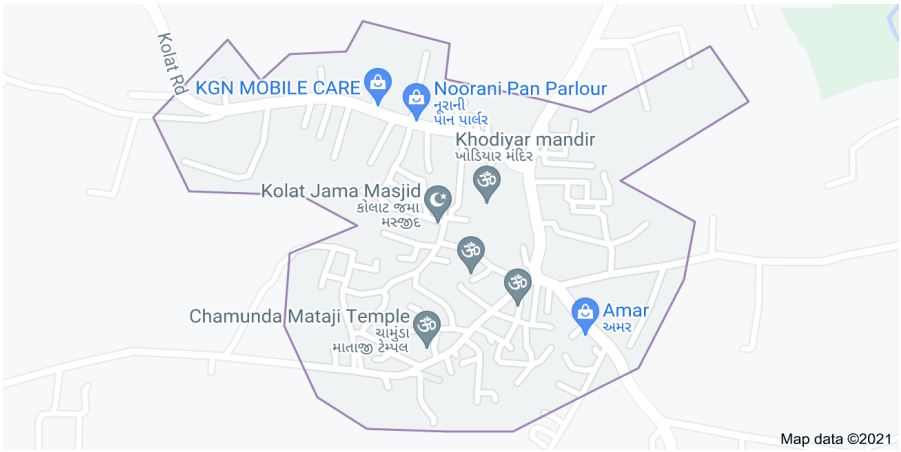


Figure 1: Study Area Details

3. LITERATURE REVIEW

After Visiting the village and studying the area of village, we got more information about the village in terms of geographical area, population and more.

3.1 About Village

Village: Kolat **Pin code:** 382210

Taluka: Sanand **Geographical Area**: 1009.33 hectares

District: Ahmedabad **Population**: 4327

State: Gujarat **Houses**: 813

Kolat is situated in the Ahmadabad district of Sanand Tehsil in Gujarat, India. It is located 5 km from the Sanand sub-district headquarters and 22 km from the Ahmedabad district headquarters. Having population of 4327 and geographical area of 1009.33 hectares.

Kolat Village fall under the parliamentary constituency of Sanand Assembly and Gandhinagar as per 2019 statics. Sanand is Kolat's nearest town, which is about 5 km away. It was found that no sewage control service was available and cleanliness was not maintained throughout the village. Lack of Medical facilities and advance infrastructure was one of the major concern for villagers.

3.2 Physical and Demographic Growth

Physical growth

Sr no.	Census	Population	Male	Female	Houses
1.	2001	3356	-	-	-
2.	2011	4327	2215	2112	813

Demographic growth

Sr.no	Description	Information/ Detail
1.	Area of village	1009 hectares (approx.)
2.	Agriculture land	886 hectares (approx.)
3.	Residential area	118 hectares (approx.)
4.	Waste land	5.2 hectares (approx.)

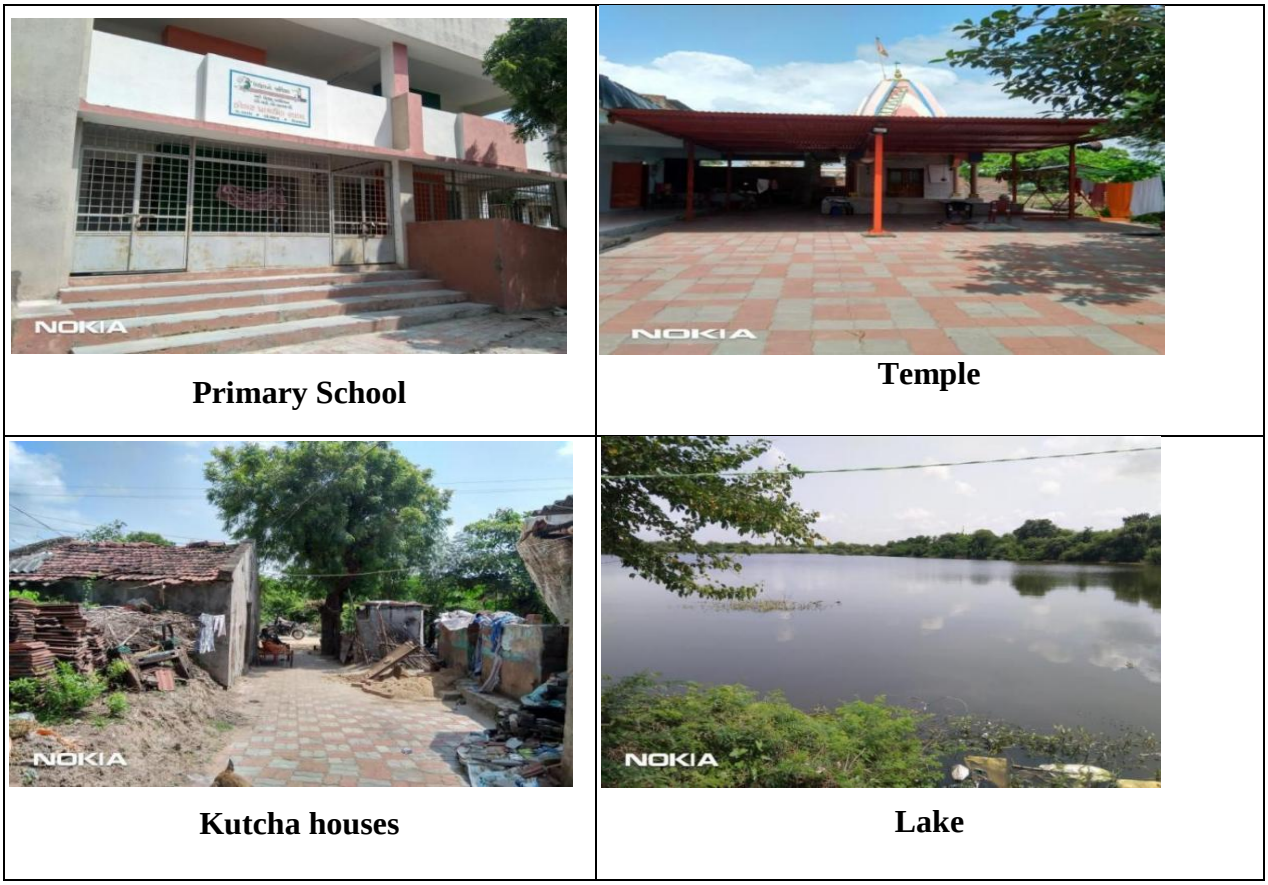
4. DATA COLLECTION

4.1 Primary data collection

By visiting the designated village, primary data collection is carried out, taking an overview of the entire village. By analyzing the map of the village, the village topography, the village population. Interacting with the Sarpanch & Talati to ask them about the rural problems faced by the villagers.

4.2 Secondary data collection

Secondary collection includes techno economic survey. Questions are put to the sarpanch, panchayat representatives, school principal, and villagers in techno economic survey. We have been able to recognize the issues related to the drinking water supply system, drainage sewage system, and sanitation facilities and lack of certain infrastructure like PHC, Library, Community hall, Post office through the techno economic survey & visit of kolat village.



Primary School | **Temple**

Kutcha houses | **Lake**

Figure 2: Photographs of Kolat Village

5. DESIGN PROPOSAL

We have suggested different designs after visiting the village and after analyzing the village extensively, which will help the villagers, improve their lifestyle. From visiting the villages and providing proper design, we have tried to build sustainable & economic design according to our knowledge & hard work.

In reference to the ideal village, our own goal is to grow the allotted village. Based on our survey, knowledge & gap analysis, we have proposed few designs for its development.

We get to know that the village has a Primary School, but there was no facilities like Library.in the school. As we know that Library is an important source of knowledge to young minds, for the welfare of students we proposed design of it.

Common Service Center (CSC) is an access point for information and communication technology (ICT) built by Indian government National e-Governance project. By providing CSC in our allotted village it will furnish to gain some knowledge of new technologies in the younger minds of the villagers.

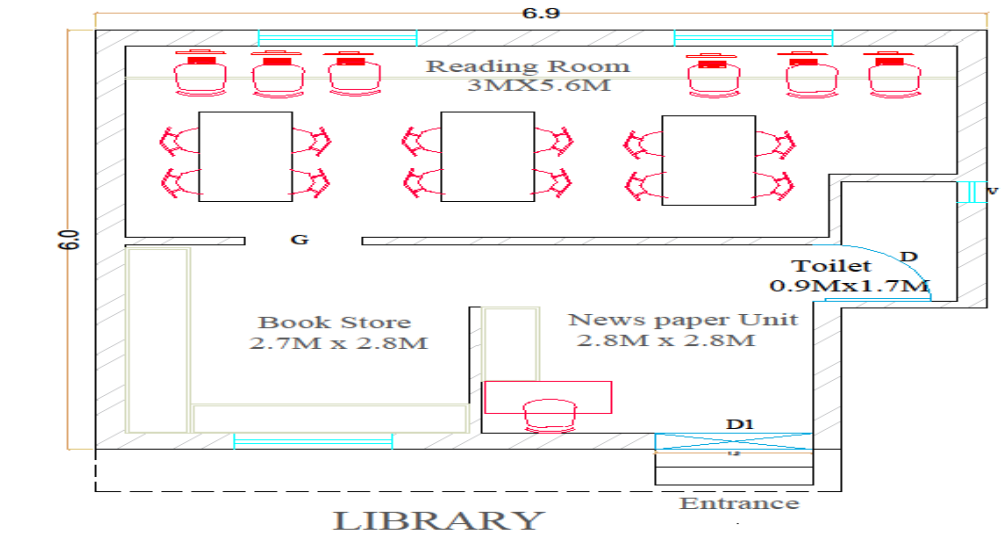


Figure 3: LIBRARY (Plan, Elevation and Side view)

ABSTRACT SHEET					
NO.	**ITEMS**	**UNIT**	**QTY.**	**RATE**	**AMOUNT**
1	EXCAVATION IN FOUNDATION	CU.M.	26.568	150.00	3985.20
2	P.C.C. IN FOUNDATION (1:4:8)	CU.M.	6.642	3900.00	25903.80
3	MASONRY WORK IN FOUNDATION	CU.M.	11.97	4900.00	58653.00
4	EARTH BACK FIILLING	CU.M.	7.956	120.00	954.72
5	5MM THICK DPC	SQ.M.	14.22	4700.00	66834.00
6	MASONRY WORK IN SUPER STRUCTURE	CU.M.	18.516	4900.00	90728.40
7	SMOOTH INSIDE PLASTER	SQ.M.	129.018	260.00	33544.68
8	OUT SIDE ROUGH PLASTER	SQ.M.	69.684	310.00	21602.04
9	R.C.C. SLAB	CU.M.	6.21	8800.00	54648.00
10	R.C.C. CHAJJA AND LINTEL	CU.M.	8.811	8000.00	70488.00
11	2' X 2' FLOORING	CU.M.	45.45	635.00	28860.75
12	DOORS IN WOOD	SQ.M.	6.3	1600.00	10080.00
13	WINDOOW IN WOOD	SQ.M.	6.912	1550.00	10713.60
14	VENTILATION IN ALUMINIUM	SQ.M.	0.18	1550.00	279.00
15	WHITE WASH(IN SIDE)	CU.M.	198.702	18.00	3576.64
					480851.83
ADD 5% CONTINGENCY					24042.59
ALL ABOVE RATE FILLED MAY VARY DUE TO MARKET INFLATION				**TOTAL**	**504894.42**

COMMON SERVICE CENTRE (CSC)

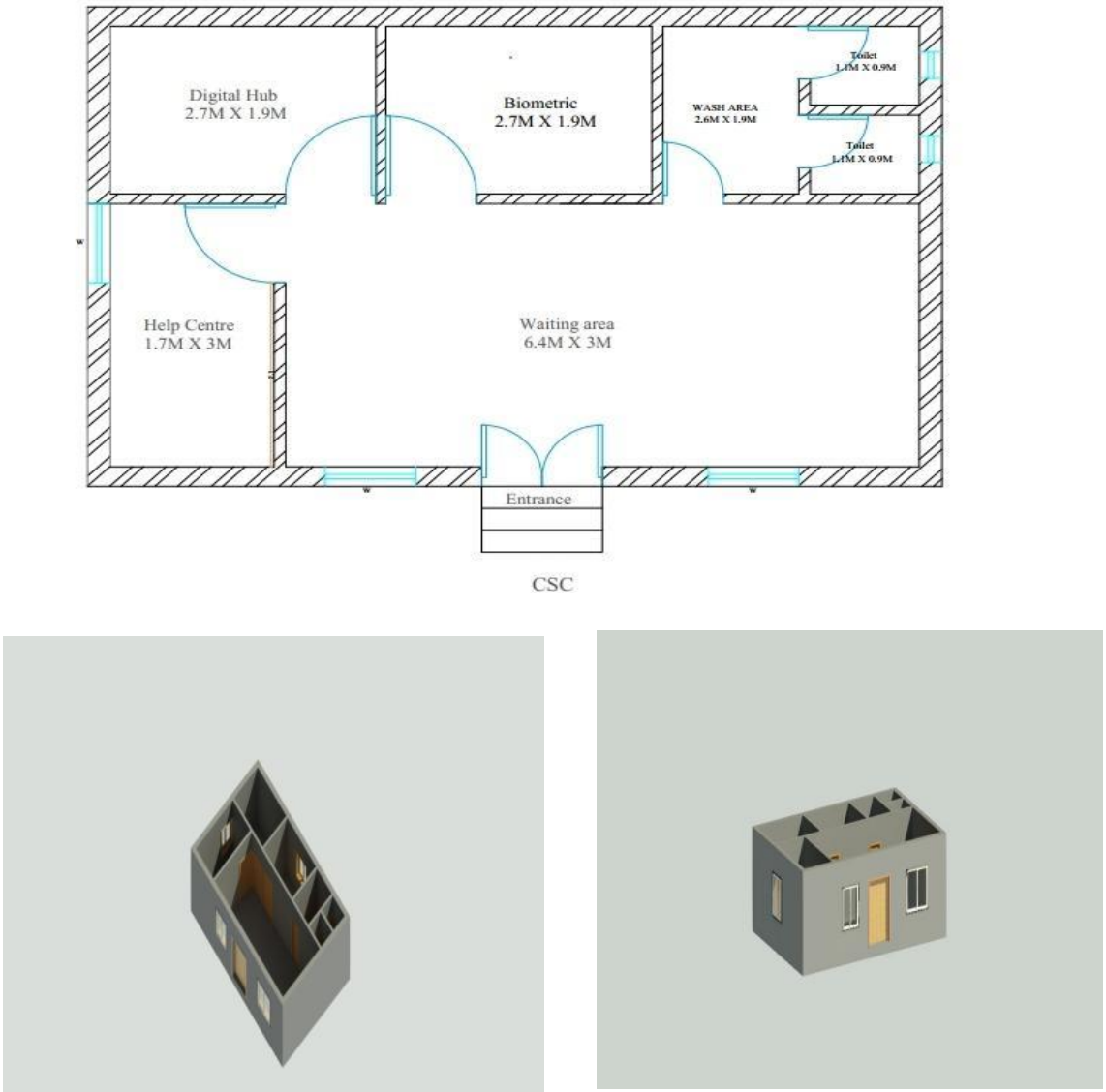


Figure 4: Common Service Centre (Plan & 3D View)

ABSTRACT SHEET					
NO.	**ITEMS**	**UNIT**	**QTY.**	**RATE**	**AMOUNT**
1	EXCAVATION IN FOUNDATION	CU.M.	29.81	150.00	4471.20
2	P.C.C. IN FOUNDATION (1:4:8)	CU.M.	7.45	3900.00	29062.80
3	MASONRY WORK IN FOUNDATION	CU.M.	13.57	4900.00	66502.80
4	EARTH BACK FIILLING	CU.M.	8.78	120.00	1054.08
5	5MM THICK DPC	SQ.M.	14.22	4700.00	66834.00
6	MASONRY WORK IN SUPER STRUCTURE	CU.M.	20.85	4900.00	102150.30
7	SMOOTH INSIDE PLASTER	SQ.M.	153.84	260.00	39998.40
8	OUT SIDE ROUGH PLASTER	SQ.M.	82.38	310.00	25537.80
9	R.C.C. SLAB	CU.M.	7.22	8800.00	63571.20
10	R.C.C. CHAJJA AND LINTEL	CU.M.	0.55	8000.00	4428.00
11	2' X 2' FLOORING	CU.M.	41.21	635.00	26168.35
12	DOORS IN WOOD	SQ.M.	11.97	1600.00	19152.00
13	WINDOOW IN WOOD	SQ.M.	3.89	1550.00	6026.40
14	VENTILATION IN ALUMINIUM	SQ.M.	0.18	1550.00	279.00
15	WHITE WASH(IN SIDE)	CU.M.	236.22	18.00	4251.96
					459488.29
ADD 5% CONTINGENCY					22974.4145
ALL ABOVE RATE FILLED MAY VARY DUE TO MARKET INFLATION				**TOTAL**	**482462.7**

6. ACKNOWLEDGEMENT

An act of gratitude is expressed to our **Prof. Parth Sinroza** and HOD **Zalak Bhavsar** from college **L.J. Institute of Engineering & Technology** for their invaluable guidance and constant inspiration. We are also thankful to **Ms. Darshana Chauhan,** from **GTU**, for all support during our work and giving us opportunity to be part of Vishwakarma Yojana.

7. CONCLUSION

Vishwakarma Yojana is preparing for Gujarat's future, and students of engineering like us have an opportunity to take real work experience and improve rural areas at economic cost with good workability and productivity during use. The goal of Vishwakarma Yojana is to develop the villagers' living standard, the project tends to improve the villagers' physical, social and socio- cultural aspects by economically implementing and improving infrastructure facilities in the village.

We decided to propose design of PHC, community hall, septic tank, library, Common service center because as per survey & gap analysis we conclude that this basic infrastructure is important for increasing living standard & create a healthy atmosphere for the villagers. By developing the above mentioned amenities all the facilities will be available to the villagers & migration will reduce & villagers need can live a good lifestyle in the village itself.

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TO DESIGN HYDROCARBON GAS OPERATED AIR GUN

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Bhagwan Mahavir College of Engineering and Technology

ABSTRACT

The Air Gun is designed to operate with different Hydrocarbon Gases such as Methane, Butane, Propane etc. rather than the traditional CO2, Nitrogen and Compressed air. The objective is to increase the effective range and power of the traditional Air Rifles by modifying and using alternative fuel and make it function like a firearm without its deadly effects.

Keywords: Hydrocarbon Gases, Piezo-igniter, Ignition, Combustion Chamber, Explosion, Detonation, Gases, Air Rifle.

1. INTRODUCTION

There are mainly 5 types of Air guns available in the market; Spring Powered, Gas piston, Pre-charged Pneumatics, Nitrogen Powered, CO2 Powered. In the Pre-Charged Pneumatics rifles there is a small chamber which contains the pressurized air which is used and regulated by a valve. Meanwhile the CO2, N2 Powered works in the same way however the fuel is pressurized CO2, N2 tubes which can be contained in a much smaller capsule like structure.

The butane, propane, methane gas is stored in canisters which are generally available in the market. So the availability is plenty, and no special equipment is required to harness the gas. The research is conducted in order to check whether usage of hydrocarbons such as butane gas, propane gas is feasible to use in the air rifle segment of sports and how it performs compared to the other types of Air guns which are available in the market.

2. OBJECTIVE & METHODOLOGIES

Hydrocarbons such as Butane, Propane and Methane have low flash point and they are readily available in the market hence they can be used as a source of energy in substitution for CO2 and N2.

It is necessary for the mechanism to be portable, hence it has been formed in a shape of a Rifle. The idea here is to create an explosion in an enclosed space, leaving one end open from where the energy can travel and has the least resistance path. A pellet or ball bearing would be placed on the exit which would be propelled by the combustive force.

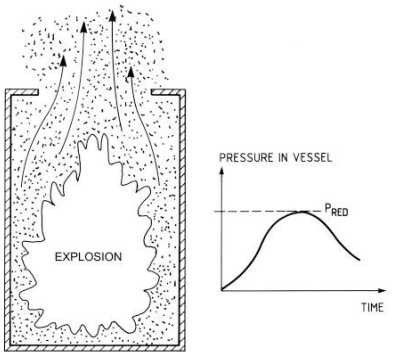

Fig. 1 Explosion direction [14]

There are other aspects of detonation phenomena which are only partially related to hydrodynamic processes and thus are out-side the scope of classical theory. These comprise transition from flame to detonation, limits of detonation, pulsation and spin of detonation waves. In addition, various problems arise from observations on the ignition of explosives by weak shocks. [1, 2].

2.1 Characteristics of Explosion Properties of the Gas

The major explosion parameters of gases are: [2]

1) Maximum pressure of explosion, max p
2) Maximum rate of explosion pressure rise, (see fig 2) or K factor: (dp/dt)max or K factor:
K=(dp/dt)max V1⁄3
3) Explosion limits
4) Detonation limits
5) Temperature of self-ignition
6) Minimum energy of ignition

Fig. 2 shows the record of the explosion pressure in a closed container. The maximum pressure of explosion Pmax is the highest pressure recorded during explosion in the closed container.

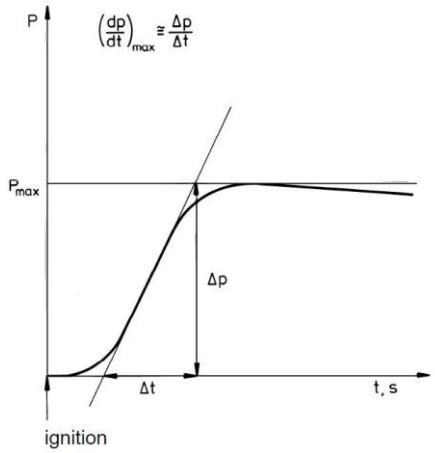

Fig. 2 Record of the explosion in a closed container [2]

2.2 Combustion properties of Gas – Air mixtures

The burning of a gas in air is a chemical reaction in which the fuel is oxidized releasing heat and often light. The chemical products of the complete combustion of hydrocarbon fuel are carbon dioxide and water vapor. Combustion of methane in air can be described by the reaction:

$$CH4 + 2(O2 + 3.762N2) \rightarrow CO2 + 2H2O + 2(3.762N2) + heat \quad \dots (1)$$

The temperature of premixed flame can be calculated from the (lower) heat of combustion of gas and the specific heats of combustion products. The flame temperature is highest for a stoichiometric mixture. This temperature is called the adiabatic flame temperature since it is calculated assuming the combustion to be an adiabatic process (no heat losses to the environment). Table 1 presents the adiabatic flame temperatures of some hydrocarbon gases and hydrogen in air [2, 3].

The adiabatic flame temperature can be used to calculate the volume of stoichiometric mixture after the combustion has occurred. It follows from ideal gas law pV= NRT that:

$$\frac{V_f}{V_i} = \frac{N_f T_f}{N_i T_i} \quad \dots (2)$$

Where,

- V_i is the initial volume in [m^3] V_f is the initial volume in [m^3]
- N_i is the number of moles in the unburned mixture in [mole]
- N_f if the number of moles in the combustion produce in [mole]
- T_i is the initial temperature in [K]

For methane, the number of moles is conserved i.e. $N_f = N_i = 10.52$

The ratio $E = {V_f}/{V_i}$ is called the expansion ratio of the gas. Values of the expansion factor E are given for hydrocarbon gases and hydrogen in table 1. For most hydrocarbon fuels, to a first approximation the mole number ratio ${N_f}/{Ni}$ can be taken as 1. The expansion factor can be equated to the ratio of the temperatures ${T_f}/{T_i}$.

fuel	flamm. range %	stoich. mixt. %	T_f K	E	H_{st} MJ/m^3
hydrogen	4 - 75	30	2318	8.0	3.06
methane	5 - 15	9.5	2148	7.4	3.23
ethane	3 - 12.5	5.6	2168	7.5	3.39
propane	2.2 - 9.5	4.0	2198	7.6	3.46
butane	1.9 - 8.5	3.1	2168	7.5	3.48
pentane	1.5 - 7.8	2.6	2232	7.7	3.59
hexane	1.2 - 7.5	2.2	2221	7.7	3.62
heptane	1.2 - 6.7	1.9	2196	7.6	3.62
acetylene	2.5 - 80	7.7	2598	9.0	3.93
ethylene	3.1 - 32	6.5	2248	7.8	3.64
propylene	2.4 - 10.3	4.4	2208	7.7	3.59
butylene	1.7 - 9.5	3.4	2203	7.6	3.64
benzene	1.4 - 7.1	2.7	2287	7.9	3.62
cyclohexane	1.3 - 8.0	2.3	2232	7.8	3.85

Table 1: Combustion properties of some hydrocarbon and hydrogen in air [3].

A basic quantity of premixed gas flames is the burning velocity - S0. This is the velocity at which the flame front (thin reaction zone) travels in a laminar flow with respect to the unburned mixture immediately ahead of it.

The value of burning velocity is determined by the molecular transport processes, such as heat and mass transfer within the flame front. The burning velocity is a function of gas concentration, reaching a maximum just on the fuel rich side of the stoichiometric concentration. This maximum value and the corresponding concentration are given in table 2 for the gases in table 1. It is seen that the maximum laminar burning velocity of most hydrocarbon fuels is close to 0.5 m/s. Hydrogen has exceptionally large laminar burning velocity 3.5 m/s [3].

fuel	max S_0 at %	max S_0 m/s	max S_f m/s	AIT K	min. ign. energy mJ
hydrogen	54	3.5	28	847	0.02
methane	10	0.45	3.5	813	0.29
ethane	6.3	0.53	4.0	788	0.24
propane	4.5	0.52	4.0	723	0.25
butane	3.5	0.50	3.7	678	0.25
pentane	2.9	0.52	4.0	533	0.25
hexane	2.5	0.52	4.0	498	0.25
heptane	2.3	0.52	4.0	488	0.25
acetylene	9.3	1.58	14.2	578	0.02
ethylene	7.4	0.83	6.5	763	0.12
propylene	5.0	0.66	5.1	733	0.28
butylene	3.9	0.57	4.3	658	0.28
benzene	3.3	0.62	4.9	833	0.22
cyclohexane	2.7	0.52	4.1	518	0.24

Table 2: Combustion properties of some hydrocarbon and hydrogen in air [3]

3. COMPONENTS & DESIGN

The components are designed in simple and compact manner which can be manufactured without much complexities. Few parts can be found in the market which can be modified according to the need and few has to be manufactured.

The core component of the design is the combustion chamber which has been inspired by combustion engine. In a Petrol engine, sparks plugs are used to combustion the fuel inside, similarly, a combustion chamber has been designed which can hold Hydrocarbon gases as fuel and it would be ignited by Piezo igniter.

Different patents related to the different components have been studied in order to gain more knowledge on their functions and designs. The parts are inspired by the features in different patents.

3.1 Gas Torch Adaptor

One of the modified parts used for the design would be the Gas Torch Adaptor which gets attached to a butane canister of 222gram or 250gram. The canister is of the standard fitting, which is available in the market and the adaptor would fit like a glove even to a propane canister. This torch is universal and available almost everywhere, as they have a variety of application in many of the industries. [Fig. 3]

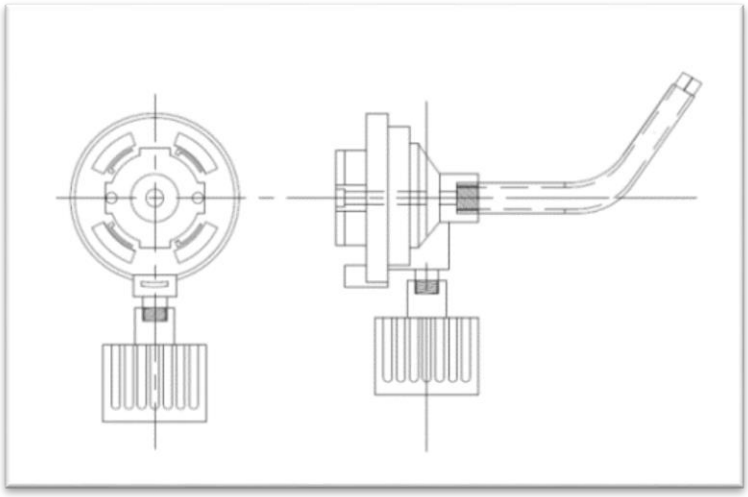

Fig. 3 Gas Torch Adapter

3.2 Check Valve / Non – Return Valve

The Check Valve is designed as well as modified for the system, a fuel check valve was available in the market but the size of it was bigger than anticipated, so to install it in the system it had to be modified using some brass nipples used in automobiles and fuel pipe. [Fig 4]

Inside the brass nipple, a 5.5MM ball bearing is inserted which sits loosely in the nipple but when back pressure is there it sits flush on the hole inside the nipple and makes it airlock. This system works as double security along with the Non-return valve as if the flames reach the canister it would be a disaster.

There is another design [Fig. 5] that was made after careful examination and analysis of the above-outsourced fuel check valve. The new design hasn't been incorporated into the system, but it certainly can be done as it reduces the number of components. The new design has been made such that two components have been combined into one component hence saving space and making the system as compact as possible. [7]

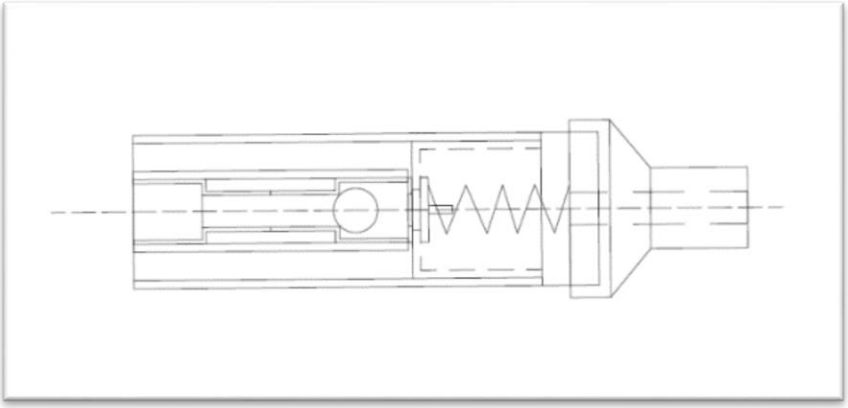

Fig. 4 Non-Return Valve

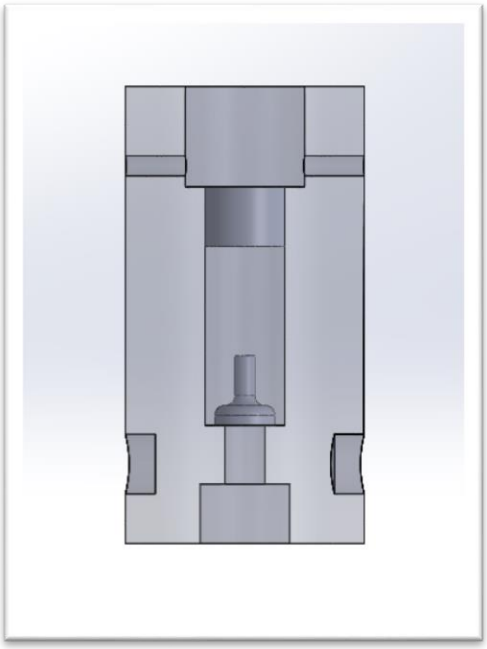

Fig. 5 Non Return Valve [New Designed]

The volume inside the Non-Return Valve would be around 4,448.49 mm^3 approximate. This is the volume of gas inside the valve when in a loaded condition.

3.3 Gas Torch & Non – Return Valve Assembly

The tip of the gas torch sits flush to the Non-Return Valve fitting due to the brass nipple assembly inside it and makes it a single component upon installation of both the components. [Fig. 6]

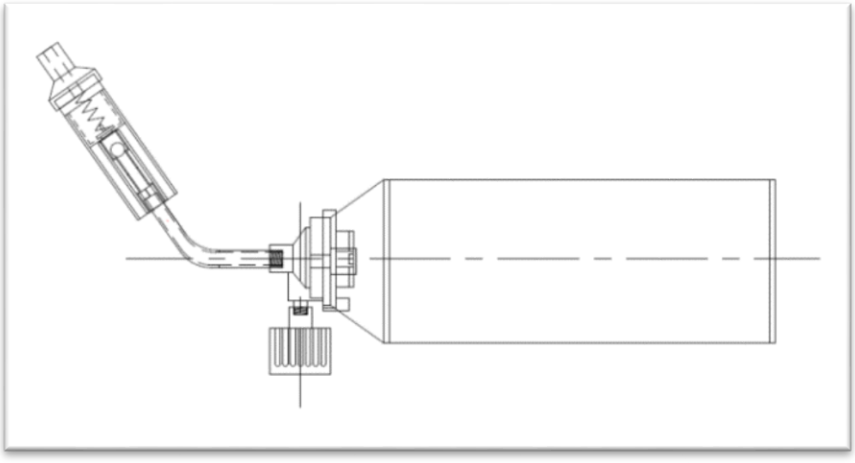

Fig. 6 Gas Torch & Non Return Valve Assembly

3.4 Piezo – Igniter

When the button on a Piezo-electric igniter is pressed, a spring-loaded hammer strikes quartz in order to create a spark. This is the typical process used in such lighters. This creates the necessary amount of voltage to generate a spark. [Fig. 7][5, 6]

Fig. 7 Gas Torch & Non Return Valve Assembly

3.5 Main Body

This is one of the main component of the model which also functions as a juncture where the entire small components are assembled on. The body is made of Aluminum (Aluminum alloy 6063) to keep it lightweight and effective. The main body hosts many parts such as Adapter, Barrel, Magazine, Ignition Module, and Stopper. [Fig. 8][17]

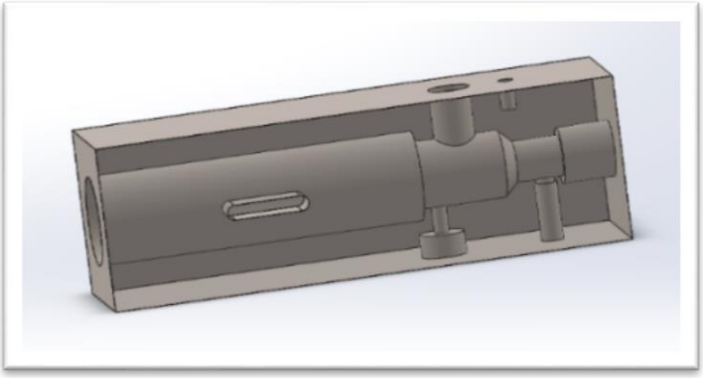

Fig. 8 Main Body 3D

3.6 Ignition Module (Ignition Chamber)

This component has two functions to serve, firstly it slides under the hole given in the Main body where it is screwed and aligned, think of this as a single bolt action gun mechanism, where a bolt is used to guide the mechanism. This guide is used for semi-automatic loading of the bullet into the chamber.

The second and the most crucial function it performs is that this component includes the combustion chamber inside itself. By doing so we don't require to make a separate chamber for butane gas to be ignited and this makes the gun compact and simple in design. [Fig. 9][17]

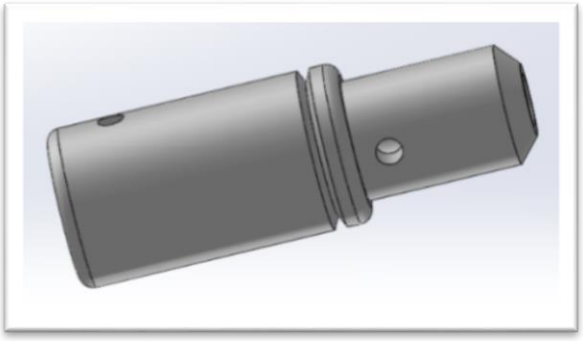

Fig. 9 Ignition Module 3D

Material [10]	**AISI 4140 Steel Bar**
Density	7.85 g/cm^3
Hardness, Brinell	197 HB
Tensile Strength, Ultimate	655 MPa
Tensile Strength, Yield	415 MPa
Elongation at Break	25.70%
Thermal Conductivity	42.6 W/m-K
Modulus of Elasticity	210 GPa
Workability	Cold: Good
Machinability	Good

Table 3: Material Details

For the calculation we are going to assume the combustion fuel as petrol whose approximate pressure inside the engine is about 120 bars and diesel has 180 bars.

DATA;

Pi = 12 n/mm^2 E = 210Gpa
Do = 9 mm E = 210000n/mm^2
Di = 5 mm FOS = 2
R = 2.5 mm μ = 0.30
L = 35mm welding factor (e) – 1.0

Yield Strength – 415 n/mm^2
Allowable stress – 14 N/MM^2

Minimum thickness requirement (UG-16)

The minimum thickness requirement of any pressure retaining component (excluding corrosion allowance) is 1.5 mm in accordance with the provisions of UG-16 i.e. [13, 15]

$$tu = 1.5mm$$

The thickness required (t_c) to handle circumferential stress arising due to internal pressure (Pi) is given as:

$$0.385\ SE = 0.39 \qquad \ldots (3)$$

$$Pi = 12$$

If $P_i > 0.385\ SE$, using Appendix 1-2: [14]

$$t_c = R\left(e^{\frac{Pi}{SE}} - 1\right) \qquad \ldots (4)$$

$$tc = 3.39\ mm \approx \mathbf{3.5\ mm}$$

The thickness required (t_l) to handle Longitudinal stress arising due to internal pressure (Pi) is given as:

$$1.25SE = 17.5$$

If $P_i > 1.25\ SE$, using appendix 1-2: [14]

$$tl = R\ (\sqrt{Z} - 1) \qquad \ldots (5)$$

$$\text{Where, } Z = \left(\frac{Pi}{SE} + 1\right) \qquad \ldots (6)$$

$$\therefore Z = 1.85$$

$$t_l = 0.900\ mm \approx \mathbf{1.0\ mm}$$

<u>The shell thickness excluding corrosion allowance (t) is the highest of the thickness amongst tc, tl, tu:</u>

$$\underline{tc = 3.39 \approx \mathbf{3.5\ mm}}$$

Maximum Allowable Working Pressure

$\frac{R}{2} = \frac{2.5}{2} = 1.25\ mm$, t = 3.5 mm

The MAWP for the available thickness is determined for circumferential stress (MAWPc) as:

If $t > \frac{R}{2}$, using appendix 1-2: [14]

$$\text{MAWP}_c = \log e\left(\frac{R+t}{R}\right) \qquad \ldots (7)$$

$$\text{MAWP}_c = \mathbf{14.5\ n/mm^2}$$

The MAWP for the available thickness is determined for circumferential stress ($MAWP_l$) as:

If $t > \frac{R}{2}$, using appendix 1-2: [14]

$$MAWP_l = SE\ (z - 1) \quad \ldots(8)$$

where, $z = (\frac{R+t}{R})^2$ ... (9)

$MAWP_l$ = **66.64 n/mm²**

The shell MAWP which is the lowest of the MAWP amongst MAWPc and MAWPl:

$MAWP_c$ = **14.5 n/mm²**

The Area inside the ignition module and valve portion would be **524.58 mm² &** Volume is **628.32 mm³**

Mass = Density of Butane gas × Volume of the cylinder

= 573 × 628.32 = **0.00036002736 kilogram**

Therefore, the mass of gas in the portion would be 0.36002736 grams. Given its gas and considering the leakages (If any) it is safe to assume that the usage of gas per shot would be 0.50 grams.

The heat of combustion of butane is -2870 kJ/mol. means, 2870 kJ energy is released when butane is burnt in the presence of oxygen.

Molecular Mass of butane is 58.12 g/mol

$$\text{Formulae - } N = \frac{mass}{Molecular\ Mass} \quad \ldots(10)$$

Therefore, number of moles in 0.5 gram of butane is 8.602 x 10^{-3} mol

If 8.602 x 10^{-3} moles of Butane is burned in the combustion the energy produced would be;

$$\frac{8.602\ x\ 10^{-3}\ mol\ CH4}{1}\ X\ \frac{2870}{1\ mol\ CH4} \quad \ldots(11)$$

Energy produced = **24.68 KJ**

According to newton's second law of motion, the acceleration of an object equals the net forces acting on it divided by its mass

M = 0.6786 g (Steel ball bearing)

F = 24680 N

Velocity (V) = **9030.52 m/s or 29627.7 ft/s**

3.6.1. Muzzle Energy

Muzzle energy is the kinetic energy of the bullet when expelled out from the muzzle to the target. Muzzle energy will be higher when bullet is heavier and moves out faster from the muzzle.

$$\boldsymbol{E_k = \frac{1}{2}\ Mv^2} \quad \ldots(12)$$

The velocity of the bullet is a more important determinant of muzzle energy. Muzzle Energy with Butane as gas would be **1619.74 J**

3.6.2. Estimating Explosive Energy Release in a Confined Explosion

One typical explosion in an enclosure is caused by flammable gas leaking, which mixes with air in the enclosure and subsequently ignites to cause an explosion. The energy released by expansion of compressed gas upon rupture of a pressurized enclosure may be estimated using the following equation [2]:

$$E = \propto \Delta H_C \, m_F \qquad \ldots (13)$$

Where,

E – Explosive energy released in [kj]

$\propto$ - Yield

ΔH_C – Theoretical net heat of combustion [kj/kj]

m_F – Mass of flammable vapor release [kg]

The yield,$\propto$ is typically in the range of 1-percent (0.01) for unconfined mass releases, to 100 percent (1.0) for confined vapor releases [31].

Heat of Combustion, Ignition Temperature; and Adiabatic Flame Temperature* of Flammable Gases			
Flammable Gas	Heat of Combustion ΔH_C (kj/kg)	Ignition Temperature T_{ig} °C (°F)	Adiabatic Flame Temperature T_{ad} °C (°F)
Acetylene	48,220	755 (1,391)	2,637 (4,779)
Carbon monoxide (commercial)	10,100	765 (409)	2,387 (4,329)
Ethane	47,490	945 (1,733)	1,129 (2,064)
Ethylene	47,170	875 (1.607)	2,289 (4,152)
Hydrogen	130,800	670 (1,238)	2,252 (4,085)
Methane	50,030	1190 (2,174)	1,173 (2,143)
n-Butane	45,720	1025 (1,877)	1,339 (2,442)
n-Heptane	44,560	-	1,419 (2,586)
n-Octane	44,440	-	1,359 (2,478)
n-Pentane	44,980	-	1,291 (2,356)
Propane	46,360	1;010 (1,850)	1,281 (2,338)
Propylene	45,790	1,060 (1,940)	2,232 (4,050)
*Adiabatic flame temperature of lower limiting fuel/air mixture			

Table 4: Theoretical Heat Of Combustion for Several Flammable Gases [30]

3.7 Stopper System

A system was required to stop the metal sphere from falling off the barrel and also to create a pressure seal such that the gas in the combustion chamber doesn't leak outside the system. To do so a simple stopper has been designing; this works with a plug and spring.

3.8 Sear Mechanism

In a firearm, the sear is the part of the trigger mechanism that holds the hammer, striker, or bolt back until the correct amount of pressure has been applied to the trigger, at which point the hammer, striker, or bolt is released to discharge the weapon. Since here, there is a hammer and striker but it is concealed within the Piezo Igniter so design only the push mechanism which would help exert a force on the Piezo Igniter. [Fig. 10][4, 8, 26, 27]

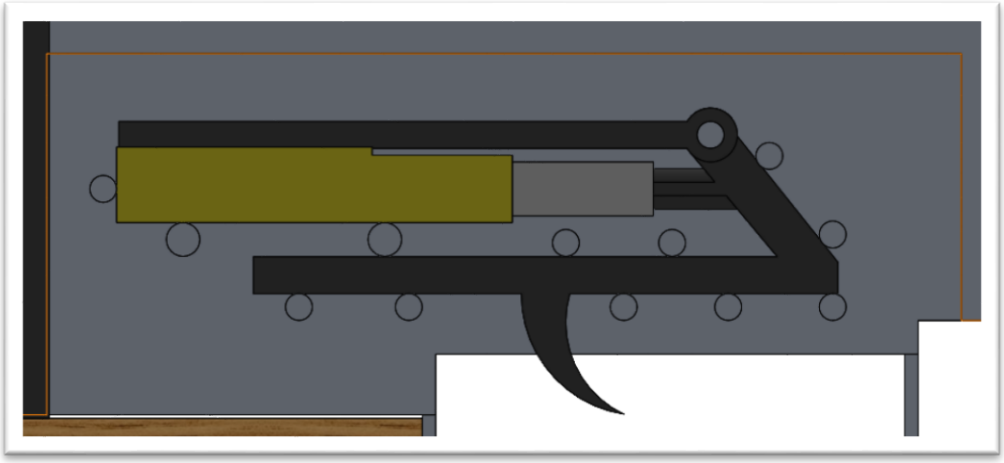

Fig. 10 Ignition Module 3D

3.9 Horizontal Fore-Grip

The Fore-grip is attached to the gun in order to provide support on the front end so it doesn't tip and can be controlled much better. Another reason to add a Fore-grip to this system is that it helps to counter the weight concentration on the front end due to the combustion chamber. Knurling is being done on the material to increase the surface roughness which would be beneficial to provide a better grip.

We can also just slide a rubber gripping pad on the handle if one doesn't have access to knurling. Or we make use strings or rope to give it a grip [Fig. 11] [9, 24]

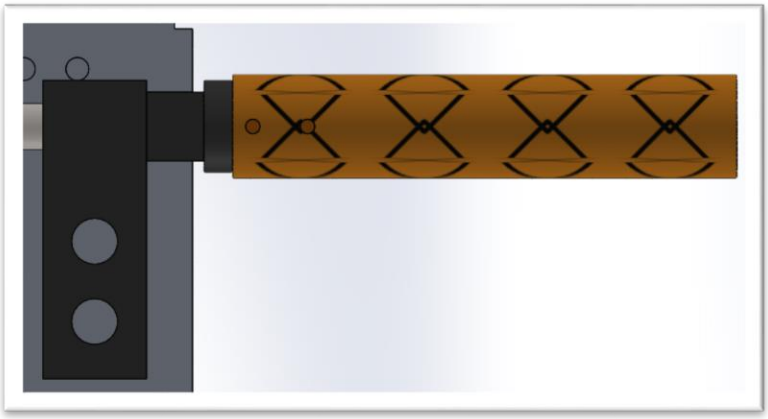

Fig. 11 Horizontal Fore-Grip

3.10 Safety Explosive Shield Cover (SESC)

The Safety Cover is a component [Red Crosses] that is used to shield the combustion chamber and the joint which is connected with valve from which the Gas enters the chamber. The Explosive Shield as the name suggests is a safety measure that is installed on the combustion chamber, this is done due to the fact that the user hand would be near the supply fuel and if the leakage takes place we need a method of safety.

It is a Stainless steel hollow pipe with 0.5 mm thickness which would be screwed into the Non-Return Valve systematically. So if there is a blast leakage then the extra protection should be able to deflect the explosion downwards which is away from the Fore-grip. [Fig. 12]

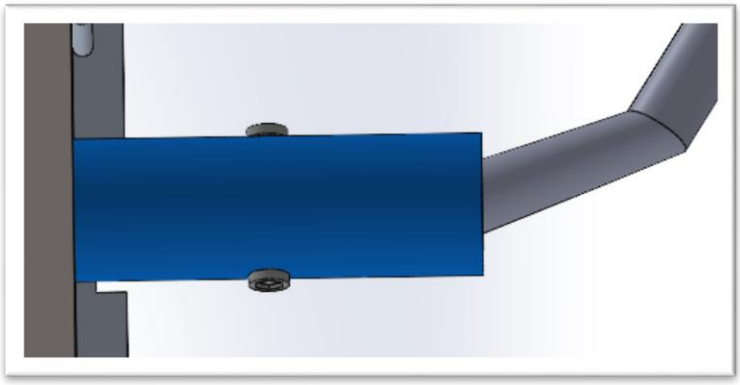

Fig. 12 Safety Explosive Shield Cover

3.11 Canister Holding Arm

All the canister weight would get concentrated on the bottom of the Non-Return Valve where it would thread. Due to this, it makes the fuel supply unstable, and chances of breakage increase. To counter this weight support element is directly attached to the frame of the system which distributes the loads from the threaded area to the support area, by doing so we can freely use the system without worry of breakage and the imbalance in the gun. [Fig. 13]

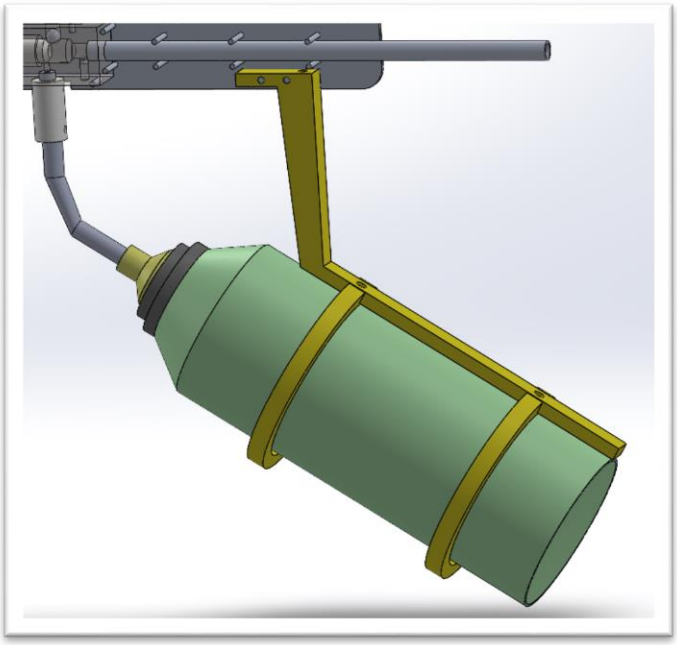

Fig. 13 Canister Holding Arm

3.12 Magazine and Feed System

As seen in figure 13, this is a single fed system in which one sphere enters the chamber, and once the combustion takes place the explosive energy pushes the module in backward motion creating an empty space which is taken over by another sphere which is fed through the magazine powered by a spring mechanism. The magazine can take up to 10 metal spheres, before loading it like a shotgun reloading mechanism. [Fig 14][18]

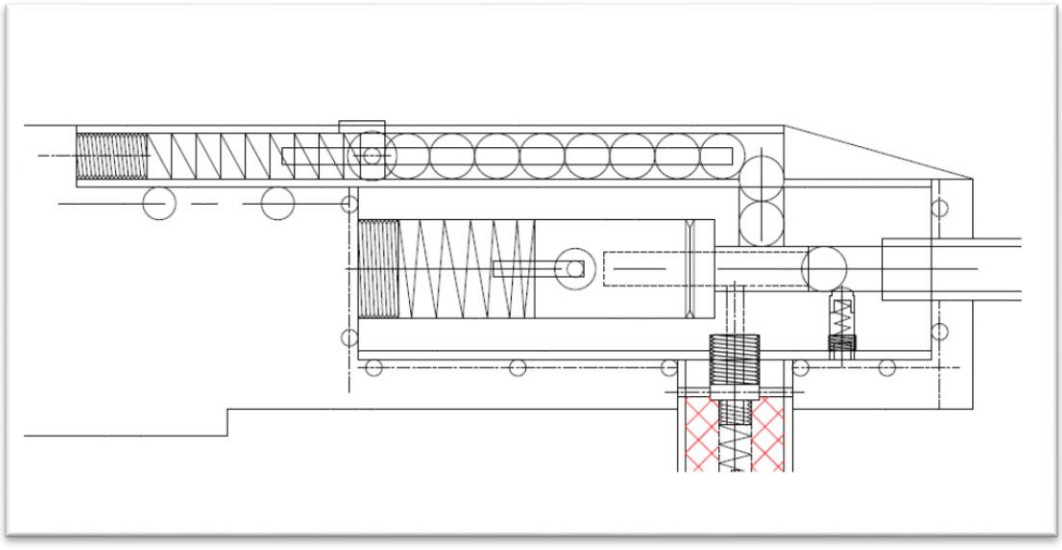

Fig. 14 Magazine and Feeding System

3.13 Foldable Buttstock or Stock

Stocks are a critical part of the rifles as the stock provides a means for the shooter to firmly brace the gun and easily aim with stability by being held against the user's shoulder when shooting the gun, and helps to counter muzzle rise by transmitting recoil straight into the shooter's body. The shoulder rest in this system is design to rotate on the left side of the gun and it can be locked using neodymium magnets in place so no complicated locking system is required. The length of the shoulder rest is kept almost equal to the length of the gun which when fold it can create a compact system that is portable. [Fig. 15][25]

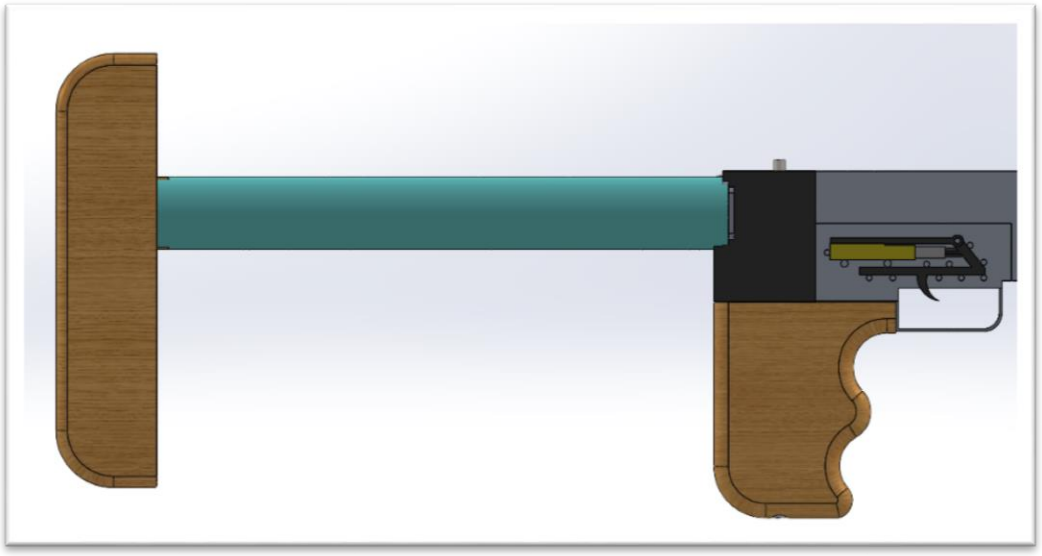

Fig. 15 Stock

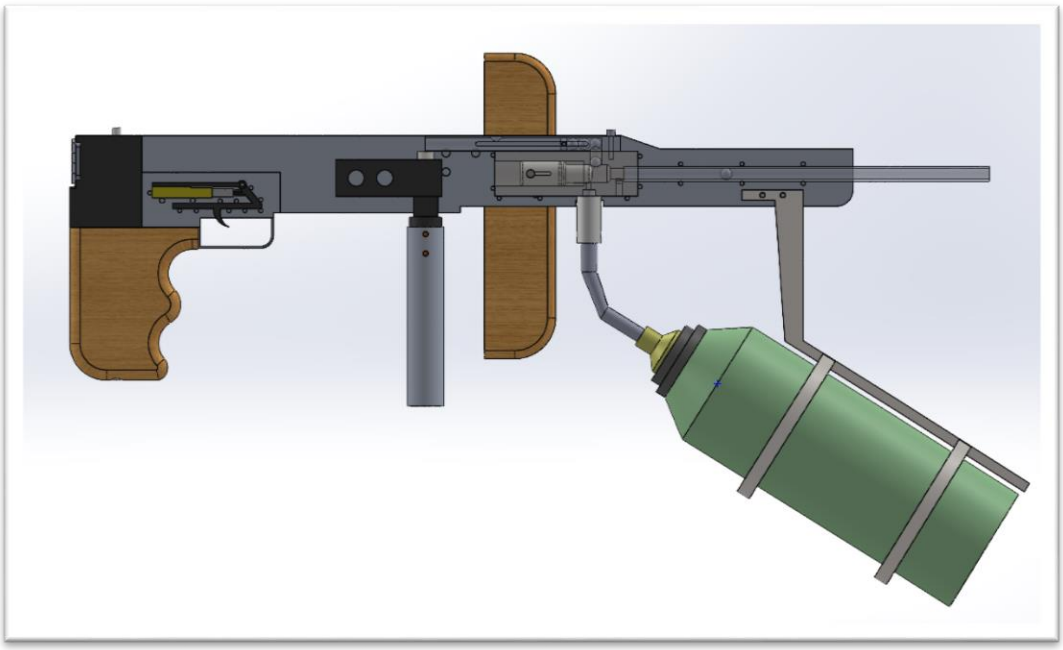

Fig. 15 Stock (Folded)

3.14 Assembly

The final product should look like this after the manufacturing and assembling all the parts together in the proper fashion and order. The above views showcase the parts in their designated place and a final cover is not attached for the internal view purpose. Aluminum is mostly used in most of the part to control the weight of the product; the critical components of the product are made of stainless steel as internal combustion is going to take place. From the given data it is estimated that the final weight of the product should be somewhere between 3.5 Kg to 4.0 KG.

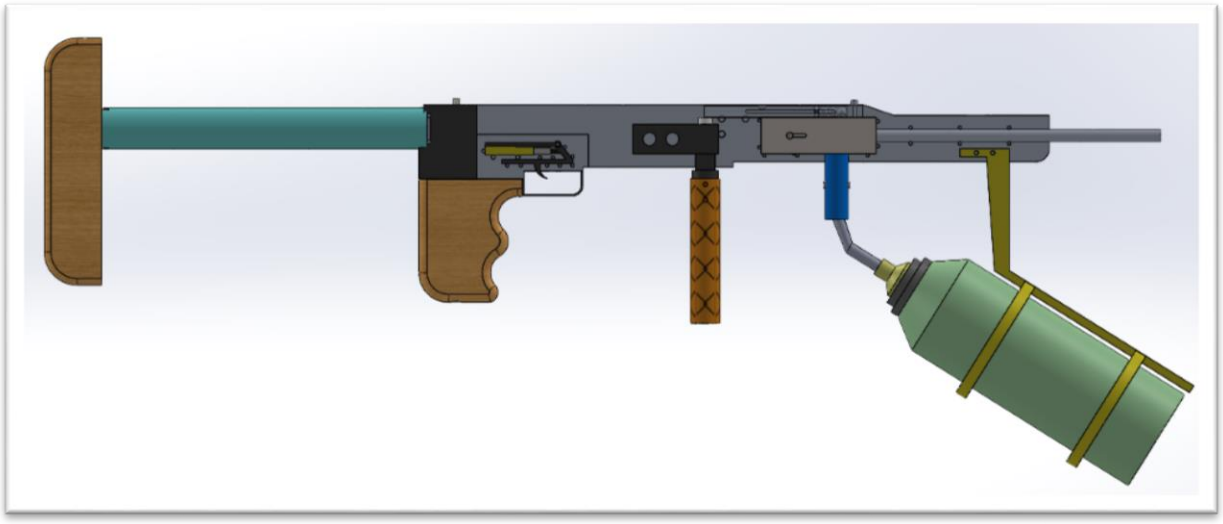

Fig. 16 Assembled

4. CONCLUSION

The system works in harmony and the combustion in the module push itself behind up to 11 mm and then all the energy is redirected towards the direction in which the barrel is open. This pushes the bearing with the given velocity out of the barrel. This is a cyclic process; however, with further research, it can be made automatic. For now, we have to open and close the Gas valve in order to fill the combustion chamber.

The calculation for the other hydrocarbons can be found in the below table;

Gases	Heat of Combustion (KJ / mol)	Molecular Mass (g/mol)	No. of Moles in 0.5 gram
METHANE CH_4	890	16.04	0.0311
ETHANE C_2H_6	1560	30.07	0.0166
PROPANE $C3H_8$	2220	44.1	0.0113
BUTANE c_4H_{10}	2870	58.12	8.602
OCTANE $C8H_{18}$	5460	114.23	23.89

Table 5: Properties of different gases

Gas	Energy Produced (KJ)	Mass (grams)	Velocity (ft./s)	Muzzle Energy (J)
CH_4	27.67	0.6786	29627.7	1815.97
C_2H_6	25.89	0.6786	28658.9	1699.15
$C3H_8$	25.08	0.6786	28.207	1645.99
C_4H_{10}	24.68	0.6786	27981	1619.74

Table 6: Energy Table

The above table [Table 6] represents the Kinetic Energy and the Muzzle Energy calculated for different Hydrocarbons gases. Out of which it seems that given the current design **Methane** would be the optimum choice of fuel as it produces the highest Energy out of all of them.

The Muzzle velocity of a CO2 rifle is 120 m/s to 180 m/s and a good Pre-Charged Rifle is capable of muzzle velocity of 240–270 m/s. The data received through the calculations suggests that for the same volume of gas (0.5 gram) **Methane CH_4** would be the best choice to be used as fuel due to its higher output off energy.

The other gases can also be used according to the availability and requirement of the design. From the calculation it is also suggested that the Maximum Allowable Working Pressure should not exceed 14.5 N/mm^2.

The Ignition module has been tested for failure on SOLIDWORKS Simulation with the following

DATA;

Fixture Type – Fixed
Load Applied – Pressure (Internal)
Mesh Type – Solid Mesh
Material – AISI Alloy 4140 Steel
Yield Strength – 4.150e+08

Pressure (N/mm^2)	Total Nodes	Total Element	Deformation Scale	Result
12	28928	18596	1505.37	Safe
14.5	28928	18596	1.245.82	Safe
24	28928	18596	752.683	Unsafe

Table 7: SolidWorks Simulation Analysis Results

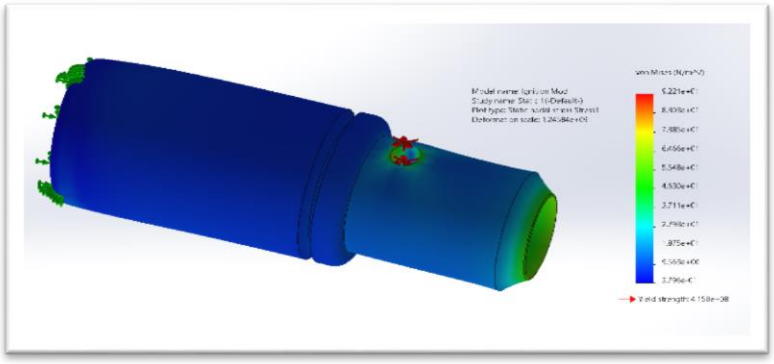

Fig. 18 Deformation at 14.5 N/mm2 Pressure

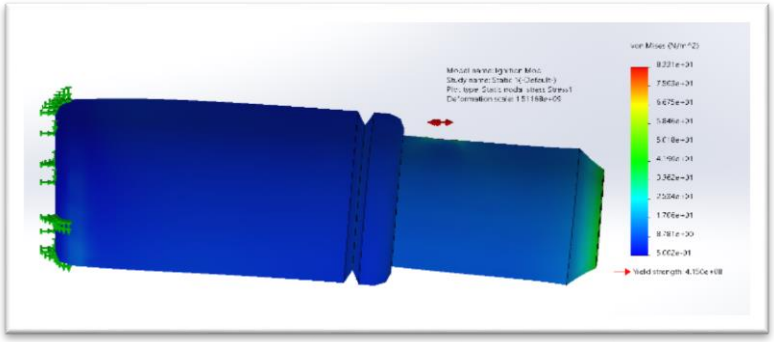

Fig. 19 Deformation at 12 N/mm2 Pressure

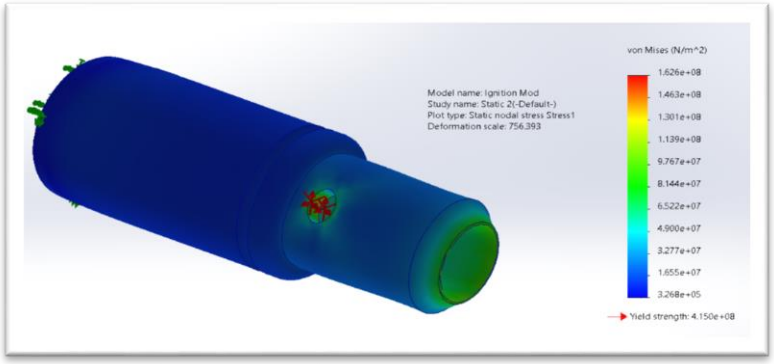

Fig. 19 Deformation at 24 N/mm2 Pressure

At 24 n/mm^2 the component starts to deform so from the data it can be said that the component is safe to use. The valve is designed to act as a non-returnable check valve hence the combustion doesn't go into that area however for safety of the user a metal cover is used to protect the main line, so even in worst case scenario the user is not met with any damaged.

So to conclude it can be said that there is a significant increase in power with the use of Methane gas as an alternative to the traditional fuel sources. If a person wants to increase the range and power even more then they have to modify the Combustion chamber to accompany more Gas intake and then the power would automatically.

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A REVIEW ON IMPACT OF SOCIAL MEDIA ADDICTION

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ABSTRACT

In recent years, as the number of smartphone users increases exponentially, the use of social media becomes an integral part of everyone's life. Social media websites and applications have attractive features such as recommendations, and endless scrolls that enforce people to stay on them. Social media makes it easier to connect to friends and family members, build a network with global communities, spread awareness on important issues, made learning platform available everywhere, and provides a new opportunity for local businesses, but excessive time spent on social media leads to being addicted to social networks and that affects job/studies, offline relations, interpersonal communication skills, the health of individual's life which is more concerned nowadays. Several screening scales are available to measure social media addiction as Bergen social media addiction scale contains 6 items based on six core addictive elements and the social media addiction scale are of 41 items with three addictive elements along with occupation and each item in both scales is of 5 points likert scale. This review aims to investigate the various research work that has been conducted so far to understand the social media addiction of the population, its impact on the population of different groups by age, gender, usage of social media, etc., and intervention/strategies for reducing social media addiction.

Keywords: Social Media Use, Social Media Addiction, Mental Health, Life-Satisfactions

1. INTRODUCTION

Social media is a revolutionary change for communication and connecting to people(Malak et al., 2021). Social media is a virtual platform with the capabilities of creating and sharing content over the internet. Social media can be accessed through web-based apps or mobile applications. Multiple platforms of social media have some common features such as it is interactive, allowing user-generated content, and developing social networks with individuals or groups. Since internet technology expanded, the use of social media platforms is increased.

According to a global statistics report (2021) in India, social media has 448 billion active users with an annual growth rate of 31.2% and 624 million internet users with an annual growth rate of 8.2%. The average time spent on social media is 2 hours 25 mins out of the total time of 6 hours 36 mins spent over the internet(*India Social Media Statistics 2021 | Internet & Mobile Statistics of India*, n.d.).

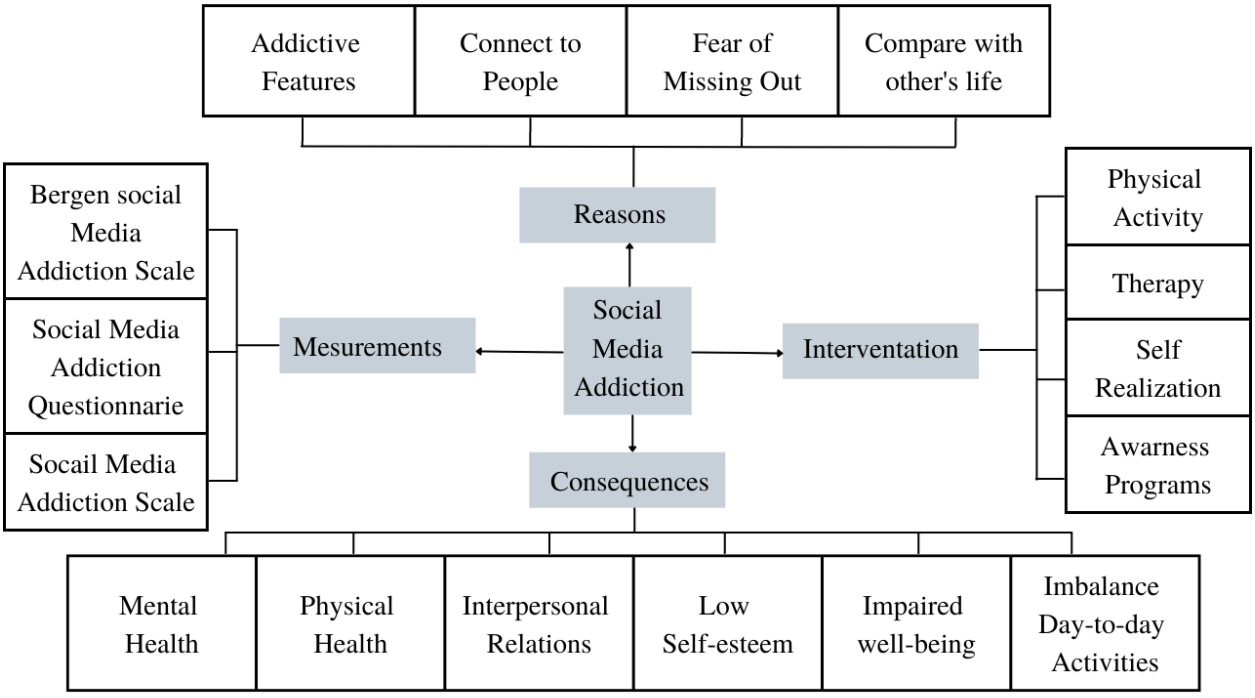
Over the last decade, social media changed the definitions of traditional education, shopping, businesses, etc. to some extent. During the pandemic, everything moves from offline to online, kids to adults everyone started spending more time on the internet, especially on social media and it became more popular from that time. Devoting more time to social media that it impairs day-to-day activities such as job/studies, psychological health, well-being, and individual relationships. Social media addiction is a sub-part of internet addiction in which an individual has an uncontrollable urge to use social media(Hou et al., 2019) and is excessively concerned about their virtual presence. Social media use is highly associated with somatic symptoms such as headaches, and back pain and individuals who have excessive usage time on

social media have a higher level of C-reactive protein(CRP)(Lee et al., n.d.). Social media addiction may lead to physical issues like eyestrain, rounded shoulder, and pain in elbows, hands, and wrists because of poor sitting positions. Mental health is as important as physical health for any humans. If someone have a mental health problem, it can affect behaviour, decision making, mood and perspective towards life. Through the digital presence on social media opens a new opportunity of earning and learning, but utilizing it for more time without any productive work, will lead to social media addiction and that can result in mental health diseases. Social media addiction has a direct and indirect impact on mental health including anxiety, depression, self-esteem, life-satisfactions because of comparing life with others even with people whom they don't know offline, emotional investment with virtual people etc. and that can affect sleeping quality, focuses on daily tasks. Although social media addiction has an impact on physical health, in this review, we will focus on life-satisfactions and psychological implication of problematic social media usage.

1.1 Purpose

The use of social media is beneficial but should be used in a limited way without getting addicted. This review aims to get a sight for measuring scale for social media addiction, determine the reasons for people being addicted to social media, investigate the impact of social media addiction on various factors, to look at the impact of an intervention program on social media addiction.

Figure 1: Social Media Addiction Reasons, Measuring scales, Consequences, and Interventions



1.2 Reasons why people being addicted to social media

As technology is growing and the system becomes intelligent day by day, social media has become the routine for most of the people. Over the internet, several different social media platforms are available from

which Facebook, WhatsApp, Instagram, and YouTube are the most popular ones. Social media have some addictive features such as endless scrolling, social pressure, behavioral suggestion, rewards system, continuous streaming, etc.(Montag et al., 2019) that make users stay on their platform. Each platform has a variety of features such as WhatsApp provides an easy and interactive system for messaging, Facebook gives the facility to connect with friends from past times, and family members and share information with them, and Instagram has an endless scrolling for posts and reels along with messaging and connecting features and YouTube delivers continuous streaming with recommendation and auto play services. According to (Emin Aksoy, 2018), social media addiction has a beginning (usage of social media for 6 months or less) and continuity (usage of social media for more than 6 months) phase. In the beginning phase, reasons for the addiction can be lack of friends, lack of socialization, and monotony of life, as it continues, individuals continue to use it for keeping up with the events, feeling of fulfillment of duty, and protection of social relationships, etc. Staying positive all the time won't be possible, everyone gets negative thoughts. Nowadays, people start scrolling over social media to distract from negative thoughts instead of analyzing thoughts and thinking about a different perspective. Escaping from negative emotions has positive tendencies toward social media addiction(Brailovskaia et al., 2020).

1.3 Measuring social media addiction

To measure the extent of addiction to the individual towards social media, there are different point Likert scales available such as:

1.3.1 Bergen Social Media Addiction Scale

The Bergen Social Media Addiction Scale is an adaption of the Bergen Facebook Addiction scale(Andreassen et al., 2012). It contains six items according to the six-core addictive element such as salience, tolerance, mood modification, relapse/loss of control, withdrawal, and conflict. BSMAS items are scored based on a 5-point Likert scale from 1 to 5 which is interpreted as 5 – very often, 4 – often, 3 – sometimes, 2 – rarely, 1-very rarely. The range of the BSMAS score is 6 to 30. According to the BSMAS score, when 4 or more items have a score of more than 3 out of 6, it is an addiction indicator and a cut-off score of 19 points was suggested as the ideal threshold at and above which individuals are classified as at-risk of social media addiction(Bá Nyai et al., 2017).

1.3.2 Social Media Addiction Scale

Social Media Addiction Scale (SMAS)(Tutgun-Ünal & Deniz, 2015) is a scale that consists of 41 items based on 4 factors. SMAS also has a 5-point Likert scale from 1 to 5 which is interpreted from 1 – never, 2 – seldom, 3 – sometimes, 4 – often to 5 – Always. The range of the score is from 41 to 205. A total score of more than 173 indicates very high addiction and 140-172 indicates high addiction.

1.3.3 Social Media Addiction Questionnaire

The social media addiction questionnaire(Hawi & Samaha, 2017) is an 8-item questionnaire derived from the Facebook Intrusion Questionnaire (FIQ). SMAQ consists of 8 important questions that are directly related to the addictive behavior toward social media. Items of this scale are measured against a 7-point scale with standard responses: 1(strongly disagree), 2(disagree), 3(somewhat disagree), 4(neutral), 5(somewhat agree), 6(agree), 7(strongly agree). The higher the SMAQ score, indicates higher the intrusion of social media affecting your daily life.

2. RELATED WORK

Social media creates a lot of opportunities in the field of business, education, society, and career and helps in improving individuals' life. But excessive use of social media has a demerit that impacts negatively on people's day-to-day life. Individuals' day-to-day life activities can be affected by their self-efficiency, motivation, work pressure, and stress and these aspects can be impacted by social media addiction.

In (Ahmed et al., 2021), ahmed et al. explored the relationship among social avoidance/distress, problematic social media use (PSMU), and self-esteem. More specifically, the study assessed the mediating role of PSMU on the association between social avoidance/distress and self-esteem. This work also examined the relationship between demographic characteristics (gender, residence type, family type, etc.), social avoidance/distress, PSMU, and self-esteem. Self-esteem is about realizing own worth. How do you feel about your capabilities and limitations(*Self-Esteem - Wikipedia*, n.d.). Sometimes you feel good and sometimes feel low about yourself according to situations. Self-esteem can be of mainly two types: low self-esteem and healthy self-esteem. People with healthy self-esteem have a positive view of themselves and have a good potential to tackle the challenges. In spite of the fact that viewing or altering one's web-based profile improves self-esteem, web-based entertainment clients are much of the time uncovered to other celebrated web-based self-introductions, which can, thus, decrease the watchers' self-esteem(Hou et al., 2019).

To conduct this study, sample data were collected from undergraduate students by taking psychometric scales including the BSMAS, the RSES (Rosenberg Self-Esteem Scale), and the SADS (Social Avoidance and Distress Scale). Cronbach's alpha was used to test the data reliability for Bergen social media scale, Rosenberg self-esteem scale, and Social Avoidance and distress scale. To process and analyze collected data, SPSS software is used. Descriptive statistics (e. g., frequencies, percentages, skewness, and kurtosis), independent sample t-tests, Pearson product-moment correlation coefficients, and process analysis using macros from Hayes were performed to get the results of the study.

The presented research study suggested social avoidance/distress as a possible risk factor for PSMU. Because individuals with high social avoidance/distress are likely to avoid social situations, they may feel more comfortable engaging in virtual interaction with other social media users. This engagement in social media negatively influences users' self-esteem. Also, it suggested that frequent social media use decreases users' self-esteem and that this relationship is mediated by upward social comparison. PSMU partially mediated the relationship between social avoidance/distress and self-esteem, while social avoidance/distress predicted the level of self-esteem. Both social avoidance/distress and the PSMU were significant predictors of self-esteem. Also, there is a non-significant difference in PSMU and self-esteem by gender.

In (Zhao, 2021), authors worked to find the impact of social media usage types on subjective well-being (SWB) and social media addiction, and the relationship between them. Types of social media use are considered social use and entertainment use. SWB refers to how a person feels and evaluates their lives in different activities and situations of their life. SWB has three components: 1. frequent positive affect (PA) such as joy, and optimism, 2. infrequent negative affect (NA) like sadness, anger, and 3. Life satisfaction (LS). Individuals are said to have high SWB if they experience LS and frequent PA and infrequent NA [17]. Social media have different types such as social networks, image/video sharing, blogs, news platforms, and professional discussion sites and so do individuals who use it for different purposes. Individuals are using social media for education, gaming, and entertainment, being social, knowing about trends, and many more. Based on the type of usage of social media, it can result positively and negatively in a human's life.

For this research, data were collected through a printed questionnaire which includes questions from the social use scale, Entertainment use scale, Bergen social media scale, and subjective well-being scale using a random sampling technique. This study uses demographic variables as control variables. After collecting the samples, it was divided into addicted and non-addicted students based on at least six items on the social media addiction scale and scored 3 or more. Descriptive statistics and correlation analysis were done through the SPSS. SmartPLS is used to evaluate hypotheses and measurement properties.

Figure 2: Path analysis for identify mediating effect

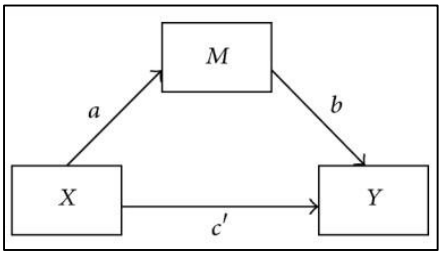


Fig 2 shows the mediating effect of M on the relationship between X and Y. where X is the independent variable, Y is the dependent variable, M is the mediator variable, a is the correlation between X and M, b is the correlation between M and Y and c' is the total effect from X to Y using M. The variables used in research model are social use, entertainment use, social media addiction, and subjective well-being.

Using the correlation between the main variables, the results of the three groups (total, addicted, and non-addicted) show that social use has a significant correlation with social media addiction, and social media addiction has a negative correlation with subjective well-being. Also, in the total group and addicted group, entertainment use is positively correlated with social media addiction, but this relationship is not significant in the non-addicted group. Different types of social media usage have a different effects social media addiction and subjective well-being: entertainment use is bound to prompt social media addiction, and social use will develop subjective well-being. Social media addiction and subjective well-being are negatively correlated with each other.

In (Malak et al., 2021), they want to analyze the direct effect of social media addiction on academic performance and the indirect effects on psychological factors among university students in Jordan. In that study, psychological factors stress, anxiety, and depression are taken into consideration. For this purpose, the hypothesis was formulated to find a signification positive relationship of SMA with stress, anxiety, and depression and a significant negative relationship between SMA and academic performance.

Data were collected through the survey questionnaire which consist of a social media addiction scale, self-rating screening scale, psychological stress scale, and academic performance (GPA). Also, some other variables are Age (range from 18-35), Gender (Male and Female), Academic Year (1^{st}, 2^{nd}, 3^{rd}, 4^{th} or more), and academic performance divided into excellent, very good, good, satisfactory, fair and poor. Using the random sampling technique, a total of 510 samples were collected from two universities. In this study, SPSS used for primarily analysis and to test and validate the conceptual research model, Structural Equation Modelling (SEM) is applied in this research. The SEM is a family statistical model that explains the relationships among multiple variables. SEM includes the PLS measurement model which represents the relationship between the observed data and the latent variables, and PLS structural model which can represent the relationships between the latent variables.

The conducted research study concluded that social media addiction had an indirect effect on academic performance, it has a direct impact on students' stress and anxiety levels. The stress could impact anxiety levels, which could straightforwardly affect students' academic performance. Students' stress levels had a direct effect on anxiety, which could result in depression**.**

In (Hou et al., 2019), inspected the relationship between social media addiction, mental health, and academic performance of college students, additionally tracking down the use of self-esteem to reduce the social media addiction and the effect of its outcomes. For this purpose, they have conducted 2 studies. In study 1, a survey was conducted to find the relationship between mental health, social media addiction, and academic performance. Moreover, they have used self-esteem as s mediator. For the study2, a survey was conducted on students who met the criteria for addiction by applying for a two-stage self-intervention program. In both studies, they have used the BSMAS to measure social media addiction. They have taken 232 data samples of college students.

In Study 1, BSMAS for social media addiction and the General Health Questionnaire (includes three subscales: depression, anxiety, and sense of adequacy) for mental health were used for measurements. They conducted three steps of regression analysis to analyze the role of self-esteem. Results from Study 1 affirmed theories that social media addiction was adversely connected to mental health and self-esteem can be played as a mediator.

In Study 2, the survey used similar to study 1 in addition to daily social media use time, and sleep quality. Participants were divided into experimental groups and control groups for investigating the effectiveness of the intervention program. The one-week intervention program was there for candidates in the experimental group, while no instructions for people in the control group. As a result, mental health, self-esteem and sleep quality is improved and diminished social media addiction for candidates in the experimental group, whereas there wasn't any remarkable change in the control group.

In (Sujarwoto et al., 2021), they have worked for tracking down the linkage between social media addiction and the mental health of university students and to check whether family relationships and religiosity may mitigate the harmful effects of social media on the mental health of students at this time. Using an online survey platform, they collected data from 709 students. To determine respondents, they have used a stratified random sampling technique. Center for Epidemiological Studies–Depression (CES-D) scale used to measure mental health. Social media addiction was measured using the BSMAS. During the COVID-19 lockdown in Indonesia, 40% of total social media users were increased and average internet accessing time increased from 5.5 to almost 8 hours per day.

For the student's data, they have collected data for CES-D score, mildly depressed/ not depressed, age, gender, Live with parents or not, BSMAS score, relationship with parents and siblings are good or not, and perceive the self as religious. While for parents, data collected were job type (formal/informal), income (different range from < 2 million to >10 million), and marital status. Statistical analyses were done using these methods. Poisson's regression and logistic regression was used to analyze and test between different variables. Then, they tested religiosity and relationship with parents to check if they can reduce the association using interaction variables and Poisson's regression.

Higher social media addiction scores are more likely to be experiencing depression in university students. Social media addiction appears to be harmful to mental health, while religiosity and nice relationships with parents can boost mental health.

In (Wan Pa et al., 2021), authors worked to find impact of social media on academic performance of undergraduate medical student using social media use as a variable. To work on this study, they have collected data from 400 students over the period of three months using questionnaire that includes questions of demographic information, internal and final assessment score, types of social media used, daily duration of using social media, usage of social media for medical education and social media addiction scale to measure addiction. From the collected data, they have seen that WhatsApp and YouTube were commonly used social media application. Also, more than 40% students used social media 3 hours per day.

Data analysis was carried out by SPSS software. Descriptive statistics used to analyze the demographic characteristics. Chi-square test was used to compare academic performance of medical students by gender. Then measuring correlation between social media use types and social media addiction using Pearson's correlation coefficient. As a Result, it is found that as social media use increased, academic performance of students decreases. Also, Social media addiction is increased with increased use of social media. They concluded the study by saying, social media has a negative impact on undergraduate medical student in this century.

In (Haand & Shuwang, 2020), study conducted to inspect relationship between social media addiction and depression in university students in ghost. For this purpose, data collected from 384 students studying in 3 different colleges using stratified random sampling technique but 55 were excluded due to not a complete response. So, 329 samples considered for study. Social media addiction was measured using Internet addiction test and depression was measured by CES-D scale. After screened questionnaires for eligibility using Cronbach's alpha, collected data were used for the further analysis.

SPSS software was used to analyze the Pearson's correlation coefficient and linear regression between depression and social media addiction. As an output of this study, higher social media addiction level indicated the higher depression level/ higher chance of depression is. Although, there is weak negative correlation, depression can significantly predict social media addiction.

Table 1: Positive and Negative correlation between different variables

Literature	Variable	Positive Correlation	Negative Correlation
(Ahmed et al., 2021)	PSMU	-	SAD, Self-esteem
(Hou et al., 2019), (Malak et al., 2021), (Sujarwoto et al., 2021), (Haand & Shuwang, 2020)	SMA	Depression, Anxiety, Stress	Mental Health
(Bhandarkar et al., 2021),(Hou et al., 2019),(Wan Pa et al., 2021)	SMA	-	Academic Performance
(Zhao, 2021)	SMA	Entertainment Use	Social Use

	Subjective well-being	Social Use	SMA

SMA: Social Media Addiction

3. REDUCE SOCIAL MEDIA ADDICTION

Accepting the behavioral change, physical health and concentration issue be the first step toward defeating social media addiction. There is very few research available that shows the mediator, intervention, or remedy that can be efficient to overcome the addiction. In (Hou et al., 2019), they have conducted an intervention program for addicted individuals with experimental (didn't receive any suggestions) and control group(provide them different methods). Their study suggested that the program has a positive impact in reducing social media addiction for the control group and helps to improve their sleeping quality and mental health. Another study(Abbasi et al., 2021) used physical activity as a moderator for beating smartphone addiction, so it surely helps to reduce social media addiction and can improve concentration. According to(Sujarwoto et al., 2021), family relationships and religiosity can mitigate the impact of social media addiction and so it can improve mental health. To reduce social media addiction, one has to speak about what they feel to the people around them and one should listen to people around them. There can be another moderator that needs to be identified to assist addicted people. Also, at school, university, or at the workplace, arranging awareness programs may prevent people to addict to social media and intervention programs to reduce it.

4. CONCLUSION AND FUTURE WORK

This review paper gathered information from existing research on the impact of social media addiction on various aspects of life, the effects of different variables on social media addiction like daily social media usage, type of social media use, etc., and moderators that can reduce the impact of social media addiction. From the reviewed work, most research was conducted on university students and it is found that youngsters are at high risk of social media addiction. Also, there is no significant difference in addiction by gender. The purpose of social media usage has a notable correlation with social media addiction in addicted people. In university students, social media addiction has a direct impact on students' stress, and anxiety that can lead to depression and so does impact academic performance. It is shown that relationships with parents and religiosity can reduce the effect of social media addiction. Considering the impact of social media addiction, an important step is to make people realize their social media usage and the result of that. Controlling the craving for the usage of social media may not reduce the addiction and its outcome but being conscious about it can surely help to improve mental and physical health. The effect of online education on social media addiction can examine in further studies. From this review, using the different affected aspects can make a system that can suggest remedies for addicted people.

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AN OVERVIEW OF EMERGING POLYMER USED IN CANCER IMMUNOTHERAPY & FUTURE PROSPECTS

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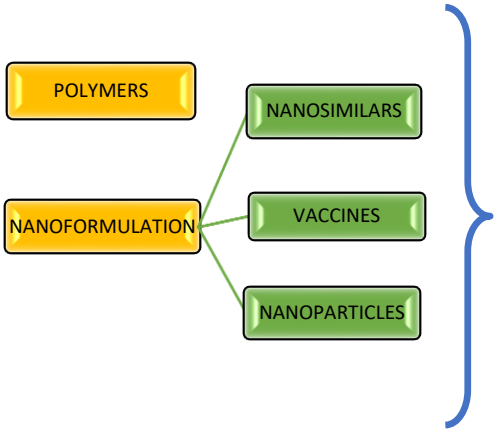
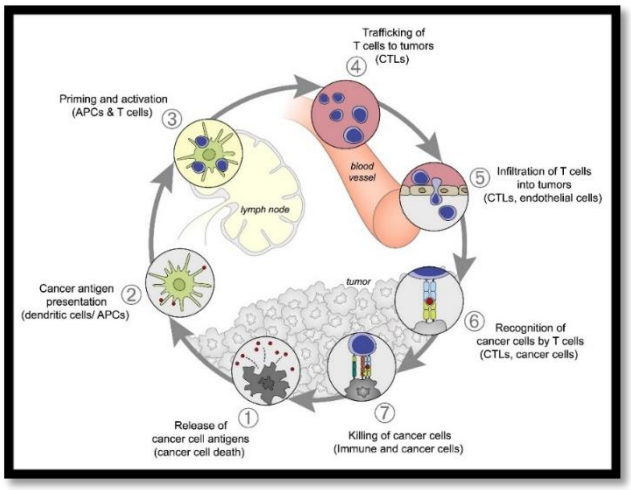
ABSTRACT
Cancer immunotherapy is one of the promising approaches in the treatment of the cancer. Various nanomaterials and nano formulations are used to treat cancer and are beneficial as they have an ability to overcome poor solubility and toxicity. This study mainly focuses on the polymers used in the treatment of the cancer immunotherapy. There are numerous polymers used in the treatment of the cancer: Block co-polymers conjugates, Thermo-sensitive polymers, pH-sensitive, Redox etc. Nanomaterials have great biocompatibility and absorption. The combination of the immunotherapies results in the increased therapeutic effect as compared to alone treatment. Vaccine prepared by nano formulations have great effect in the treatment. Patents of the cancer immunotherapy and future prospects are also presented. This review focuses mainly on the polymer used in cancer immunotherapy and also on the recent trends and future perspectives of the polymers used.

Keywords: Cancer immunotherapy, Nano formulations, vaccines, polymers.

Graphical abstract:

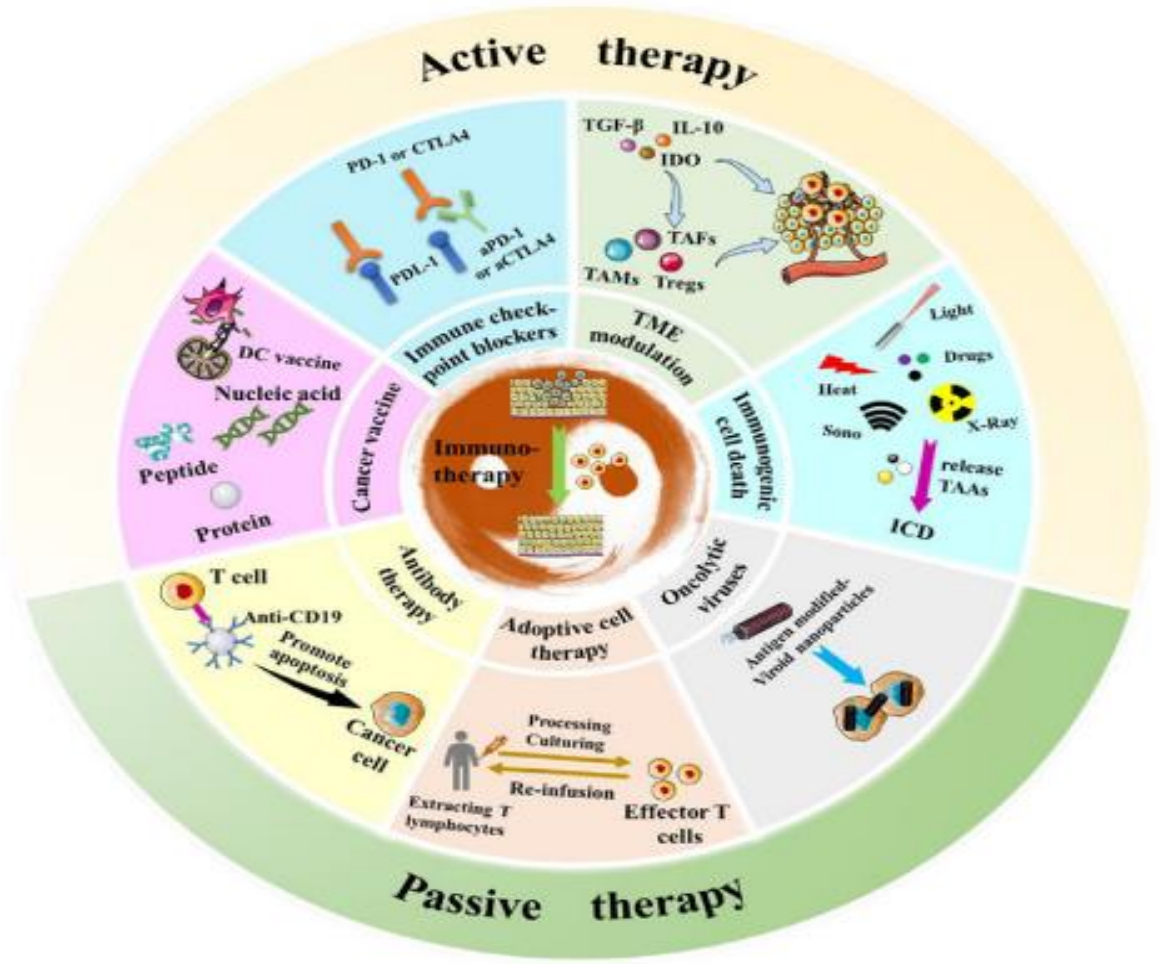




1. INTRODUCTION

Immunotherapy is a one way to deal with the treat disease hence it shows powerful therapeutic viability without the adverse results, experienced by ordinary remedial methodologies, for example chemotherapy, surgery, and the radiation [1]. The current treatment approaches of cancer immunotherapy and the corresponding mechanism of each immunotherapeutic approach mention in figure 1[2].

Figure 1: The current treatment approaches of cancer immunotherapy and the corresponding mechanism of each immunotherapeutic approach. [2]



Polymers play an essential function in the drug application, particularly in the field of drugdelivery. There are numerous polymers used in the cancer treatment such as Block co-polymer conjugates, Thermo-sensitive polymers, pH- sensitive polymers, Redox-polymers etc. The main principle of combining the polymers to chemotherapies is to accomplish the synergistic impact to improve their pharmacological actions [3].

Nanomaterials have several advantages including great biocompatibility, mucosal adsorption, and biodegradability. Other extraordinary physicochemical properties of nanomaterials as non-viral vectors incorporate a simplicity of handling and adjustment, controllable surface properties, the advancement of utilitarian particles into cells, and the assurance of DNA and proteins from degradation. Numerous nanomaterials have been created, including iron oxide nanoparticles, gold nanoparticles, cerium oxide nanoparticles, carbon-based nanomaterials and polymeric nanoparticles have displayed incredible potential in the uses of antibodies and medications. Furthermore, nanomaterials themselves have antigenic or restorative movement, and can inspire a solid insusceptible reaction; nanomaterials can hinder or even execute pathogeniccells by utilizing their cell poisonousness or autoimmunity [4].

Polymeric nano formulations have increased expanding acknowledgement for malignancy immunotherapy since they can possibly improve the immunotherapeutic adequacy and overcome limitations of IRAEs. For instance, polymeric nanomedicines permit for focused conveyance of malignancy antigens to antigen-introducing cells (For e.g. macrophages and dendritic cells) by which the immature T-cell can be successfully prepared. As in recent years, polymeric nanomedicines such as medications stacked micelles and polymer-drug forms have gotten expanding consideration for malignant growth treatment since they can viably convey anticancer operators to tumours by passive or dynamic focusing on mechanisms. Polymeric nanomedicines have been applied to different intractable illness, including diabetes, stroke, rheumatoid joint inflammation, furthermore myocardial localized necrosis. Vaccines are used to control or eradicate various diseases. Many new vaccines have been developed with modern advancement such as recombinant vaccines, synthetic vaccines, DNA vaccines and nanomedicines. As the era passes, the development in vaccine is also been seen as in improving the immunity, enhancement in design of vaccine, minimizing toxicity, adverse effect or side effects and improvement in its effect. Polymer and their roles in cancer drug delivery are mention in figure 2 and different nano formulation are mention in figure 3 [5].

Figure 2: Role of nanoparticle in cancer immunotherapy [5]

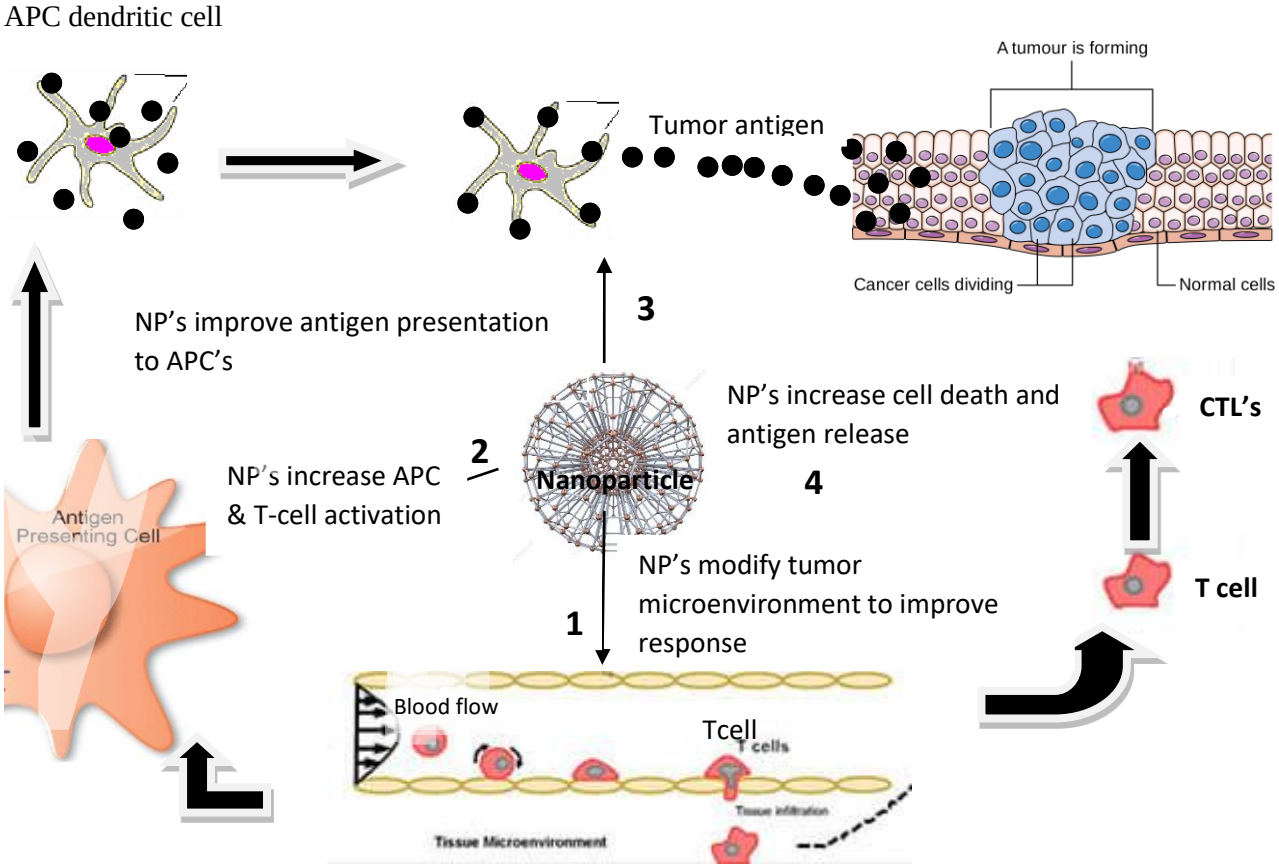
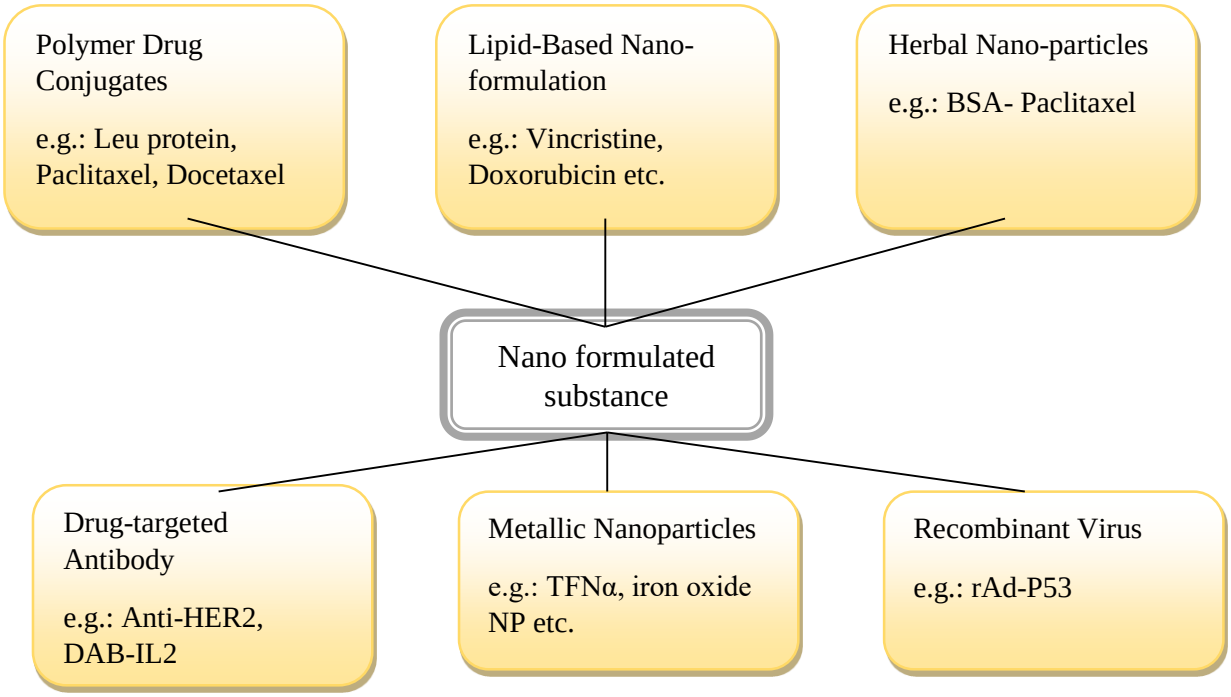


Figure 3: Nano-Formulated Drugs [5]



The different Nano-formulated Drugs used are as follows:
Polymers mainly are classified as: Natural polymers, biosynthesized polymers and chemically synthesized polymers.

1.1 Natural Polymer

Natural polymer is a sustainable asset that can be gotten from an assortment of sources, it can be debased into water, carbon dioxide and inorganic atoms. These can be created by physical and compound strategies, or through adjustment to turn into another material utilizing developing nanotechnologies. At present, regularly utilized common polymer materials incorporate chitosan, starch, alginate, cellulose, hyaluronic corrosive, chondroitin sulfate and so forth (Mention in Table 1) [6-9].

1.2 Biosynthesized Polymers

Biosynthesized polymers are acquired through catalyst hydrolysis (utilizing microbial chemicals). These mixes contain microbial polyesters and microbial polysaccharides. Delegate items are poly-β-hydroxybutyrate (PHB), poly (3-hydroxybutyrate-co-3- hydroxy valerate), biofibre group, polyamine corrosive and so forth (Mention in Table 2) [12-14].

1.3 Chemically Synthesized Polymer

Artificially orchestrated polymer materials, including PLA, PLGA, Polyurethane (PU), Poly(methyl methacrylate) (PMMA), polyester, polyvinylpyrrolidone (PVP), silicon elastic,polyvinyl liquor, and so forth, (Mention in Table 3) that are utilized in clinical materials are created through strategies [15-17].

Table 1: Natural Polymers [10-11]

Nano materials	Role	limitations	Structure	Melting Point

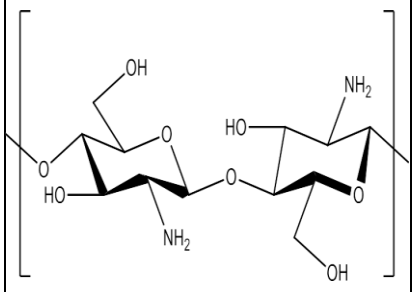
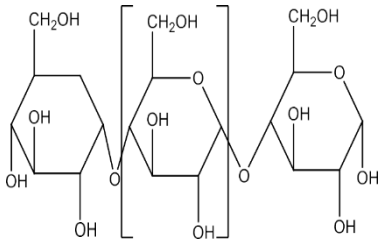
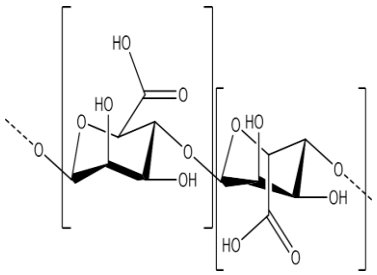
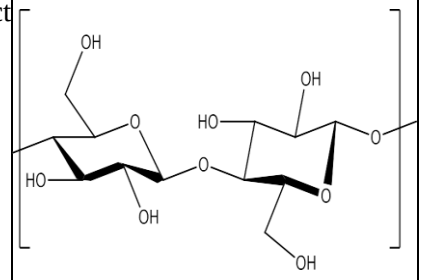
Chitosan	Biocompatibility, harmless, anti-microbial, easy to degrade, adsorbability, film formation, moisture retention	Poor spinnability, low strength, and less water soluble.		88ºC
Starch	Extensive source, co steffective, safe and non-toxic, non-antigenic	Less mechanical properties, resist to water, bad blocking performance		256-258ºC
Alginate	Less toxic, degraded safe and no toxic, non-antigenic	Low biodegradability, poor cell attachment.		99 °C
Cellulose	Extensive source, Cost - effective	Rare adverse effect are seen		260–270 °C

Table 2: Biosynthesized Polymers [10-11]

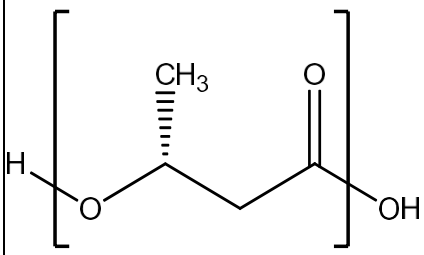
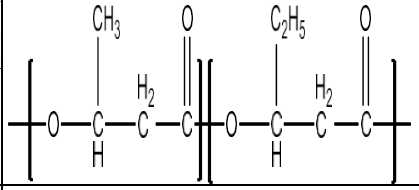
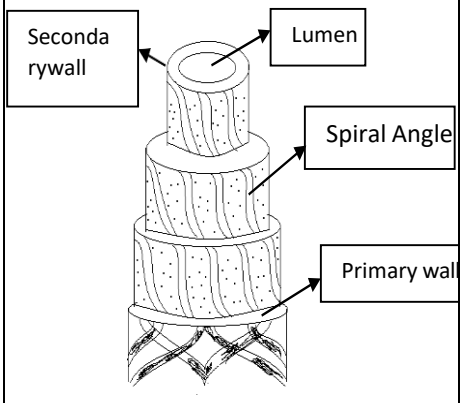
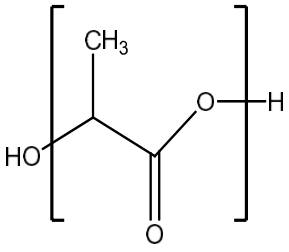
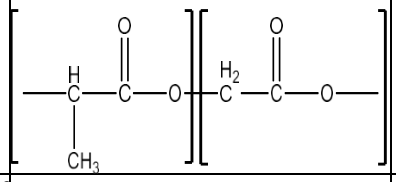
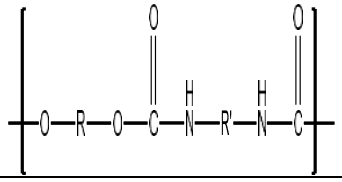
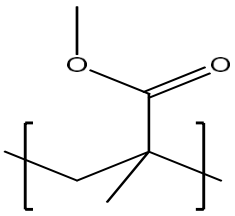
Nanomaterial	Role	Limitations	Structure	Melting point
Poly- β-hydroxybutyrate	Biodegradable effective, non-toxic, good physiochemical properties	Highly crystalline, low thermal stability		175 °C
poly (3-hydroxybutyrate-co- 3-hydroxyvalerate)	Easily biodegraded, non-toxic, biocompatible	Expensive, less thermal stable, brittle, difficult in processing.		153 °C
Biofiber	Cost effective, recyclable, less density, high mechanical properties, thermally stable	Hydrophilic, variability		165 – 195 °C

Table 3: Chemically Synthesized Polymers [10-11]

Nanomaterial	Role	Limitations	Structure	Melting point
PLA	Biocompatible, high mechanical property, non-Toxic.	Low toughness, easily degradable, hydrophobic,		130-180 °C

PLGA	Controlled biodegraded, biocompatibility	High cost, low stability		156.6 ± 0.2°C.
Polyurethane	Cost effective, rich source, high mechanical resistance	Low speed of degradation		56°C.
PMMA	Easily operable, high biocompatibility	Cytotoxic, easily oxidized		160°C

2. CANCER IMMUNOTHERAPY CYCLE AND Cis

Cancer immunotherapy is one of the promising approaches in the clinical practice to eradicate cancerous cells at primary stage. In comparison to radiotherapy, chemotherapy orthe surgery, immunotherapy shows one of the advantages in anti-tumour response and also reduces metastasis [18]. Till now around 3000 immunotherapeutic drugs have been approved by USFDA. Cancer vaccine regulates dendritic cells, immune checkpoint blockade which strengthens the T cells by blocking activity of tumour microenvironment (TME) [19].

Advantages in cancer immunotherapy are:
It results in superior therapeutic effects which potentiate patient's immune system. Generates memory T- cells, B-cells which cause long lasting immune memory. Its universal application is it overcomes the limitations of conventional cancertherapies.

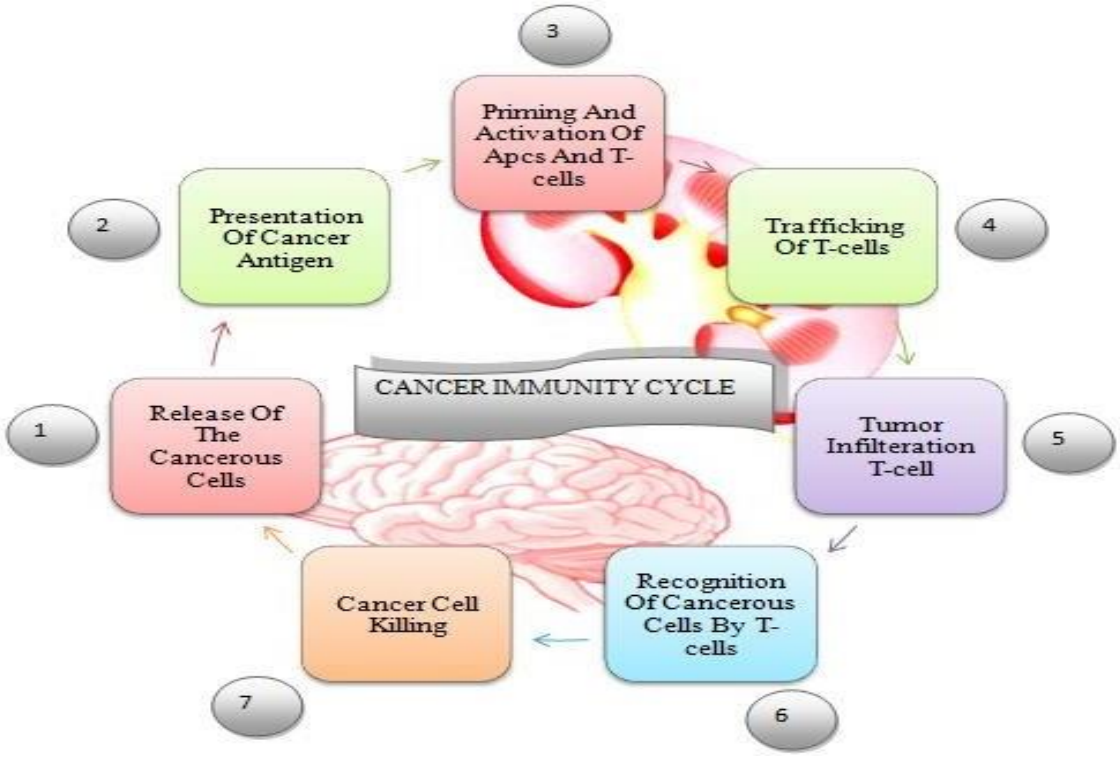
The **limitations** in cancer immunotherapy are:
Low reaction rate restricts the adequacy of immunotherapy. Systemic administration prompts unavoidable irAEs, as dermatologic harmfulness, toxicity in gastrointestinal, pneumonitis and some uncommon adverse effect related to immunity. Clinical interpretation is another issue. Immune evasion is also one of the reasons which results in low antitumor response rate that activates immune system. Various mechanisms make the treatment ineffective such as the defective antigenpresentation [20]. The schematic illustration of the process of the Cancer immunity cycle (Mention in figure 4).This process was developed by Daniel Chen & Ira Mellman in 2013.
This process was developed by Daniel Chen & Ira Mellman in 2013.
This process involves basic 7 steps: They are:

1. The cancer immunity cycle starts with the condition in which the cancer cells are present. When this cancer cells die, they release their content. This is the 1st step in Cancer Immunity cycle i.e. Release of cancer antigen cell into the surrounding micro- environment.
2. These released antigens are then taken up by the antigen presenting cell such as dendritic cells, like

other antigens the dendritic cells passes the antigen and present them on their surface.

3. The dendritic cell then migrates to nearby lymphatic organ such as lymph node where they present the antigens to the T-cells. If a cytotoxic T-cell passes an antigen presenting dendritic cell that has correct T-cell receptor for antigen recognition. This results in binding to one another. The interaction between the T-cells and dendritic cell is guided by several positive and negative factors. The most important factor in activation is the connection between the T-cell receptor and antigen, which is presented by MHC Class II molecule. This induces the positive signal inside T-cells thereby activating it. An e.g. of negative modulator is the binding CD80/CD86 to CTLA-4. The connection between thesecreates the negative signals inside the T-cell, inhibiting activation. In simple terms if the positive signals exceed the negative signals, T-cell is activated and starts to multiply.
4. The T-cell tries to control body. They eventually reach the organ containing tumor. This is facilitated by cytokines directing T-cell especially if the information is present in the effective tissue.
5. Activated cytotoxic T-cell infiltrate the tumor.
6. With the receptors the T-cell recognizing antigens express on the surface of the cancer cells and bind to them i.e. recognition of the cancer cells.
7. This step involves the interaction between the cancer cell and the T-cell, which results in the killing of the cancer cells and signifies the completion of the single round of the cancer immunity cycle. Upon binding, the cytotoxic T-cells aims to induce apoptosis in the cancer cells, this interaction is regulated by the positive and the negative signals in the T-cell. The positive signal is the interaction between the T-cell receptor and the antigen bound to MHC Class I on the cancer cell. A negative signal is the link between the PD-1 receptor and its ligand PD-L1. The negative signal can prevent T-cell mediated killing of cancer cells which leaves the cancer immunity cycle uncompleted [21-22].

Figure 4: Cancer Immunotherapy Cycle [20-22]



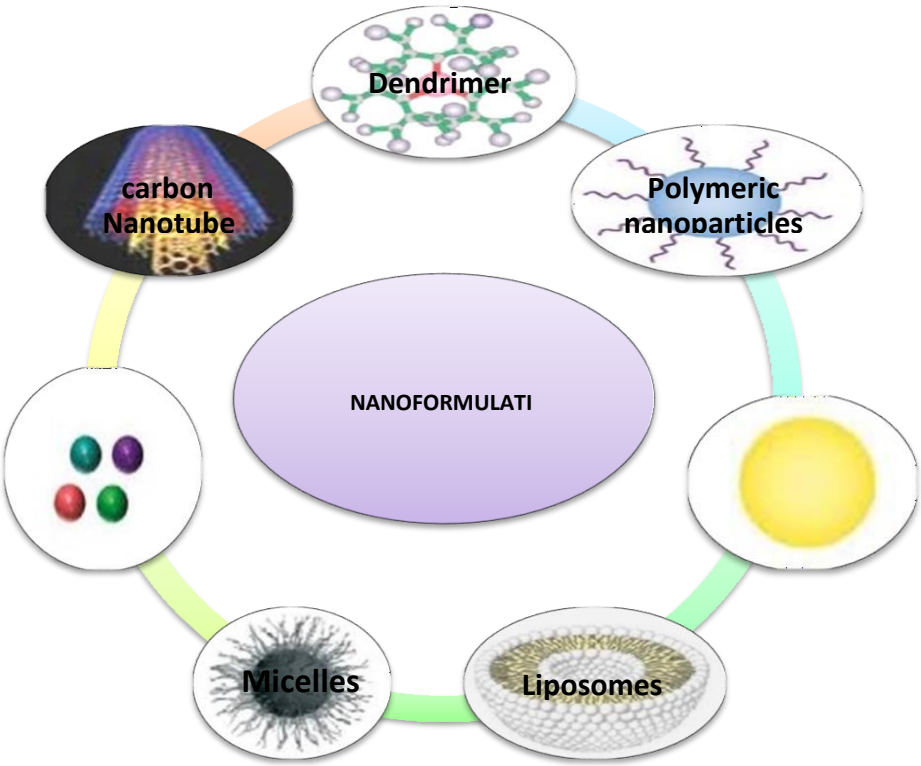
3. NANO FORMULATION EXPLORED IN CANCER IMMUNOTHERAPY

Nano formulation are defined as materials that have at least a dimension between 1 & 100nm, but practically they are usually from 1-200nm. In diagnosis and therapy of cancer there hasbeen tremendous success in this field. It is accepted that nanomaterial with a size 10- 200nm avoids kidney clearance while penetrating tumour tissues. Due to this reason, drugs that are loaded inside the nano formulation have long blood retention time and enhancement of tumour distribution and decreased toxicity that results in high tolerated dose. Nano formulation are easy to modify and the ligands pre-loaded on the surface helps Nano formulations taken up by specific cells. Nano formulation can be used for cancer vaccine design as well as in TME modulation (Mention in Table 4 & Figure 5) [21].

Table 4: Uses of Nano formulation in cancer vaccine and TME [21]

Nano formulation for cancer vaccine design	Nano formulation TME modulation
Co-encapsulation	Immune checkpoints
Adjuvant effect	Soluble mediators
Lymph node drainage	Targeting TAMs
DC uptake	Targeting MDSCs
DC targeting	Targeting Tregs
Antigen presentation	Targeting TAFs
Peptide/DNA/mRNA/whole cell antigen	

Figure 5: Nano formulations used in treatment of cancer [21]



4. ENHANCEMENT OF IMMNOGENICITY

Immunogenic cell death of the tumor improves the identification of APCs, which results in autoimmunity. Thus, in order to get an effective response against tumor it is frequently needed to destroy tumor totally from ordinary medicines [23]. One of the most challenging factors in immunology is to induce the strong and continued adaptive response post- ordinary treatment for the destruction of the tumor cells and metastasis. Chemotherapy induced DNA often initiates STING and cGAS pathway, which results in increase immunogenicity. There are few chemotherapeutic agents that kill the cancerous cell and trigger ICD and results in activation of immunity. The immune responses are usually weak when chemotherapeutic drug is given alone and are counteracted by tumor inhibitory micro-environment [24-25].

Comparatively, a combined treatment of PTT and CpG results in the superior effect of the immune system, rather than giving PTT or immunotherapy alone. This combination of medicine with immunotherapy results in potential therapeutic effect against tumor.

Faisal et. al. report a phase III trial non-small cell lung cancers with less PDL1 illustrated that Pembrolizumab-Chemo drug shows the superior effect whereas alone chemotherapy and immunotherapy does not show such superior effect. This combination provides a model forthose patients who have less expression towards PD-L1.

In other phase III trial, when patient with metastatic triple negative breast cancer received antibody inhibition Atezolizumab + Albumin-bound-Paclitaxel results in enhancement of anti-cancer activity of Atezolizumab. This combination results in greater therapeutic effect in metastatic small lung cancer, metastatic gastroesophageal adenocarcinoma and metastatic melanoma [26].

4.1 Targeting Antigen Presenting Cells

On exposure of tumor-specific antigens, the next step is recognized by the APCs.\ to T cells in lymphatic organ to activate CTLs. DC plays a vital role in activating immune between humoral and cellular immunity. Upon recognizing tumor antigens by DC, it gets displayed on the surface of the cells by MHC. In lymph node, there occurs interaction between MHC and T cells via T-cell receptors. This interaction evokes a progression of T- cell mediated immune response. Nanocarriers not only exclusively convey adjuvant and antigen both to APCs and lymph, but it results in increasing the efficacy of uptake of DC and antigen presenting cell, as nanocarriers are also used as immunogenic or as vaccine to activate DC. For e.g.: polysaccharides, inorganic nanoparticles, liposomes, polymers etc. Wu C et. al. (2019) report that by integrating the Polydopamine-stabilized graphene quantum dots with poly-cationic polymer/CpG oligodeoxynucleotide immunoadjuvant is by dendritic cells activation. On laser irradiation, this complex results in highly capability of photothermal therapy. In return, this activated DCs forms more CD8+ cells which infiltrate into tumor and conquer the tumour growth. Another novel DCs activation was previously developed byin-situ gold nanoparticle in melanoma, where AU3+ ions where decreased to metallic nanoparticle by interaction with redox enzyme and carbohydrates of the cell membrane as well as cytoplasm. Thus, the in-vivo study has proved that the DCs stimulating based immunotherapy can successfully eradicate tumour or inhibits the tumour recurrence [27].

4.2 Targeting T-Cells

The subsequent steps in cancer immunity cycle are summed up as follows:

APC present MHC antigen and immunogenicity sign to T-cell. This T-cell separates into CD8+ CTLs. Hence, the effector CD8+ T-cells relocate to the tumor site, where they applytheir antitumor impact. On the one hand, CD8+ T-cell recognize the antigens present on MHC I molecule and kills them. On the other hand, the cytokines (IFN-γ, TNF-α, IL-2) which are secreted by CD8+ recruit more immunogenic cell towards tumor site. Another important effector T-cell ie. CD4+, maintains the CD8+ activity by producing cytokines. At the point when tumor executing action is close to an end, the CD8+ T cell are immediately consumed, and less proportion of T cell differentiate into memory T-cell to prevent the re-irruption of cancer cell [28-32].

Wilson DS et. al (2017). report that CAR-T cell therapy increases the proportion of CD8+ T cells by activating and increasing T cells in-vitro and infusing them back to patient's body. These T cells can actively target specific tissue and achieve success in malignant cancers. Thus, this T cell manufacturing

process is lengthy, high costly and low response rate of immune. Nanomaterials can be used to activate DCs to shorten them and thus signifies the processof amplification. Chemically, TCR stimulation and co-stimulatory signals bind to the material surface of DCs. For e.g. a plan was presented to stimulate ACT T-cells by ACT- target PEGylated liposomes using fragments against antigens or cytokinin II molecule.

Other study showed that a synthetic DNA nanoparticle method by circulating T-cell with tumour, thus results in time consuming process, and low response rate. The Nanomaterials loads cytokines and controls their release to maintain T cell and promote their proliferation. The cytokine interleukin-2 was encapsulated by biodegradable PLGA, which gets conjugated by avidin palmitate through emulsion technique to promote the presentation of avidin on particle surface. This shell nanoparticle gets attached by anti- CD3, antiCD28, and peptide MHC complex [33].

5. NANO FORMULATIONS FOR CANCER IMMUNOTHERAPY AND ROLE OF POLYMERS

Nanotechnology is a vast branch and is broadly used to improve the efficiency of chemotherapy. Nano formulations of various drugs show advantages in therapeutic windows. Firstly, the increase in size of the nano formulations does not allow quick elimination. A nanoparticle enhances the accumulation of the drug within tumor by passiveand active targeting. Nanoparticles target the cancerous cells by either ligand or receptor and binds to the cell surface that has tumor cells. As conventional medicines targets cancer cells, the nanomedicines not only target cancerous cell but also lymphocytes or APCs in lymphatic tissue and blood. The nanoparticles that carries T cells, concentrate drug in tumors more as compared to nanoparticles alone, which results in more efficiency of the anti-cancer drug to tumor using nanoparticles [34].

Various natural-based nano formulations can be used to treat cancer such as Chitosan, Hyaluronic Acid-based nanoparticle, Alginate based nanoparticles, Dextran-based nanoparticles, Albumin based nanoparticles, Gelatin based nanoparticles. Other natural ingredients are: Polymeric gel, Polymeric micelles, Liposomes, Cell membrane-based drug delivery system, Cyclodextrin Inclusion Complex [35].

In comparison to conventional medicine, natural material-based drug delivery shows beneficial result. It offers high benefit such as biocompatible, biodegradable, non-toxic. There are various natural polymers that have different electronic charge, which is associated with the encapsulation of therapeutic agents. The electronic charge can be adjusted by polyamines with various natural materials.

Mechanical properties focusing on capacity and medication discharge way can likewise be constrained by adjusting the structure of common materials with polyamines and focusing on ligands.

There may be some biological issues, but apart from that there may be few challenges as well. It is not easy to scale up the industrial production to laboratory. This production requires equipment's and that may be costly. The stability of nanoparticles is also one of thebiggest concerns. Sometimes, the result of in-vivo and in-vitro may also result in contraindications. On evaluating the therapeutic efficacy, there is a wide difference between the patient and animal model, and so complete testing and evaluations in needed [36-37].

6. APPLICATION

Application of nanoparticle mention in below figure 6. In all this Surgery is one of the oldest methods for treating cancer. Initially, it was very crucial but as time passed, radiotherapy, chemotherapy, immunotherapy has played a tremendous role in the treatment of cancer. The current progress on surgical is such that the evaluation of disease extent using latest studies on imaging, less invasive surgery, short hospital stay andfast recovery rate. To prevent the tissue damage many surgeons are resort to robotic and image guided surgery. Recently, nanotechnology plays important role in treatment. The main contribution is nano endoscopy, real time tumor imaging, lymphatic mapping and use of nanotechnological based equipment's or instruments. It is expected in future, that combination of radiation therapy and chemotherapy can increase the effect [37-39].

There are numerous studies on animal model that gives a new concept of incorporation in

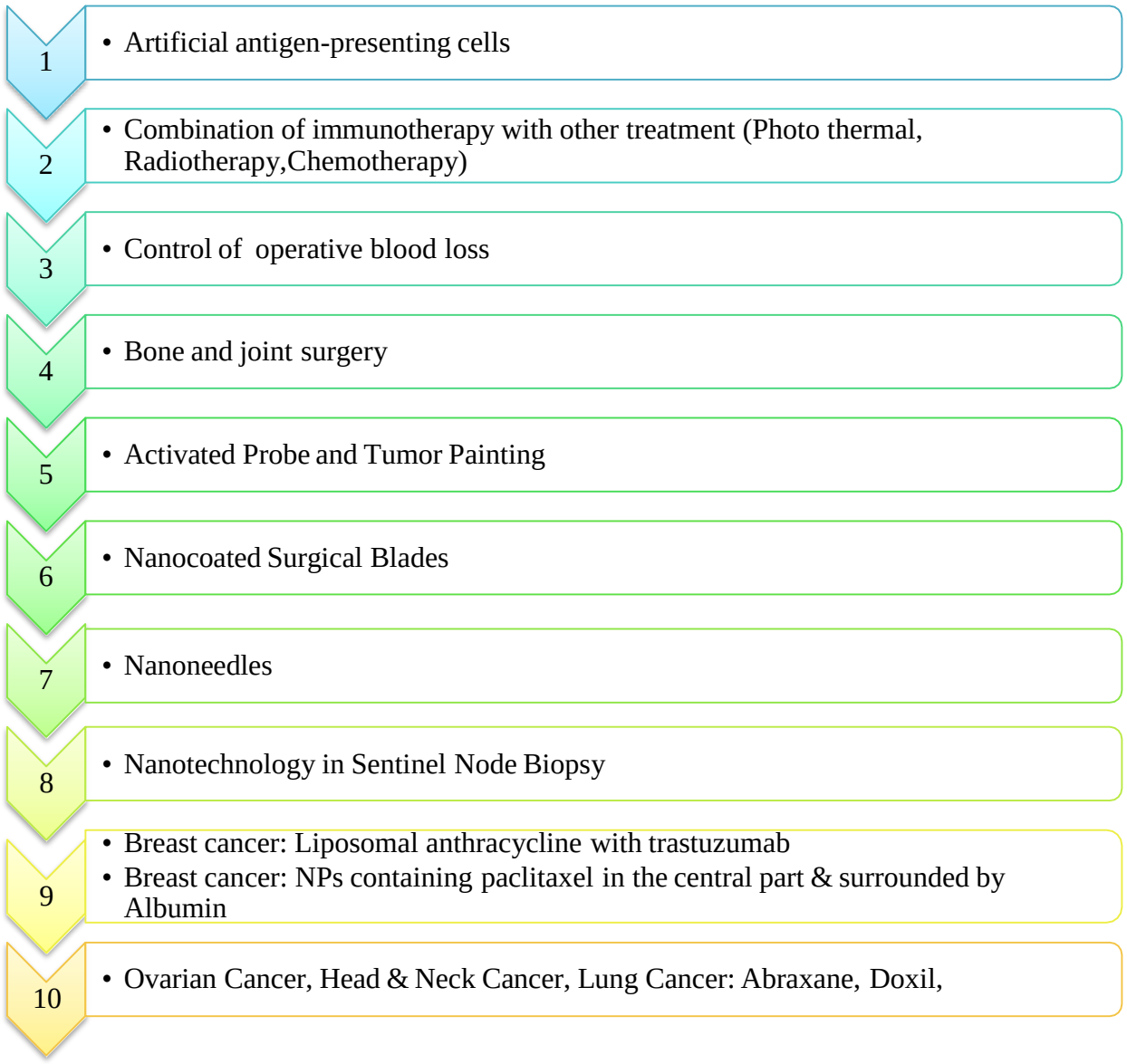
nanotechnology in surgery. Infrared Quantum dots nanoparticles are injected to skin of animals having cancer foe early localization. The same study is extrapolated to other lymphatic regions of body. In colorectal cancer, nanotechnology is used in cancer imaging by guanylyl cyclase C (GCC) in intestinal mucosa [40].

Nanoparticles can also apply in diagnosis and treatment of brain tumor. The only limitation involves is of blood brain barrier (BBB). Water, carbon dioxide, oxygen and fat-soluble substance such as alcohol can easily penetrate BBB. The main treatment involves is invasive operations, physiological approaches, and drug treatments. Researchers use drugs and physiological methods to increase the treatment efficiency of brain tumor. Those limitations mentioned above can be overcome by nanoparticle treatment. The first nanoparticles which were used were a type of Fe_3O_4, known as monocrystalline Fe_3O_4.

Gold, organics, polymers, liposomes, dendrimers and hydrogels can also be used as a nanoparticle for treatment of cancer.

In comparison with theragnostic Nanoparticles, Quantum dots, Fe_2O_3, Au and polymers have higher success in treatment comparatively [41-42].

Figure 6: Applications of Nanotechnology [37-39]



6.1 Polymers and their role in Vaccines for Cancer Immunotherapy

Cancer vaccine refers to either vaccine given to patient to prevent cancer or to a therapeutic vaccine given to eradicate tumor existing. For e.g., Gardasil® and Cervarix® is used to prevent cervical cancer, while Sipuleucel-T is used as a therapeutic vaccine for metastatic prostate cancer. A vaccine consists of tumor antigen and an adjuvant capable of producing immune response. Adjuvants stimulates the maturation of DCs. DCs then presents tumor antigens from vaccine on MHC surface molecules and stimulates anti- cancer T cell response.
Tumor antigens may be classified as tumor associated antigens (TAA) or tumor specific antigens (TSA) or can be expressed as proteins known as cancer-testis antigens (CTA).
TAAs are proteins that are expressed at high level in tumor cell as compared to normal cells.
TSAs are expressed by tumor cells. Non-cancerous cells lack the genetic materials that reduce off-target effects. These antigens arise from somatic mutations and evade immunological tolerance.
CTAs is the group of protein that are expressed in fetal ovaries, but may also be expressed in several types of the cancers. CTAs are also attractive substrates for cancer vaccine design [43].

6.2 Oncolytic Virus Therapy

Oncolytic infection treatment depends on specific disease and replication of hereditarily designed infectious inside malignancy cells, prompting immunogenic disease cell death.
After getting exposure to disease, these oncolytic infections can make malignant cells burst by killing the cancerous cells and delivering malignant antigens. These antigens results in stimulation of the immune and eliminates the remaining cancerous cells and possibly anywhere else in the body [44-46].
Clinical trials are been carried out in combination with other therapies i.e. immune checkpoint inhibitors or chemotherapy.
Results may differ as per the kind of oncolytic infection, what it targets and can also be influenced by the location as well as patients health. Sometimes, the oncolytic cells attacksthe normal cells of the body and results in risk for infection.
Other side effects may include: Fatigue, Flu, pain, nausea, vomiting and fever [47-48].

6.3 Monoclonal Antibodies

Monoclonal antibodies were developed by hybridoma technique in 1975. The characteristic of mAbs are antibody-dependent cellular cytotoxicity, antibody dependent cell phagocytosis. mAbs are used in 3 ways:

1. mAbs mark the cancer cells by which they are easily identified and destroys the immune system.
2. It can inhibit the action of the abnormal protein towards cancers.
3. The antibodies release the mechanism of immune system, which kills the cancerous cells [47].

6.4 Adoptive T cell Therapy

This therapy is one of the promising approaches in cancer immunotherapy which provides anti-tumor properties to eliminate tumor cells. In this, firstly the lymphocytes are stimulated, and then activated by T cells into patients. For adoptive therapy, large number of T cells is utilized that benefit from the combination of antibody to TCR. The most effective therapy involves Adoptive cell therapy using autologous TILs with anti-tumor activity [50-51].

6.5 Tumor-Infiltrating Lymphocytes (TIL) Therapy

The killer T cells are powerful immune cells and have the ability to recognize and eliminate the cancerous cells. For the effectiveness of the T cell, they have to be firstly been activated and so they can effectively kill the cancerous cells and can able to maintain their activity for a longer time.
This therapy firstly eliminates the T cells that have been placed in patient's tumor and thenactivate them, thereafter expands them. Thus, large numbers of T cells are infused in patient and then the cancerous cell gets destroy.

6.6 Engineered T cell Receptor (TCR) Therapy

Not all the patients T cell are being recognized by the tumors, for those patients TCR therapy is been approached. In this approach, the T cell are taken up from the patient, instead of activating and expanding them, it is been equipped with new T cell which targets and kills the cancerous cells

6.7 Chimeric Antigen Receptor (CAR) Therapy

To overcome the limitation of TIL & TCR, which targets and eliminate the cancerous cells, scientists have equipped T cell of patient with synthetic receptor known as CAR i.e. chimeric antigen receptor. The main advantage of CARs is even if the antigens are not present on the surface, they bind with cancer cells. As CAR T cell recognize antigens that are expressed on the surface of the cells, so antigen targets is lesser than with TCRs.

6.8 Natural killer (NK) cell Therapy

NK cells have the ability to detect as well as destroy the transformed cell by release of cytotoxic granules. This therapy shows better outcomes in cell lung cancer, gastric, colorectal carcinoma and melanoma associated with NK cell infiltration. NK cells has one application being investigated in the centre includes furnishing NK cells with disease focusing on CARs [52-53].
Different advantages and Limitation of polymers are mention in table 5.

Table 5: Advantages & Drawbacks [54-55]

CONTENT	ADVANTAGES	LIMITATIONS
Solid-Liquid Nanoparticles	Good solubility, bioavailability, control of drug release	Low drug loading capacity, contains colloids and has complex physical state
Liposomes	Wide range, increase drug load& minimize undesired activity of drug, low toxicity	Rapid degradation, requires special storage condition, limited permeation to skin
Polymeric	Versatile	Degradable
Magnetic Nanoparticles	Influenced by external magnetic field	Potential material toxicity
Quantum Dots	Fluorescent property	Potential material toxicity
Carbon Nanotubes	Able to penetrate and localize at cellular level for the delivery of chemotherapeutic agent	Potential material toxicity
Polymeric Nanoparticles	Controlled and sustained drug release, reproducible data are produced, highly stable	Scale-up difficulty, toxicological assessment is insufficient
Polymeric Micelles	Highly soluble for lipophilic drugs, controlled drug release	Only used for lipophilic drug, Low drug loading capacity

Dendrimers	Highly soluble for lipophilic drugs, multiple functional groupfor target drug delivery, solubility enhancers	Not good candidate for hydrophilic drug, cellular toxicity, costly
Lipid based Nanocarriers	Large scale production, less toxic, low cost	Low drug loading for SLNs

7. REGULATORY CHALLENGES FOR POLYMERS USED IN CANCER IMMUNOTHERAPY

Throughout the most recent years, nanomedicines have been effectively presented in the clinical practice and the persistent advancement in drug research is making more advanced ones which are entering in the facility preliminaries. In European Union, nanomedicines market is created by nanoparticle, liposomes, nanocrystals, nano emulsions, polymeric- protein forms, and nanocomplexes [56].

Nanomedicines were presented under the conventional structure of the benefit/risk ratio. Another challenge is evaluation of the follow-on nanomedicines at the time of patent expiration of the reference medicine [57].

Specific challenges are getting clear in two distinct areas. To start with, corresponding to the evaluation of those follow-on nanomedicines items presently starting to emerge as first-generation product come off patent. Such products are portrayed as 'comparative nanomedicine' (nano similar). These are new nanomedicines that are professed to be 'similar' to reference nanomedicine that has been permitted a marketing authorization license. To demonstrate similarity, there is a need of comparability study in relation to quality, safety, and efficacy of nano similar product and chosen reference nanomedicine. As nanomedicine contrast fundamentally in their complexity and nature, there might be necessity of product class specific approach. Before granting the permission, the drug development must be comparable with reference patented drug in terms of quality, safety, and efficacy. Given the degree of multifaceted nature of numerous nanomedicines products,uncommon logical contemplations might be expected to guarantee the equivalence of performance [58].

To introduce the generic in market, several parameters are to be involved. A complete analysis is needed for biological and non-biological, nanomedicines that goes far off concentration of plasma concentration. A comparison of bioequivalence, quality, safety, and efficacy with respect to reference medicine, leads to therapeutic equivalence and correspondence interchangeability is also required [59]. Different drugs approved by FDA in immunotherapy was mention in table 6.

The ongoing advances in nanoscience are bringing novel opportunities to ace issue at nanoscale sizes and this is prompting the formation of considerably more unpredictable, crossover structures by both new top-down fabrication and base up assembling strategies.

This is preparing for an influx of new pharmaceutical, imaging agents and combinational products that require the regulatory approval prior to approval of market authorization. Individual nanomedicines present challenge during development and regulatory evaluations. Robust methodology is to ensure long benefit-risk ratio and to ensure product characterization and manufacturing control specific tools are required.

Table 6: FDA Approved Immunotherapeutic Drugs [44, 60-62]

Sr. No.	Drug	Target	Patent No.	FDA approval	Antibody Class
1	Nivolumab	PD-1	US7595048	2014	IgG4
2	Ipilimumab	CTLA4	US10196445	2011	IgG1

3	Pembrolizumab	PD-1	US8952136	2014	IgG4
4	Avelumab	PD-L1	US2014341917	2017	IgG1
5	Atezolizumab	PD-L1	US8217149	2016	IgG1
6	Durvaluamb	PD-L1	US8779108	2017	IgG1
7	Spartalizumab	PD-1	US9683048B2	2009	IgG4K
8	Cemiplimab	PD-1	US20150203579	2018	IgG4
9	Camrelizumab	PD-1	US20160376367A1	2019	IgG4
10	Tislelizumab	PD-1	US8735553B1	2017	IgG4
11	Dostarlimab	PD-1	US9815897B2	-	IgG4
12	MEDI-0680	PD-1	US8609089B2	-	IgG4
13	SSI-361	PD-1	US20180346569A1	-	IgG4
14	AMP-224	PD-1	US20130017199	2014	PD-L2 IgG2a fusion protein
15	CX-072	PD-L1	US20160311903A1	-	Protease activable prodrug
16	BMS-936559	PD-L1	US7943743	2015	IgG4
17	KN035	PD-L1	US20180327494A1	-	Fusion proteinssof humanized anti-PD-L1 single domain antibody and human IgG1

Specific security issues identifying with novel Nanomaterials have been generally audited. Definition of nanomedicine safety is unmistaken from the more extensive issues identifying with nanomaterial toxicology as the product is intended for use at particular dose, with frequency of administration and in context of patient population. Environmentalimpact, safety and efficacy must be established. It is important to determine pharmacokinetic and Pharmacodynamic profile of nanomedicine. In determining safety and efficacy, the nature and stability of nanomedicine product is essential. Non-clinical studies of nanomedicines with respect to acute and long-term safety can be challenging. The proportion determining for the selection of dose administration is used to assess long term safety in clinical studies and during development [63].

EMA have released papers regarding nanomedicines. These papers are applied to nanomedicines and nano similar to provide guidance in marketing authorization application. They mainly outline issues

related to complexity and provides basic information on development of pharmaceutical, clinical and non-clinical studies.

In order to assess need for regulatory requirements for evaluation of nanomedicine, in 2006, the European Medicines Agency (EMA) created- Nanomedicine Expert Group. It was the further expanded by establishment of International Regulators Subgroup, an initiative launched jointly by medical regulatory agency of EU, USA, Japan and Canada. Experts were gathered from various countries and attended the workshop which was held in London in Sept 2010. More than 200 participants have attended. The main aim of the workshop was to share global experience, review of the existing and emerging nanomedicines, and discuss particular issues related to nanomedicines [64-65].

8. Future Trends

Recent studies have shown a new modification in nanomaterial-based modulation of immune cells. Nanomaterials are used mainly because they overcome poor solubility, low selectivity, as well as high toxicity of drugs [66]. Various nanomaterial such as lipid-based nanoparticles, polymers nano formulations and inorganic nanoparticles are formed as carriers. There may be many issues, but safety is the first concern. It is important to study toxicity data that should be performed for both long and short terms. The modulation of immune cells evokes toxicity due to interaction between drug loaded with nanomaterial and immune cells. Future studies should also include the direct targeting of nanomaterial with immune cells. Most of the studies have used tumor inhibition as major end point of cell-targeted Nanomaterials. There is usually the lack of known ligand molecules that are used to differentiate immune cells of normal tissues and tumor tissues. Further study is needed to identify specific ligand molecules or biomarkers and other immune cells [67].

Another issue is related to time for evaluating efficacy of immunotherapy in models. Unlike conventional therapy, immunotherapy requires greater time for study of clinical data due to delay activity of immune system. After several months from start of treatment,a benefit to immunotherapy can be observed. Tumor model should be selected carefully. As each tumor have different type of characteristic cell profile. It is shown in clinical data that the combined application of CTLA-4 & PD-1 that affects two different immune checkpoints, could improve the overall survival of melanoma patients. Many studies have utilized combinational strategies involved in checkpoint inhibitors and therapeutic drug- loaded nanocarrier. These combinational treatments have shown a synergistic outcome of immunotherapy on models of metastasis. For the enhanced clinical outcome, the nanomaterial based immune cells might be combined with immune checkpoint therapy [68-69].

9. Conclusion

This review focuses mainly on the polymer used in cancer immunotherapy. It also focuses on the recent trends and future perspectives of the polymers used. This review highlights different types of polymers explored for making nanoparticles intended for cancer immunotherapy. This review highlights vaccines used for cancer immunotherapy, preparedfrom the polymers. In recent advances, it is shown than combination therapy shows greatereffect as compared to alone therapy. Nanoparticles are mainly used in immunotherapy as they are highly stable, less toxic and provide good biocompatibility and bioavailability. As compared to conventional drug, nanoparticles have better pharmacokinetic and Pharmacodynamic action as well as biocompatibility and stability. These nanoparticles are applied widely to chemotherapy, radiotherapy, gene therapy. Nano vaccines and artificial APCs have results in increased efficacy as compared to conventional treatment.

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